6

Foster Learning

It may be true that "you can't teach an old dog new tricks."

But then, we aren't dogs.

In this chapter:

- The unique characteristic of the brain's design that makes life-long learning possible
- How positive and negative emotions affect the way we learn and remember
- The two factors the brain considers when deciding whether information is worth retaining
- Why a good night's sleep can be crucial to the learning process
- The brain science behind the idea of "getting it right the first time"
- How our fundamentally social nature influences the way we teach and learn

While driving back from Mexico to his home in California, 30-year-old David was involved in a terrible traffic accident that left him in a coma for five weeks. Although he had to have his right arm amputated and had suffered a severe trauma to his head, when he finally regained consciousness, his parents were greatly relieved that he seemed to exhibit no deterioration in his mental capacities. Moreover, the doctors saw no obvious signs of any psychosis or other emotional disturbances.

No *obvious* signs.

Much to their shock, what his parents soon discovered was that David no longer recognized them anymore. It wasn't that he didn't know what his parents looked like. He knew *exactly* what they looked like. But he was convinced that the two people who claimed to be his parents, the two people who lived in the house where David's parents were supposed to live, were another couple -- an exact copy. It's true that the man and woman who claimed to be his father and mother seemed to know absolutely everything about him, including many things that only parents could know, but as far as David was concerned, they were just very clever impostors. "He looks exactly like my father but he really isn't,"[1] he told the doctor, admitting that although the man who claimed to be his father seemed nice, he just wasn't his dad.

The woman who insisted that she was David's mother found herself in a similar predicament. One evening when she made him a dinner that apparently he didn't enjoy, David told her, "You know, that lady who comes in the morning she cooks much better than you." But of course the lady who had fixed him the dinner he didn't like and the better cook who had come to the house that morning were one and the same.[2]

As time went on, David's parents grew steadily more saddened and frustrated by the fact that their son stubbornly insisted that they were impostors. After two months of this disturbing behavior, they finally sought the help of world-renowned neuroscientist V.S. Ramachandran.

Ramachandran was able to quickly identify David's strange behavior as something called Capgras Delusion. Named after the French psychiatrist Joseph Capgras, who first described the disorder in the 1920s, Capgras Delusion is characterized as "delusional misidentification syndrome." Although it is found most often in cases of paranoid

schizophrenia, it also occurs in patients who have experienced brain trauma or are suffering from dementia. Perhaps because Capgras himself was a psychiatrist, the syndrome was initially thought to be Oedipal in nature. In fact, the predominant Freudian theory suggested that a patient might be attempting to resolve the intense anxiety caused by a sexual attraction to his mother by branding both parents as impostors.

As a neuroscientist, Ramachandran was understandably skeptical of this psychiatric explanation, pointing to documented cases where Capgras patients believed that even the family dog had been replaced by an impostor. It seemed clear to him that something else was the cause.

There was yet another wrinkle to the story that made an already strange situation even stranger. One day when his father called home, it was David who answered the phone. Although he was still firmly convinced that he was living with counterfeit parents, David had no trouble believing that the person on the other end of the line was actually his father. What was it that allowed David to accept his father's authenticity on the phone, but left him unable to believe him in person?

As it happens, the solution to David's mystery is also the key to why we remember some things and not others and the answer to how you can improve the odds that any learning you do will be learning that lasts.

* * *

Our plastic brains

Most people, even neuroscientists, once believed that learning was limited to your youth and that your brain was essentially hard-wired by the time you reached adulthood. The expression, "you can't teach an old dog new tricks" has reinforced this mistaken impression. So have countless experiences of people who tried unsuccessfully to take up a foreign language later in life or who returned to college as adults and found school to be a struggle.

Contrary to the old saying and despite anecdotal evidence, neuroscience has proven that lifelong learning is entirely possible. This concept is known as neuroplasticity.

Rather than being frozen when you're younger, your neurons have the potential to constantly rewire themselves throughout your life. Neuroplasticity can physically change the structure of your brain, increasing the size of particular regions and the speed with which those regions communicate with each other.

One of the most dramatic demonstrations of neuroplasticity involved some taxis, some buses, and one of the world's best-known cities.

Taxi!

Getting around London isn't easy. As humorist Dave Barry once explained, "… no street ever goes in the same direction or keeps the same name for more than 35 yards. At that point it veers off in a new direction under a new name, assuming a whole new identity…"[3] Unlike Washington, D.C., which was carefully mapped out in advance, London simply evolved. Through the centuries it steadily expanded by gobbling up unsuspecting villages and towns in its path like some sort of geographical Godzilla. No wonder there's little rhyme or reason to its layout. Granted, from time to time, the city added the occasional innovation, such as the sadistic "roundabout," the evil older brother of the American traffic circle, which gyrates unsuspecting motorists until all but the hardiest are completely disoriented.

A genuine navigator's nightmare, Swinging London and its 25,000 streets provided an ideal laboratory for demonstrating the brain's extraordinary capacity for change. Scientists scanned the brains of a group of London cab drivers. Then they did the same for a group of the city's bus drivers. Two years later, they scanned the brains of both groups again. What they noticed when comparing the scans was amazing. With each cab driver, the posterior hippocampus, a region associated with spatial learning, had increased in size, while the bus drivers showed no similar change. What accounted for the difference? Unlike the bus drivers, who traveled the same route day in and day out, the cab drivers were constantly called upon to navigate new nooks and crannies of the city's crazy geography. The challenge of finding their way around town led to the creation of more neurons. Their brains literally expanded to accommodate the new information.[4]

The ramifications of this study are startling. And they certainly aren't limited to people who live in London or spend their days driving a taxi. What the London cabbie

study shows is that we can continue to acquire new skills well into adulthood and that the regions of our brain – commonly known as gray matter – will increase in size to help make this possible. Lifelong learning isn't simply a tired slogan. It's an exciting reality.

