

KW 18 : Learning & Memory

Psychology 465 - Human Neuropsychology - Spring 2014

Monday, April 21, 14

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Overview of Learning & Memory

- Short History of Learning & Amnesia
- Taxonomy of Memory Systems
- Patient “HM” & “KC”
- Long Term Memory Systems
 - Explicit
 - Implicit
 - Emotional Memory
- Short Term Memory
- Uncommon minds: Asperger’s and Savantism

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History of Memory & Amnesia

- 1880s - Ebbinghaus - first formal studies of human memory
- 1900s - autopsies of brains with severe memory impairment
 - often showed medial temporal cortex atrophy
- 1916 - Karl Lashley - lesion studies in animals - behavioral measures (e.g. maze pathfinding)
 - unable to find specific site of “memory”, but more damage = more memory loss
 - “not possible to demonstrate the isolated localization of a memory trace...”
- (N.B: this may be why the result of HM’s surgery were a surprise)
- 1950s - HM and other patients

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Case History: “HM” (Henry Molaison)

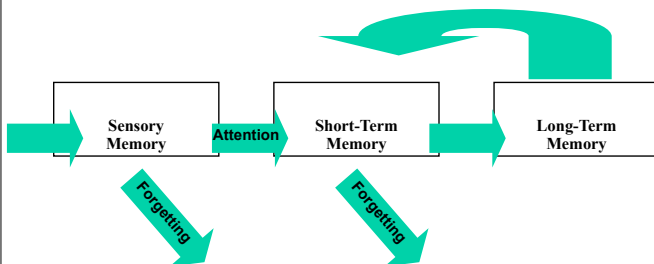
- HM : 27 year old male with long history of epilepsy (worsening frequency & severity), post 7 year old bike accident
- Surgery: experimental, removed medial-temporal-lobe
- Results:
 - normal memory for life prior to surgery
 - above average IQ (118)
 - almost zero ability to learn new conscious information
 - after working 6 months at a new job, unable to recall a single detail, though he did learn to navigate within 2 blocks new home (8 yrs)
 - skill learning : preserved
 - emotional changes (reduced prosody & sensitivity to emotional stimuli)

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3 Memory Systems

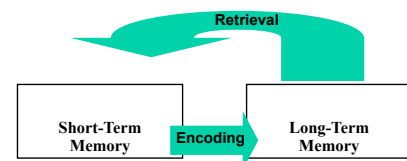


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Encoding and Retrieval



- **Encoding:** Getting info into LTM
- **Retrieval:** Getting info out of LTM
- Which is important for good memory?

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Explicit Versus Implicit Memory

- Explicit (Declarative):
 - Knowledge that can be retrieved and then reflected on consciously.
- Implicit (Nondeclarative):
 - Knowledge that can influence thought and behavior without any necessary involvement of conscious awareness.

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Taxonomy of Human Memory Systems

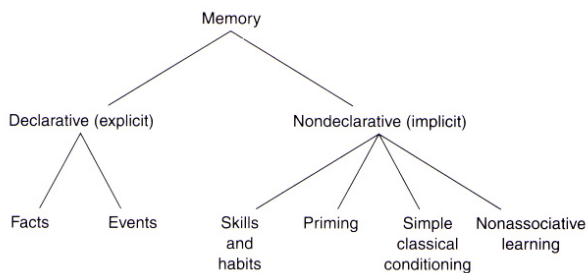
- Short Term Memory
 - sensory, cognitive, motor
- Long Term Memory
 - Explicit (conscious)
 - Episodic (events)
 - personal, autobiographical
 - Semantic (facts)
 - general knowledge
 - Implicit (unconscious)
 - skills, habits, priming, conditioning
 - Emotional (conscious & unconscious)
 - attraction, avoidance, fear

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Squire's Taxonomy of Long-Term Memories



