Pat Wolfe Brain Matters

(Pages correspond to page numbers on slides.)

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During any fractional moment in time, an enormous amount of sensory stimuli is bombarding our bodies, giving us much more information than we can possibly attend to. If you were consciously aware of all the images, sounds, tactile sensations, tastes, and smells that were simultaneously impinging upon your body, you would experience sensory overload.

There has to be some provision for discarding irrelevant data. The role of filtering the enormous amount of information entering the senses is what we are calling sensory memory.

By some estimates, 99% of all sensory information is discarded almost immediately upon entering the brain.

There would be little functional or survival value in remembering what your clothes felt like on your body a few minutes ago, or how a pen felt in your hand when you were writing a week ago.

Pg 80
When information travels from sensory receptors to where it's processed, it transforms.
In other words, we don't see the photon of light or the sound wave per se, we <u>perceive</u> a figure or a sound.

***The figure didn't change; your perception changed based on what you were asked and your knowledge of numbers and letters. To a child who had no stored information of numbers or letters, it would be a meaningless figure.
Meaning of incoming stimuli depends on prior knowledge and on what we expect to see. Matching of new input to stored info is called pattern recognition and is a critical aspect of attention.

** Children often criticized for not paying attention. There is no such thing. The brain is always paying attention to something. What we really mean is that the child is not paying attention to what we think is relevant or important.

Pg 82
Novelty is an innate attention-getter. To survive, our remote ancestors living on the savannahs or in caves had to be aware of any novel or unique stimulus present in the environment. Our brains today are still programmed to pay attention to the unusual.
Teacher examples.
If same sight or sound occurs over and over, brain becomes accustomed to stimulus and ignores it. Habituation (airplanes flying overhead, smell of perfume)

Intensity & Movement

Teacher flicking lights or talking louder than students only works initially.

Last two factors teachers have more control over.

Pg 84
Think about picking up a book or magazine in waiting room, but it's in another language. Sustained attention on something you can't figure out or that makes no sense is not only boring, it's almost impossible. Yet too often teachers expect this out of children.

Meaning: Dalmatian Picture

Even though you can't see entire dog, your brain used what information was there to allow you to recognize it. You would never be able to detect this dog among the spots if you had never seen one or a picture of one and it were not already stored in your brain.

Pg 86
If your brains can find no previously activated networks into which the new information fits, they are much less likely to attend to it. Our species has not survived by attending to and storing meaningless information. Our brain discards information that is meaningless.
If what we teach in schools fits this description, we shouldn't be surprised that our students' brains often refuse to attend.

Emotion: pg 86
Brain is constantly scanning its environment, sifting and sorting through incoming information to determine what to keep and what to ignore. Why? It's essential for the survival of individual and species. If a dangerous animal were charging toward you and your brain decided to focus on its rate of speed or taxonomic classification, you wouldn't be around later to pass on your genes.

If you see something coming toward you, your brain reacts emotionally. Is this something that could hurt me or something I like? Do I run away from it or toward it? The brain is programmed to attend first to information that has strong emotional content. We not only pay attention to physical dangers, but also facial expressions and other body language that contain emotional information necessary for survival. Consider the social problems of autistic children who generally lack the ability to read these cues.

Pg 93
Think of working memory as the CEO of a company, who keeps track of who does what and makes sure everything gets done.

Pg 95
Without rehearsal or constant attention, information stays in the working memory for about 18 seconds. It may seem too brief, but it's actually efficient. If you couldn't remember information for at least 18 seconds, you would forget the words at the beginning of a sentence and comprehension would be impossible. On the other hand, it would not be good to remember permanently every word in every sentence you have ever read.
Fortunately strategies exist for retaining information much longer than 18 seconds.

Pg 96
How is it that in a noisy, confusing environment, (at a party) where many conversations are occurring, you are able to focus on a single conversation? Your brain uses selective auditory attention- or the cocktail party effect. This allows you to filter out the other conversations and pay attention to the one most relevant. It's mostly not possible to pay attention to two conversations at once.
This was first studied in the 1950s. Subjects were asked to repeat or "shadow" one train of thought coming from one earphone. They remembered little of the unshadowed message.

