



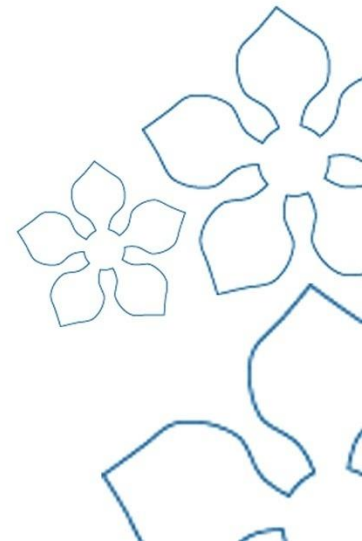
Cognitive Psychology

Long-Term Memory (LTM)

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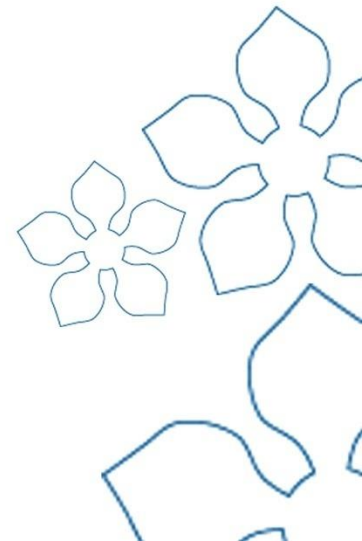


Essential Reading!!!!

- Eysenck, M. W., & Keane, M. T.
Cognitive psychology:
Chapters 6 and 7.



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LTM: Lecture Coverage

- Importance of LTM to general cognition
- Fragmentation of LTM (non-unitary?)
- Evidence for sub-types of LTM
- Encoding, storing & retrieving from LTM
- Structures vs Process accounts



Long-Term Memory

- Why is LTM an important topic?
- Possible to argue *central* to Psychology
 - What areas of Psychology related to memory?
 - Cognitive function
 - Social Psychology
 - The 'self'
 - Related subjects e.g. Counselling/Education



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Long-Term Memory

- Difficult to theorise a 'Psychology' that did not make reference to 'memory'
 - Holding of information
 - Use of that information in some way
 - What we mean by 'understanding' or 'knowledge'
 - Also partly related to concepts such as 'intelligence' or 'ability'.



Long-Term Memory

- What is held in LTM?
- Responsible for *all* info we could wish to retain/use
 - A very large amount of information
 - Reflects complexity of the world & our behaviour within it
 - Not just to remember a sequence of numbers!
 - Different *types* of information, e.g. Consider:
 - Year for Atkinson & Shiffrin publication?
 - Muscle movement to balance a bike
 - Memory for going to a concert or sports event



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Long-Term Memory

- LTM: made of separate memory systems due to fragmentation of different memory types:
 - Episodic v Semantic memory (Tulving, 1972)
 - **Episodic memory**: holds conscious recollection of an episode of encoding
 - E.g. Being at a concert/sports event
 - **Semantic memory**: knowledge for a fact without memory for an episode
 - E.g. Capital of France



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Long-Term Memory

- **Procedural memory:** Procedures and routines
 - E.g. Riding a bike, driving a car
 - (Cohen & Squire, 1980; Schacter et. al, 2000)
- **Autobiographical memory:** Includes memory for the events of one's own life.
- **Declarative memory:** knowing something is the case, involves conscious recollection and memory for facts (semantic) and events (episodic). Known as *Explicit memory*.
- **Non-declarative memory:** Influences behaviour but doesn't involve conscious recollection (procedural). Known as *Implicit memory*.

Long-Term Memory

- May be more obvious to depict LTM as a 'store' of information (of different forms)
- This seems to represent the 'structure'
 - Also have to remember not only a store (passive) but also active in terms of use
 - Accurate **retrieval** of information
 - Appropriate access and choice of information
 - Active in encoding (representing) and storing (organising) forms of information



Encoding → Storage → Retrieval

- Elaborate Rehearsal needed to pass information to LTM from STM (Craik & Lockhart, 1972).
- **Retrieval** a crucial process of memory function
- Information needs to be retrieved to be useful
- **Different** ways to access this information?
 - Imagine task of 'getting to the lecture' today
 - Remembering time of lecture
 - No external cue: **Recall** information from LTM
 - When you reach room & know location is correct
 - External cue present (see room): **Recognise** info.

