Chapter 13
Cognitive Learning Theories

COGNITIVE PSYCHOLOGY

This chapter focuses on cognitive theories of learning. Cognition means thinking. Psychology means study of the soul or study of the mind. Cognitive psychology means the study of mind or soul as it relates to thinking. Whereas behavioral psychology examines and describes learning only in terms of outward, observable behaviors; cognitive psychology focuses on the mind and the acquisition and organization of knowledge in its description of learning. According to the cognitive view, we cannot observe learning directly; we can only observe the effects of learning. That is, we cannot observe a mind taking in information, organizing it, and storing it. At best, we can observe the effects

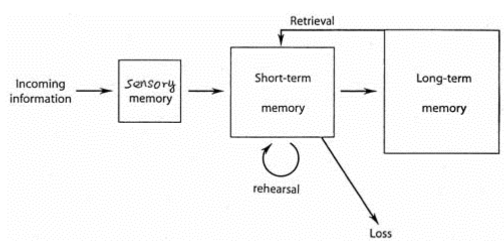
Learning, File Cabinets, and Computers

As described in Chapter 3, a cognitive structure is the file cabinet in our head used to organize bodies of information. Within this file cabinet are the individual files related to specific bodies of information called schema or schemata (plural). We can say that learning has occurred when new files (schemata) are added into the file cabinet or when the files are rearranged to accommodate new information. We can also say that learning has occurred when new information has been added to individual files or when information within the individual files has been rearranged to accommodate new information.

This is a good place for a quick review of Piaget's concept of assimilation and accommodation: Assimilation occurs when we encounter new information that corresponds with our current schemata. Accommodation occurs when we encounter new information and it either doesn't fit current schemata or there isn't a schema related to this new information. The learner accommodates by changing existing schemata or creating new ones. You see both assimilation and accommodation in the cognitive view of learning.

THE INFORMATION PROCESSING MODEL

The information processing model, sometimes called the standard memory model, is central to understanding the cognitive learning theory. It describes the brain's role in taking in information, analyzing and organize it, storing it, and retrieving it.



Perception – Sensory Register – Sense Memory

Stimuli are the sense data we encounter in the form of sights, sounds, smell, feel, and taste. *Perception* is the detection of stimuli through one of your five senses. We are bombarded with millions of stimuli every day. However, if we were to attend to all the stimuli we encountered we'd go crazy.

"Too much information!"

Thus we make decisions about which stimuli to attend to. *Attention* is making choices about which perceived stimuli to allow into consciousness in order to assign meaning. Put another way, in any given situation, you decide which particular stimuli upon which to focus. For example, as you're reading this text

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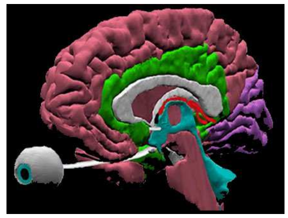
you're choosing to attend to the visual stimuli in front of you (hopefully) in the form of letters and pictures. Hopefully, you are ignoring the sounds in the background, the sound of your own breath, the feel of the clothes against your skin or the book in your hand. You are making choices about blocking some stimuli while allowing others to move into your consciousness. If you did not make these choice, comprehending the words and ideas in front of your would be very difficult.



Sense memory, sometimes called sensory register, is where this original sense data is registered. It has an unlimited capacity; however, it has a very short duration. It retains an exact copy of what is perceived but this only lasts for one to three seconds.

So what? Teachers sometimes have to help children attend to relevant data. You might use your voice to get their attention by saying things such as, *"I need to have all eyes up here right now."* You might also use verbal cues such as, "*This is an important point to remember …"* or *"There are three things you need to keep in mind when …*" You can also do things like vary the pitch of your voice and the pace of instruction, use pauses, and move around to keep students' attention. Children must be able to perceive before they can attend. To enable children to attend to what you say your instruction should be clear, organized, and loud enough for students to hear.

Some children (and adults) are not able to block out unwanted stimuli. They attend to too many things in their environment and are not able to concentrate. Study carrels can by used to help these students tune out unwanted stimuli in order to concentrate.

