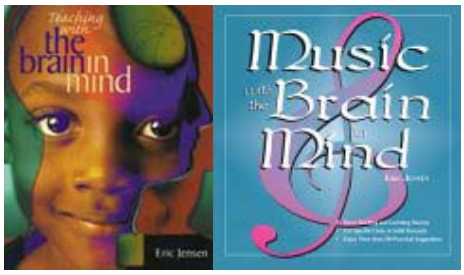
Chapter Two: The Musical Brain



- Resources from Eric Jensen (The Brain Store - http://www.thebrainstore.com/store/)
- *Teaching with the Brain in Mind* and *Music with the Brain in Mind* - Eric Jensen
    - *Teaching With the Brain in Mind* balances theory and research with tips and techniques for applying what we now know about the brain and learning to everyday classroom practice. From its primer on brain biology to its in-depth discussions of emotion, memory, and recall, this popular volume is invaluable for educators looking to better reach students through truly brain-compatible teaching.
    - *Music With the Brain in Mind* - Although compelling evidence supports the value of the musical arts in school, many of us still fight for its inclusion. This timely new resource translates the latest brain and music research and provides practical strategies for incorporating the musical arts at all levels.
- Read the Excerpt from Teaching with the Brain in Mind (ASCD) - http://www.ascd.org/readingroom/books/jensen98book.html

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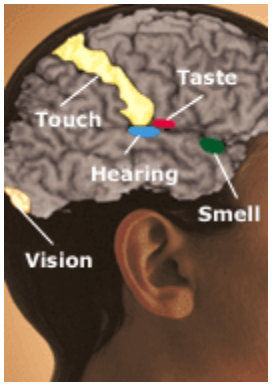
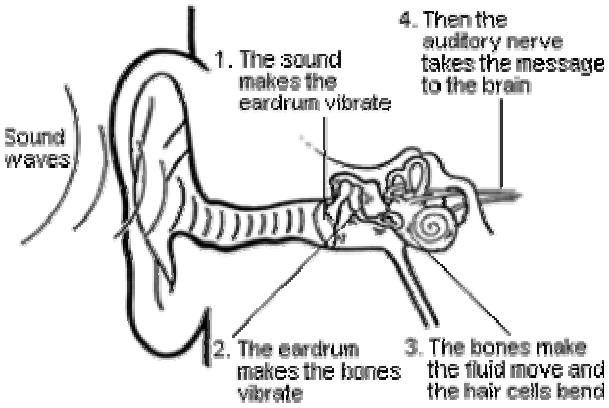
Auditory - Learning through the Sense of Hearing

How does the brain process music?

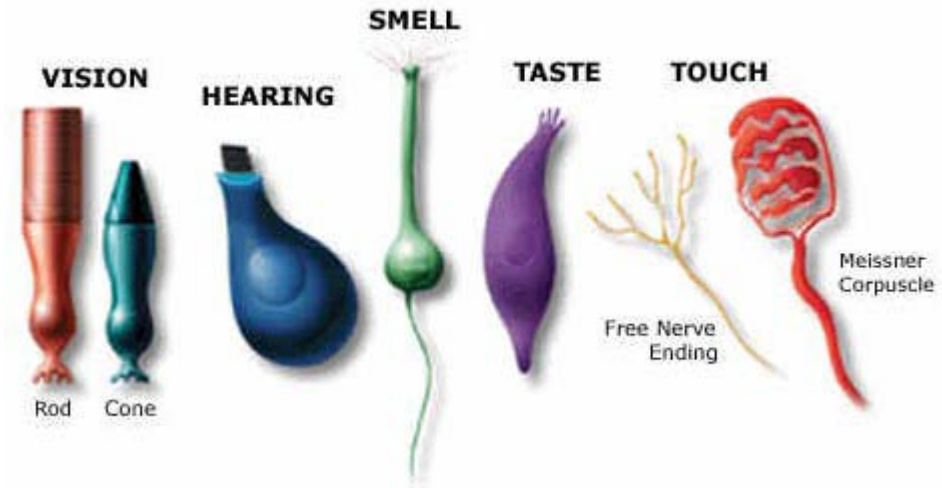


The Five Senses

How do we hear?



"Sound waves enter your ear canal and hit your ear drum. This makes it vibrate. Three tiny bones in your middle ear link the vibrating ear drum with the inner part of your ear. The last of these bones is connected to a tiny bone structure that looks a bit like a snail shell, but is about the size of a pea. It is called the cochlea (pronounced *cock-lee-ah*). Your cochlea is filled with a liquid that carries the vibrations to thousands of tiny hair cells. Each cell is tuned to a particular sound (or frequency). As these little hair cells move in the fluid, they carry a message to the nerve that is connected to your brain, which turns this signal into what you hear. All this happens in a fraction of a second." Resource: http://www1.mydr.com.au/default.asp?article=3361



