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Whole Student Learning Series  
Study Tips for Improving Long-Term Memory 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: WRONG! This is an unfortunate and all-too-common source of teacher-student miscommunication. What they almost always mean is that you should 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?
  - " Pay attention to the learning task at hand and avoid distractions
  - " Get 7-8 hours of quality sleep on a regular basis
  - " Incorporate “active recall” into your study plan
  - " Deliberately link new information to existing knowledge
  - " Adopt a deep approach to learning <http://www.learningandteaching.info/learning/deepsurf.htm>

All perceived stimuli enter your memory storage system as “sensory memories.” Stimuli you attend to enter short-term memory (STM) – your attention 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 24-hours (and probably after a minute) is a long-term memory (LTM). Even so, many common study methods create “weak” memories (neural networks) that render retrieval all but impossible after a short period of time (hence erroneously referred to as “short-term” memory). Imagine that forming a LTM is like wearing a path in a rug. The first time you walk across a rug you leave footprints, but after a short time they are no longer detectable (STM). However, the more you traverse the same path (rehearsal), the deeper and more permanent the wear pattern becomes (LTM).

Sensory Memory	Process: Sensory Encoding	Short-Term Memory	Process: Consolidation	Long-Term Memory
A sensory 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 the amount of information that can be held in STM.  Rehearsal increases the length of time in STM and improves chances of transfer to LTM.  Poor STM can be a limiting factor in learning.	Stabilization process in the conversion of STM to LTM.  Deep (slow-wave) sleep is essential to creating long-term memories.  Not all STM become LTM (or at least not in a way that can be later retrieved)  New LTM is linked to existing LTMs via formation & strengthening of neural synapses (neural network).	Permanent storage.  LTMs are 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.

<http://www.human-memory.net/processes.html>

## Study Tips for Improving Long-Term Memory Retention and Recall

- ! How are long-term memories (LTM) stored?
  - " The brain has a complicated storage system for long-term memories. An LTM is 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.
  
- ! How are memories retrieved?
  - " "Remembering" (accessing a stored memory) involves replicating the 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 (like the depth of the wear pattern in a rug). Because memories are stored throughout the brain, retrieval involves reconstructing the memory, like putting together a jigsaw puzzle.
    - o 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 access to 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, 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. The MSUCOM curriculum takes advantage of this aspect of memory by revisiting certain topics over again, but you can also incorporate this into your overall study strategy.
  
- ! What is "rote learning" ?
  - " Rote learning methods are based exclusively on repetition and rehearsal – the idea is that the more something is repeated the easier (and more quickly) it can be recalled.
  
- ! Is rote learning a good study method?
  - " In some situations, but generally not. Rote methods represent a surface approach to learning that are very useful for some learning tasks, such as memorizing a long list of random words or numbers. Medical students often utilize rote learning to their detriment, and describe their learning process as memorizing the course material. However, "memorizing" and learning are not synonymous. Of course, one must "remember" something in order to later recall it to answer a test question, but rote memorization creates LTMs that

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are particularly devoid of context, associations, and meaning. Rote study techniques 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 are alternatives to rote learning?
  - " Alternatives to rote learning include deep learning approaches: meaningful learning, associative learning, and active learning.

STUDY TIPS FOR IMPROVING LONG-TERM RETENTION AND RETRIEVAL

- ! What are some study methods that produce deep learning?
  - " Link new information to things you already know ("elaborative rehearsal"). 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” using rote techniques.

- o What to do
  - # Use your own words to rephrase definitions/descriptions
  - # Think of familiar examples – things that you can relate to
  - # Use familiar acronyms, acrostics, analogies, codes, musical jingles and rhymes
  - # 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 relates to 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?
  - # Create concept maps

*“A key to improving memory ...is increasing the quantity or quality of ... retrieval cues”<sup>1</sup>*

- " Actively participate in your own learning (“generation effect”). Retention and recall are improved when you actively participate in the creation of your own knowledge.
  - o What to do
    - # Create your own summaries, study guides, diagrams, charts, etc.
    - # Ask and answer your own questions.
    - # 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.

Note: As a medical student you don’t have time to do this for all your course material; sharing student-created study aids is both necessary and beneficial. However, 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 difficult or for trying to remember very detailed information that you are struggling with.

- " Create both a visual and a verbal memory for the same information (“dual coding”).
  - o What to do
    - # Associate words with pictures
      - Use your own words to describe a picture/figure/diagram
      - Translate a written passage into a drawing or diagram
    - # Examples of specific memorization techniques that employ imagery include the method of loci and journey method.

## Study Tips for Improving Long-Term Memory Retention and Recall

- " Whenever possible, study in an environment that is similar to the testing environment ("state- & context dependent memory"). 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.
- " Spread studying out over several days, rather than cramming ("distributed effort"). Say you're going to spend 10 hours studying a particular topic, it is 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, than it is to spend one marathon 10-hour session. 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.
- " 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.
- " 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 shortly after you wake up.
- " 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.

### USEFUL RESOURCES RELATED TO MEMORY AND LEARNING

Memory <http://www.human-memory.net/index.html>

Memory Techniques: [http://www.mindtools.com/pages/main/newMN\\_ISS.htm#mem](http://www.mindtools.com/pages/main/newMN_ISS.htm#mem)

How to Improve Your Memory: [http://www.helpguide.org/life/improving\\_memory.htm](http://www.helpguide.org/life/improving_memory.htm)

Enhancing Memory <http://www.sparknotes.com/psychology/psych101/memory/section4.rhtml>

Memory Curve [http://www.com.msu.edu/Students/Academic\\_Development/memory\\_curve.pdf](http://www.com.msu.edu/Students/Academic_Development/memory_curve.pdf)

Optimal Memory Curve [http://www.com.msu.edu/Students/Academic\\_Development/optimal\\_memory\\_curve.pdf](http://www.com.msu.edu/Students/Academic_Development/optimal_memory_curve.pdf)

### Reference:

1. Tigner RB (1999). "Putting Memory Research to Good Use" College Teaching, 47(4) 149.



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