A similar effect can be observed in visual processing. The following experiment will allow you to experience this. You will see a paragraph. As quickly as you can, read **ONLY** the words in **BOLD.**
Recall all you can about what you read. Nor try to remember the light words. You probably didn't remember many light words. Did you notice that they are the same 7 words repeated over and over?

Pg 97
Have you experienced this in real life? Talking on phone and someone else tries to talk to you? It is nearly impossible to consciously process two trains of thought at the same time, especially if they involve the same sensory modality.

Consider the typical lecture in class where students are required to take notes. Trying to take notes is a difficult task. If students begin to think about what the teacher said, the next input may be missed. Often students write the words on the page but have little conceptual understanding of what they just wrote. If students don't comprehend, or begin to daydream, none of the lecture is processed.
Note that doing 2 things at the same time is different from consciously processing two inputs at the same time.
Ex: writing is now automatic, reading/decoding is. We comprehend when we read because decoding is now automatic for us.
Brainstorm a more effective way to lecture.

Pg 98
Spend 7 seconds memorizing this list of numbers.
Now take 10 seconds to memorize 10 numbers.
You probably did not do as well on the second one.
Studies have shown that people remember about 7 items, be they words, objects or numerals, plus or minus 2.
5 year olds= 2 digits
7 year olds= remember 3
Age 11= 5 digits
Age 15 , same as adults, about 7 +- 2.

How to improve on this magical number of 7? This limitation can be circumvented somewhat by the ability to chunk information.

Pg 99
Try memorizing this sequence of 14 letters. Difficult b/c it exceeds the capacity of your working memory (7). But what if you rearranged the same letters into more meaningful units? Now the letters form 5 chunks that are easy to remember.
Phone numbers and SSN are chunked into 3 groups
The difference between novices and experts in a field appears to be that experts have the ability to organize information into much bigger chunks while novices work with isolated bits of information.
We can't increase the number of chunks we can store, but we can (by reorganizing or recoding) increase the amount of information that can be stored in each chunk.

Pg 100
Teachers often want to “give” their students the benefit of their experience and tell them what the connections are and how the information fits together. This seldom works; students need to make the connections themselves. Mark Twain quote. Teaching is guiding and facilitating the formation of neural connections in the student’s brain.

Chess players don’t become experts by having someone tell them how to play. They have to pay a lot themselves and become familiar with the patters and reorganize the information to be able to “see” the chunks. Teachers provide the experience and the guidance, but the students need to do the work.

What does this work look like? Rehearsal or practice.

Pg 101 Pg 102-
Rote- repeat information over and over until it becomes automatic.
Decoding, driving, swimming, riding a bike,
Playing piano, writing, basic math,

Elaborative-
How many of you have memorized a definition for a test (and hopefully no one talked to you right before) but the definition had no meaning for you and you forgot it the next week? The same is true for *comprehending* an event in history, an algorithm in math, or a formula in chemistry. That’s why rote rehearsal isn’t effective for much of what we should be learning in school. We should be using elaborative rehearsal strategies.

Partner- list different tasks and label as better for rote or elaborative learning

Pg 103
The brain is continuously scanning the world to make sense of the constant bombardment of stimuli impinging on the body. For our survival it’s one of the brain’s most important jobs so we’re not overloaded and can’t make decisions necessary for our survival.

The brain sifts through all incoming stimuli and selects those that are most relevant or meaningful and we determine that in part by consciously processing information. Remember, information storage in the brain can best be described as networks of associations. These networks are formed over our lifetimes by the experiences we’ve had. Information that fits into our adds to an existing network has a much better chance of storage than information that doesn’t

In our attempt to help learners store information and improve their ability to recall it, we need to make certain that what we are teaching is not “nonsense” to the student’s brain. Teachers need to take advantage of the brain’s natural proclivity to attend to what is meaningful.

Pg 104-5
One of the most effective ways to make information meaningful is to associate or compare the new concept with a known concept, to hook the unfamiliar with something familiar.
Analogies, similes, metaphors

To explain parallel lines, have students think of RR tracks, sides of paper, door, windows

In studying fish for the first time, it’s easier to understand the function of gills, if you’ve already studied the function of lungs and teacher can show how they’re analogous.
The best way is to make something personally relevant. Talking about wins and losses for soccer or football games when learning about percentages or talking about “math families” to younger students is effective.