Seeing, Hearing, and Smelling the World - Howard Hughes Medical Center

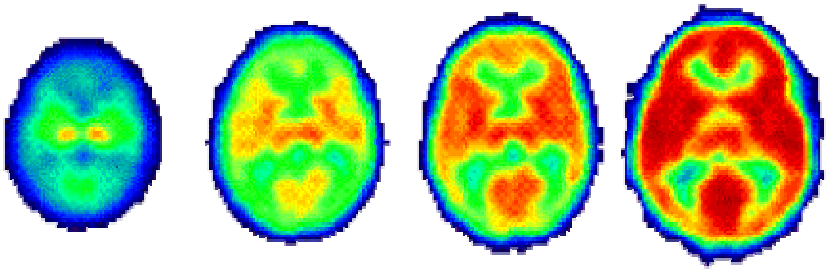
http://www.hhmi.org/senses/

This is a great website presenting research on how we hear and how the brain processes sensory input. These readings are optional, but they provide some wonderful resources for understanding how we know the world through auditory experiences. Here's a quote from "Sensing Change in the Environment." "Everything we know about the world comes to us through our senses. Traditionally, we were thought to have just five of them—sight, hearing, touch, smell, and taste.

Scientists now recognize that we have several additional kinds of sensations, such as pain, pressure, temperature, joint position, muscle sense, and movement, but these are generally included under "touch." (The brain areas involved are called the "somatosensory" areas.)"

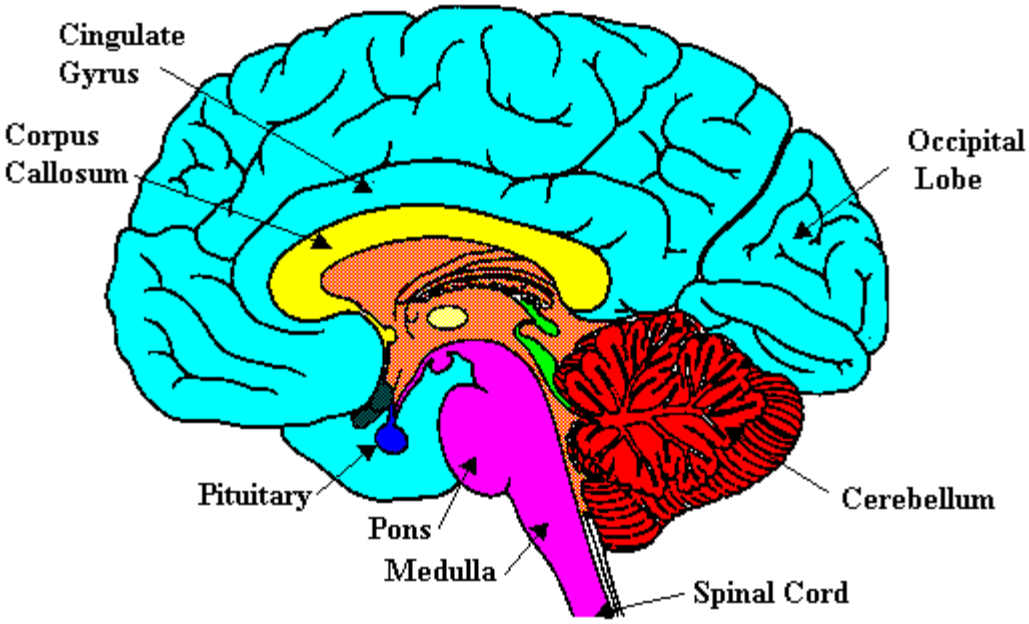
- Examine It's All in the Brain - http://www.hhmi.org/senses/a120.html
  - Illusions Reveal the Brain's Assumptions
  - Sensing Change in the Environment
  - Vision, Hearing, and Smell: The Best-Known Senses - http://www.hhmi.org/senses/a130.html
  - More Than the Sum of Its Parts
- The Quivering Bundles That Let Us Hear
  - Signals From a Hair Cell - http://www.hhmi.org/senses/c110.html
  - The Goal: Extreme Sensitivity and Speed
  - Tip Links Pull Up the Gates of Ion Channels
- View brain scans in a Brain Map of Auditory Space
  - What Is This Person Hearing—Music or Just Meaningless Clicks?
  - http://www.hhmi.org/senses/c210.html (Click on Side Bar)
- Virtual Tour of the Ear - http://ctl.augie.edu/perry/ear/hearmech.htm

Brain Activity by Age - Stages of Development Through Sensory Experiences in the First Year

