*Issues and Ideas:*

# Perspectives in Pedagogy

*Rebecca Johnson, Editor*

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## What does research tell us about the learning process?

One of my favorite comics in the *Columbus Dispatch* is called "Zits." As you might surmise, it is about a teenaged boy and his often befuddled parents. Occasionally, when his mother is particularly at a loss she opens a door in his forehead and peers in to see what in the world is going on in there. I have often wished that each of my students came equipped with one of those doors, so that I could see why some concepts and skills "stick" and others seem to slip through like greased jelly. Dr. Suzanne Schons has researched how the brain works when we learn concepts and skills, and in this article she gives us an easy to understand lesson on how the brain functions, and some valuable tips on how to apply this knowledge in our students' lessons. ▲

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## *What's going on in there? How students learn*

by Suzanne Schons

### Glimmers of light

Piano teachers are likely to ponder all kinds of questions about what is going on inside students' brains. Why is it that practice makes playing easier, and why are mistakes so hard to fix? How do students' brains process new learning, and what makes them more likely to remember new concepts? Is there anything teachers can do to help students whose brains seem more ready for sleep than for a piano lesson? The answers to these questions are complex and multi-faceted, and much has yet to be discovered about how the brain learns, but research in the fields of neuroscience, psychology, and education is constantly being updated, helping to shed light on how students acquire, store, and retrieve memories. With the availability of new brain imaging technologies such as MRI, fMRI, CT scans and PET scans, scientists and educators are gaining information that can offer tremendous insights into how people learn. Applying this research to piano teaching can be tricky, because the field of brain research is young — findings that appear to impact education a certain way one day can be refuted a short time later. However, understanding some basic information about how the brain learns can be invaluable to teachers for advising students on sound practice strategies, developing and testing teaching strategies, and explaining and reaffirming teaching techniques that teachers have already found to be useful.

### Learning = neural communication

All of learning and memory can essentially be described as one thing — neural communication. When the brain receives sensory input such as a sight, sound, or smell, certain neurons communicate with one another and form a pathway. One neuron releases neurotransmitters that spark a series of electrochemical reactions, causing another neuron to fire. The firing process continues to other neurons, forming a chain reaction. If the sensory stimulus is not received again during a standby period of a few hours to a few days, the neural pathway will most likely disintegrate, and no memory will be formed. If, however, the firing pattern is repeated during the standby period, the group of associated neurons will

build an increased tendency to fire again in the future, and the firing will require less stimulation — in other words, a memory is formed and that memory will get stronger with repetition. Ultimately, whenever one neuron is triggered, the whole network fires and is strengthened, thereby consolidating a memory and making it easier to retrieve in the future. The more the pathway fires (or gets used) the stronger it becomes. Furthermore, there is a fatty substance called myelin that coats the axons of neurons (the part of the neuron that sends the signal to the next neuron). Myelin insulates the neural pathway, allowing communication to happen more rapidly, and protecting it from interference from nearby reactions. Myelin builds up much more on axons that get frequent use. This too, is a reason that use and repetition make learning last and aid skill acquisition.

## Implications for practice

Knowledge of the brain's neural communication process makes it easy to understand why practicing makes piano playing easier and more automatic. The more something is practiced, be it a phrase, physical gesture, or memorization of various musical elements, the more the neural pathways for that learning are strengthened and "burned" into the brain. Likewise, when one practices incorrectly, whether it is playing wrong notes or rhythms or leaving out an element such as dynamics, it becomes harder and harder to correct. With every key played and every note heard, the brain is constantly rewiring itself. It is a perfect explanation for the saying, "Practice makes permanent!" How many students, when they miss a note during practice, simply move on, half-heartedly vowing to "fix it later?" Most students probably know that mistakes should be fixed immediately, but they may not understand *why* it is important not only to fix mistakes, but also to learn music correctly from the start so that unwanted neural pathways are not established in the brain and then strengthened through careless or inaccurate practice. Teaching our students how the brain learns can help motivate them to be "kind" to their brains, feeding them the right information every time.

When it comes to motor skills, students should know that it takes about six hours after practicing a new skill for the brain to establish a strong memory for it. When a new skill is initiated, the frontal lobe and motor cortex of the cerebrum are activated to concentrate on and control the skill. After about six hours, however, the activity shifts to the cerebellum, which is when the skill becomes more automatic. Memory of motor skills is further established during sleep, which is why piano playing often feels easier the next day after practicing. One important implication of this for students is that cramming before a lesson or performance does not work!