Moreover, the brain's capacity to change isn't limited to its gray matter, which occupies only about half of the brain. Whereas gray matter handles our thinking, computing, decision-making, and most of all, our memory, white matter provides the brain's essential network connections. Increasing the size of your white matter can be like replacing a straw with a fire hose or trading in an old dial-up modem and installing a T1 line instead. As white matter expands, the rate at which one neuron can communicate with another gets faster and faster.

People who acquire a variety of new skills – everything from juggling to meditating to ballroom dancing – show an increase in white matter as they become steadily more proficient.

An Oxford study showed that learning to juggle resulted in improved connectivity in those parts of the brain that – not surprisingly – are needed to catch the balls.[5] After six weeks of training, jugglers showed increases in white matter in the parietal lobe, the region used for what we commonly refer to as "hand-eye coordination."[6] What's remarkable is that all of the subjects showed changes to their white matter, regardless of their abilities.[7] In fact, the benefits to the brain didn't come from the juggling but from learning something new. As University of Hamburg's Arne May, the author of earlier juggling studies, told *New Scientist* "It suggests that learning a skill is more important than exercising what you are good at already – the brain wants to be puzzled and learn something new."[8]

When you perform an activity that requires specific neurons to fire together, they release a special protein called brain-derived neurotrophic factor, or BDNF, which helps to consolidate those neurons so they fire together in the future. In fact, BDNF activates the nucleus basalis, which triggers acetylcholine. Acetylcholine, the A in the DNA of Peak Performance, is associated with sharper focus. BDNF also encourages the growth of myelin, a thin fatty coating that provides a slick sleeve around each neuron. Myelin is kind of like cognitive Crisco, the gloppy white vegetable shortening once common in

kitchens. It's a fatty material that builds up on your nerve connections, that greases the skids of your neurons, making connections from one neuron to the next more efficient and faster.[9]

As unbelievable as it may sound, neuroplasticity can even make it possible to retrain your brain's physical abilities simply by imagining those changes. In several studies, mental practice was found to produce the same alterations to the brain's motor system wiring as physical practice.[10] That air guitar you've been playing ever since high school may actually be providing you with genuine practice.

In the best known of these experiments, subjects were taught to play a simple melody on a keyboard. The group was split in two. One group practiced the melody two hours a day for the next five days, while the other group sat in front of the keyboard for the same amount of time and simply imagined playing the melody. Amazingly, both groups showed identical changes to their brains.[11] Although when called upon to play the piece, the subjects who trained on a physical keyboard had a slight edge after the same amount of training, a single two-hour training session was all it took to bring the mental practice group up to the level of their physical practice counterparts.[12]

In another study that is bound to make couch potatoes jump for joy (assuming they don't find even *that* too strenuous), subjects who did a physical exercise for four weeks increased their muscle strength by 30 percent, while those who only *imagined* the exercise saw a 22 percent increase in muscle strength during the same period of time. When we vividly imagine an exercise, the neurons tasked with stringing together instructions for movement are activated and strengthened, which in turn strengthens the muscles when they are contracted.[13]

Practicing practice

Bill Robertie, a world-class expert in chess, backgammon, and poker, credits his extraordinary success in these three very different games with his ability to learn how to learn. "I know how to practice," he says. "I know how to make myself better."[14]

Practice makes perfect and practice makes practice *more* perfect. Just as practicing a particular activity improves your ability with that activity, constantly learning improves

your overall ability to learn. According to neuroplasticity pioneer Dr. Michael Merzenich, learning changes the structure of the brain and in the process further increases our capacity to learn.[15] In other words, learning how to learn is a skill in itself, and it can pave the way to more successful learning in a variety of subjects.

When you're aware of how your brain acquires knowledge and have developed strategies that capitalize on that awareness – psychologists call this metacognitive awareness – you have a powerful set of tools and techniques that should make all subsequent learning easier and more rewarding.[16] Former chess prodigy Josh Waitzkin, who earned the title of International Master when he was only 16, abruptly shifted his focus to the martial art of T'ai chi ch'uan while in his early twenties, and won the world championship at age 27. In his book, *The Art of Learning: An Inner Journey to Optimal Performance (2008)*, Waitzkin explains how he transferred the skills he acquired playing notoriously cerebral chess to become the best in the world in a physically demanding martial art.[17]

By the way, if you needed yet another reason not to multitask (see Chapter 3), here it is. Dr. Merzenich discovered that paying close attention was absolutely essential to long-term plastic change. When monkeys performed tasks automatically – without paying attention – they rewired their brains but those changes didn't last.[18] Long-lasting neuroplasticity depends on that now familiar trio that makes up the DNA of Peak Performance: dopamine, noradrenaline, and acetylcholine. While noradrenaline keeps you alert, the rewards that come from learning lead to secretion of dopamine and acetylcholine, which help to consolidate changes in brain maps.[19]

Of course, neuroplasticity is not without its downsides. Bad habits can change the brain as readily as good ones. That's why if you take up a new sport or acquire new information, it is important to "get it right the first time."

Get things right in the beginning

Thinking of taking up golf? If so, your best bet might be to take lessons right away rather than waiting until you've had a chance to play a few times. Unlearning is at least as difficult as learning, and probably even more so. Anyone who has picked up a bad habit can attest to this fact.