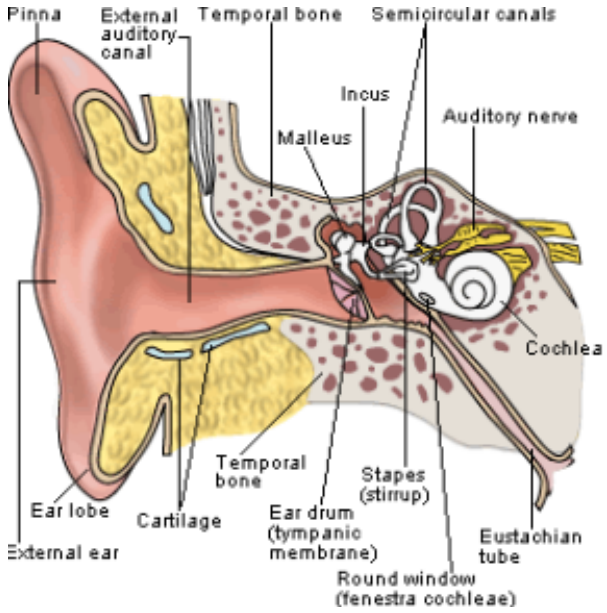


Learning through the Senses - Great Sites for Kids

- Go to the Senses Website - http://faculty.washington.edu/chudler/chsense.html
- The Ear (from Neuroscience for Kids) - http://faculty.washington.edu/chudler/bigear.html
- Southwest Educational Development Laboratories - http://www.sedl.org/scimath/pasopartners/senses/welcome.html
- Sound Effects Game - http://faculty.washington.edu/chudler/flash/sounds.html
- Brainy Games - http://faculty.washington.edu/chudler/flash/fgames.html
- Brain Pop - 5 Senses - http://www.brainpop.com/health/senses/
- 5 Senses - http://school.discovery.com/lessonplans/programs/humanbody/



How the Brain Responds to Music Sound Waves



- Sound waves connect with hair neurons that match the frequency.
- The frequency activates neurons and mechanical energy is turned into electrical energy
- Neurons project to the brainstem in the cochlear nucleus of the medulla where the location of sound is determined.
- Projections from the auditory cortex send information back to the cochlea to aid in auditory discrimination
- Electrical package (music) sent to thalamus
- These impulses flow to the auditory cortex on the left side of the brain and light up the brain during PET or MRI scans

- Brain has developed elaborate neural networks that process the components of music - pitch, timbre, harmony, and rhythm.
- Music is processed in the brain - sensed, sorted, categorized, recognized, and responded to as quickly as the neurons can fire, connect, and oscillate.

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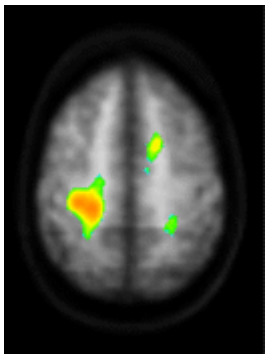

Our non-dominant hemisphere processes harmonic structure, interval, quality, timbre, and the spatial, temporal, and long-term patterns of music. (right for most people)
Our dominant hemisphere recognizes short term signatures, rapid variance in volume, rapid and accurate pitch trajectory, pacing, and lyrics (left for most people

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<td>
Two Cerebral Hemispheres - Left and Right

Connected by bundles of nerve fibers
Allows each side of the brain to exchange information more freely
Although each side processes things differently, the early concept of left brain/right brain is outdated
Left-handed and Right-handed people use differing parts of the hemisphere for some activities
Left Hemisphere

Processes things more in parts and sequentially
Musicians process music in left hemisphere

Right Hemisphere

Music and Arts have been considered right-brain "frills" but trained musicians use more left-brain and novice musicians use more right.
Higher-level mathematicians, problem solvers, and chess players actually have more right-brained activity, but beginners use more left brain.

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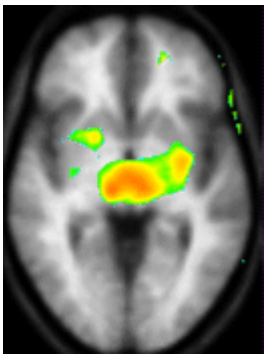
The Thalamus

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The thalamus is often thought of as the individual consciousness - the "You"

Narrow bands across the top middle of the brain

Sensory Cortex - Monitors skin receptors
Motor Cortex - Needed for Movement

Cerebellum

Latin for "the little brain"
Back lower area of the brain
Responsible for balance, posture, motor movement, and some areas of cognition
Thought to include the essential long-term memory traces for motor learning.

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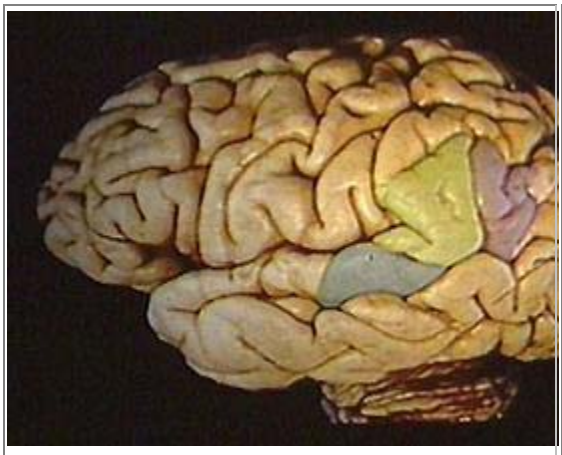
Broca

Music is processed differently for different people depending on kind of music and musical background.