APPLICATION

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Gestalt. *Gestalt* is a German word that refers to completing a pattern or configuration based on partial data. Gestalt can be thought of as a perceptual dot-to-dot picture, meaning that you perceive incomplete data but your brain automatically organizes it into meaningful patterns. For example, the two lines in Figure 14.1 are simply two lines. However, your brain automatically fills in the blanks and they are registered on your brain as being a chalice or two people facing each other with their lips very close. In the same way, the series of lines and shade in Figure 14.2 can also be perceived as two different pictures; one an older woman with a big pointed nose and chin long looking down, and the other a young woman with a slight chin and small nose looking away. In both instances, the visual stimuli are the same; the difference is how your brain organizes and completes the picture.

Figure 14.1. Two lines

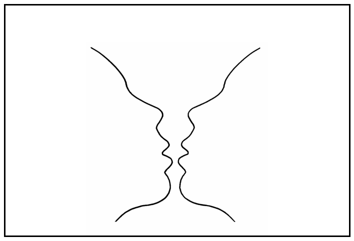
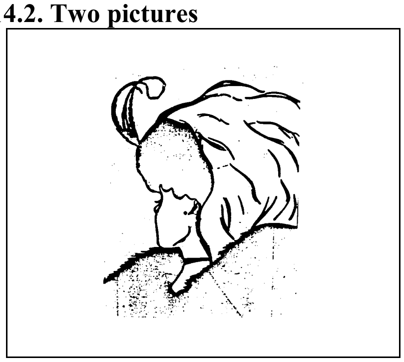


Figure 14.2. Two pictures



Short Term Memory

While the terms, *short term memory* and *working memory* are often used synonymously, technically they are different. Short term memory (STM) is like a small holding pen for perceived data from sensory memory. It can also hold information burped up from long term memory (more on this later). Short term memory has a limited capacity of about seven plus or minus two (7+/-2) bits of information. This mean that most people can hold seven bits of information; however some can hold up to nine bits and some only five bits. That's not a lot of information. It is interesting to note that both license plates and telephone numbers (without the area code) contain no more than seven numbers or letters. I'm not sure if this is planned or merely coincidental.

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Holding more bits. How might you hold more information in STM? *Chunking*. Chunking is organizing bits of data into meaningful larger wholes in order to make more efficient use of the limited space in STM and enabling you to hold more information.

To illustrate, I do the following experiment with my students: First, I select six students and ask them to leave the room. Two of these students are called in individually and shown a large poster with the following single digit numbers on it: 1-9-7-2-2-0-1-0-1-9-9-8-1-7-7-0. They're given 10 seconds to memorize them and then they're asked to repeat back as many digits as they can. Students are generally able to repeat from five to seven digits. Next, two other students are called back in and given the same numbers; however, this time they're grouped or chunked into more meaningful wholes (double digits): 19-72–20–10-19-98-17-70. These students are generally able to repeat back five to seven of these double digit numbers for a total of 12 to 14 total digits. Finally, the last two students are called in. Under the same conditions, they're shown a poster with the following numbers on it: 1972-2010-1998-1770. In this last condition the numbers here have been chunked into meaningful whole related to years. Students here are generally able to repeat back all four years for a total of 16 total digits.

A personal application of chunking that you can use tomorrow. So, let's imagine you're on the phone ordering my book with your credit card and you want the process to go faster, instead of telling the operator your credit card number as a series of single digits: 3, 4, 7, 2, 9, 6, 2, 1…, use two-digit numbers (34, 72, 96, 21) or even three-digit numbers (347, 296, 21 …), in order to speed up the process and make it more likely that the numbers are recorded correctly.

APPLICATION

Learning to read. The idea of chunking also affects early literacy instruction. Teaching children letter-sound correspondence (phonics) is an important part of learning to read. As they encounter words in text, phonics is often used as a cueing system to decode and recognize unknown words. However, phonics is not very efficient in terms using the limited processing space in STM. Instead of focusing on ideas, words, or even word parts, phonics forces the reader to attend to individual letters. This makes it more likely that what is being read will seem meaningless and abstract. (Expert readers, use minimal letter cues when reading.) Remember, you could hold seven letters in STM or seven words. In creating meaning with text (comprehending) it is always more efficient and effective to hold seven words in STM.

So what's the application? Asking students to sound out a word, letter-by-letter may sometimes be the wrong thing to do. Unlocking the meaning of unfamiliar words by examining them letter-by-letter leaves less space in STM to create meaning with the text. Children should be taught a variety of ways to recognize unknown words include (a) using context clues (what makes sense in the sentence) with minimal letter cues, (b) looking for familiar phonograms or word parts, and (c) looking for familiar prefixes, suffixes, and root words. These should be taught as well as using letter cues (phonics).