Bad habits take over a particular brain map, making those habits increasingly difficult to unlearn. This fact underscores not only the benefits of hiring golf pro, but also the value of early education.[20] Once you've practiced things the wrong way and the incorrect procedure has been stored in your basal ganglia (for more on habits, see Chapter 4), it can be tough to get it out. That hitch in your swing or that unorthodox grip you developed when you were still experimenting may prove difficult to overcome.

The tenacity of the initial learning experience explains why a number of prominent companies (including HP, IBM, and McKinsey) hire straight out of college (or grad school) so the first thing their employees learn in the working world is the company's particular way of doing things. Because the first time has the added advantage of novelty, that triggers dopamine, which helps to make your memories of that initial experience, whether it's right or it's wrong, even stronger and harder to unlearn.[21] Unlearning is difficult but not impossible. It just requires the right recipe.

Oxytocin and unlearning

In the 2004 movie *Eternal Sunshine of the Spotless Mind*, Joel and Clementine, former lovers, both seek to have memories of their failed relationship completely expunged from their minds. She gets zapped first without telling him, but when he finds out, he feels hurt and seeks a similar procedure out of spite. Luckily, there's a nearby company that's willing to provide the service for a reasonable fee. But this is the movies, and so the relatively straightforward goals of the estranged couple turn out to be significantly more complicated.[22]

Unlearning isn't simply learning in reverse. Different chemistries are involved in the two processes. When we learn something new, neurons fire together and wire together, and a chemical process occurs at the neuronal level called "long-term potentiation," or LTP, which strengthens this wiring.[23]

When the brain unlearns associations and disconnects neurons, another chemical process occurs, called "long-term depression," or LTD (which has nothing to do with a depressed mood state). Unlearning and weakening connections between neurons is just as plastic a process, and just as important, as learning and strengthening them. It appears that unlearning existing memories is necessary to make room for new memories in our

networks. If we only strengthened connections, our neuronal networks would get saturated.[24]

But how do we go about unlearning? Surprisingly, evidence suggests that oxytocin, the famous "cuddle hormone" (see Chapters 2 & 8) plays a role in our ability to wipe the slate clean of old information, although not necessarily old relationships.

Biologist Walter J. Freeman found that sheep release oxytocin when delivering their young but if that action is blocked that they fail to bond with their offspring. But here's the interesting part: The sheep don't release oxytocin when they deliver their *first* litter. The neuromodulator only plays a role in delivery in the second and subsequent litters. Yet ewes seem to have no trouble bonding with the offspring of her first litter. What this suggests is that rather than simply encouraging *new* learned behavior oxytocin aids us in forgetting *old* learned behavior.[25]

People who pair up with a new partner or spouse and find themselves – often to the dismay, amusement, or confusion of long-time friends – adopting brand new taste in music, clothes, politics, and perhaps even friends have first-hand experience with this phenomenon. It seems that oxytocin makes our neuronal pathways more malleable, enabling us to learn – and unlearn – more readily than we normally would. We become more impressionable and as a result, change becomes easier. Ironically, Joel and Clementine might've have saved considerable time, money, and heartache if they had each simply gotten involved with other people. And in a way, they did. But you'll have to watch the movie to see what we mean.

Old habits may die hard, but old skills can go fast. Another pitfall to neuroplasticity is that the brain is constantly searching for unused or neglected neurons that it can recruit for a brand new purpose.

The skills in your brain are like squatters. When they detect real estate that seems vacant or fields that have gone fallow, they take them over. This means that if you fail to practice the foreign language you learned way back in high school or stop dribbling a basketball, another function is waiting in the wings to take over that territory and use it for its own purposes.[26]

Many of us commonly refer to this as "being rusty." Cognitive scientists call this "competitive neuroplasticity." Like most of our body, the brain lives by the motto of "use it or lose it." When it comes to preserving a skill, if you want to retain it, you have to maintain it.

Like a person who is bored and desperately looking for something to do, neglected neurons usually find other purposes, and often quite rapidly. According to Nancy Kanwisher at MIT, "Neurons seem to 'want' input."[27]

This opportunistic tendency on the part of the brain often works in our favor. When a person goes blind, for example, the occipital lobe, the part of the brain that once handled visual stimuli, doesn't simply wither away. Instead it gets colonized by circuits used for processing sounds. Thus, it's no illusion that sight-impaired people often have more acute senses of hearing as well as extraordinarily sophisticated tactile skills that are needed to differentiate the raised-dot letters used in Braille. Their plastic brains have made this adjustment.[28]

Re-awakening old skills

Although the skills you once learned but fail to maintain may slowly fade from your memory, they're forgotten but not gone. The pathways are still there, but the space they occupy and the resources they consume have been greatly reduced.

These dormant neuronal pathways are a bit like the large purple fitness ball you once used with great enthusiasm for everything from push-ups to sitting at your desk but gradually grew tired of. Perhaps it's now deflated and sitting on a shelf in your closet or garage where it takes up less room. But if you should decide to begin using it again, you don't have to go out and buy another one. All you have to do is take it out, fill it with air, and it will be almost as good as new.

Once learned but rarely used neuronal pathways aren't purple and they aren't exactly deflated. Instead, key connections called dendritic spines, which look something like the buds on a fruit tree in early spring, grow or shrink depending on whether the skill is practiced or discontinued. As a result, when you re-learn an old skill, you don't have to start from scratch. The spines wake up from their winter of neglect and expand in a

springtime of renewal.[29] That explains, among other things, why you can hop on a bicycle after a 30-year hiatus and still pedal with the same skill and proficiency you first developed as a child.