- Familiar music activates Broca's area (left hemisphere)
- Rhythm notes are activated in Broca's area and the cerebellum
- Harmony activates the left side of the brain more than the right in the inferior temporal cortex.
- Timbre activated the right hemisphere (the only musical element that did)
- Pitch activated an area on the left back of the brain - the precuneus.
- Melody activated both sides of the brain.
- Composite listening - Left and Right Hemisphere - Auditory Cortex
- Understanding lyrics - Wernicke's Area



Wernicke's Area - Lyrics

Auditory Cortex - Melodic Contour

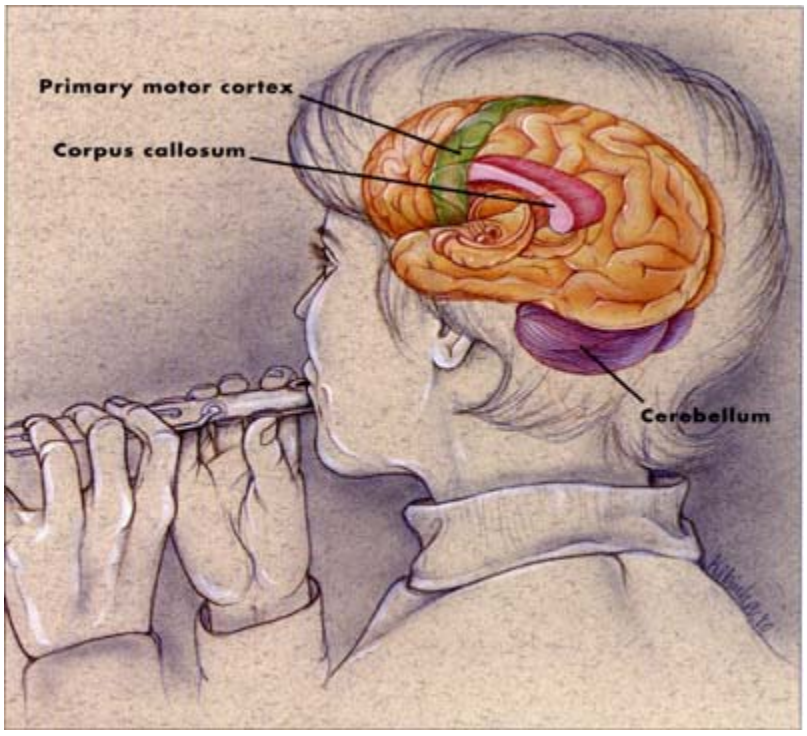
Learning Changes the Brain!

- Some kind of stimulus to the brain starts the learning process.
- The stimulus is sorted and processed at several levels.
- Results in formation of memory.
- Either doing something we already know how to do - or we are doing something new.
- Stimulation is doing something new - lighting up the brain scan.

- Once a task is learned, the brain lights up less.
- Neurons (brain cells) make connections between different parts of the brain.
- Information is carried inside a neuron by electrical pulses and transmitted across the synaptic gap from one neuron to another by chemicals called neurotransmitters.
- Learning is a critical function of neurons.
- Dendritic branching helps make connections between cells.
- As cells connect with other cells, synapses occurs.
- New synapses appear after learning.
- Repeating earlier learning makes neural pathways more efficient through myelination (fatty substances formed around axons)

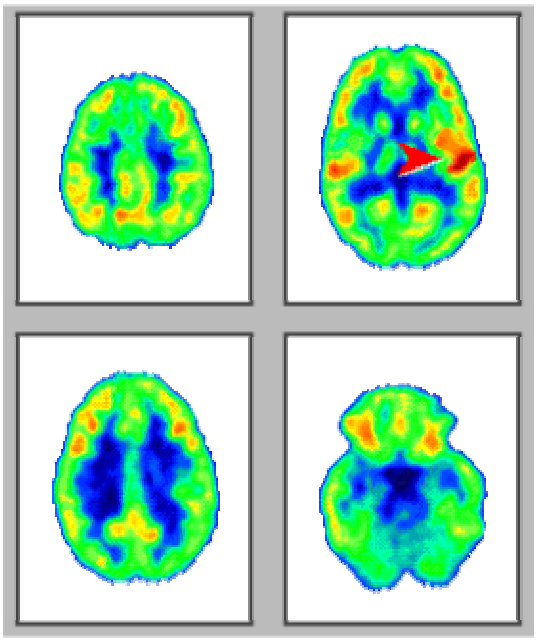
Brain Activation with Different Stimulation and Levels of Activity

Performing music makes neural connections between various parts of the brain. Auditory and motor activities take place through playing an instrument. Rhythm and melody instruments require motor coordination. Reading music involves visual activity. Singing songs and recalling or reading lyrics activate language processing areas of the brain. Dancing or moving to the rhythm of music stimulates the brain's motor areas.

