Michigan State University College of Osteopathic Medicine

Academic Success

Study Tips for Improving Long-Term Retention and Recall

MYTH BUSTERS

Myth: When a teacher says, "don't memorize this," it means stop paying attention because this won't be on the exam.

Reality check: Not likely! This is an unfortunate and all-too-common source of teacher-student miscommunication. What they almost always mean is that you should seek to understand it, not just memorize it for later regurgitation. More than likely, it will be on the exam!

BUILDING A MEMORY

On its journey through the three stages of the brain's memory storage system—sensory, short-term (STM), and long-term (LTM)—a tremendous amount of information is filtered out. Your goal as a medical student is to select learning strategies that maximize retention and minimize loss of important information.

What are the take home messages?

1. Pay attention to the learning task at hand and avoid distractions
2. Get 7-8 hours of quality sleep on a regular basis
3. Incorporate "retrieval practice" into your study plan
4. Deliberately link new information to existing knowledge
5. Adopt a deep approach to learning

How are long-term memories (LTM) stored?

- ✓ The brain has a complicated system for creating and storing long-term memories (see Table 1).
- ✓ All perceived stimuli enter your memory storage system as "sensory memories."
- ✓ Stimuli you attend to enter short-term memory (STM). Your attentiveness essentially signals the brain, "Hey, that's important!" Depending on what you do next, some STMs will be lost and some will enter long-term storage.
- ✓ In the absence of continuous rehearsal (e.g., repeating a phone number over and over again), anything you can recall after about a minute is a long-term memory (LTM). Even so, many common study methods create "weak" memories that render retrieval all but impossible after a short period of time, such as almost immediately after an exam.
- ✓ LTMs are distributed in a neural network (i.e., group of neurons primed to fire together) with different aspects of the same memory stored in different brain areas, e.g., visual aspects of an episodic memory stored in the visual cortex and associated sounds stored in the auditory cortex.

Table 1: Memory Stages and Processes[1]

Stage 1: Sensory Memory	Process: Sensory Encoding	Stage 2: Short-Term Memory	Process: Consolidation	Stage 3: Long-Term Memory
• A buffer that briefly and accurately holds all perceived sensory stimuli – sight, sound, smell, taste, & touch – for less than a second.	• Crucial first step in memory creation. • Attention is essential: ignored information vanishes. • Not all information makes it into STM.	• Holds 7 +/- 2 items for less than a minute. • Chunking increases amount of information held in STM. • Rehearsal increases length of time in STM and improves chances of transfer to LTM. • Poor STM can be a limiting factor in learning.	• Stabilizes conversion of STM to LTM. • Deep (slow-wave) sleep is essential to creating LTMs. • Not all STM become retrievable LTMs. • New LTM linked to existing LTMs via formation & strengthening of neural synapses (i.e., creation of neural network).	• Permanent. • Distributed throughout the brain. • Memory decay diminishes ability to access a memory at a future time. • Accessing LTMs (e.g., recall) strengthens the neural networks.

How are long-term memories retrieved?

- ✓ "Remembering"—retrieving LTMs—involves replicating a pattern of neural activity that occurred when the memory was originally formed. The relative ease or difficulty of memory retrieval is related to the "strength" of the neural connections. Because memories are stored throughout the brain, retrieval involves reconstructing the memory, like putting together a jigsaw puzzle.

  Example: Imagine trying to remember someone's name, but you can only recall that the person was female and her name began with the letter 'B' so you mentally run through all the female names you know that begin with the letter B. Alas, recollection finally comes from a different retrieval cue altogether, "Her name was Betty and I remember because we talked about how much we both liked the Flintstones when we were kids."
- ✓ To be readily accessible, a memory needs to have multiple, relevant retrieval cues. Study methods that improve long-term retention and subsequent recall of a stored memory involve intentionally creating meaningful associations. In the example above, retrieval cues included: female category, name begins with letter B, instance of discussing mutual fondness of the Flintstones, and Betty Rubble was a Flintstones' character.
- ✓ Two main processes are used to access memories: recognition and recall. Recognition involves comparing a current stimulus (e.g., a sight, sound, or smell) to something sensed in the past; it is a single step process and is generally easier and faster. Recall involves directly accessing information in LTM, and is generally more difficult because there are no direct retrieval cues (stimuli), thus the entire neural path must often be reconstructed.
- ✓ When retrieved, information is pulled from LTM back into "working" STM and must undergo a process of reconsolidation, which can strengthen and even alter the memory.

What does it mean to "forget"?

- ✓ In the absence of pathology, the human brain is capable of storing LTMs permanently, but "memory decay" is a normal physiological process. Just as new neural connections can be made, old ones that haven't been used in a while can be "pruned"—"use it or lose it." Forgetting is either the result of poor initial encoding and/or faulty retrieval—without adequate retrieval cues, a memory might as well not exist. Forgetting happens rapidly at first, but slows as time progresses. Re-studying information at spaced intervals staves off forgetting and improves long-term retention and retrieval. This important concept should guide your overall study strategy.

What is "surface learning"?