Brainstorm lists of examples.
Pp 105-6
There are some things students need to have “at their fingertips” that have little inherent meaning. When meaning or relevance is difficult to establish (such as remembering the alphabet or stages of cell division in mitosis) using a mnemonic device is another effective elaboration technique. Acronyms and acrostics associate a list of items in order with a known word or sentence, thereby making them much easier to remember.

Play game, brainstorm examples.

Pg 179
Many educators consider mnemonics as intellectually unrespectable because they do little to enhance meaningful understanding. The truth, however, is that mnemonics can be effective learning strategies. Contrary to what many people believe, they don't just foster rote memory at the expensed of comprehension and problems solving. Mnemonics are based on the principle that the brain is a pattern seeking device, always looking for associations between the information it is receiving and what is already stored. We require students to remember a considerable body of material that has no inherent meaning, such as letter of the alphabet or items that make up a classification system. Mnemonics create links or associations that give the brain an organizational framework on which to hook new information.

Examples

Keyword method
6th graders using this strategy recalled twice as many foreign words as children of comparable age and ability who were left to learn the words on their own

Loci mnemonics
Link a word to a place already in your memory. Take a mental walk through a familiar place, like your house and visualize the items to be remembered there. Exaggerate their size, make them animated, or change their color. When you need to recall the list, you take another walk through your house and 'see' the items in the order you placed them.

Narrative chaining
Weave items to be remembered into a story framework. Ex. To help them remember the freedoms listed in the First Amendments to the constitution, one narrative imagined a group of people marching through the town and eventually assembling in front of a large cathedral. (freedom of religion and assembly)They strung cables, set up microphones, and began giving speeches (speech) about their right to have guns to protect themselves.(bear arms) Many members of the press arrived and began taking photographs and videotaping interviews with members of the groups (press,)

Students who used narrative chaining recalled more than 90 % of the 120 words whereas the control group remembered only 13 %

Pg 106-7
So recall that elaborative rehearsal is a broad category encompassing a variety of strategies to enhance understanding and retention. We just talked about meaning and retention. Now we're going to talk about Emotion and retention.

We already learned that the brain pays attention to information that is emotional. Whatever our behavioral reaction, an emotional event is nearly always stamped with extra vividness which results in enhanced memory. Our own experiences validate that we remember for a longer time events that elicit emotions in us; this idea is also supported by a lot of research.

Examples: positive and negative --giving birth, being spanked, humiliated by teacher.

How does this work? Chemicals such as epinephrine (adrenaline) released during flight or fight response enhance memory for that emotional event. Pos or negative, however, the more intense the emotion, the stronger the imprint. It's almost as if the brain has 2 memory systems, one for ordinary facts and one for those that are emotionally charged.

Activities such as simulations and role plays are often highly engaging and enhance not only the meaning of the material but also the emotional connections. Teachers who have their students act out a particular event of history or form a mathematical equation using fellow students are increasing the chances of retention for the event or equation.
Setting up a grocery store in the classroom to learn about the value of coins and bills and how to make change is more likely to hook into the emotional network than completing a worksheet on the same subject.

Pg 109
Solving real-life problems is another way to raise the emotional and motivational stakes. For example, students in one school district acquire problems from local businesses and work out solutions, which they then present to the owners. A group of MS students designed a way to save water in their state, contacted their state legislator to help them draft a bill, then lobbied for passage of the bill in the state capital.

Effective teachers make use of the neurological basis of the effect emotion has on learning and design ways to make what students are studying more meaningful and emotional. They do this by….

Think about your own school experiences. Which ones stand out? Chances are you'll be able to recall the emotional component of those experiences that caused you to remember them over all others.

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If you have no stress in your life, you probably won't get out of bed in the morning; if you have too much stress in your life, chances are you won't get out of bed in the morning. As with many things in life, more is not necessarily better, especially when it comes to the stress response. The ability to experience and talk about our emotions is a singularly wonderful human quality, but it has its downside. The stress response was designed for life in caves, but we don't live there anymore. The contemporary human brain does not distinguish between actual physical danger and psychological danger; it sets the same physiological chain of events in motion in either case. Having your blood pressure go up, blood clotting elements released into your bloodstream, and your immune system suppressed is fine if you are faced with a cave bear. It isn't particularly helpful when someone pulls into a parking spot you thought was yours.