Evidence for different LTM systems?

- Amnesia: Impairment of LTM due to brain damage:
 - Bilateral stroke
 - Closed head injury
- However: some memories retained, others impaired.
 - **Anterograde**: Inability to remember info **after** damage
 - **Retrograde**: Inability to remember info **prior** to damage
 - Patients have difficulty forming declarative memories but can readily form non-declarative memories.
- How could this be if there was only one LTM system?



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Famous Case Study

- **Patient H.M.** Underwent surgery to hippocampal area of brain to control severe epileptic seizures.
 - During surgery front half of both sides of hippocampus & amygdala removed.
 - After Surgery: Had normal STM span & memory for events before surgery were intact - suggesting normal STM & LTM function:
 - **HOWEVER:** unable to transfer new info in to LTM (Anterograde Amnesia).
- 

Episodic vs. Semantic memory:

Evidence from brain-damaged patients

- Spiers et al. (2001): 147 cases of amnesia with damage to hippocampus or fornix.
 - Episodic memory impaired in all cases
 - Less problems with semantic memory
- Vargha-Khadem et al. (1997): Two patients with bilateral hippocampal damage at age before semantic memory is developed.
 - Both had poor episodic memory but semantic memory within normal range.
 - Considered stronger evidence as semantic memory *intact*.



However:

- Gardiner et al. (2008): one of the patients did have semantic memory problems:
 - Rate of learning significantly slower than healthy controls.
 - Re-studying info suggested as explanation for original findings.
- Episodic memory depends on hippocampus
- Semantic memory depends on entorhinal, perirhinal, and parahippocampal cortices.
 - Damage to hippocampus and cortices likely leads to both episodic & semantic deficits (Vargha-Khadem et al., 1997)
 - Damage only to the hippocampus leads to greater deficits in episodic memory (Bindschaedler et al., 2011).



Episodic vs. Semantic memory: Evidence from Retrograde Amnesia

- Greater retrograde amnesia for episodic memory compared to semantic memory:
 - Bayley et al. (2006): retrograde amnesia for episodic memories spans several years.
 - Manns et al. (2003): retrograde amnesia for semantic memory is generally small.
 - Theory to explain retrograde amnesia:
 - **Consolidation:** “Long-lasting physiological consolidation of episodic memories in the hippocampus.”
 - “Fixes” information in LTM.
- 

Consolidation

- Hippocampus: crucial role in consolidating memories
 - Over time memories stored elsewhere, which protects them from hippocampal damage.
- Recently formed memories still being consolidated are vulnerable to interference and thus forgetting.
- Involves: A rapidly formed and relatively long-lasting increase that postsynaptic neurons in the hippocampus will fire in response to neurotransmitters released from presynaptic neurons.
 - New memories are clear but fragile and old ones are faded but robust (Wixted, 2004, p. 265).
 - Fits with findings of 'Forgetting Curve'.

Consolidation: Evidence

- Excessive alcohol drinkers suffer "blackout" and loss of memory: failure in consolidation.
 - Moulton et al. (2005): memory impairment in Ps who drank alcohol shortly **before** learning but alcohol consumption **after** learning led to improved memory.
 - Suggests alcohol may prevent the formation of new memories, which would interfere with consolidation.
- Jenkins and Dallenbach (1924): much less forgetting when Ps sleep between learning and test: due to a reduction in disruption in the consolidation process.
 - However, Hockey et al. (1972) found that the time of day was more important than whether participants slept.

Alternative theory

- Episodic memories become more like semantic memories over time? ***Semanticisation.***
- However: too much contradictory data from empirical research to support any of the main theories (Kopelman & Bright, 2012).
- Finally: episodic memories usually depend on a single learning experience, while semantic memory relies on several learning experiences.