To illustrate, consider the process you are using to read and comprehend this text right now. As you encounter the words on these pages, I am guessing that you are not attending to each individual letter. You are most likely

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using minimal letter cues to unlock these words.  Instead, you are using
context clues (what makes sense within the passage or paragraph), recognizing
some words instantly, seeing family root words or suffixes such as 'phono' and
'gram', and in many cases skipping the word entirely.  This is what mature
readers do when they try to create meaning with text.  They do not read letter
by letter.  Thus, if letter-by-letter reading is the ONLY method used to teach
students how to create meaning with print, you are most likely retarding
rather than speeding up their literacy development.
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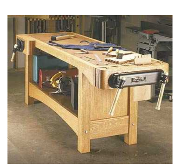
Chunking with metaphors, analogies, parables, and stories. A last example of chunking is the use of metaphor, analogy, parables, and stories to hold greater ideas. You will notice in this textbook that I make liberal use of analogies and metaphors (see cognitive structure and schema above). That's because it's much easier for our brains (both STM and LTM) to hold an image than a series of facts. Therefore, connecting a series of facts to an image, it makes it much easier to process and remember the facts. In much the same way, various religious traditions use stories and parables to first understand then hold onto complex theological and spiritual ideas.

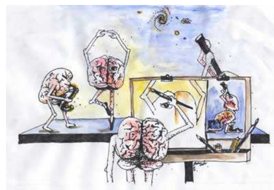
Holding bits longer. The duration of STM is about 15 seconds. After this the things held there begin to fade. There are two ways to hold onto things longer: The first is called *maintenance rehearsal*. This is repeating things over and over. For example, let's pretend that you meet somebody very interesting. You get his or her phone number so that you can call that person at a later time; however, you discover that have no paper or writing utensil. What to do? Maintenance would be to simply repeat the number to yourself many times so that it sticks in LTM and you can retrieve it at a later time, meet the wonderful person, and live happily every after (see, educational psychology does have some real life uses).

The other trick is called *elaborative rehearsal*. Here you associate what is to be remembered with something meaningful. For example, my gym locker combination here at Minnesota State University, Mankato is 30, 20, 14. To hold on to these numbers in STM and eventually commit them to long term memory (LTM) I associated them with age. I elaborated by picturing myself at age 30, 20, and 14. This made it much easier to hold onto these in the short term and to retrieve them from LTM in the long term.

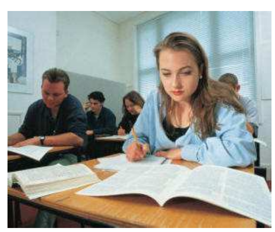
Working memory. *Working memory* is the active part of STM, the workbench where information is held as you process it or manipulate it in some way. Whereas STM is a passive receptacle, working memory is an active space used to work with information in STM. What types of things might you do on this cognitive workbench? You could add to data, analyze data, organize data, restructure data, or make connections. For example, as you're reading this very paragraph, hopefully you're holding onto the concept of working memory in STM (you're working with working memory in your working memory). Eventually you'll connect this new concept with the idea of a workbench found in a carpenter's workshop, you'll analyze the concept to find the main point, and decide which storage schema or storage bin in your LTM in which to put this idea.



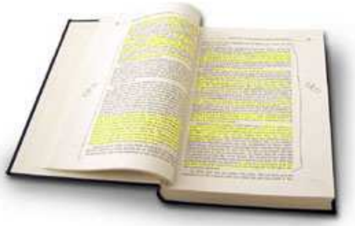
Working memory is also the place where *metacognition* takes place. Meta is a Greek word meaning to transcend or to go beyond, above, or higher. We know that cognition means thinking. Metacognition is to go beyond merely thinking to think about thinking or monitoring one's thought process. In the act of learning, to engage in metacognition means to monitor your comprehension. You're asking such questions as: "*Do I understanding what I'm reading? Does this make sense? Do I need to read this paragraph again? What's the main point my instructor is trying to get across in this lecture? How is this like something else I've learned? Does this description of metacognition make sense?*" Metacognition then involves thinking about thinking, checking for understanding, or monitoring your own thoughts.