In contemporary life, we often extend the response by talking about the stressful event, reliving it, or worrying it will happen again. We have a tendency to keep ourselves in a chronic, prolonged fight or flight state, with potentially negative consequences.

In the classroom, a student can perceive even a mild stressor to be threatening, initiating the stress response and lessening the student's ability to perform. Being laughed at, bullied, timed tests, being called on when not prepared, or general fear of failure. Under these conditions, emotion is dominant over cognition. The rational/thinking cortex is less efficient. Have you ever received an insult and not been able to think of a retort until the next day?

Emotion is a double-edged sword, with the ability to enhance learning or impede it.

Ch 7 long term memory

Pg 112-114
You smell a particular antiseptic and the memory of a hospital stay comes flooding into your consciousness, even though you haven't thought about that event for years. People start singing a song and you remember most of the words even though you haven't sung it in years. You haven't ridden a bike for a long time and some kid wants you to show him how and soon you are doing wheelies.
These examples are all thanks to long term memory. Without it you would be unable to learn or benefit from experience.
The information stored in long-term memory is relatively permanent but not always accurate.

While we often think of memory as a single process, memory storage is actually more than one type of process. The two forms of memory are localized in different neural systems.

Procedural vs. declarative.

Partner up- A tell B how to tie shoes <u>without doing it</u>

<u>Tying your shoes is procedural memory</u>

Procedural memory is knowing how versus knowing what. It is sometimes called nondeclarative; You do not need to 'declare' anything, and you may not be able to say much about what you are doing, for the information to be stored. The first type of procedural memory is your ability to store automatic processes for routine actions (SKILLS). The "how" to do things. Walking, brushing your teeth, driving, decoding. After lots of repetition and practice, these become automatic and we do them without a lot of conscious thought. Once we have this skill, it's hard to access it without performing it. Like teaching someone how to tie a shoe, swing a golf club, write a word.

Reading is a nonmotor skill. When you first learn to read your eyes move slowly from word to word. Skilled readers move their eyes about 4 times a second taking in the meaning of more than 300 WPM.

Second type of procedural memory is PRIMING. This involves being influenced by a past experience without any awareness of consciously remembering that experience. Skills and Priming are both called implicit memory. You aren't consciously aware of what you are doing.

All this to say that having seen or experienced something previously seems to prime our ability to recall it later.

Declarative memory is our ability to store and recall information that we can declare (speak or write). It requires conscious processing and if reflective rather than reflexive.

Two categories, episodic and semantic memory.

Episodic memory is sometimes called “source memory” because it involves remembering where and when information was acquired. It allows you to remember a hike you once took, how much you loved your first grade teacher, and a surprise birthday party. As critical as episodic memory is (you need to remember where you parked your car), it can be problematic at times. The brain does not store memories in a linear manner like a video camera does. It stores memories in neural circuits or networks. When we recall an event, we are actually reconstruction it. While many events are important or emotional enough to be remembered, the details often escape us. The brain “fills in” the details (refabrication)- reconstructing memory from bits and pieces of truth. As we tell our stories over and over, we embellish them, add to them, and make them more elaborate. Eventually, it’s virtually impossible to distinguish it from what actually happened.

Semantic memory on the other hand is generally fairly accurate. It includes words, symbols for them, rules for manipulating words, and their meanings. Grammar rules, chemical formulas, math facts (6x7=42) is semantic memory.

Pg 118
Long-term Potentiation (LTP)

Synapses between neurons representing experiences become strengthened or potentiated over a period of time. (LTP). The more often the pattern of neurons is activated, the more efficient the synapse becomes.

Rat study- in an “enriched” environment- up to 20% more synapses per neuron were found in the visual cortex of some of the animals. Wild rats had even more dendritic growth and heavier cortices.

What can that mean for humans? Children? Babies?