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Episodic vs. Semantic memory:

Evidence from brain-damaged patients

- **Semantic Dementia:** Severe issues with semantic memory but relatively intact episodic memory.
 - Damage to anterior temporal lobes resulting in loss of info about meaning of words & concepts, but episodic memory reasonably intact.
 - Adlam et al. (2009): patients able to perform comparably well to healthy controls when asked what, where, & when they had performed tasks in a previous 24 hour period.
- **Double-dissociation:**
 - Amnesic patients: poor episodic but fairly intact semantic.
 - Semantic dementia: poor semantic but fairly intact episodic

Evidence from Amnesia

- Can be difficult to interpret memory impairments due to brain damaged patients displaying other cognitive deficits.
- Instead focus on patients with Korsakoff's syndrome:
 - amnesia due to chronic alcoholism.
 - However:
 1. Onset of amnesia is gradual
 2. Brain damage is widespread
 3. Area of brain damage varies among patients
 4. Non-direct assessment
 5. Brain plasticity & use of compensatory strategies can alter how patients perform on memory tasks (Fama et al., 2012)



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Evidence for separate LTM systems:

Procedural Memory

- Procedural Memory (also called skill learning):
 - E.g., Sequence learning, Mirror tracing.
 - Often intact in amnesiacs: e.g., H.M.
 - Evidence from serial-reaction time tasks (P must respond as quickly as possible to a target stimulus):
 - In amnesiacs, performance is typically intact.
 - Evidence from motor skill task: driving ability (Inc. steering, speed control, safety errors, driving with distraction) of 2 amnesiacs was comparable with those of healthy controls (Anderson et al., 2007).

Evaluation: Declarative vs. Procedural

- Cannot assume one task is only performed with the use of either declarative or non-declarative memory.
- E.g., weather prediction study: Ps use various cues to predict if it will be sunny/raining.
 - Reber et al. (1996): amnesiacs did just as well as controls
 - Suggests the task involves procedural memory.
 - Foerde et al. (2006): Ps performed task either on its own or with a secondary task
 - Single task condition associated with medial temporal lobe activity (declarative memory), dual-task condition associated with activity in the striatum (non-declarative memory).
 - Schwabe & Wolf (2012): Non-stressed Ps relied on declarative memory (hippocampus), stressed Ps relied on non-declarative memory (striatum).

What does this tell us...

- The specifics of the task can lead to the involvement of either the declarative or non-declarative memory system depending on:
 - Conditions of the task (single vs. dual)
 - Characteristics of participant (stressed vs. not-stressed).
- Possibly an interaction between the systems?
- Evidence suggests skill learning also involves the hippocampus (Albouy et al., 2013).
- Functional connection between implicit & explicit memory (Robertson, 2012).

Implicit vs. Explicit distinction?

- Based on conscious access to stored info.
 - Assumes systems involving conscious access rely on hippocampus while systems not involving conscious access do not.
- However, increase in inconsistent findings has led to alternative theories being developed.
- Tasks designed to only examine one of the systems (either explicit or implicit) may not always be successful in their endeavours.
 - E.g., Word-stem completion tasks (Mace, 2003).

Alternative accounts:

- Distinction between implicit and explicit memory is based on consciousness and awareness
- But neither are understood.
- **Henke (2010)**: rejects consciousness as criteria for distinguishing between memory systems.
 - Instead: systems should be identified on the type of ***processing*** involved – she proposed 3 basic modes:
 1. Rapid encoding of flexible associations: involves episodic memory & involves the hippocampus.
 2. Slow encoding of rigid associations: involves procedural & semantic memory and involves the basal ganglia.
 3. Rapid encoding of single/unitised items: involves familiarity in recognition memory and depends on parahippocampal gyrus.

Comparison between Traditional System account and Processing account:

Henke's Model	Traditional Model
Hippocampus involved in unconscious and conscious learning.	Hippocampus only involved in conscious learning.
Patients with hippocampal damage should find it difficult to form associations regardless of whether learning is conscious or not.	Only conscious learning will be affected in patients with hippocampal damage.
Hippocampus not directly involved in familiarity judgements in recognition memory.	All forms of episodic memory depend on the hippocampus.