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Amnesia Definitions

- Causes
 - Infantile Amnesia
 - Fugue State
 - Transient Global Amnesia
 - Delirium, intoxication, drugs or ECT
- Kinds of Amnesia

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Infantile Amnesia

- Infantile amnesia - lack of episodic memory for first few years of life
 - birth to 2.5 years: very few true memories
 - most "memories" are incorrect
 - 2.5 to 10 years : true memories mixed with false memories
 - 10+ years : memories are more adult-like
- Freud: due to trauma
- Modern thinking : memory systems undeveloped

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Psychogenic Amnesia (soap opera amnesia)

- Uncommon
- Sudden onset following physical or psychological stress
- Most commonly, personal information is forgotten
 - Sometimes the patient is unable to recall anything about his or her past
- During memory loss cognitive skills are intact
- Recovery is usually complete within 48 hours
- Fugue State

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Transient Global Amnesia

- Transient Global Amnesia
 - acute state
 - loss of old memories
 - inability to form new ones
- Causes?
 - concussion, migraine, hypoglycemia, epilepsy, stroke

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Other causes

- Delirium, intoxication, drugs or ECT

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Episodic Versus Semantic Memory

- Episodic (Events):
 - Autobiographical memory-- stores personally experienced events -- "What house did you grow up in?"
- Semantic (Facts):
 - Stores general world knowledge : concepts and categories -- "What is a house?"

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Amnesia

- Permanent loss of memory or memory abilities due to brain damage or disease
- Affects conscious (explicit) episodic memory
 - STM intact
 - Semantic memory intact
 - Implicit memory intact: Skill learning, Word-stem completion, Repetition priming

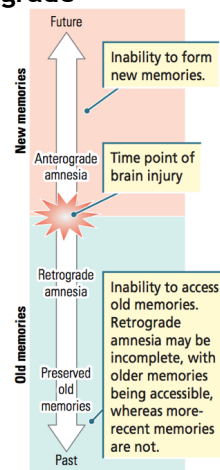
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Anterograde vs. Retrograde

- Anterograde: Loss of memory for events after the injury
 - Caused by damage to the hippocampus and temporal lobes
 - Mechanism: Failure of Learning or Retrieval?
- Retrograde: Loss of memory for events before the injury
 - Most common with neural degenerative disorders (e.g., Alzheimer's)
 - often temporally-graded)
 - Mechanism: Failure of Learning, or Retrieval?



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Dissociation of Episodic and Semantic Memory

- Dissociation: A disruption in one cognitive process but no impairment of another.
- Double Dissociation: Finding reciprocal patterns of disruption-- In one patient, A is disrupted by brain damage but B is not.
- In a second patient, B is disrupted but A is not.

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Examples of Dissociation

- Patient K.C.
Episodic memory processes disrupted, but semantic memory processes intact.
- Patient H.M.
Unable to transfer new information into LTM, but able to retrieve already stored memories from LTM.

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K.C. (Kent Cochrane)

- Widespread brain injury, especially frontal regions, in a motorcycle accident.
- Complete loss of episodic memory “he cannot remember...a single thing he has ever done or experienced in the past... from either before or after his accident”
- Can not “time travel” - (can not imagine future or past events or plans) - loss of “autonoetic consciousness”
- Episodic: Amnesia -- Anterograde? Retrograde?
- Semantic: normal.
- Confabulation? -- brother’s funeral was “very sad”
- b. 1951, d. March 2014

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H.M.