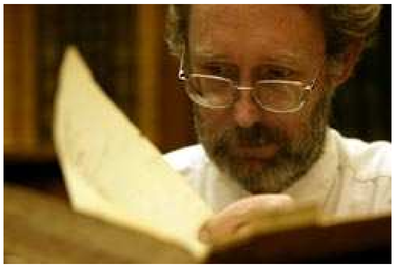
The magic of paper. Question: What are two of the most important learning devices ever invented? I'll give you a hint. It's not a fancy new computer, an expensive reading curriculum, or a series of new standardized tests. The answer: A simple, inexpensive piece of paper and a writing device of some kind. Paper can be used along with a writing to hold ideas indefinitely. When used as a note taking device it takes the stress off of STM. It allows you to extend STM and see all the ideas in front of you instead of having to hold them in your head as your process them. This is why during the act of reading a college textbook, most students take notes as they read, especially if the material is new or confusing. Taking notes helps you to see the main idea in front of you, to write your own explanations of the material, and to make connections. In short, note taking is an external and permanent form of much of the work that occurs in working memory. In much the same way, taking notes during lectures keeps you engaged in what is being said, extends and enhances STM, and helps your process and understand what you're hearing. I would highly recommend note taking during both of these activities.



What about highlighting important passages? Is the act of highlighting passages in a textbook an effective studying practice? Let me say that highlighters are not magic wands. *"Bippity-boppity-boo."* Running yellow or orange ink over the words in a textbook does nothing, in and of itself, to enhance comprehension or help you understand new or confusing material. It has been my experience as a college professor for the last 12 years that those students who simply highlight passages in their textbook generally do not do very well on exams. To be an effective study/comprehension strategy, highlighting needs to also include note taking in some form. I would recommend the following: First, read through the chapter and highlight just the important ideas found in the chapter. Then, go back and take notes on what has been read and highlighted. Included in your notes should be your own explanation of the material. It is sometimes helpful to take notes in the margin of the text as well in order to add depth and dimension to what is printed.



The answer to the question that is now forming in your head is yes. *"Yes, you must read new or complicated material through more than once."* Most of my students are surprised to learn that most college professors also have to read research articles and textbook chapters through more than once or employ some note taking strategy in order to fully comprehend what they're reading. I don't want to burst your bubble, but your college professors are not necessarily more intelligent (whatever intelligence is) than you. (Some of you are thinking, *"Tell me something I don't know."*) They don't necessarily have brains that function differently than yours, and they don't have superhuman learning powers. What they do have is discipline. They're able to put their butt in a chair on a sunny, summer day in order read, write, conduct research, or engage in some scholarly activity. They've also learned how to use their brains in the pursuit of knowledge. That is, they've discovered how their brain works in correlation with the skills necessary to understand new and complex information.



Automaticity. The last concept described related to STM is *automaticity*. You can see the word 'automatic' within this word. Automaticity is the act of performing a procedure or operation without thinking about it or with very little conscious awareness. Put another way, the thinking processes involved with a particular skill are automatic. The best example of this is driving. As we drive, most of us don't have to consciously think about pressing the gas pedal or break pedal or turning the wheel. We respond to the curves and stop signs we encounter automatically with very little conscious attention. If we had to devote a lot of our attention to each of these functions we would have less attention to devote to driving conditions and we would be far less safe on the road.

Likewise, when I play my guitar, I don't have to consciously think about each individual finger movement with the right hand strumming pattern or the left hand cord placement. The strumming patterns and finger positions have become automatic, enabling me to concentrate on other dimensions of the music. If I had to consciously attend to each finger placement I'd be playing at a very rudimentary level for a long time.

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In the same way, when I was the wrestling coach at River Falls High School in River Falls, Wisconsin I would teach my wrestlers new moves. We would go through a move many times in order to learn it initially, and then drill and practice every day so that my wrestlers developed a sense of automaticity. In this way, they didn't have to consciously process the particular steps involved before they acted; rather, they could react quickly without thinking. If they had to think through the steps of a particular move as they were wrestling, they'd spend the majority of the match on their back looking up at the lights.

Developing automaticity with certain academic skills enables us to devote more space in STM to higher level thinking. The skill most associated with automaticity in school is reading. Here we want children to develop automaticity as they recognize words. In this way they are better able to analyze, evaluate, and engage in higher level thinking as they read. Automaticity is important in other skill areas as well including writing, mathematics, and keyboarding.

