Brain-Based Vocabulary Teaching and Learning

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Abstract

Today's scientists are making remarkable progress as they strive to understand and explain the many intricacies of the human brain. Educators and students alike can benefit from understanding the basic tenets of this research and then putting that knowledge into play in the classroom. To that aim, this article first explains some basic brain structures and the physiological process of learning, and next gives examples of classroom activities that can capitalize upon that knowledge in order to improve vocabulary teaching and learning through neuro-educational strategies.

Keywords: Vocabulary, Brain-Based, Neuro-Education

Daily life depends on the people around us being experts at what they do. We depend on our accountant to understand budgets and taxes. We depend on the IT staff to know how our computers work. As teachers, our students depend on us to know how their brains work; that's where all learning takes place, of course, and yet most of us teachers only have a vague idea about *how* learning actually happens. As Sousa (2011) tells us, "there are plenty of 'how-to' books available" for teaching, but educators now need to focus on not only the "how to" but also on the "why-because-how-to" (p. 3). By learning the basics of neuro-education and applying Sousa's "why-because-how-to" concept to teaching vocabulary, both teachers and students will benefit. This is much needed because vocabulary learning and retention are one of our students' main challenges when learning a foreign language.

"Why-Because" - Brain Basics

Neurons

Neurons (or cell bodies) can be thought of as the storage garages of our brains. This is where our brain stores information we hope to remember. When a student learns the word "orange," one neuron may "light up" and become the storage place for the concept of the color orange; another neuron may store the concept of orange as a fruit; another neuron will store the phonological information needed to pronounce the word orange; and yet another neuron might store the grammatical rules associated with orange. Thus, when we learn a new word, neurons all over our brains are firing simultaneously.

Axons and Neurotransmitters

Since our brains store information in myriad locations, we need a way to somehow connect and assemble that information logically when we want to understand a concept or recall a word. True learning, then, is the process of simultaneously activating multiple neurons which then send electrical impulses through our brain as they *connect* with one another. Imagine little light bulbs going off all over your brain when you encounter a new concept (processing). Then imagine all those little lights strung together to create a healthy glow; this is learning, and each time it happens our brains grow a little, not in overall size, but in the number of neurological connections we have in particular areas, therefore actually strengthening the processing ability of that area of the brain. Jensen (2009) explains it this way, "the acquisition stage is the making of connections; neurons are now 'talking' to one another. The relevance of this is that learning takes time because learning physically changes the brain" (p. 5).

Thus, the learning process takes place when the information in our storage garages (neurons) is connected, but how exactly does a neuron on one side of the brain connect with a neuron on the other side of one's head? Neurons are connected when electrical impulses called neurotransmitters (think of them as the tiny trucks carrying information between garages) drive down the "roads" in our brains which lead from one neuron garage to another. These roads are called axons. If we look at a map of our brain, we will see millions of neurons connected by thousands upon thousands of axons. This labyrinth is our brain's information storage and transportation system (Carraway, 2014).

In sum, neurons are the storage garages and when the neurons fire (garage doors going up and down), neurotransmitters (trucks full of information) travel down axons (the roads between garages) to connect all that activity into one process — learning.

Synapses, Dendrites and Myelin

Of course, learning is not that simple. If it were, our students would learn everything they encountered in our classes with just one go; imagine! The reality is that when neurons are firing and therefore attempting to connect, the neurotransmitters travel down the axons, but before the neurotransmitters can connect with the other firing neurons (and learning or retrieval can take place), they must jump a tiny gap at the end of each axon to reach the next neuron. This gap is called a synapse.

Luckily for us, our brains have two strategies to improve the odds of getting neurotransmitters across that gap. First, there are some tiny tentacle-like growths that reach out from each neuron to bridge the synaptic gap. These tentacles are called dendrites and we can think of them as bridges that connect the axon roads to the neuron garages. In 2000 Eric Kandel won the Nobel Prize with his research proving that the more often our cells re-fire, the thicker and stronger these dendrites grow, making the synaptic bridges stronger and therefore the connections between neurons easier (Carraway, 2014).

The other fantastic tool our brains have in order to help us more quickly and efficiently connect neurons is a fatty substance called myelin. Each time a neurotransmitter travels down an axon to connect neurons, myelin is laid down. Think of myelin as a kind of pavement for the axon road. The more myelin, the smoother the road, and the faster the neurotransmitter can travel from neuron to neuron (Wolf, 2007). It is similar to taking the highway to work instead of taking some unfamiliar unpaved side roads. You're more likely to travel faster and less likely to get lost when you take the smoothest highway and cross the biggest bridges. Myelin and dendrites make this more efficient neurological route possible and both are bolstered by repetition.