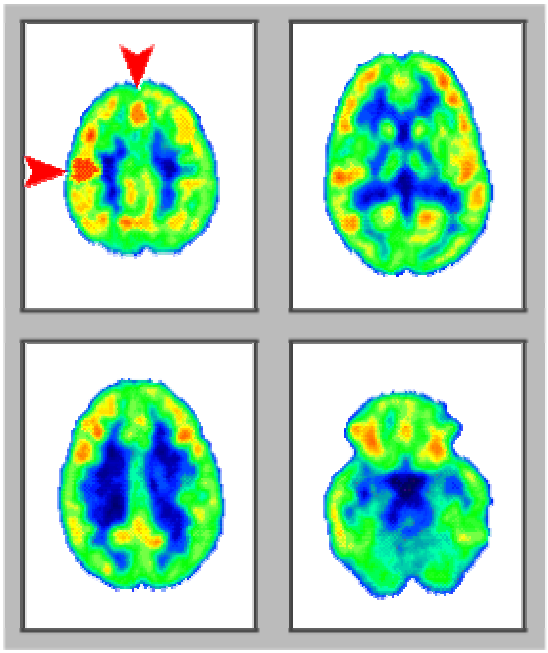


Brain research provides support for emphasizing the visual and performing arts in the classroom!

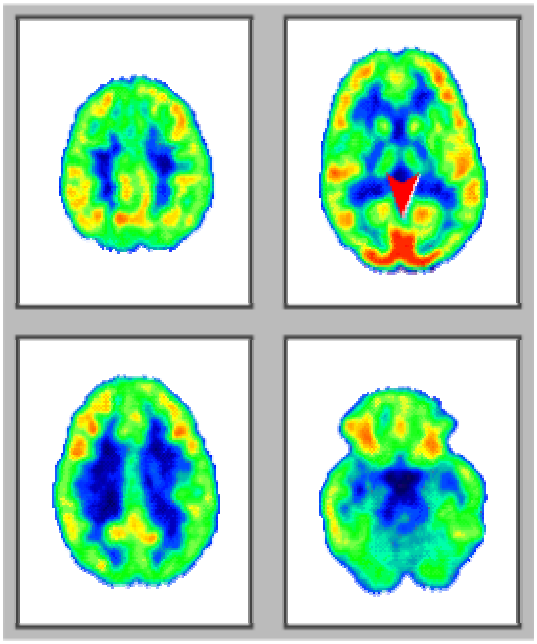
Auditory Activity



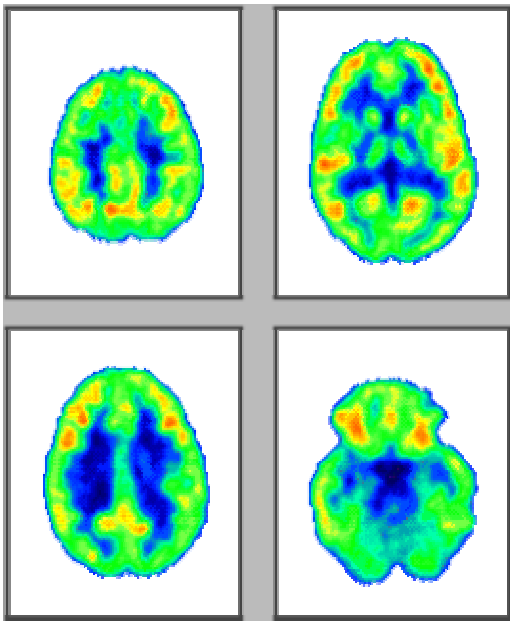
Motor Activity



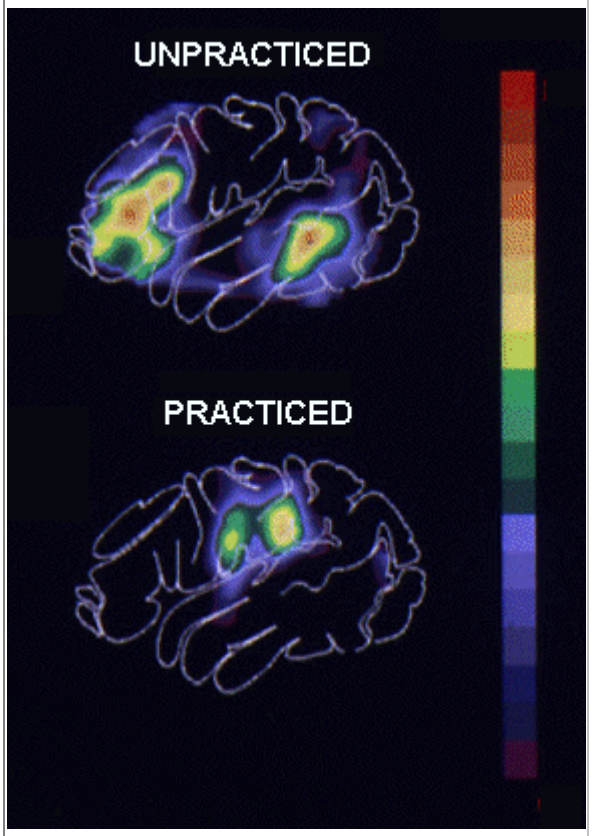
Visual Activity



The Resting Brain



What a Pet Scan Can Do



http://www.epub.org.br/cm/n01/pet/pet.htm

Language Processing

A good example of the fantastic imaging capabilities of PET is shown in the images at the left, made by Dr. Marcus Raichle, at the Neuroimaging Lab or the Washington University School of Medicine, St Louis, USA.

These scans "were taken under two different conditions. In the first one (uppermost image), an individual was hearing a text, in order to learn a new language task. The color map shows the regions of the brain which were activated by this task, in other words, where there were cells working more than in their resting state, with a higher metabolism (using more energy and more blood flow). The PET machine shows the degree of activity in several tones of color, like in a rainbow. Yellow and red regions are "hotter", that is, they indicate a higher cell activity. Blue and black regions show decreased activity or none at all. While obtaining this image, the patient was still unpracticed at the language learning task. The highest brain activities are shown in an area called temporal lobe, responsible for the hearing perception, and in another area called prefrontal cortex, responsible for understanding language.

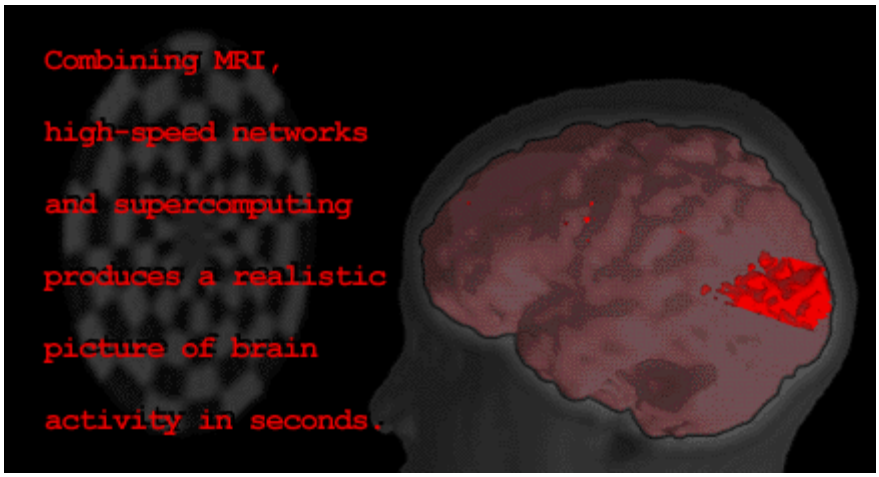
