Any act of memory requires success at three aspects:
- Input, or the acquisition of knowledge
- Creation of a memory trace, or the storage of knowledge
- Ability to use the knowledge, or retrieval

Acquisition
- Includes any instance of deliberate or incidental learning
- Attention and engagement with to-be-remembered material is crucial; acquisition is not passive or “camera-like”
- Raw input: translated first into a form that can be “acquired” by the brain
  - This is a complex process itself!
The Stage Theory of Memory

- Different types of memory, each with different properties
  - Working memory
    - Instantly accessible information
  - Long-term memory
    - Less instantly accessible

Storage Capacity of Working and Long-term memory

- Long term capacity: huge
- Working capacity: more modest
- Memory span: way of measuring working memory capacity
  - Random, unrelated information: we can store about 7, plus or minus 2, items (5 – 9 items)
  - Referred to as “the magic number 7”
Working Memory

- “Loading platform” analogy
- Long term memory must be “loaded” or “pass through” WM
- How does it move? How is it transformed into Long term memory?
  - Rehearsed
  - Chunked
Active memory and organization: A changed emphasis

- “Architecture” of memory: Storage labels (long term, short term) and analogies of loading docs
- BUT: Learner’s activities must be considered when examining memory
  - Maintenance rehearsal
  - Processing and organizing information: the “Royal Road into Memory”

Depth of processing

- Deep processing:
  - Meaning-based attention
  - Anything that connects new information to already-learned material
  - Material that “makes sense” will be encoded more efficiently
  - Results in superior recall

Other instances of deep processing

- Memory connections:
  - Links among ideas
  - Abstract similarities
- Mnemonics
  - “Method of loci”
  - Based on rhythm/rhyme/melody/visualization
    - “Thirty days hath September, April, June, and November”
    - Alphabet song
Storage

- Once encoded, must be stored until needed
- Record: memory trace or the engram
- Storage process difficult to research: long-term potentiation is no doubt involved
  - But: a memory is NOT stored in a single location: different aspects of a memory can be stored in different brain structures

Consolidation

- Consolidation: the engram is created over time (several hours usually)
  - Achieved through some aspect of protein synthesis and neural reorganization
- Evidence for consolidation?
  - Retrograde amnesia: a blow to the head can interrupt the process of consolidation for events that happened 1-2 hours *before* the accident occurred
  - Memory for events during that time period is lost
Retrieval

- Storage is not enough; we must be able to access the memory when needed
- Inadequate coding → failure to retrieve
- With an adequate retrieval cue, sometimes we realize that encoding wasn’t the problem after all

Retrieval cues

- Links between engrams are activated
- Context reinstatement
  - Re-creating or re-minding oneself of the context in which one originally learned something increases likelihood of being able to retrieve it later

Examples: Studying for an exam in the same room you will take the test; returning to your hometown and remembering things you had “forgotten”
When memory fails

- “Drawing a blank”: no memory at all is recovered
- Mistaken memory: we think we remember, but we make a mistake in what we recall in subtle or significant ways

Memory failures

- Inadequate encoding: Forgetting can often be traced to poor or missing strategies for encoding
- Forgetting: we knew it once, but no longer
  - Passage of time
  - Can be graphed with a “forgetting curve” – the opposite of a “learning curve”
  - Ebbinghaus: Memory declines with time, more sharply at first, then more gradually

![Graph showing the forgetting curve](image-url)
Decay and interference

- Decay: a process that occurs on a cellular level by normal metabolic “wear and tear” on cells involved with memory
- Interference: New learning interferes — independent of the passage of time
  - Passage of time not a powerful factor in explaining forgetting
  - Number of intervening events a more useful variable to examine to explain forgetting

Other retrieval errors

Retrieval failure:
One type: the “tip of the tongue” phenomena
  - What is that technique used to carve whalebone?
  - What is the name of that Russian sled drawn by three horses?