Learn with your heart not your head

Despite its seemingly miraculous potential, neuroplasticity depends on a secret ingredient that you can't find in a pill or buy at any store. The stereotypical image of the highly knowledgeable person who is cold and efficient is actually at odds with the way that learning really works. The key to learning lies in the knowledge that it is a fundamentally emotional process, driven by the threat and reward circuits that reside in the limbic system. It's no surprise that an unpleasant experience, such as burning your hand on a hot stove, leads to immediate learning. Children who make this unfortunate mistake rarely make it a second time. The same applies to traumatic events such as the attack of the World Trade Center in 2001, which triggered what psychologists call a "flashbulb memory." Images of that morning or vivid (but not necessarily accurate) memories of "where we were when we heard the news" are etched in the minds of people all over America as well as in much of the world.

Although they aren't as powerful as threat responses, reward responses are the more common and much preferred driver of successful learning. It's no coincidence that children often learn best by playing or having fun. The importance of this crucial emotional element isn't limited to learning during childhood. A Spanish executive who had struggled for years to master English finally found the spark that enabled him to learn when he was able to make a connection between English and one of his favorite passions and pastimes.

Tanks for the English lesson!

It was no use. He was quite convinced of that. After all, he had tried on numerous occasions and each time he couldn't do it. By the time we met him, the Spanish executive was adamant: he would never, ever be able to learn English. He had a string of failures to prove it. He insisted that we were wasting both our time and his.

We had other ideas. Rather than following in the footsteps of our failed predecessors

and starting right in with a traditional English lesson, during his first session we took some time to get to know him. He was in his fifties and quite successful, despite his inability to speak the native language of everyone from Shakespeare to Shaquille O'Neal.

It didn't take long to realize that outside of his work that this man had a definite passion. He was enthusiastic student of World War II history. Although he read nearly everything about the subject that he could get his hands on (everything in Spanish, that is), he was especially fascinated with tanks. In fact, he even liked to build scale models of World War II tanks in his limited spare time.

Suddenly, we saw our opening. It was rewarding to see the man's face light up and his speech quicken whenever he got on the topic of his favorite subject. Our first session was drawing to a close and we had barely discussed English at all. Before we parted, we left him with a modest "homework assignment": Bring along one of his scale-model tanks for the next lesson, so he could explain all about it. If he could tell us about the components of his tank in Spanish, we'd return the favor by teaching him how to explain the name and function of each part in English. You could sense that this skeptical man was actually looking forward to his next English lesson – perhaps for the first time in his life.

Sure enough, for the next lesson, the executive brought in a lovingly constructed and meticulously painted scale model of a tank. And although it had required a little homework on our part as well, when the man methodically went through and identified each component of his tank, we were able to respond to his explanation with the equivalent in English. After that, we spent the rest of the lesson discussing tanks, but only in English.

In a short time, our reluctant executive could provide a simple, English-only description of his tank and its components. With each passing lesson we pulled further away from World War II and tanks and closer to the present day and to the practical English vocabulary that a business executive needs to remain competitive in a global marketplace.

Hot stoves, twin towers, and World War II tanks all share the common element of emotional impact. In general, when information moves us, scares us, pleases us, or

otherwise makes a powerful impression, we are more likely to remember it. But even this rule has its pitfalls and limitations.

When novelty backfires

If a teacher walks into a lecture room dressed only in a Speedo or bikini, that class is almost certain to be memorable. But as for the actual content of the class? It's likely to get lost in the shuffle.

Every now and then, there are well-intentioned attempts to make information more meaningful by livening up the lesson in one way or another. Unfortunately, there is a common tendency to confuse emotional relevance with sheer novelty. While attending a seminar of the psychological faculty of the Ludwig Maximilian University in Munich, we heard the sad tale of how instructors in business administration tried to freshen up a stale accounting lesson by changing the traditionally generic names in a well-worn example. "Company" became "Robot Racing Company" while "Person 1" and "Person 2" were replaced by real names, such as "Thomas" and "Annette," all with the goal of making things a little more exciting.

On one level, the strategy worked perfectly. It *was* more exciting. During class, it definitely seemed as though the students were having more fun and were more engaged. But when it came time for exams, reality reasserted itself with a vengeance. Although all of the students were able to correctly remember the silly name of the company as well as the names of the people in the accounting example, their test scores were abysmal. In fact, they were the worst ever!

What happened? Rather than supporting the accounting example, the creative names actually distracted from it. Students were drawn to the novelty of the names but lost the lesson in the process. The dazzling details outshone the essential information.

Because the size of working memory is limited and the stimuli that bombard your brain are practically relentless, your prefrontal cortex is often forced to make some pretty tough choices. Dopamine, the D in the DNA of Peak Performance, is a primary decider. Dopamine asks "Is it new?" And if the answer is yes, there's a good chance that your PFC will zero in on the information and that your working memory will begin the process

of retaining it. But if the information that is merely new is at odds with the information that is truly important, the latter is likely to get crowded out, leaving you with little or no recollection for the stuff that really matters and a dubious storehouse of titillation and trivia instead.

The lesson for leaders is clear: If you seek to increase the interest in the information you convey, be sure that the embellishments you add to liven up your lesson support your core message instead of competing with it.

