

## What college teachers should know about memory: a perspective from cognitive psychology,

Michelle D. Miller, College Teaching 59, 117-122, 2011, <http://dx.doi.org/10.1080/87567555.2011.580636>

~ Summary ~

This article is about what helps us store and retrieve information from our brains. Note that the article does not encompass the much broader scope of “learning” – i.e. developing complex skills like problem solving, creative or critical thinking, and so on. Remembering is no doubt a precursor to developing abilities to think and act more like experts, but it is not the whole story. This article is a focused, practical review about memory as it affects those designing or modifying their teaching in post-secondary settings<sup>1</sup>.

### Introduction

The subject (memory and recall) is very complex, with many outdated and inaccurate ideas in the educational literature. Also, it has been difficult to translate theory into useful teaching practice. This article contrasts outdated with newer concepts about memory, and considers ways of applying them to teaching practice.

### History from 1960’s

Early ideas about memory were based on studying how lists of unrelated words are remembered. An early simplistic concept of memory comprised three components: (1) sensory memory, (2) short-term memory and (3) long-term memory. Transfer from (2) to (3) was enhanced by rehearsal.

Regarding sensory memory, visual information is “retained” in unanalyzed form, but it is not clear why. Many consider this part of the *perceptual* system rather than a component of the *memory* system.

### More recent perspectives:

The notion of “short term” memory has evolved towards a more flexible model of “working” memory. FMRI<sup>2</sup> research shows there are dedicated brain regions that temporarily hold word sounds, however no conclusive link is seen between this component of memory and sentence comprehension.

So, while a short term component of memory seems to be unnecessary for understanding speech, it does appear to be needed when new terms are involved. Evidence from studies with brain injured people suggest there are two pathways:

- 1) When words in sentences are understood, ideas are sent directly to other components of memory or incorporated into “packaged” representations without any need for temporary storage, rehearsal or processing.
- 2) In contrast, when words and ideas in a sentence are NOT understood, recalling and thinking resources are needed immediately to parse or process words into meaning before retention of information can occur.

### Cues, and the adaptive view of memory

These and other issues indicate limitations of applying research about cognition carried out under strictly controlled conditions of a psychology lab. *How* memory works must account for what the memory is needed *for*.

One alternative framework for understanding why we remember and forget the things we do is the *adaptive view*. “We are attempting to process and remember 21<sup>st</sup> century information using a hunter-gatherer brain”. This is not in competition with “working memory” but seems more fruitful for application to teaching and learning.

Long term memory has been less intensely studied, but it seems there is no shortage of “storage” capacity. The limitation is the capacity to find what’s wanted when it’s wanted.

The importance of *cues* seems well established. Cues act as a trigger to solve the retrieval problem. Evidently, information is encoded with multiple links to other information. Two important implications are discussed in the article.

First, studying for long term retention is better done spaced over short periods and in a variety of contexts (instead of single cramming sessions). Studying with multiple contexts provides a variety of cues and avoids overly dominant cues, whereas studying in few contexts limits development of cues that help with recall. For example, always studying in one place will aid recall of the material in that same place, while studying in a variety of locations with different ambient noise will promote recall in more diverse settings.

In contrast, the second implication is that for increased accuracy of recall, practicing should involve activities that are highly similar to those used during a test. This is called “*transfer-appropriate processing*”<sup>3</sup>.

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<sup>1</sup> Summary by Francis Jones. Any errors or omissions in transferring key points of the article into this two page form are mine. Please Email problems or questions using contact information below. Thanks to Warren, Beth and Sarah for useful suggestions that have improved the summary.

<sup>2</sup> FMRI – functional magnetic resonance imaging.

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<sup>3</sup> “*Transfer*” means application of knowledge or skills in a situation that is novel at the time – i.e. new to the person applying it.

Compare these two implications. Evidently, strategies that enhance recall are not the same as strategies that enhance skills or transfer. Both are crucial aspects of learning, but we cannot expect students to develop transfer skills unless we provide opportunities to practice in a range of settings – i.e. transfer skills do not develop automatically. This is what is happening when you complain (as we have all done!) that “they’re supposed to have learned that in first year math – why can’t they apply it in my course?”