Long Term Memory

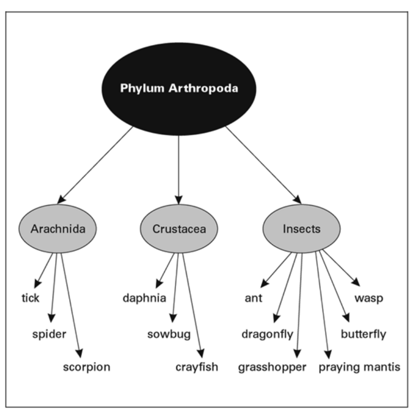
Long term memory (LTM) has an almost unlimited capacity to store information for an almost unlimited duration. This means that everything we've ever experienced is tucked away in our brains somewhere. Then why don't we remember important things? Why do we forget? It's not a matter of storage; rather, of retrieval. That is, the information is still in our memory; we just have a hard time getting to some of it.

The storage locker analogy. This might be better understood using an analogy of a rented storage locker. Putting data in and taking it out of LTM is very much like putting things in a rented storage locker. Three important terms in this process are encoding, storage, and retrieval. *Encoding* is the process of organizing and putting data into LTM. This is like gathering up your things, sorting them, putting them into boxes and plastic storage bins, and putting them into the storage locker. *Storage* is the actual holding of information in LTM. This is like the physical storage locker filled with boxes and bins containing your things. *Retrieval* is getting access to information found LTM and pulling it back out into STM. This is like getting specific things from the boxes or bins and taking them out so that you can use them. Thus, to learn one must have things in the boxes and bins, have access them, and then be able to use them or have the potential to use them.

Enhancing storage in and retrieval from LTM. Now, in putting things in your rented storage locker, if you just threw them in there all higgily-piggily without first organizing or putting them in boxes and bins, you'd have quite a bit of trouble retrieving the specific things for which you were looking. In the same way, encoding and storing information without organization makes it hard to retrieve. As teachers, we can enhance students' ability to encode and retrieve data by doing the following:

1. Plan and organize your lessons. Effective teachers plan their lessons. A well-designed lesson plan makes it more likely that you will have a logical flow of events, it minimizes confusions, and it reduces the time students spend off-task.

2. Show students the structure of material to be learned. This makes it much easier to store and retrieve data in LTM. In your teaching practice, put outlines of your lesson on the board or use some sort of semantic map or *advanced organizer*. An advanced organizer is any sort of brief outline or chart that shows the structure of what is to be learned or read (described more fully in the next chapter). In the same way, if you're writing an educational psychology textbook you would use headings and subheadings to delineate the structure. This enables the reader to see how things are related and provides a sense of what is to be learned or read.



Using the storage locker analogy, this would be like telling students what box or bin specific things belong in and showing them where to put each box and bin within the storage locker. Then within the storage locker the bins and boxes would be organized according to what's in them. For example, your books are in one section, your sports equipment in another, and your stereo and electronic equipment in another. If you were looking for a book you'd know exactly where to go.

3. Connect the new to the known. It makes it much easier to encode and retrieve new data if you connect it to what students already know. One common example of how this applies to teaching practice is the KWL strategy. KWL stands for 'know', 'want to know', and 'learned'. Before teaching a lesson or assigning a chapter, you would have three columns listed on the front board, labeled K, W, and L. In the K column you would ask students to generate a list of things they know about the topic. For example, if the lesson or chapter were on frogs, students would generate a list of things they already knew about frogs. In the second column, students would generate a list of things they want to know or would like to find out about frogs. After the lesson or after reading the particular chapter students would then list those things learned about the topic and make any corrections necessary in the K column.

KWL Chart

What I Know	What I Want to Know	What I Learned

kwl

4. Use elaboration. Elaboration involves making information more meaningful by creating additional links or adding new information during the encoding process (Eggen & Kauchak 2007). For example, in designing a lesson, involve students' emotions and imagination, make personal connections to their lives and experiences, or use analogies and metaphors. These would all serve to create connections with other things and thus enhance encoding and retrieval. Granted, it takes a little thinking to come up with these various connections; however, that's what makes teaching so stimulating. Teaching at all levels is a creative, intellectual endeavor. It is the designing and creating of these various teaching experiences that keep the experience alive and vital. Other ways to elaborate a lesson involves using things such as songs, pictures, drama, stories, creative writing, visual art, music, or even dance.

Staying with the storage locker analogy, if I were to simply put a book in a box once, I would probably have a very hard time remembering where I put the book or the box in my storage locker. However, if I visited the box many times, if I created a very wide path, and if I touched and opened many of the surrounding boxes as I put the book in the storage locker, I would have a very easy time retrieving the box and book. This is what occurs when elaboration.