Does this mean no Speedos or bikinis? Not necessarily. In his book *Brain Matters*, author and molecular biologist John Medina recalls a course on the history of cinema that he took as an undergraduate. One day in class the lesson was about the portrayal of emotional vulnerability in art cinema. As the instructor lectured, he began steadily and deliberately removing articles of his clothing. Stripped to just a T-shirt on top, he finally reached down to unzip his trousers, which fell to his ankles. As his trousers dropped, so did the jaws of most of the students in the classroom. Mercifully, he had on a pair of running shorts underneath. He looked out at his rapt audience and said triumphantly, "You will probably never forget now that some films use physical nudity to express emotional vulnerability."[30] And perhaps now you won't either.

An emotional neighborhood

Sometimes things become a lot clearer once you've had a chance to take a look at a map. Given the vital role of emotion, it makes sense that the key component of learning, the hippocampus, resides right smack in the middle of the brain's emotional neighborhood, the limbic system. Its neighbor on one side is the amygdala, which is associated with the threat response. Its neighbor on the other side is the nucleus accumbens, which is associated with rewards.

When we acquire new information, it goes to the hippocampus, which decides whether that information is emotionally relevant and if so, whether it's relevant in a positive or negative way. The hippocampus then compares this information with other information that has already been stored in long-term memory to determine whether this "new" information is really that new.

The principle underlying learning is an evolutionary one: "Minimize danger, maximize reward." Your brain's limbic system is constantly scanning your surroundings for things that have the potential to either hurt or help you. When it discovers them, it makes mental notes that become our long-term learning and memories. Not surprisingly, most dry textbook facts don't fit into either category. We aren't evolutionarily designed to earn an MBA or even to get the most out of a weekly company meeting. The brain is very efficient and even a little lazy. If it concludes that the information is neither threatening nor rewarding, it unceremoniously discards it without wasting precious brainpower on something it considers irrelevant.

Outsmarting your brain

The brain may be ruthless, but it's also easily fooled. Let's face it: Not all information you absolutely need to learn is going to be emotionally relevant. That's OK. Strictly speaking, the decision of whether to retain or discard information isn't a matter of like or dislike as far as your brain is concerned. Instead, it hinges on the release of the same three neurochemicals that keep popping up like a cork again and again throughout this book. If you can trick your brain into releasing sufficient quantities of dopamine, noradrenaline, and acetylcholine, chances are you will learn and remember, whether the information was emotionally relevant or not. Although nothing beats learning that is emotionally relevant and fun, there are ways that you can prime your brain for what might otherwise be an unrewarding learning experience.

Don't start with a recap. Well-meaning teachers, presenters, and leaders often make the same mistake. They start with an overview of what's gone before. This may seem like the most logical way to begin, but it's actually one of the worst from the standpoint of learning. Recaps are old news, precisely the sorts of thing that our brains are engineered to minimize or ignore. It's novelty that gets us to sit up and take notice. Whether you're presenting to a group or learning on your own, open with something energizing and even a little surprising. In our seminars, it's not unthinkable for us to start by talking about the pitfalls of comparison-shopping or the bad habits of Hollywood stars. Then, once we've gotten your attention, we circle back to where we left off. With any luck, you should feel engaged in a way that might not otherwise have been. The

dopamine your brain releases will provide motivation and momentum to carry you through.

If you can't change the subject, change the setting. The brain doesn't base its assessment on whether or not a task is novel entirely on the work at hand. The context of the activity plays a role as well. If you're stuck with an old or uninspiring task, try shifting to a novel setting. Sometimes this can be as simple as changing chairs. Other times it can mean shifting to another office or location. Benjamin Franklin liked to write in the bathtub. Marcel Proust did his writing in bed. It can even help to work on a different computer – or to write in a different font. Anything you can do that will send a message to your brain that says, "Hey, this is new!" can help to pull you out of the doldrums and into a state of rewarding productivity. By the way, this technique also works in domestic situations. Family therapists commonly advise bickering couples to change the room in the house when they are fighting. A simple shift of scenery can often be enough to convince the pair to make peace and to engage in more constructive discussions.

Don't over-structure

Some structure is good, but too much structure can actually undermine learning. Although some people love rules and learning things in a theoretical way, most of us learn more effectively when we pick up rules implicitly. Children provide a classic example of this principle. They don't learn to talk by studying grammar. Their brains unconsciously identify the patterns and rules that structure their native language. That's why most native English speakers can read the opening lines of Lewis Carroll's famous poem "Jabberwocky" and even though most of the words are gibberish still somehow tell that the poem is grammatically correct! Most of them don't know the pluperfect from the indicative. They just know what sounds right.

The work it takes to make sense out of something that is loosely structured, oddly structured, or even missing some key information, can actually make it easier to remember than something that is carefully organized with everything in place.

In a presentation at the TEDx conference in Sitka, Alaska, Daniel Coyle, author of *The Talent Code*, showed the audience two columns of word pairs and gave them 15

seconds to memorize as many items from the lists as they could.[31]

A	B
ocean / breeze	bread / b_tter
leaf / tree	music / l_rics
sweet / sour	sh_e / sock
movie / actress	phone / bo_k
gasoline / engine	ch_ps / salsa
high school / college	pen_il / paper

When he took away the lists, Coyle asked members of the audience to name as many pairs as they could recall. Their responses were lopsided. Combinations that they could remember from Column B greatly outnumbered those from Column A. In fact, when the study was conducted in a laboratory setting, subjects were 300 percent more likely to remember items from Column B than from Column A.[32]

What accounted for the dramatic difference in recall? Whereas the word pairs in Column A were easy to read – they were literally spelled out for them -- the pairs in Column B were a bit of a challenge. You had to work to make sense of them. That little bit of extra effort, that tiny gap in the structure, was enough to activate a burst of noradrenaline that provides just the right amount of extra oomph to make those word pairs memorable. When information is arranged in a completely orderly and predictable fashion, it requires almost no effort for the reader or listener to understand it. That makes it easy to decipher but all too easy to forget and thus harder to learn.