Pg 120
In his book, science writer Ronald Kotulak uses the metaphor of eating a meal to represent the encoding and storing of information.
If you think about it, this is efficient. The same brain cells can be used many times to recall similar lines, colors or smells. For example, it allows us to see the color red in a red rose, a read heart, red sunset, etc. But <u>there is no memory center in the brain that represents an entire event at a single location.</u>

So if memories are not stored in specific locations in the brain, how do we retrieve them? It is essentially a process of reconstruction or reactivation.
Recall the Dalmatian picture. You only needed the definitive elements to reconstruct the total picture. When a critical mass of sensory neurons is activated, the brain fills in the missing portions to complete the picture. But you had to have previously stored the image of the Dalmatian in order for it to be retrieved. The same is true when remembering an event. If the cue or reminder of an event is weak, what is reactivated may differ from the original memory or even belong to another episode. That is why "eye-witnesses" or events are generally unreliable.

Pg 122
<u>Procedural pathway to LT storage</u>
You may drive your car on a familiar route, get to your destination, and realize you were not aware of driving there. When you meet someone new, you automatically extend your hand in greeting. You may read a page of text, get to the bottom and realize you don't remember what you just read b/c you were thinking about something other than the text! There motor skills and habits are all examples of procedural or non-declarative memory and were accomplished without your conscious awareness.

<u>pg124</u>
<u>Declarative Pathway to LT storage</u>
With repeated activation, the memories form neural links that become more or less permanently embedded in the frontal cortex and temporal cortex.
Even after an event has been placed into memory, some time must pass for the memory trace to become fully established or organized in the brain. This gelling or setting time is labeled the consolidation period. Consolidation is undoubtedly enhanced by rehearsal.
When we replay our experiences (talk about them and think about them) we are providing more opportunities for consolidation. Perhaps this is why instruction that allows students to hook new information to previous experiences increases the strength and complexity of their neural connections and therefore, the retention of the information.

Pg 126
During sleep, especially REM sleep, our brains are relieved from processing the continual input of information that occurs during waking. One neuroscientist hypothesizes that during sleep, the brain continues to work through the experiences of the day. You have probably notices that your own dreams often contain fragments of what you did during the day. It may be that your brain is replaying these experiences, helping to consolidate them just as consciously reviewing information during waking hours does. If this is true, sleep is an important participant in the formation of long-term memories.

Researchers most frequently discuss consolidation in terms of declarative memory, but recent research indicates it also involves motor (procedural) memory. When subjects learned a second motor skill task immediately after a first skill was learned, the consolidation of the first motor skill was disrupted. The disruption did NOT occur if 4 hours elapsed between the first and second skills.

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Educational Implications
Unfortunately we don't know exactly how long students' brains need to consolidate a particular learning before moving on to another. We do know, however, that consolidation occurs and that it takes time. We also know that teaching something new too soon disrupts consolidation of previous learning.
Teachers can build elaborative rehearsal strategies into instruction- allow students time to process information more in depth- this may increase the strength of the learning b/c these strategies allow consolidation to take place.

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Students often memorize information for a test and then promptly forget it. The problem is exacerbated by the demands to cover more curriculum- and covering is often all that happens. Coverage (going over information superficially) does not build strong neural connections and therefore is seldom remembered or remembered incorrectly.

Elaborative rehearsal better than rote for long term declarative memory. Take time to process information for consolidation.

Part III 3 levels of learning
Concrete Experience Example
Imagine that you are a young child going for a walk with your father. Suddenly a small, furry, four legged creature that you have never seen before comes out of a yard and sits on the sidewalk in front of you. After telling you not to be afraid, your father labels this creature for you. He tells you it's an animal, a dog. He lets you pet it. This experience will be stored in your brain in actual physiological connection between neurons. If on subsequent walks you encounter this same dog again, the connection will be strengthened, and we say that you have *learned* what this animal is.
But learning isn't this simple, b/c it won't take long for you to realize that dogs come in many shapes, sizes and colors. All this info will be incorporated into your "dog network" Some dogs will be friendly, others not and you will add emotional associations to the existing information. This network is well underway to becoming complex, when you'll go for another walk and encounter another small, furry, four legged creature. This time, you say dog, but your dad say's no, it's a cat. Your brain now has to begin forming a new network containing information about cats. In time, this new web will be part of a larger network labeled "animal."