- ✓ Surface learning occurs with "cognitively passive" study methods, many of which are based on repetition and rehearsal, i.e., rote memorization. These techniques can make it easier (and faster) to recall information within a narrow window of time, but when it comes to application, analysis, and other higher-order types of knowledge, they may be worse than useless because they consume valuable time that could/should be spent on deep learning approaches.
  - ➢ "Cognitively passive" study methods include: attending class but not being engaged, reading/highlighting text, copying/re-writing notes, making/using flashcards, and asking questions before trying to discover the answer.
- ✓ "Memorizing" and understanding are not equivalent. Of course, memory is critical, but rote memorization creates LTMs that are particularly devoid of context, associations, and meaning. Rote practices do not lead to genuine understanding and fail to produce retrieval cues required to recall and apply information in a novel context such as answering an unfamiliar or higher order exam question (i.e., knowledge "transfer").

What "cognitively active" study behaviors produce "deep learning"?

- ✓ **Retrieval practice[2]**. Self-quiz frequently by recalling information from your memory. Every time you access a memory, you strengthen it. So, not only does self-quizzing help you identify your areas of weakness, it also helps you retain the information for later recall by strengthening the neural connections.
  - ➢ Instead of taking notes, in the same amount of time, write your own study questions and use them to test yourself
  - ➢ Take a break from reading or pause a lecture to actively recall what's just been covered
  - ➢ Explain what you've been learning to someone else
  - ➢ Draw and label diagrams from memory, make copies of blank tables and fill in from memory
- ✓ **Elaborative rehearsal[3]**. Link new information to things you already know. Access to memories is greatly improved when the information being learned is meaningful. To aid in recall, study methods should involve deliberate creation of logical, intuitive, and even fanciful associations with existing knowledge. Make sense of new information and develop an organizational scheme/framework; information you understand rarely needs to be "memorized."
  - ➢ Use your own words to rephrase definitions/descriptions; try to imagine how you would explain/describe a physiological/pathological/biochemical process to someone with no science background
  - ➢ Think of familiar examples—things that you can relate to
  - ➢ Relate new information to knowledge from other courses (past or present) or to life experiences
  - ➢ Relate theory to everyday practice
  - ➢ Think about how the information fits into the medical "big picture": What is the clinical/practical significance? Why are you learning this? What is the impact on/relationship to patient diagnosis and treatment?

"A key to improving memory … is increasing the quantity or quality of … retrieval cues"[3]

- ✓ **Generation effect[3]**. Retention and recall are improved when you actively participate in the creation of your own knowledge. Though, as a medical student you will not likely have time to do this for *all* your course material—sharing student-created study aids is both necessary and beneficial—the learning benefits of the *creation* process are undeniable. In the interest of efficiency, reserve self-generated memory-enhancing study materials primarily for concepts that ***you*** find most difficult or detailed information ***you*** are struggling with.
  - ➢ Create your own summaries, study guides, tables, flow charts, diagrams, etc.

- ➢ Write your own study questions (and use them to quiz yourself).
- ➢ Create concept maps
- ➢ Use your whole brain, not just your left hemisphere. Play around with information until some outstanding feature suggests a memory "hook", such as a mnemonic, picture, pattern, rhyme, or story; the more emotive (funny, dirty, disgusting), the better.

- ✓ **Dual coding**[3]. Create both a visual and a verbal memory for the same information.
  - ➢ Associate words with pictures
    - o Use your own words to describe a picture/figure/diagram
    - o Translate a written passage into a drawing or diagram
- ✓ **Distributed effort**[3]. Spread studying out over several days, rather than cramming. Say you're going to spend 10 hours studying a particular topic, rather than spending one marathon 10-hour session, it is far more effective to spend that time as 10 one-hour sessions, or 5 2-hour sessions, or even 2 5-hour sessions, spread out over two or more days. This is why it is so very important to review everyday. Obviously, you cannot review everything everyday, but make sure you frequently review the things that are most challenging to you.
- ✓ **State- & context-dependent memory**[3]. When possible, study in an environment that is similar to the testing environment. Recall is enhanced when the environmental context is similar during both the encoding (learning) and recall phases, and is one reason why studying in a quiet place is generally preferable to a noisy one. This is also why it can be helpful to attend lecture when the exams are given in the same classroom.
- ✓ **Task focus**. Avoid multitasking when learning difficult or dense material. Research has found that although multitasking does not impact recall, it is extremely detrimental to the encoding process. Multitasking divides attention, takes up valuable short-term memory space, and negatively impacts on LTM formation.
- ✓ **Sleep effect**. Review information you're trying to memorize right before you go to sleep. Deep sleep plays an important role in memory consolidation. This is a good time to spend a few minutes reviewing a chart or going through some flashcards. To further enhance your memory, try to recall the information (test yourself) shortly after you wake up.

USEFUL RESOURCES RELATED TO MEMORY AND LEARNING

Memory http://www.human-memory.net/index.html
Enhancing Memory http://www.sparknotes.com/psychology/psych101/memory/section4.rhtml

Reference:

1. http://www.human-memory.net/processes.html
2. Karpicke JD and Blunt JR (2011). "Retrieval Practice Produces More Learning than Elaborative Studying with Concept Mapping" Science, 331(6018) 772. http://science.sciencemag.org/content/331/6018/772.full
3. Tigner RB (1999). "Putting Memory Research to Good Use" College Teaching, 47(4) 149. http://www.jstor.org/stable/27558967?seq=1&