Learn with a friend

A revolution in what is known as social cognitive neuroscience is prompting scientists to completely revise or re-examine fundamental assumptions not only about the brain, but also about society as a whole. As we'll see in Chapter 8, many long-held beliefs about our basic needs have been totally turned on their head. The verdict seems clear and the data support it: First and foremost, we are social creatures.

That revelation has affected everything, including our understanding of learning. In

many if not most cases it pays to learn in groups instead of individually. The social interaction that comes from learning with someone else – a friend or a learning buddy – releases oxytocin, which, as we've already seen, enhances neuroplasticity and the possibility for change. This not only explains why falling in love can profoundly change your behavior and even your personality, but it's also why children learn so well when they interact with their parents. It also reinforces the importance of being a good role model for the people around you. If you are the boss and everyone sees you are doing a great job, then they are going to pick it up from you! Social interaction makes us feel good. And when we feel good, we trigger chemicals that make it easier to learn.

Keep things manageable

One of the key lessons from Kaizen (see Chapter 4) is that goals are easiest to accomplish when they're taken in small steps. The same principle applies to learning. Undivided and uninterrupted, even valuable, interesting information can trigger a threat response. When it finds itself overloaded, your brain is likely to activate the amygdala, which is your body's equivalent of a burglar alarm. To "tiptoe past your amygdala"[33] when you're learning, divide a big learning task into smaller manageable pieces, and take frequent breaks to allow your memory to consolidate what you've learned so far and to prevent yourself from feeling overwhelmed. Likewise, the thousands of facts you may need to acquire will register as less threatening and more memorable if you place an emphasis on the meanings that hold these facts together instead of getting bogged down in a deluge of details that would also be likely to sound the alarm.

Use multi-modal learning

The capacity of your working memory is surprisingly small, but it can handle words and pictures simultaneously. What's more, other senses, like our sense of smell, bypass the working memory entirely and yet can serve as an additional trigger for recall.

In fact, the more parts of the brain that are involved when you learn something new, the more likely you are to remember it. This is because memories of that information are stored in multiple regions in the brain and neuronal connections are made between these far-flung locations. Then in the future, if you trigger one, the others will be activated as well.

And when more of the brain is involved, you are far more likely to remember more. Think of a "conversation" you might have on e-mail compared to one you have in person. Even the most emotionally involved e-mails are usually harder to remember than direct, in-person conversations, where your brain, in addition to encoding what the other person says, also notes how it was said (the volume, intonation, etc.), the expression on the other person's face, her posture, as well as the location of the conversation, the time of day, and perhaps even the weather.[34]

Molecular biologist John Medina, author of the highly entertaining book *Brain Rules*, compares a well-encoded memory like the one you might get from an in-person meeting to the front door of a shoe store he used to visit as a child. Instead of relying on just one handle, the door had three - one up high, one in the middle, and one down low, a fact that particularly impressed him as a little boy. The strongest memories tend to work the same way, providing multiple handles instead of just one.[35]

Improve Your Odds

Just as you can bolster your resistance to emotional imbalance by creating life conditions that promote balance (see Chapter 2), you can take certain steps to improve your odds for long-term learning. A healthy lifestyle of sleep, exercise, and stress reduction can influence learning and memory.

Sleep on it

Getting sufficient sleep not only aids in emotional regulation (see Chapter 2), but it also improves your ability to learn. It reduces the levels of stress hormones such as cortisol in your bloodstream, while encouraging the growth of new nerve cells that are necessary for learning and memory. And finally, it assists the hippocampus in determining which of the information you've recently learned will be stored in long-term memory for future use and which will be discarded.[36] This transfer process is every bit as important as the initial intake of information. Psychologists discovered this from the same source from which they've gained dozens of cognitive breakthroughs: from rats.

Studies with rats by Mark Bear of MIT's Picower Institute were rigged up with electrodes that looked like little houses perched atop their rodent heads. During the day

scientists would record the brain activities of rats as they ran through a series of mazes. At night, technicians would disconnect the rats from the machines but keep the little houses, which would've had to be surgically removed otherwise.

One night the rats were inadvertently left hooked up to the machines while they slept. As can often be the case, this little mistake led to an important insight. What Dr. Bear and his colleagues discovered is that the patterns the rats had recorded in the hippocampus during the day were actually being played backwards during the night! This told them how the hippocampus, which was acquiring information during the day, transfers that information to long-term memory during the night during slow-wave sleep.

If you fail to get an adequate amount of sleep, the hippocampus is unable to do its job, and you fail to remember. You may *think* you remember, but in fact, you don't. Ironically, executives often refrain from sleep so they can spend more time learning. In fact, as counterintuitive as it sounds, it makes more sense to spend less time learning in order to make room for sleep.

Run with it

"Physical exercise," writes John Medina, "is cognitive candy."[37] Exercise promotes the growth of new neurons and increases your cognitive performance. Things that require focused attention and a lot of coordination between body parts, such as dancing and tennis, trigger a burst of dopamine (released when you're having fun) and acetylcholine (when you're focusing your attention and are really present in the moment). Both dopamine and acetylcholine help your hippocampus to perform better. And, as we know, the hippocampus is the primary place where learning occurs.