Another guiding principle of memory is the notion of “*survival relevance*”. Our memory abilities have been naturally selected for over many millennia without formalized education. Therefore, considering the kinds of cues that are most successful at helping us to tag information as crucial for survival helps identify the most effective cues to incorporate into our teaching. These include:

- Cues with sensory impact: concrete information that is accompanied by sound, tactile, and especially visual sensations is more readily remembered than purely abstract information.
- Cues with emotional impact: information will be more readily stored and retrieved when associated with survival such as danger, food, infants, personal history, etc.
- Cues incorporating evidence of structure: the distinction between important information and background clutter is clearer when the information can be placed within a previously learned or recognizable structure.
- Cues involving personal participation or that appeal to vested interests: performing the task generates cues that help recall that cannot be acquired with the information when the information is encountered passively.

The notion of survival relevance helps explain why, in general, lurid news, story plots, gossip are easier to remember than technical, legal, detail-oriented information.

### Importance of attention

Some researchers suggest that “short term memory” is more usefully understood in terms of “*attentional focus*”. In other words, limitations on attention underlie the failure to encode and recall information. Three implications are:

- It is no longer helpful to think in terms of offering fewer than 5-7 “chunks” of information.
- Instead, instructors should focus on 1) gaining and keeping attention, and 2) supporting development of structure for the information.
- Cognitive capacity should no longer be thought of in terms of “items” to remember, but rather as the limitation on processing resources and how they are distributed across different demands.

For example, deciding whether to interject an anecdote into a lesson may depend on whether students need to maintain focus on a new concept, or whether the interjection comes at a time when attention can be safely dropped.

### Three other points

First, the testing effect is now well established across many domains. This refers to the fact that taking a “test”<sup>4</sup> on information produces a stronger effect on memory of that material than simply reviewing it.

Second, “learning styles” have lost significant ground as a useful paradigm for designing and delivering teaching. It has been shown that attempting to align the mode of presentation with a presumed “learning style” does not enhance learning. Instead, it was suggested that it may be better to consider this issue in terms of associating new information with multiple cues, with well-established structure, and in ways that enhance motivation and attention.

Third, but not mentioned in this article by Miller, is the notion of “desirable difficulties”<sup>5</sup>; essentially the idea that a certain degree of difficulty is good for learning, within reason of course. In other words, the mental effort of engaging with concepts is what produces learning. This is consistent with the need to capture and keep attention of the learner, and with varying modes of delivery and engagement so they are not always perfectly aligned with individual preferences.

### Essential take home messages

- The concept of short term memory is of limited use.
- The *working memory model* suggests that learning is limited by how much we can process or pay attention to at one time.
- Our brains have a remarkable capacity to take in information that is well structured, personally relevant and rich in sensory and emotional qualities.
- Use pedagogies that help associate new information with personally and emotionally relevant cues.
- Without attention there is no meaningful/useful memory.
- Students do not learn to transfer knowledge or skills into new settings automatically. This must be practiced.
- Varying the type and sensory modality of a learning situation may help by promoting attention, engagement, and by increasing the number and variety of cues.
- Frequent testing is not an interruption of learning – it is a central contributor to it.

In closing, keep in mind that “memory” is not the same as “learning”. Remembering is no doubt a precursor to (or a part of) developing abilities to think and act more like experts, but it is not the whole story.

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<sup>4</sup> Here “testing” means recalling (and maybe using) information in a setting where it “counts” or is meaningful or important.

<sup>5</sup> E. L. Bjork and R. A. Bjork “*Making Things Hard on Yourself, But in a Good Way: Creating Desirable Difficulties to Enhance Learning*”, in M. Gernsbacher, R. Pew, L. Hough, & J. Pomerantz (Eds.), “*Psychology and the real world: Essays illustrating fundamental contributions to society*” (pp. 56-64). New York: Worth Publishers (2011)