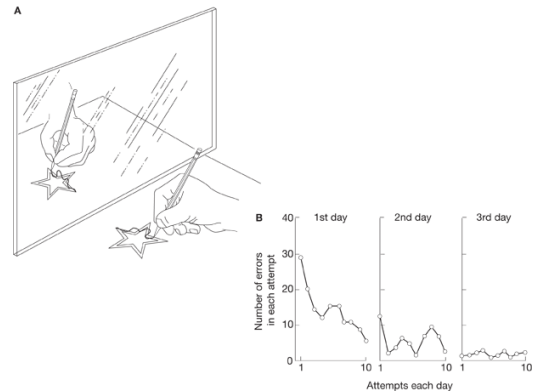
- Hippocampus removed on both sides (small, but important areas)
- Attention, STM and Retrieval of LTM for events before the surgery were intact
- IQ 118
- Complete Anterograde amnesia -- unable to learn from new episodic memories
- Implicit memory intact
 - Mirror-drawing performance improved, but zero memory of having practiced

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- A. In this test, the subject’s task is to trace between the two outlines of the star while viewing his or her hand in a mirror;
B. Patient H.M. shows clear improvement in motor learning star task, an instance of implicit learning and memory. After Blakemore (1977).



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H.M.

- Hippocampus is critical for transfer of explicit memories from STM to LTM
 - Gateway to LTM
 - Not a site of storage
- Amnesia is not due to injury of brain regions which process or store info

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Retrograde Amnesia & Consolidation

- Data
 - Patients with hippocampus damage show similar pattern
 - profound anterograde amnesia
 - moderate retrograde amnesia
 - time-dependent (aka “temporally graded”)
- Theory:
 - hippocampus temporarily holds memories and helps consolidate them (move them to the cortex for permanent storage)

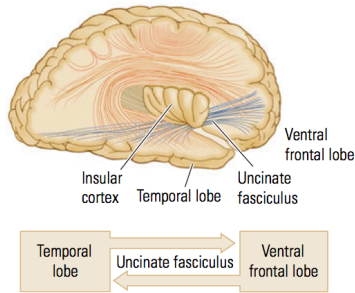
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Neurobiology of Episodic Memory

- Temporal Lobe and Ventral frontal lobe
- Connected via uncinate fasciculus



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Neurobiology of Explicit Memory

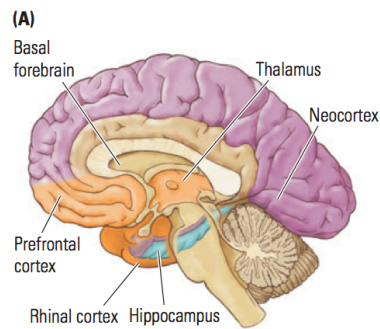
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Neural Substrates of Explicit Memory

- Prefrontal Cortex
- Temporal Lobe
- Medial Thalamus
- Rest of cortex
- Brainstem



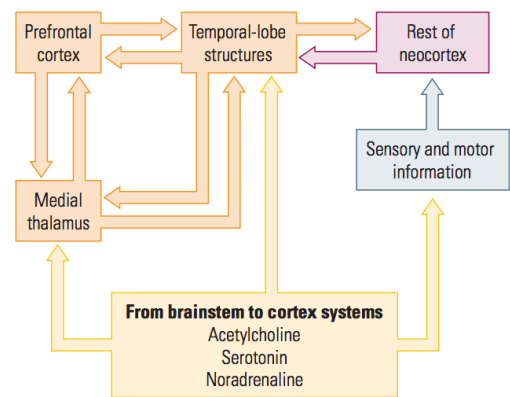
- Conclusions:
- Much of brain is involved

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Neural Substrates of Explicit Memory



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Explicit Memory : Focal Damage

- Focal damage to many areas can cause some form of explicit memory impairment
- Pattern of impairment follows pattern of damage
 - e.g. compare HM to KC

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Explicit Memory : Diffuse Damage

- Diffuse damage also can cause explicit memory impairments
- Examples
 - Herpes Simplex Encephalitis
 - brain infection due to herpesvirus
 - tends to cause retrograde, and anterograde amnesia
 - Alzheimer's Disease
 - loss of ACh projections to cortex
 - first anterograde, then retrograde amnesia
 - Korsakoff's Syndrome
 - alcoholism that induces severe thiamine (B1) deficiency
 - confabulation is a major symptom

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Neurobiology of Implicit Memory

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Priming : Implicit memory

- Priming is usually spared in Amnesia
- Examples:
 - Gollin Incomplete Figures Test...
 - Word-Stem Completion...