In the second condition (lowermost image), the same individual has now learned the language task and is spelling out. You can easily see in the color map that two different regions of the brain were activated in each condition. Now the activity is concentrated in the area of the cortex which is responsible for the motor control of voice, the so-called area of Broca, so named because it was discovered by a French physician named Paul Broca, in the turn of the century. Thus, the functional map obtained with PET closely corresponds with what we know about the brain's functional neuroanatomy, discovered by other methods. The difference here is that we can actually obtain a real-time image of brain function."

Neuroscience

We now know much more about how the brain functions due to technological advancements in "Neuroscience."

Explore these online resources on the brain!

- Secret Life of the Brain (PBS) - http://www.pbs.org/wnet/brain/index.html This is an amazing site providing you with information on the history of brain research, the anatomy of the brain, brain scans and animations, as well as descriptions of brain development at different stages.
- Explore the Neuroscience for Kids Website - http://faculty.washington.edu/chudler/neurok.html



Neuroscience - Developing through 1970's, 1980's, and 1990's

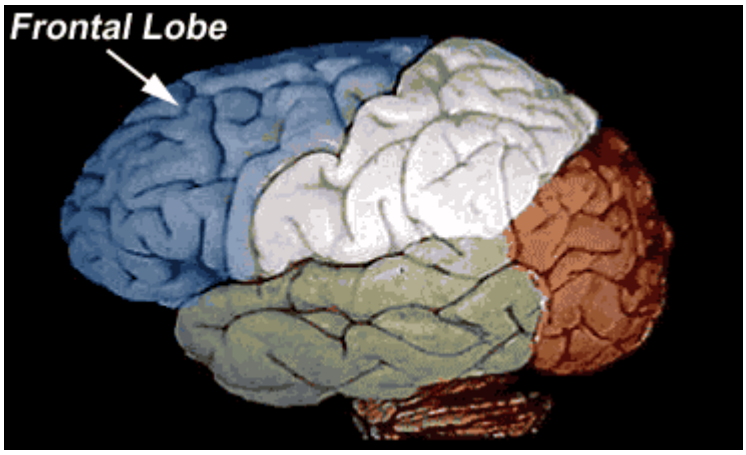
- Technology paved the way for paradigm shift
- Enabled researchers to understand and see inside the brain.
- Brain scanners developed - Brain Imaging Technology
    - Magnetic Resonance Imaging (MRI)
    - Positron Emission Tomography (PET) - Radioactive glucose used to determine activity in different parts of the brain
- International Society of Neuroscience established - 1969
- Computerized Electrodes
    - Electroencephalography (EEG) - gives us readings about electrical output of the brain
    - Detect brainwave patterns
    - Can detect abnormal cerebral functions (seizures or dementia)
    - Can help us detect brain activity during problem solving
- Autopsies
    - Show weight, stages of development, and amount of decay or lesions