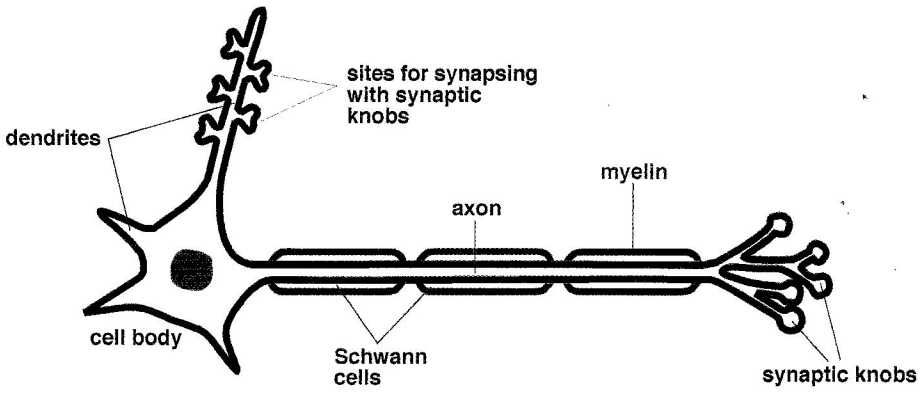


*Diagram of a neuron. Image courtesy of Brian Kahn, United Nations International School.*

## Types of memory

Memory has two major categories: *short-term memory* and *long-term memory*, with short-term memory further divided into the subcategories of *immediate memory* (or *sensory memory*) and *working memory*. These terms do not refer to specific memory areas of the brain, but rather are labels to help one understand how the process of memory works. Immediate memory is like a clipboard. It takes in all the information gathered by our senses — sights, sounds, smells, tastes, and touches — and holds them only for a few seconds, after which much of this information is quickly discarded. We are often unaware of this process — there are simply too many stimuli to keep track of at any given time. Our working memory is where we consciously process information and actively think through concepts. Working memory is what piano students use to process new concepts learned in a lesson and decide how to use them. Piano teachers want students to take those concepts from working memory and transfer them to long-term memory so that they can be stored and retrieved in the future. Fortunately, there are many things teachers can do to help make that happen.

## Teaching strategies: novelty and chunking

Two key strategies to transferring information from working memory to long-term memory are to keep the information active in working memory, and to make connections to other learning. Keeping information in students' working memories can be a challenge for teachers, because working memory is limited in both how long it can focus on particular tasks, and in the number of chunks of information it can retain at one time. Individuals vary greatly in the time limits and capacity of working memory, but

it is safe to say that children do not have the same abilities as adults in either regard. Adults can focus their attention on a working memory task for longer periods of time, while children, especially young children, have a much shorter attention span.

Adults on average can retain about seven chunks of information in working memory at any given time, while 6-14 year-olds have a capacity of about five chunks, and children under six only two chunks. There are, however, things teachers can do to help expand working memory time and capacity. Introducing novelty helps the brain to stay focused for longer periods of time. The brain pays more attention to novel stimuli than redundant stimuli. If the teacher can shift gears in a way that makes the brain think something new has arrived, the brain wakes up and pays attention. A great way to do this is to switch sensory approaches within a lesson. For example, if a student is working a piece that uses I and V chords in the accompaniment, the teacher might break for a moment to do a quick ear training activity using the same chords. Or, she might have the student write some I and V chords, or transpose them. Creative skills can be fostered by improvising a short piece using the same chords. If the chords were played in the left hand, the student can try playing them in the right hand.

Using a variety of sensory approaches has another benefit as well. The more senses that are used in learning and memorization (visual, aural, and kinesthetic, as well as analytical means), the more storage sites the brain will have from which to recall the information. Some authors of education literature today suggest assessing a student's dominant sensory learning modality (visual, aural, or kinesthetic) and teaching in a way that caters to that learning style, but others believe that it is more effective and practical to use a variety of senses and approaches with all students, regardless of the "dominant" modality. Piano teachers should be ready to do activities that use different senses, and they should encourage students to use multi-sensory practice strategies between lessons for optimal retention.

Chunking techniques go a long way towards helping the brain process more information at once, and a knowledge of music theory is essential for chunking musical information. If a student never learns how to spell and recognize minor chords, for example, the pitches G, B-flat, and D will be processed by working memory as three chunks (individual notes) instead of one (g minor triad). Teachers might illustrate this to students who do not understand the importance of theory by playing a memory game, asking them to memorize a series of letters quickly, such as EOEBTNHVE, and seeing if the student can recall the letters again a few minutes later. Trying the game again with a familiar ("chunkable") rearrangement of the letters (BEETHOVEN) illustrates the value of chunking.