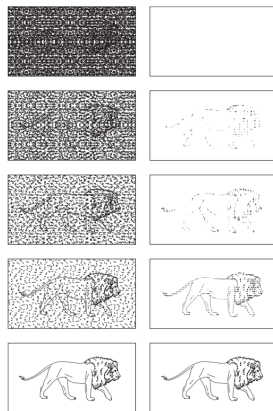
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Priming: Gollin Incomplete Figures Test

- Subjects see sequence of pictures to identify object
- On later repetition, reaction time & accuracy improve
- Effect independent of conscious (explicit) memory for test



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Priming: Word-Stem Completion

- Subjects see sequence of words to remember.
- Later asked to fill in the blanks
- Words previously seen more likely to be used
- Effect independent of conscious (explicit) memory for test

Test 1 - learn list
Table, box, carpet

Test 2 - fill in blank
TAB____
BO____
CAR____

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Case "JK" : Implicit Amnesia

- Can people have amnesia for Implicit memories?
- JK, b 1914, above average IQ, worked as engineer for 45 years. When in 70s Dx. Parkinson's disease.
- At 78 memory difficulties
 - difficulty recalling how to do common tasks:
 - turn on the lights
 - turn off the radio

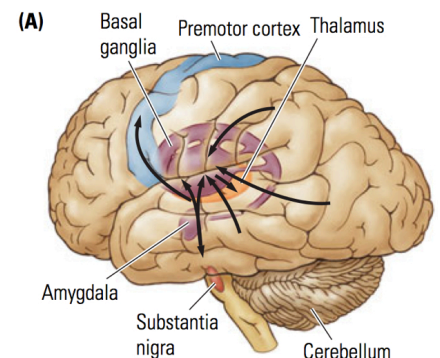
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Neural Substrates of Implicit Memory

- Basal Ganglia
- Ventral Thalamus
- Pre-motor Cortex
- Rest of cortex
- Substantia Nigra
- Cerebellum



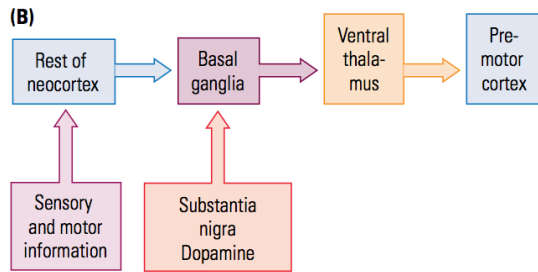
- Conclusions:
- Deep brain structures, associated with movement

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Neural Substrates of Implicit Memory



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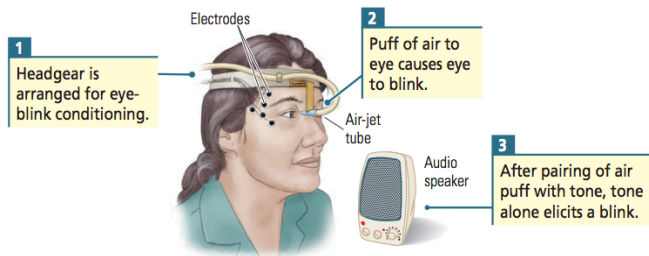
Neurobiology of Conditioning

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Cerebellum - classical conditioning



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Neurobiology of Emotional Memory

