From One Brain to Another:

What We've Learned About Learning

An Acclivus R3 Research Report by Deirdre M. Campbell

Many traditional approaches to teaching and learning are no longer viable. With the exponential growth of information, the idea that force-feeding the brain more and more knowledge results in more intelligent solutions to complex problems is neither a sustainable expectation for educators nor a supportable one by neuroscientists. Academic institutions and training organizations are beginning to focus instead on a more enlightened approach based on some principle findings of neuroscience, the most obvious of which is that if we want to teach the brain efficiently, we need to know how it works.

IF WE WANT TO TEACH THE BRAIN EFFICIENTLY, WE NEED TO KNOW HOW IT WORKS

The inconvenient reality is that the learning process is complex and not necessarily a conscious one. The challenge for academic institutions and training organizations is that this process takes time, is different for each person, and frequently needs far more than written instruction to strengthen and solidify the necessary neuronal connections in the brain that constitute learning. Perhaps these facts alone explain the reticence in adopting neuroscientific principles in education. The good news is that there are many simple techniques based on basic assumptions of how the brain learns that can enhance any learning experience in any environment.

In simple terms, learning can be defined as moving data out of short-term memory and consolidating it into long-term memory. The purpose of teaching or training is to facilitate that process. In more scientific terms, learning is a neurobiological process indicated by the growth and strengthening of connections between neurons. The stronger the connections between neurons, the more likely new learning will be encoded into long-term memory. This entails a kind of pattern checking, comparing new information to information already stored in the brain. Strengthening neuronal connections presents a challenge, however, because each brain is wired differently and has a preferred way of learning dependent upon the individual's

THE BRAIN AUTOMATICALLY PAYS ATTENTION TO THAT WHICH IT HAS ALREADY SEEN OR HEARD

psychological, intellectual, and sensory profile. This suggests that no one curriculum is appropriate for all learners, a contradiction to how many learning institutions and training programs are presently set up.

The Learning Experience

One of the basic principles to rely upon when attempting to solidify learning is that the brain seeks novelty above all else and is highly activated by anything new or unusual. Conversely, when the brain is bored, it stops paying attention and learning is impossible. Novelty can include the use of humor, movement, music, and other multisensory instruction, all of which stimulate the reward centers of the brain with a rush of endorphins as well as oxygen in the case of laughter and movement. When we engage novelty in the learning experience, we also are activating the hippocampus, an area of the brain associated with memory retention.

The involvement of multiple senses in a learning experience results in faster neuronal processing and denser encoding of information in multiple areas of the brain. This suggests the importance of delivering our message to the brain through as many senses as possible. Some of you will recall that in the "olden days" we sang our alphabet and times tables, sometimes while stomping out a rhythm with our feet at the same time. The take-away here is that the more senses engaged, the more parts of the brain involved in storing the information, and the more likely the retrieval of that information later. In addition, presenting two stimuli at once strengthens neural connections even more so. These brain principles alone suggest that there are no limits to the possibilities of designing exciting and creative learning experiences.

There is another dimension of brain functioning to keep in mind when designing effective learning experiences and that is that the brain has two hemispheres, each which processes information differently. Research on right-brain/left-brain functioning has seemed to coincide with the general realization that there is a critical need in corporate and academic settings for right-brain thinkers who demonstrate holistic reasoning, pattern recognition, and the interpretation of emotional, non-verbal communications. Institutions that are cognizant of this aspect of brain functioning can enhance creative thinking throughout their organizations, and educators and trainers who learn to teach to both the right and the left hemispheres of the brain can enhance considerably the learning experience.

No matter which hemisphere you choose to address first, you have to do so powerfully to catch a person's attention because you have no more than a few minutes to hold it. In addition, the brain can only hold onto a few ideas at once in short-term memory. Overloading the brain with a continuous input of data into short-term memory is not productive because the brain will begin to "kick out" excess data — anything over three to five pieces of data at a time — and may be getting even smaller with the advancement of the digital age. Complicating things further is that we are not really in control of which things the brain pays attention to. The brain automatically pays attention to that which it has already seen or heard — what it has experienced in the past. To override this automatic response, we must create interest in new material by matching it up in some way to prior experiences. If attention is lost, however, there are techniques for recovering it. For instance, alternately shifting between a narrow (the details) and a wide (the big picture) focus when presenting difficult concepts is an effective technique for holding the attention and for solidifying information into memory.