What are examples of educational experiences that are concrete?
Field trips? Outside?
How realistic?
Fortunately we are not limited to learning solely in this way.
Instead of going to zoo all the time, children can look at pictures in an animal book and they will quickly learn to match the name of the animal to its picture. But the initial concrete experience will make the exotic animals much more meaningful than if the children had never visited the zoo.
Using symbols or representations of real objects is a second level of learning . At the zoo, your brain took in the entire environment as well. All that sensory data became part of the animal memory and are activated when it is remembered. When you look at the picture of an elephant, the neural network you activate allows you to remember where you were when you saw one, how it smelled, the trumpeting sound it made, perhaps the feel of water it sprayed on you. Without the concrete experience, the representation or symbol may have little meaning no matter how much someone explains it to you. This is certainly true in schools, where students are often exposed to representational information that has no concrete antecedent. Textbooks are crammed with pictures of science experiments, photographs of people in other communities, diagrams of digestive systems, and other symbols of real things. While they may be visually appealing, they do not bring to the

students' minds the rich sensory info contained in a concrete experience and therefore have less meaning.
A third level of learning uses primarily words or numbers. Now that you are older, is there any way you can expand your neural network of animals? It is probable that you can now discuss animals you've never seen, whether real or imaginary (3 headed fluffy in Harry Potter). How? By reading about them. With a strong neural network formed by both concrete and representations of animals, it is not possible to read about an animal and "see" it in your mind's eye. Many abstract concepts don't even have a visible concrete counterpart, such as "democracy" or "culture."

Read pages that talk about specific examples, discuss with group, be ready to share with class. Complete G. O.

Visual and Auditory

Take a moment and think about a particularly memorable event in your life. (share) Whatever comes to mind, you remember it not in words but in images and sounds. Of course, when you describe the event to someone else, you use words, but what you are describing is what you are seeing and hearing inside your head.

These sensory abilities are powerful components of brain functioning and we can use them to enhance understanding and retention of information.

5th grade students have difficulty with multiplying and dividing fractions. It is difficult for most students to create a mental picture of ¼ x 1/3. It can be done if you understand that it really means ¼ of 1/3 of a whole.

There is impressive data showing that piano keyboard training, taught in conjunction with a computer program that uses image to depict math and science concepts, dramatically increases elementary students' math understanding and test scores.

One study had a group memorize dictionary definitions of words, a second group drew pictures of them. The second group remembered more.

College students memory of Spanish vocab words went from 28-88% when they linked a picture to an English noun.

A first grade team designed a "gallon" person, with the body being a gallon, the arms and legs being one quart each, the wrists and ankles making up 8 pints (2 each) and four digits on the hand and foot representing cups.

To help students understand the correct placement of quotation marks in written dialogue, students can draw a happy face and place the quotation marks at the corners of the mouth.

MS. A science teacher has students take notes in split page format. Left side they take notes on what they are reading, right side, draw pictures to represent what they have written.

Can you do that on your own at home?

Mindmaps, thinking maps, webs, clusters, network trees, fishbone maps, graphic organizers, have proved effective because these visual devices make it possible to see connections between aspects of the information that are not obvious in a linear form such as an outline or narrative. The

structure of these frameworks resembles the structure of the brain to organize the information.

Music

People can typically remember lyrics of tunes and rhymes but less successful in recalling prose.

Music uses many of the same higher brain functions as math and science and training in music can enhance these functions.

There is an interactive math software program called Spatial-Temporal Animation Reasoning (STAR) which allows children to solve geometric and math puzzles that increase their ability to manipulate shapes in their mind. Combining instruction on piano keyboards with STAR training has raised inner-city 2nd graders score 27 % higher in math and fractions.

When studying fractions, link whole, half, and quarters to notes.

Piggy back songs

One group of boys explained the braking system of a car to the tune of "YMCA, with all the appropriate motions included.

In an environmental science class, students wrote riddles about various chemical elements such as "I'm the lightest of gases, I'm found in all stars, Touch me with a match, and I'll blow them apart! What am I?"