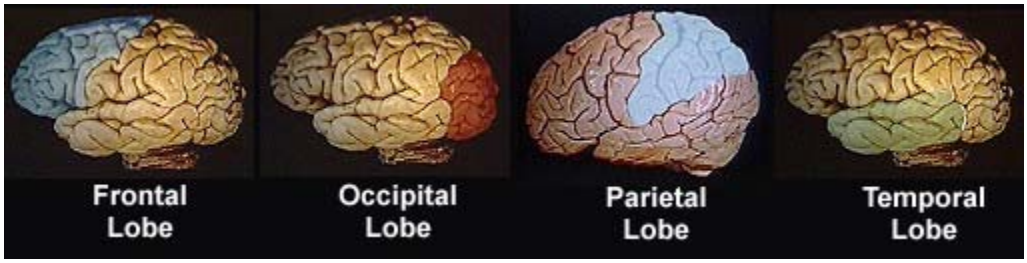
- Dendritic activity shows how brains physically changes with different tasks
- Spectrometers
  - Measure specifics of brain chemicals or neurotransmitters as activity occurs
  - Levels of neurotransmitters present in different brain lobes.

Facts About the Human Brain

- Weighs approximately 3 pounds
  - Mostly water - 78%
  - Fat - 10%
  - Protein - 8%
- Soft enough to cut with a butter knife
- Grapefruit-sized organ
- Outside of the brain
  - Convolutions or folds
  - Wrinkles are part of the cerebral cortex
  - Folds allow maximum surface area
- Makes up critical portion of the nervous system
  - Nerve cells connected by nearly 1 million miles of nerve fibers
- Has the largest area of uncommitted cortex of any species giving humans flexibility for learning.
- Brain consumes about 20% of the body's energy .
- The Brain uses about 1/5 of the body's oxygen.
- The Brain gets about 8 gallons of blood each hour (supplying nutrients like glucose, protein, trace elements, and oxygen).
- Brain needs 8-12 glasses of water a day for optimal functioning.
- Two kinds of brain cells:
  - Glia - (Greek word meaning glue)
    - 90% of the brain cells
    - Less known about glia cells
    - No cell body
    - Remove dead brain cells and give structural support
  - Neurons (Greek word meaning bowstring)
    - 100 billion neurons in human brain
    - Neurons essential to performing the brain's work
    - Consist of a compact cell body, dendrites, and axons

Lobes - Four Areas of the Brain





Frontal Lobe

- Area around your forehead
- Involved in purposeful acts like judgment, creativity, problem solving, and planning.

Parietal Lobe

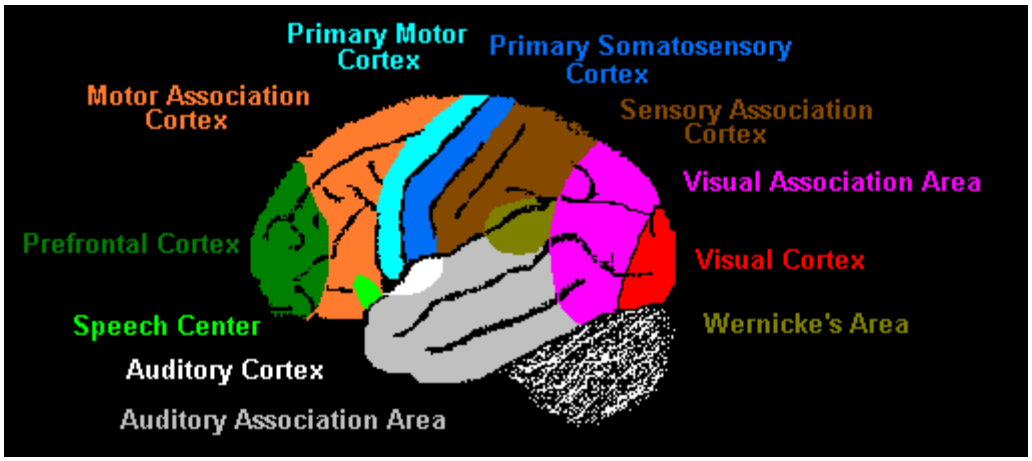
- Top back area of the brain
- Processes higher sensory and language functions

Temporal Lobe

- Left and right side above and around the ears
- Primarily responsible for hearing, memory, meaning, and language.
- Some overlap in functions of the lobes.