Let me elaborate on elaboration to enhance your encoding and retrieval of this concept: Think a song that brings you back to a very memorable time and place. Chances are the lyrics and melody conjures up images, sounds, and smells as well as emotions. Also, the sights, sounds, and smells bring back the melody and lyrics. Encoded singularly, retrieving the lyrics or even the melody to this song would be difficult. However, connecting the song data to a variety of other data enhances retrieval.

I remember the song, "*Afternoon Delight"* I know exactly where I was when I first heard it. It was a warm sunny, summer afternoon in June of 1976. I had just graduated from high school and was looking forward to my first year of college at the University of Wisconsin, Superior. My friend Brent and I were out in his motorboat with two lovely young ladies. We spent the afternoon water skiing, drinking beer, and laying in the sun. (It was legal to drink beer at age 18 in Wisconsin in 1976. What a world.) We had a radio with us in the boat. It was here that I heard the song for the first time. I remember the emotions and the feelings of utter contentment. When you're 18 years old, what more could you possibly ask out of life? The words and melody of this song were encoded with all the other stimuli on that lovely afternoon at Little Wood Lake in Grantsburg, Wisconsin. Now, hearing the song brings me back to those particular sights and sounds, the smell of sun tan oil mixing with the smells of the speed boat. The song data was encoded along with the other data. Having to simply recall song lyrics from 1976 would ordinarily be very difficult; however, this song data was encoded with a variety of other data and its retrieval is relatively easy.

Afternoon Delight

Gonna find my baby, gonna hold her tight
Gonna grab some afternoon delight
My motto's always been 'when it's right, it's right'
Why wait until the middle of a cold dark night?
When everything's a little clearer in the light of day
And we know the night is always gonna be there any way

Thinkin' of you's workin' up my appetite
Looking forward to a little afternoon delight
Rubbin' sticks and stones together makes the sparks ingite
And the thought of rubbin' you is getting so exciting

Sky rockets in flight
Afternoon delight
Afternoon delight
Afternoon delight

Started out this morning feeling so polite
I always thought a fish could not be caught who wouldn't bite
But you've got some bait a waitin' and I think I might try nibbling
A little afternoon delight

Sky rockets in flight
Afternoon delight
Afternoon delight
Afternoon delight

Please be waiting for me, baby, when I come around
We could make a lot of lovin' 'fore the sun goes down

Thinkin' of you's workin' up my appetite
Looking forward to a little afternoon delight
Rubbin' sticks and stones together makes the sparks ignite
And the thought of rubbin' you is getting so exciting

Sky rockets in flight
Afternoon delight
Afternoon delight
Afternoon delight

Afternoon delight!

Starland Vocal Band, 1976

5. *Use multimodal presentations.* Multimodality is a form of elaboration. This involves presenting information in a variety of modalities such as using lecture (sound), printed information, pictures, models, demonstrations, simulations, and even things such as dance, movement, or poetry. Being multimodal enables new information to be encoded and stored in a variety of ways. For example, with this textbook I'm using pictures, diagrams, cartoons, illustrations, and personal anecdotes to create a multimodal presentation. I'm also including activities and reflection prompts to help you make personal connections (elaboration) so that these concepts might become more meaningful, thereby enhancing encoding and retrieval. In your own teaching situations, you can enhance learning by presenting new information in as many modes as possible.

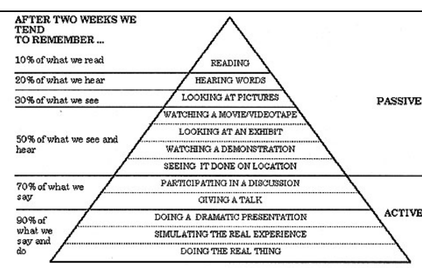
6. *Get students to do something with new information.* Students learn more and are better able to retrieve information from LTM if they are active learners rather than passive receivers of information. Manipulating or doing something with new information as they are encoding it avoids the problem of *inert knowledge*. This is where knowledge lays in LTM and doesn't move. That is, it can't be retrieved. According to the *levels of processing theory*, the more extensively we manipulate information during the encoding process, the easier it is to be retrieved. Manipulating information also helps us understand and learn more deeply. The *learning pyramid* in Figure 8.1 shows that retention and retrieval rates are greater when students are actively involved with the subject matter.

Figure 8.1. The learning pyramid.

THE LEARNING PYRAMID

Retention rates:

5% lecture
10% reading
20% audio visual
30% demonstration
50% discussion groups
75% practice by doing
90% teaching others.