Brain Pruning

So in an ideal learning environment, students' neurons are firing and myelination is taking place. Why, then, do students often appear for class the next week and seem to have no idea that they have ever encountered the target words before? What's happening here frustrates every teacher (and student) across the globe, but this is actually an amazing and healthy part of brain function, which is called brain pruning.

We've seen that through increased synaptic connections and dendrite growth our brains are constantly growing and reshaping themselves. Scientists call this "brain plasticity" because one's brain has the ability, like plastic, to reshape and remold itself. This means, however, that as new information is being added and stored in our neuron "storage garages," old information must be cleaned out to make way for the new. Our brains are constantly de-cluttering our storage garages and even building new ones. If a neuron is inactive, it means that there is a reduced amount of blood flowing to that cell. When blood isn't reaching a cell, a layer of calcium forms around it. A build-up in this calcium triggers an enzyme called calpain, which actually destroys the inactive cell to make way for newer or more active cells to grow (Willis, 2006). It is an amazing process and one that means that our brains can learn and store new information throughout our entire lives, proving that you actually can teach an old dog new tricks, but that old tricks can be forgotten as well.

"How-To" - Encouraging Brain Growth and Avoiding Brain Pruning

Using Video to Activate Multiple Neurons

Since we know that learning is the process of newly encoded neurons connecting to existing neural structures, we should logically try to activate as many neurons as we can each time we introduce a new lexical item to our students. I have found video to be the easiest way to get my students' neurons firing because of video's multimodal nature. In truth, I used to be hesitant to use video. One reason was that I thought that in order to introduce new vocabulary through video, the lexical item itself needed to be used within the video. That made it extremely difficult to find the "right" video. Thus, I changed my approach. I now believe the best use of video is actually when the target vocabulary words are not used in the video, but rather when the teacher uses the video to structure activities using the target words later. For example, for a unit about airlines from a TOEIC (Test of English for International Communication) textbook, I use a short video of a young backpacker named Andrew traveling around the world. There are no words in the video, only images set to a catchy instrumental tune. My students respond well to the video and, in my opinion, seem more eager to learn new target words through activities that describe Andrew's journey than they were when the target words were introduced solely via the textbook. By using a video that suits my students' interests, despite the fact that the video itself contains none of the target words, students' neurons are firing for visual connection, personal relevance, musicality, and novelty. Of course neurons are also still firing based on meaning, transcription, phonology, and grammar, just as they would have been with traditional textbook wordlists.

Avoiding Brain Pruning through Repetition and Movement

How can we ensure that students retain the knowledge that they have been exposed to in that video-based lesson? Neurologists tell us that brain pruning is healthy because it increases brain function by allowing us to actually forget information that might be cluttering our brains and slowing us down (Willis, 2006). As teachers, though, we obviously don't want our students' brains pruning away last week's vocabulary words. To avoid brain pruning, then, each cell that was actively firing when a new lexical item was introduced needs to fire again — and again. Each time a neuron fires it not only grows stronger dendrites and lays down more myelin along the axon, but it also calls for more blood flow, which in turn feeds more dendrite growth and myelin production, and ultimately prevents calcium build up around the cell, thereby halting the pruning process (Willis, 2006).

This is truly a "use it or lose it" system. Repetition, then, is the first way we can avoid brain pruning. All teachers know that we need to repeat, repeat, repeat. Repetition has to be handled carefully, though, in order for students to view it as valuable and stay engaged. The brain works best when lexical items are meaningfully repeated, but not when they are repeated in *exactly* the same way, which can become mundane. Take the example of the video following the young backpacker on his world trek. If I used this video to introduce the target TOEIC airline words, I would need to find another video that follows this theme, but doesn't bore students with exact repetition. For example, when practicing the target words later, we watch a video of a toy robot who uses google street maps to "arm chair travel" around the world. It's the same theme and same target words, but a different video. Sometimes I randomly assign students one of the target words from the last lesson, show the video, and have them write sentences about the video using their assigned word. Sometimes I list all the words on the board, show them the video, and have them cross out any words that don't fit with the theme or events in the video. They key is that when you recycle the words you do it with a twist.

Another element that helps keep students' brains active and free of calcium buildup is kinesthetic learning. Each time we get our students up and moving, increased oxygen and blood flow to the brain. Activity further feeds brain cells by triggering our liver to release more glucose to help us fuel the activity (Jensen, 2009). More glucose flowing means more energy and therefore more neurons firing. Simple "walk and talk" surveys using the target vocabulary are one way to get students moving. Another way to add movement to the classroom is to have students find a partner based on the target words' meanings in context. I give half the class sentences with a word missing. I then give the other half of the class pictures that match the sentences. Next, I have students find their partner based on matching visual meaning with syntactic meaning. Then, I have them try to use the appropriate vocabulary word from the last lesson to complete the sentence. Another movement-based activity is to hang four to six images around the room. Each student is then given a card with a target word on it and they must decide which image their word matches best. Once they have decided where their word fits, they must go stand by the image they have chosen. While standing with their group, they then work together to create example sentences that connect their words to the image. In all of these examples, students are up and moving around while using the target words. Multiple neurons all over their brains are firing (vision, auditory, meaning, novelty, humor, emotion), blood is flowing to the brain cells, and glucose is being produced and used to fuel more efficient brain function.