Designing Effective Learning Experiences

There are some basics to take into account when designing learning experiences. For instance, we learn best by observation. In addition, because the brain has very little neuronal territory designated for language, written instruction by itself is the least effective way to stimulate learning. Techniques that stimulate learning include teaching others, which helps us solidify the material ourselves. In fact, people learn better when working with others toward a common goal. The trick to memory consolidation is having time to manipulate the new learning, frequent breaks to move from one aspect of the subject to another, and periodic refreshers throughout the learning experience. In this process, the use of stories is a powerful technique for consolidating information. A story not only catches the listener's attention, it conveys more meaning because it uses words that activate different sensory areas of the brain. A story also allows the brain expanded means for later retrieving a concept because its parts are stored all over the brain and can be readily recalled by its intellectual, emotional or sensory details.

Although a period of REM (rapid-eye movement) sleep is necessary for the brain to consolidate information into long-term memory, we can help that process by taking into account that the memory of new material is best stimulated at the beginning of a learning session and at its conclusion. Thus, the middle of a learning session might best be used for the repetition of the material. Since memory begins to degrade within hours after a learning session, repetition is not only helpful but absolutely necessary. Repetition stimulates the use of more neurons and the growth of more connections between neurons. Again, the more these

Learning Redefined

Learning can be defined as moving data out of short-term memory and consolidating it into long-term memory. The purpose of teaching and training is to facilitate that process.

OUR ABILITY TO LEARN IS STRONGLY INFLUENCED BY OUR RELATIONSHIPS TO OTHERS

connections are strengthened, the more likely learning will become permanent. Both teaching concepts in as many ways as possible and practicing the new material in as many ways as possible help consolidate learning into long-term memory. In addition, when learning a new task, visualizing performing that task first activates the same neurons as those we activate when actually doing the task and can result in better performance overall.

The Emotional Connection

There is also an emotional component of brain functioning necessary for successful learning. A positive learning experience results in the release of endorphins, which increases the odds of retaining new material. However, a negative experience releases the hormone cortisol and activates the emotional centers of the brain containing the amygdala — a structure of the limbic system associated primarily with emotional responses such as fear, responses so intense they shut down attention and negatively affect memory. So that the amygdala does not commandeer our attention completely, a learning experience needs to be designed to be non-threatening and with enough flexibility that takes into account the different ways individuals learn.

The importance of emotional functioning is made evident by the multiple brain areas and neurons involved in processing social interactions, such as learning. Our ability to learn is strongly influenced by our relationships to others. All social interactions, including learning, are dependent upon the existence of mirror neurons that allow us to understand and empathize with one another. These neurons activate when we experience an emotion or when we observe another's emotions. Therefore, an inventive educator can trigger positive emotions in those around her by demonstrating those emotions. However, the success of a learning experience requires more than a good relationship between the teacher and student; it is also dependent upon the emotional atmosphere in which the learning occurs, as well as the content.

Continued Learning

Learning changes the structure of our brains. These structural changes occur with every learning experience and continue throughout our lifetime. The more the brain learns, the greater its ability to learn because each learning experience either creates new neuronal connections or strengthens existing ones. Continued learning can delay the normal degeneration of the brain and in some cases sidestep the results of degenerative diseases of the brain. Ultimately, as we continue learning, each one of us makes different neuronal connections to the existing troubles of the world we find ourselves a part of, increasing the possibility that our unique neuronal associations might lead to brain changes that will result in correspondingly creative solutions to the world's problems.

Deirdre M. Campbell is a senior research consultant with Acclivus R3 Solutions. For questions or comments email consulting@acclivus.com.

Takeaways

We can improve the learning experience with the design of more brain-friendly teaching techniques that take into account these different aspects of brain functioning:

- Novelty captures attention and activates memory retention
- Short-term memory is limited and should not be overloaded
- The more senses involved, the easier and faster memory storage and retention
- Each hemisphere of the brain processes and recalls information differently
- The brain prefers what it has already experienced
- The big picture and details activate the brain differently
- Stories consolidate information
- Sleep is a necessary component of learning
- Emotions affect memory retention and the ability to learn
- Visualization is a means of better performance
- Mirror neurons allow us to activate positivity in others

ACCLIVUS R3

R3 SOLUTIONS®