Adapted from: Edgar Dale *Audio-Visual Methods in Teaching*, Holt, Rinehart and Winston.

So, what are some things that students might do with the new information they're learning? *Bloom's taxonomy* of educational objectives can be useful here. In *Taxonomy of Educational Objectives* (1956), Benjamin Bloom described six levels of thinking (Figure 14.3). These six levels of thinking and the specific cognitive operations for each level can be used to help design questions, activities, or assignments to go along with the information you're telling your students during the lesson. For example, let's say you're teaching a lesson on Bolivian grain exports. If you wanted to include thinking at the evaluation level, you could have students (a) make a case to support a statement related to Bolivian grain exports, (b) define a criterion for some aspect of Bolivian grain exports, make a formal critique, (c) compare and contrast something, or(d) use one of the other operations at this level in create questions, activities, and assignments. You're limited only by your imagination here.

Figure 14.3 Taxonomy of educational objectives and corresponding operations.

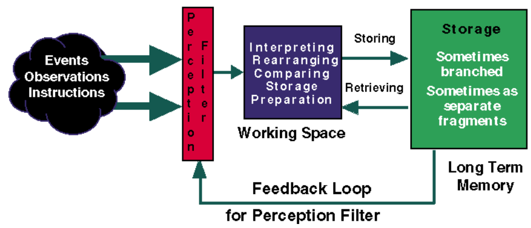
1. Knowledge. Recalls facts or remembers previously learned material. ***Knowledge level operations*** -- define, describe, identify, list, match, name, tell, describe, show, label, collect, examine, tabulate, quote, duplicate, memorize, recognize, relate, recall, repeat, reproduce, or state.
2. Comprehension. Grasps the meaning of material. ***Comprehension level operations*** -- interpret, explain, summarize, convert, defend, distinguish, estimate, generalize, rewrite, contrast, predict, associate, distinguish, estimate, differentiate, discuss, extend, classify, discuss, express, indicate, locate, recognize, report, restate, review, select, or translate.
3. Application. Uses learned material in a new situation. ***Application level operations*** -- apply, change, compute, demonstrate, operate, show, use, solve, calculate, complete, illustrate, examine, modify, relate, change, classify, experiment, dramatize, employ, illustrate, interpret, operate, practice, schedule, sketch, or write.
4. Analysis. Breaks things down into parts in order to understand, organize, or clarify. ***Analysis level operations*** -- identify parts, distinguish, diagram, outline, relate or associate, break down, discriminate, subdivide, analyze, separate, order, explain, connect, classify, arrange, divide, select, explain, infer, analyze, appraise, calculate, categorize, compare, contrast, criticize, differentiate, discriminate, distinguish, examine, experiment, question, or test.
5. Synthesis. Puts parts together to form a new whole. ***Synthesis level operations*** -- combine, compose, create, design, rearrange, integrate, modify, substitute, plan, invent, formulate, prepare, generalize, or rewrite.
6. Evaluation. Uses a given criteria to determine the value of a thing or quality of a product or performance. ***Evaluation level operations*** -- appraise, criticize, compare and contrast, support, conclude, discriminate, find main points, explain, infer, deduce, assess, decide, rank, grade, test, measure, recommend, convince, select, judge, explain, discriminate, support, argue, choose compare, defend, estimate, judge, predict, rate, select, value, or evaluate.

THE TWO WAY FLOW OF INFORMATION

Notice in the diagrams of the information processing model that the arrows point both toward and away from LTM. This is to indicate the two-way flow of information. In the act of perception, encoding, and retrieval, data moves both to and from LTM.

LTM to STM

As we take in information from sense memory it moves to STM and eventually to LTM; however, data in LTM helps us understand and encode information in STM. In this way it moves from LTM to STM and even sense memory. And the more knowledge about a particular topic we have in LTM, the easier it is to understand and encode data in STM. For example, I have a lot of knowledge in my LTM related to educational psychology. When I encounter new information related to this topic I am able to understand and encode it quickly and efficiently without much memory loss. Also, when I read books related to this subject I am able to comprehend and remember much of it. Now I'm guessing I'm able to do this better than most of you who are currently reading this book. But it's not necessarily because my brain functions any better than your's. Instead, it's because my brain is jammed full of Ed Psych stuff. This enables me to perceive, encode, and retrieve data Ed Psych data fairly easily. I know exactly what to look for it, where to store it, and how it relates to or is connected with other things.