Stress relief

Sleep and exercise can both improve your brain's capacity for learning, but stress can be diabolical in its ability to diminish it. Stress releases cortisol. With chronic stress, cortisol can actually shrink your hippocampus, impairing its ability to learn and remember. And, as we'll see in Chapter 9, the magnitude of your response to stress may differ depending on your genetic predisposition. Luckily, both sleep and physical exercise have been shown to alleviate the symptoms of stress.

From Learning to Teaching

The principles that support effective learning can also be used for more effective teaching. The paramount importance of emotional relevance in both learning and memory requires what former Belgian Davis Cup tennis coach and internationally recognized team performance expert Koen Gonnissen calls a "bridger," "someone who can translate the rational objectives of the CEO into something that touches the heart." Once again, social interaction can be key. If you run a lecture more like a seminar and provide a series of leading questions that helps participants to reach your desired conclusion, they are more likely to adopt the idea as their own.[38] And you're apt to benefit as well. When you have to teach someone who knows less than you, you often end up learning the material better yourself.[39]

Likewise, using stories to support your ideas will stimulate the social brain. A stray line from a curmudgeonly character in a 2004 movie significantly changed Americans' wine-drinking preferences.

Sour grapes

For decades, Merlot was one of the most popular red wines among Americans. That is, until the 2004 film *Sideways* featured a cantankerous wine snob who summarily dismissed the variety as inferior, adamantly declaring, "…if anyone orders Merlot, I'm leaving!"[40] Much to their dismay, winemakers witnessed a noticeable drop in Merlot sales that year[41], especially after *Sideways* garnered five Academy Award nominations.[42]

Tell me a story

Given the paramount importance of emotional relevance in learning, it should come as no surprise that when you are able to reach your audience emotionally that you are more likely to succeed in getting your message across. The most direct route to those emotions is through stories. A carefully constructed argument in favor of a particular variety of grapes might win you some converts among sophisticated wine drinkers, but its impact would almost certainly pale compared to even a stray remark from a compelling story. As Nelson Mandela once advised, "Don't talk to their minds; talk to their hearts."

As you may recall from Chapter 3, our default mental network is also known as the

narrative network. That's because we contemplate our past and look ahead to our future by forging events into chains that make sense to our brains. In short, we create stories. This provides some insight into why stories may be so effective in engaging us: they echo the way that our minds already operate.[43]

One thing is clear: Storytelling is universal. It is found in all cultures and has existed throughout the entire course of human history.[44] Some social cognitive neuroscientists have suggested that stories grew out of a group's need for social cohesion. The tales our ancestors told may have supplied a way of communicating the latest about each member of the group. If one group member ventured too far afield and narrowly escaped an encounter with a lion, the story of his adventure would not only raise his status, but it would also provide valuable, useful information for the other group members. After all, much of what we learn, we learn indirectly. If someone eats berries from a particular plant and gets violently ill, his cautionary tale saves everyone else in the group from making the same mistake. We don't all need to eat the same poisonous berries to learn that they are bad for us.[45]

The power of stories to persuade and motivate stems from the fact that they activate our emotions and increase our receptiveness to information. When we hear a story, we often feel a desire to connect it to our own life and experiences. Our insula (the part of the brain that detects body awareness) is activated and we respond viscerally to the joy, pain, humor, and disgust of the narrative. All of these reactions help us to become more receptive and engaged.[46]

Research done at Princeton a few years ago found that when you tell a story - and tell it well - that your brain and those of your listeners actually sync up in a process called "neural coupling."[47] The findings from the Princeton study suggest that the stronger the neural coupling the better the understanding.[48]

In fact, when you truly have your audience rapt, the evidence from brain imaging indicates that they actually start to anticipate what you're going to say. This doesn't mean that your story is dull and predictable. On the contrary, it shows that your listeners are so fully engaged that they're excited to find out what's going to happen next![49]

Granted, not all stories are universally effective. A story that wins over one group

may fall flat with another. Some level of connection is essential for a story to be successful. We need to be able to relate it. A study by psychologist Melanie C. Green showed that prior knowledge and experience can influence the level by which you are immersed in a story. Thus, a story about a gay Boy Scout is more likely to resonate deeply with people who are gay or have been Boy Scouts. More likely, but not exclusively. Green also found that people who demonstrate a high level of empathy are more susceptible to being swept up by a story, regardless of their prior knowledge or experience.[50]

Recent neurocognitive science research has revealed another fascinating aspect of storytelling. We are often drawn to stories that we think will be emotionally relevant to others in our social group. Our love for listening to stories is nearly matched by our desire to share those stories with others. So when we listen to a story, a part of our brain is deciding whether it's a story worth retelling. If we decide that it is, our attention intensifies and our learning and memory increase. If you convey information in a story that people want to share, then you have succeeded, not only as a storyteller, but also as a teacher.

From a standpoint of a leader and a teacher, the power of stories is not simply that they can be moving and entertaining. They can also be persuasive. Another study done by Dr. Green suggests that people are more receptive to ideas when their minds are in story mode as opposed to when they are in a more analytical mind-set.[51]

It's doubtful that the Americans who stopped drinking Merlot after seeing the movie *Sideways* did some careful research before deciding to forego this once popular variety of wine. They simply saw a story that reached them emotionally and changed their behavior as a result. If you can illustrate the points you want to stress by using stories, you are far more likely to get your message across – and have it remembered.

Stories activate our emotions and increase our receptiveness to information in a powerful way that rivals information that is well organized and well supported, but emotionally inert. Using words and images in concert to convey information will also improve the effectiveness of teaching. The more parts of the brain that are involved in acquiring new information, the better the chances are that it will be retained and

remembered.