Intrusion: Misinformation
  - Provision of misinformation creates the “memory” for that information
More (!) retrieval errors…

- Intrusions from general knowledge
- Misplaced familiarity
  - Difference between recollection memory and familiarity

Big problem for us: No reliable way to tell “good” memories (accurate) from “bad” memories (those that are false or contain misinformation or inaccuracy)
Techniques for improving memory

- How to help us create better memories?
  - Techniques for improving “eyewitness identifications” that are more reliable:
    - Re-create mind-set
    - Minimize distractions/distractors
  - Unhelpful techniques:
    - Hypnosis: may improve motivation, but also creates eagerness to “please” the hypnotist

To Remember is an Action

- “Videorecorder theory” highly inaccurate:
  - We create our memories; choose what to encode, how to encode, and how/when to retrieve
  - We link what we know; we trace connections; we even “fill in” gaps in our own knowledge and “remember” that knowledge later
- “Videorecorders” do none of that!
- Overall, despite problems noted, memory is a highly effective system

Varieties of Memory

- Episodic
  - Memory for specific events
- Generic
  - Also called “semantic” memory
  - Refers to knowledge ‘about’ things, with no particular “episode”: you know this is the color blue, but you have no memory of how or when you acquired that piece of information
- Explicit
Varieties of memory, cont.

- Implicit
  - Memory for something without any awareness that we know it
  - Repetition priming: subliminal exposure affects later information processing – even without awareness
  - Implicit memory can be quite specific – doesn’t generalize broadly with respect to our subsequent behavior, as does explicit memory

Anterograde Amnesia

- Different brain tissue supports implicit memories as compared to explicit memories
- Evident when studying anterograde amnesia
  - Lesions in hippocampus and temporal cortex: create anterograde amnesia
  - Lesions from other types of brain injury: create retrograde amnesia

Supports the theory that different brain structures/regions “handle” different types of memory
Emotional Remembering

- Does memory for emotional events differ in any systematic way?
- Emotional events: remembered…
  - More vividly
  - More completely
  - More accurately
  … than memories for emotion-neutral events

“Flashbulb memories”

- Especially vivid memories
- Focus: immediate and personal details
- Special mechanism to produce this type of memory?
  No evidence that these types of memories are in a special class with respect to immunity from error or extreme longevity
Memory and Trauma

- Most traumatic events are well-remembered
- Some events seem to be “enhanced” or even more vivid than other memories
- Exceptions do exist and memory may be troubled/incomplete/absent:
  - Youth / age at time of event
  - Other confounding factors (sleep deprivation, head injury, medication/drug usage at time of event)
  - Extreme stress

Repression?

- Very controversial issue
  - What is the nature of “recovery” of traumatic memories, e.g. sexual abuse as a child?
  - Some: accurate, corroborated
  - Some researchers believe that recovered memories are almost always inaccurate or fabricated
- Veracity of recollection is almost always problematic
Some final thoughts: Different types, but Common Principles

- Many variables come into play when discussing common principles / phenomena of memory
  - Many variables need to be examined when researching these issues
- Link between memory and perception: both trying to inform us about “reality”
- Perceiving, learning, memory and thinking: tied tightly together.

Concept Quiz

1. According to the stage theory of memory, memory acquisition is a process of:
   - a. increasing the storage capacity of long-term memory
   - b. directly encoding experience into long-term memory
   - c. moving memories from working memory to long-term memory
   - d. maintaining memories in working memory

2. Which of the following is a strategy you could use to keep information in your working memory?
   - a. context reinstatement
   - b. maintenance rehearsal
   - c. interference
   - d. declarative processing
Concept Quiz

3. You are trying to remember the name of a person you met last week. According to the principle of context reinstatement, it would be most helpful to bring to mind:

- a. the place and time you originally met this person.
- b. the reason you want to remember this person's name.
- c. the names of other people you recently met.
- d. the face of the person whose name you want to remember.

Concept Quiz

4. In a psychology study, you are asked to memorize a list of words. After a rest period, you are asked to memorize a second list of words. Your ability to remember the first list of words is likely to decrease because of:

- a. decay
- b. interference
- c. retrograde amnesia
- d. the primacy effect

Concept Quiz

5. H.M. is a patient made famous for his case of anterograde amnesia, in which he lost the ability to:

- a. recall events that occurred just prior to the onset of amnesia
- b. recall events that occurred in early childhood
- c. acquire new procedural knowledge
- d. acquire new declarative knowledge