Supportive evidence for Processing Accounts

- Associative learning can occur without conscious awareness (Hannula & Greene, 2012).
- Duss et al. (2011): presented face-occupation pairs below level of conscious awareness – e.g., Doctor, Artist, etc.
 - When faces only presented again in test phase, Ps able to classify them on regularity of income and length of education
 - How? = Based on subliminally presented occupation in study phase.
- Henke et al. (2003): conducted the face-occupation study with the use of fMRI:
 1. Hippocampal activation during non-conscious **encoding** of face-occupations pairs
 2. Hippocampal activation during non-conscious **retrieval** of occupation associated with faces on the memory test.
- These findings support the first prediction of Henke's model:
 - Hippocampus is involved in unconscious and conscious learning.

Supportive evidence for Processing Accounts

- Support for Henke's second prediction:
 - Patients with hippocampal damage should find it difficult to form associations regardless of whether learning is conscious or not
 - Ryan et al. (2000): Amnesiacs & healthy controls presented with colour images of real-world scenes in 3 conditions while eye movements recorded to examine proportion of eye fixations in critical regions:
 1. Novel scenes, 2. Repeated old scenes, 3. Changed old scenes
 - Healthy controls looked at critical region (manipulated portions) of the changed old scenes compared to other 2 conditions.
 - Amnesiacs did not – why?: They failed to form associations between objects and their locations.
- However, there are discrepancies on whether patients are tested with verbal or perceptual associations (see Verfaellie et al., 2013).

Evidence to support Processing Accounts of LTM

- Support for Henke's third prediction:
 - Hippocampus not directly involved in familiarity judgements in recognition memory comes from the explanation that brain damage often includes other parts adjacent to the hippocampus which are associated with familiarity (e.g., the perirhinal cortex).
- Aggleton et al. (2005): Amnesic patient with hippocampal damage but no damage to perirhinal cortex unable to perform as well as healthy controls on recognition tasks but was comparable in performance on familiarity tasks.



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Processing Components

- Cabeza and Moscovitch (2013): also proposed a processing account of LTM.
 - Similar to Henke's but more flexible
 - Proposes a number of processing components that can be combined & re-combined for different learning requirements
 - Evidence comes from neuroimaging studies
 - Particularly the fact that “Brain regions attributed to one memory system can contribute to tasks associated with other memory systems” (Pg. 49).



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Processing Accounts: Evaluation

- Can help explain the neuroimaging evidence.
- Does not rigidly focus on the distinction between declarative and non-declarative systems.
- Better flexibility: can help explain why some tasks use different processes depending on the person and the study conditions.
- However, it does not always make specific predictions – can be “fuzzy”.
- Devising specific tests to examine its assumptions can be difficult.

Separate LTM systems:

- Evidence for separate LTM systems also comes from the fact that different *types* of information can be forgotten from LTM and at differing rates:
- Baddeley (1997): forgetting rate unusually slow for continuous motor skills e.g., riding a bike.
- Most research suggests forgetting is slower in implicit memory:
 - Mitchell (2006): Ps shown pictures: 17 years later shown fragments of the pictures: still able to identify them.
 - Suggests very good long-term implicit memory.
 - Explicit memory was poor – some Ps didn't even remember taking part in the study.

Long term memory: Summary

- Structure and process in memory
- What do we mean by 'structures' in memory?
 - Neurological basis
 - Fragmenting functional components of memory
- 'Process' in memory?
 - Active processing in memory
 - Processing of information
- Marr indicates how we can make descriptions at different levels:
 - Hardware (structural/neurological)
 - Computational (processes)
 - Both levels of description can add something and may be present in a model

Long term memory: Summary

- Structure and process in LTM:
- Can depict different types of LTM:
 - E.g. episodic, semantic, procedural
 - More 'structural' emphasis
 - And correlated search for brain regions involved
 - Also, the type of forgetting used as evidence for depicting different types of LTM.
- More recent emphasis on processing-based theoretical accounts.
 - However, these have limitations and perhaps the traditional memory systems approach could be developed to account for most of the relevant findings.