However, when this same brain is exposed to information related to operating my digital camera, encoding seems to be slow, inefficient, and labored with a much memory loss and very little understanding. This is because there are very few files folders in my LTM related to operating digital cameras.

For example, I recently brought my brain to the store to buy a digital camera. The store clerk said to me *"It's easy."* But as she tried to explain how the camera worked, all I heard were a bunch of meaningless words coming out of her mouth. Since there was no flow of information from LTM to STM to help my brain process and encode those words, they instantly leaked out of my head into the universe someplace. And because I didn't' want to appear a total ignoramus, I nodded my head as the store clerk spoke to me and said, "*Uh huh, yep, yep, uh huh, I see,"* as if I was getting every word.

And when I got home and tried to read the direction manual there was very little comprehension. Even re-reading the material did little to improve my understanding. What I will eventually have to do is play around with it so that I had some experiential knowledge to the file in LTM. I may also have to ask a colleague to explain it to me using very simple words. These things may enable me to go back and read the direction manual with more understanding.

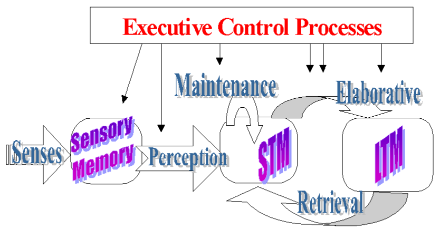
The point is this: The same brain was interacting with the Ed Psych stuff and the digital cameras stuff yet meaning and understanding vary greatly. What is different is the type and amount of pre-existing knowledge in the brain.

LTM to SM/Perceptions

In the same way, we use information in LTM to help us perceive and attend to stimuli in sensory memory. Two specific example of how LTM enhances perception: The first example occurs during the process of reading. As discussed briefly above, the knowledge in my head related to educational psychology helps me to perceive and identify important words and concepts quickly. In reading I am able to perceive these words microseconds faster than I would words related to digital cameras. Again, it is the knowledge in LTM that enhances this process.

The second example: I am able to perceive a wide variety of data when I visit an elementary classroom. This is because I taught in elementary classrooms for nine years and have visited hundreds of classrooms in the Twin Cities and in Southern Minnesota area over the last 17 years as part of student teaching and other field experiences related to our teacher preparation programs here at Minnesota State University, Mankato. These experiences (episodic knowledge), combined with the countless books and articles I've read and written related to teaching and learning (semantic knowledge), give me quite a large file in my cognitive file cabinet devoted to these things. As such, I can go into a classroom and instantly perceive things that my beginning students cannot. I am able to give you a sense of the overall tone, the effectiveness of instruction, the probably philosophy of the teacher, and the particular strengths of that teacher. This type of perception is related to Bruner's concept of intuition, which is being able to see the connections between a many data dots.

EXECUTIVE CONTROLS



The last thing I'll look at in this chapter is the executive control or executive function process of the information processing model. One way to conceive of this is as the mind behind the brain. This can be an area where educational psychology and educational philosophy overlap a bit. The human entity is not simply a brain responding willy-nilly to stimuli. Instead, there is a mind driving the great brain tractor. The tractor driver controls where attention is placed, what stimuli to attend to, what strategies to use, what information to encode and retrieve, what signals to send to various parts of the body, metacognition, and all other functioning. Right now, your tractor driver is controlling where you put your attention and looking to create meaning with the words appearing in front of you.

This executive control process can also be thought of as metacognition (thinking about thinking) or even metamemory which is the awareness of and control over our memory processes (Eggen & Kauchak, 2007). However you choose to conceive of it, there is a part of our brain that controls perception, attention, encoding, retrieval, and other memory functions.

Looking Ahead

The next chapter will describe how the cognitive learning theories can be applied to teaching and learning.

Summary of Key Ideas

• The information processing model or the standard memory model describes how we take in information, analyze, store it, and retrieve it.
• Sensory register or sense memory holds onto sensory information just long enough to be processed and moved into short term memory or discarded.
• Short term memory holds 7 +/-2 bits of information for about 15 seconds before being moved into long term memory or forgotten.
• Working memory is the part of short term memory that manipulates or works with information received from sensory registrar or retrieved from long term memory.
• Long term memory can store an almost unlimited amount of information for an almost unlimited amount of time.
• Information flows both ways; from sensory register to short term memory to long term memory, and back.
• The executive control determines perception, attention, encoding, and retrieval of information.

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