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Example : Fear conditioning

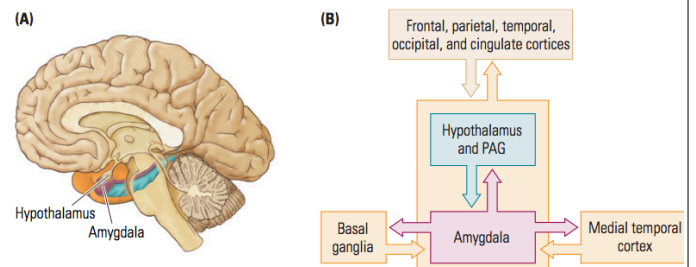
- Pairing of noxious or painful stimuli with neutral stimuli
- Establishes a conditioned “fear response”
- Example: Dr. Claparede had amnesic patient. Shook hands with a sharp pin in the hand. Eventually patient refused to shake Dr’s hand, but could not explain why

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Neural Substrates of Emotional Memory

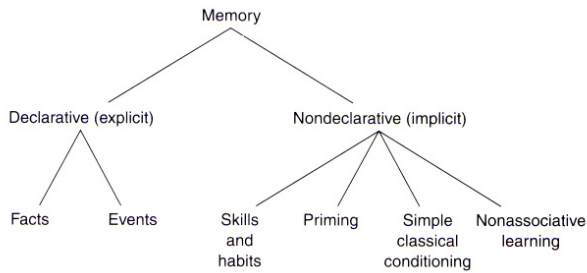


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Squire's Taxonomy of Long-Term Memories



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Neurobiology of Short Term Memory

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Short Term Memory patients

- Patient "KF"
 - Inability to repeat sequences of letters, words, digits, or sentences.
 - Long term recall : normal
- Luria reports two patients with impaired STM : one impaired for digits presented aurally but not visually, the other has the opposite pattern.

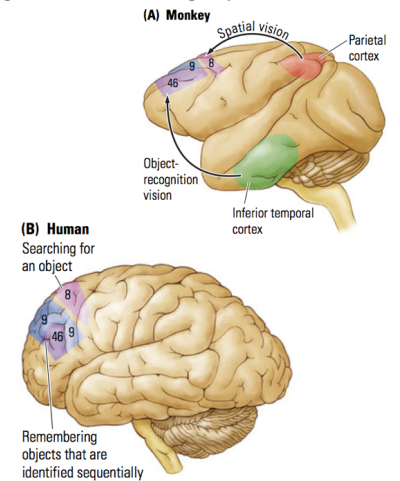
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Neural Substrates of STM

- Areas 8, 9, 46
- Other cortical areas
- Conclusions:
- Primarily frontal-lobe and connected areas
- Multiple systems for different sensory modalities



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Unusual Memory Abilities

- Savantism
 - Asperger's syndrome
 - Autism

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Case History "S"

- S : a newspaper reporter studied by Luria
- incredible episodic memory
- could report, verbatim, an entire meeting
- Table (on right) after 2-3 minutes, could repeat forward, backwards, diagonal, etc. He remembered it 16 years later
- Luria felt he suffered in other areas - he was dull, superficial, lacked abstract thought, couldn't understand poetry...

Table 18.1 Example of tables memorized by S.

6	6	8	0
5	4	3	2
1	6	8	4
7	9	3	5
4	2	3	7
3	8	9	1
1	0	0	2
3	4	5	1
2	7	6	8
1	9	2	6
2	9	6	7
5	5	2	0
x	0	1	x

Note: With only 2 to 3 minutes' study of such a table, S. was able to reproduce it in reverse order, horizontally, or vertically and to reproduce the diagonals.

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Autism / Savantism

- Autism
 - spectrum of disorders characterized by impaired social interaction, restricted interests, obsessions, and repetitive behavior
 - Prevalence 1-2 out of 1000
 - Asperger's syndrome : an Autism-spectrum-disorder
- Savant Syndrome
 - One or more areas of mental brilliance or excellence.
 - About 50% are autistic, about 50% have developmental disorder, mental retardation, brain injury or disease
 - Very rare: perhaps 100 worldwide

Stephen Wiltshire

- Diagnosed autistic
 - mute until age 3
 - first words “paper” and “pencil”
 - full language developed by age 9
- Video
- Panorama