Use aversive learning with care

A training video for a major airline warns employees not to get too close to a jet engine when it's operating. Rather than providing rules or even text, it just shows a flight attendant who makes the mistake of walking too close and is sucked into the engine with a result that would make even seasoned viewers of Hollywood splatter movies feel nauseated. However, the video makes its point, and the airline has never had an incident where an employee was killed by getting too close to a jet engine.

An elevator company wanted its mechanics to be well aware of the small space at the bottom of every elevator shaft that could conceivably save their lives if they were ever trapped beneath a free-falling elevator car. New mechanics were asked to crouch into a ball at base of the shaft, and then the elevator was sent speeding down toward them. It was a harrowing and even sadistic experience, but it was a lesson that all of them survived and almost certainly that none of them ever forgot.

Although teaching usually works best by appealing to our reward response, when used sparingly and responsibly, teaching that triggers the threat response can be highly effective.

Negative learning is good at inhibiting behavior, but it's terrible at teaching you to find creative solutions. That's because with negative learning, you go into a threat state, which means your PFC is temporarily shut down and with it your executive functions. Your reaction may be speedy and instinctive, but it isn't nuanced and thoughtful. In certain, specialized situations that can be OK. In organizations, there are generally two areas where it can be helpful to work with fear conditioning: health and safety and compliance. In situations involving health and safety, such as the airline and elevator examples, it can literally be a matter of life and death. The same applies to many military and law enforcement procedures, where the moment you hesitate may prove to be your last. In the case of compliance, people should know that if they break the rules or the law that they will be punished.

* * *

The mystery of Capgras Delusion, the strange phenomenon that allowed David to recognize his parents but fail to accept them as authentic, turned out to be a mystery of emotion. As it does with most of us, a region of the brain known as the fusiform gyrus, part of our temporal lobe and located just above each ear, did the job of facial recognition. It relayed the information to the hippocampus, which confirmed that the man and woman he saw matched the stored description of his two parents.

But this is where the process broke down. The link between David's capacity for recognition and his ability to gauge emotional relevance had been badly damaged in his accident. When we see someone we love, our limbic system responds with emotion, sending a message to our autonomic nervous system. Our heart rate quickens and our perspiration subtly increases. In David's brain, the message was never sent. David was willing to concede that the man and woman who professed to be his parents were friendly and helpful, but he was unable to make an emotional connection.

Although it was the absence of emotion that created confusion for David as well as heartbreak and frustration for his parents, it was ultimately neuroplasticity that came to their rescue. As it turns out, Capgras doesn't have to be permanent. Following his accident, David gradually regained the emotional response to his parents and no longer considers them to be impostors.

In short, he learned.

Chapter 6 in a nutshell

Key learnings from "Foster Learning"

Your incredible, flexible brain. Once believed to be hardwired by the time we reached our 20s, the brain has now been found to be far more malleable and plastic than even most neuroscientists imagined. New research indicates that the dream of life-long learning is no longer an impossible one. You just need to know how to learn.

Learning is an emotional process. The seahorse-shaped hippocampus, the first stop on the road to memory formation, is located in the heart of the brain's emotional neighborhood, right next to the amygdala, which processes negative information and the nucleus accumbens, which handles positive stimuli. This is no accident. Learning will only happen when you are emotionally involved – either positively or negatively. Without emotional relevance, your long-term prospects for retaining new information are doomed.

Passing the hippocampus test. Even emotionally relevant information may not be retained for the long term. The hippocampus weighs two factors in deciding whether information is worth remembering. Emotional relevance is one. Novelty is the other. Unless the information is truly new, the brain may not see the value in expending extra energy to hold onto it.

It's all about survival. Learning may not seem like a life or death situation, but ultimately it's all about enhancing our survival. Experiences we find pleasant are a signal that something is good for us and thus is worth remembering. On the other hand, information that triggers our threat response is even more crucial to retain. Anything neutral is seen as a waste. Failure to understand this fundamental fact explains why many adults find learning so difficult. They see it as a cold and rational process when in reality it depends almost entirely on our emotions.

While you were sleeping. Information deemed worth retaining is transferred from the hippocampus to long-term memory, usually while you sleep. This is why if you want to learn well that it's so important to get enough sleep. Rather than studying into the wee hours of the morning, your time would be better spent getting some shuteye in order to allow your brain to store this hard-earned information in long-term memory.

Get it right the first time. Learning isn't always easy, but un-learning is even harder. Once the brain has gone through the time and trouble to commit information to long-term memory, it is understandably reluctant to invest the extra energy required to delete what it worked so hard to retain. When learning a new skill, don't start off on the wrong foot. Find the best teachers and focus most of your effort at the outset. From the standpoint of leadership, this means investing the time and money to train people correctly in the beginning before they have a chance to acquire incorrect procedures that they may never fully unlearn.

Use aversive learning with care. Once you burn you hand on a hot stove, you're unlikely to do it again. By far the strongest form of learning comes from negative experiences. But be careful. Since the PFC will shut down when a person goes into threat mode, any potential for creative or even analytical thinking will be lost. As a result, stay away from aversive learning when your goal is to encourage positive behavior. Save it instead for those rare situations when you want to *inhibit* undesired behavior, such as for health and safety or compliance.

The company that learns together… As fundamentally social creatures, we learn better in the company of others. As a leader you have a unique responsibility as a role model. People will learn far more from what you practice than from what you are preaching. Another way that people find social connection is through storytelling. If you polish your storytelling skills, you will greatly improve the chances that people will retain more of what you have to say. And if you can perfect the skill of spinning tales that people like to retell, then you will multiply your impact.

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