## Making connections

Making connections to existing learning is vital in establishing long-term memories. When a student can take a new concept and link it to a known concept already established as a long-term memory, retention is much more likely. A memory is a series of neurons that fire together when stimulated; linking a new concept to that neural pathway causes other neurons to fire with the pathway as well, so it is now joined to that network. Linking new learning to previous learning also helps create relevance for a student. Meaning and relevance play an essential role in motivation and learning, so teachers should always strive to have students use new learning right away. Helping the student see the connection between new concepts and repertoire that the student wants to play will add relevance and importance to the new concepts.

## Closure

An additional step teachers and students can take at the end of lessons, and that students can do after practice to tie everything together, is to go through a process called *closure*. After a learning episode, if the student summarizes what was learned and thinks about how that learning connects to current knowledge, the tendency to remember that learning and store it in long-term memory is increased. The teacher should be careful not to summarize *for* the student at the end of the lesson. The brain that works is the brain that learns! For true closure to take place, the student must challenge his or her brain to recall the recent dealings of working memory and connect to long-term memory to help strengthen those neural pathways. The end of the lesson or the end of a lesson segment is a good time to ask students to summarize what was learned and how it is linked to other learning and goals. Closure is useful after practice sessions too, and a great way to do it is to keep a practice journal of what was done in practicing, also jotting down goals for the next practice session.

## Encouraging wakefulness

Even a teacher armed with numerous brain-friendly teaching strategies will run into difficulties when trying to work with a student whose brain seems to want nothing more than to take a nap. Adolescents often do not get enough sleep due to busy schedules and other factors, and circadian rhythms might also cause a dip in mental energy during the lesson time. Teachers can help their students (and themselves) feel more alert by supplying the teaching area with bright light. This can reduce the levels of melatonin in the body and signal the brain to wake up. Another important strategy is to supply the brain with proper fuel. Oxygen and glucose are important fuel sources for the brain, and low amounts of either will produce lethargy and sluggishness. Fruit is an excellent source of glucose,

and it is a much better source of energy before a lesson than sugar. Water is important to neural communication too — avoid dehydration! Teachers cannot control how much sleep their students get or what they eat and drink, but we can advise them on how to make the most of their lesson and practice time by doing things such as grabbing a drink of water and making smart nutrition choices. Getting up periodically to stretch is another excellent way to revive sleepy students. Sitting for extended periods results in reduced blood flow to the brain, and standing up and stretching gets the oxygen-rich blood circulating again. Taking a break from sitting on the bench part way through a lesson will help students regain focus, and this also provides an excellent opportunity to switch sensory approaches or add novelty by doing some movement activities.

## In conclusion ...

Piano teachers will never know completely what is "going on in there" when it comes to understanding what our students are thinking and how they are learning, but research and technology are giving teachers more and more insights and tools that can help them to instruct students in a "brain-friendly" manner. Understanding the basics of neural communication and memory and using techniques to foster connections will help students learn more effectively and efficiently, which can make the whole experience of piano study more successful and exciting. I encourage you to do a closure activity of your own — jot down a few ideas that you most want to remember or that you can apply directly to your teaching this week. Post it in your teaching area so that you can quickly recall what you learned, and put it to use! ▲

*In the next issue:*

How do you teach students who learn at a slower pace?



## Recommended resources

The following resources contain additional information on brain research and practical applications to teaching and learning. Especially recommended for students interested in the brain is Eric Chudler's website, based at the University of Washington. It has a wealth of information in the "Neuroscience for Kids" section, which presents information on the brain and learning in an accessible and entertaining format.

### Books and articles

Bryne, Faith Hickman. *101 Questions Your Brain has Asked about Itself but Couldn't Answer ... Until Now* (Brookfield, CT: The Millbrook Press, 1998).

Carter, Rita. *Mapping the Mind* (Los Angeles, CA: University of California Press, 1998).

Jensen, Eric. *Brain-Based Learning* (San Diego, CA: The Brain Store Publishing, 2000).

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Levitin, Daniel. *This is Your Brain on Music: The Science of a Human Obsession* (NY: Penguin Group, 2006).

Sisterhen, Lesley. *Enhancing your musical performance abilities*, American Music Teacher 54, No. 1, (2004): 32-34.

Sousa, David. *How the Brain Learns*. 2d ed. (Thousand Oaks, CA: Corwin Press, Inc., 2000).

Wolfe, Patricia. *Brain Matters: Translating Research into Classroom Practice* (Alexandria, VA: Association for Supervision and Curriculum Development, 2001).

### Websites

Brain Connection:
http://www.brainconnection.com/

Eric H. Chudler, Ph.D.:
http://faculty.washington.edu/chudler/ehc.html

Society for Neuroscience:
http://www.sfn.org/ ▲