"Why-Because" - Deeper Knowledge based on Emotion

If we're embracing a brain-based classroom approach, by now we've done our best to get multiple neurons firing. Hopefully dendrites are growing and myelin is being produced. We're repeating and practicing target language and our students are up and moving around. The class activities may be going well, but our students are still at a fairly superficial stage of learning. How, then, can we help them form a deeper knowledge of the new words they are working with? The answer is in the limbic system or the emotional regulatory system of our brain, which is comprised of the thalamus, amygdala, and hippocampus (Carraway, 2014).

The limbic system is often referred to as the brain's gatekeeper. It decides which input is important enough to become part of deeper knowledge and long-term memory, and which information needs to be kept for only short-term use. Working together, the thalamus, amygdala, and hippocampus sort incoming information based on novelty and personal connection, both of which involve emotion (Carraway, 2014). If students find something novel (and therefore "pay-attention worthy"), the limbic system is more likely to deem it worth storing as deeper knowledge. Likewise, if something resonates personally with the student, then the student's limbic system will mark it for deeper memory storage. Often if novelty and personal connection are present, then emotion is also involved. Our body naturally stores emotional information more carefully and in a more readily accessible area of the brain. Willis (2006) interprets the results of both PET (positron emission tomography) and fMRI (magnetic resonance imaging) scans of limbic system activity for us with this summary: "When these gatekeepers are jump-started by positive emotion, more brain activity is seen passing through these portals and lighting up the frontal lobe memory storage centers" (p. 40). Thus when novelty and personal connection are present, information is tagged as highly important and worthy of keeping over the long-term.

"How-To" - Novelty, Connection, and Emotion during Class

Photographs

Once again, visuals such as photographs or videos are a great way to ensure that students' brains (and specifically limbic systems) are engaged because visuals are an easy way to bring emotion into class. I often have students get out their smart phones and open up their own digital photo albums. I'll assign each student one of the target words and they must scroll through their own photo bank until they find an image that fits their assigned target word. They then create a sentence using the word and the image together. Next, I add movement to the activity by asking students to get up, move around the classroom, and explain their photo and sentence to at least three other students. From my experience, students willingly use the target words and seem genuinely interested in each other's photo choices and stories. Getting students laughing, which often happens during this activity, gets their brains primed for learning because laughter releases the neurotransmitter dopamine and also increases oxygen movement to the brain (Willis, 2006). Personal connection, novelty related to other students' photos, positive emotion, and movement are all helping students learn the target words during this activity. If we're lucky, the limbic system is also hard at work tagging the target vocabulary as important enough to store away for the long run based on the positive emotions created by using students' own photos.

To follow up on this activity, later I encourage students to post their images and captions on "Edmodo" (www.edmodo.com). Edmodo is a social network which functions very much like Facebook, but which was created for educational purposes. My students have begun not only posting their photographs and sentences from the in-class assignments, but also photos and sentences using the target words about their lives outside of school. As with Facebook, other students "like" the photo, or comment, and a very natural, engaging exchange springs into action. What I find important is that my students are voluntarily using the target vocabulary to describe their own lives, and doing it in a way they enjoy.

Personal Stories

Another activity that allows students to create emotional connection with target lexical items is simply having them use the words to tell stories about their own lives or culture. Most of us have used story-telling in our classroom at one time or another because we recognize that students respond well to it. This is, in part, because stories have two of the elements our limbic system loves, novelty and emotion. One of the easiest and best ways I have found to use stories is through a free online program called "Storybird" (www.storybird.com). Storybird makes it easy to create picture books in which the students use the target words to tell their stories. I often finish the semester with a Storybird project because it seems the best way to tie all the brain-based aspects of class together — visual stimulation, emotion, humor, novelty, repetition, personal connection — they are all there.

Summary

A basic knowledge of how the brain works can provide both inspiration and grounding in every teacher's classroom. When we seek to present new information in a variety of ways we ensure that multiple neurons are firing simultaneously in our students' brains. This encourages both dendrite growth and myelination, which help our students recall and access the information they are attempting to learn. Taking it even further, when we get our students up and moving, engage their emotions, and create personal relevance to the lexical items we are trying to teach, our students' brains will not as readily prune those words away, and the limbic system may even tag the new words as emotionally relevant and therefore worthy of long-term memory storage. When we employ brain-based teaching methods, students and teachers both benefit.

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