Occipital Lobe

- Back of the brain
- Primarily responsible for vision



Territory in the Middle of the Brain - The Emotional Area of the Brain

- 20% of the brain by volume
- Sometimes called "The Limbic System"
- Responsible for
  - Emotions
  - Sleep
  - Attention
  - Body regulation
  - Hormones
  - Sexuality
  - Smell
- Responsible for production of most of the brain's chemicals

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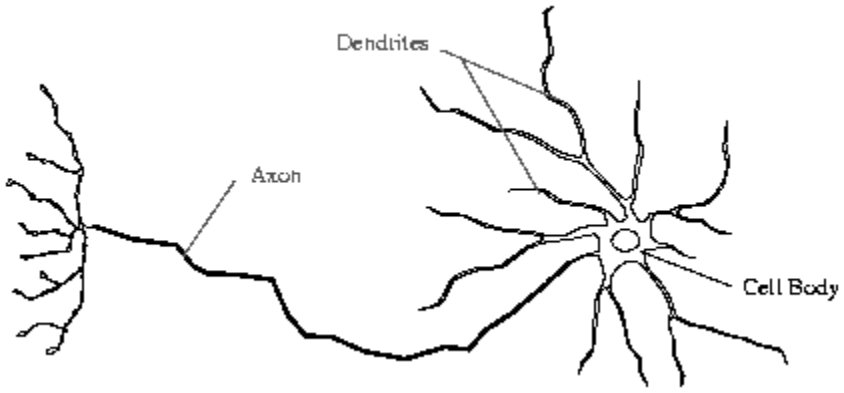
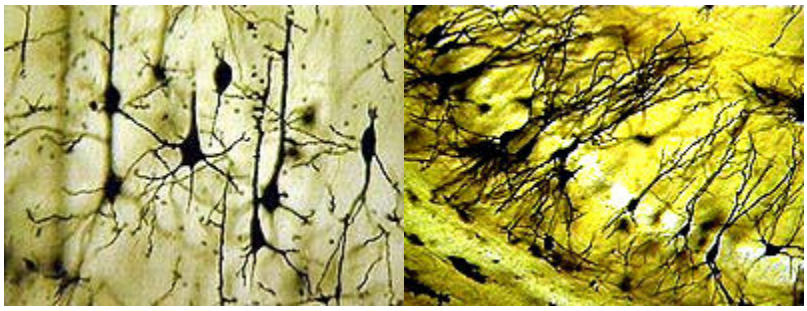
Neurons - Brain Cells

Gallery of Neurons - http://faculty.washington.edu/chudler/gall1.html



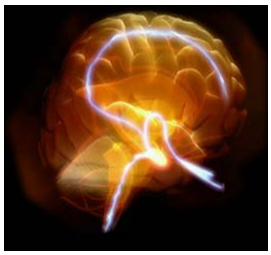
Dendrites and Axons

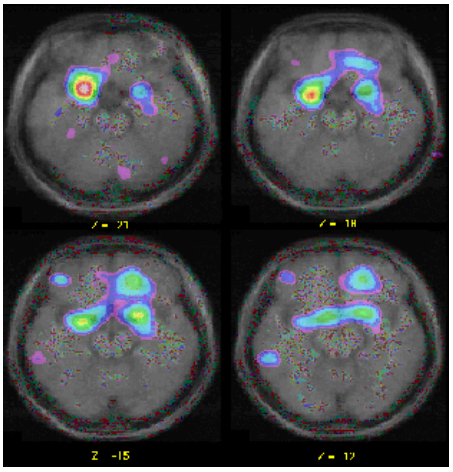
Neurons have specialized projections called dendrites and axons. Dendrites bring information **to** the cell body and axons take information **away** from the cell body. Information from one neuron flows to another neuron across a synapse. The synapse is a small gap separating neurons. (The Synapse - http://faculty.washington.edu/chudler/synapse.html)



- **Dendrites**
  - Responsible for information processing
  - Fibers convert chemical and electrical signals back and forth
  - A normal functioning neuron is continuously firing, integrating and generating information
  - Hotbed of activity
  - Many dendrites extend from each neuron
  - Each dendrite has one axon that splits to subdivide itself and connect to other dendrites
  - Information flows from cell body down to axon to the synapse.
  - Branch-like extensions that grow outward when the environment is enriched.
  - Neurotransmitters - chemicals
- **Axon**
  - Conducts information in the form of electrical stimulation
  - Transports chemical substances
  - The thicker the axon, the faster it conducts electricity and information.
  - Myelin (fatty substance) forms around well-used axons ("myelinated")
    - Some say there is a correlation between thicker myelin and intelligence.
    - Optional Biology Website on the Future of Myelination - http://student.biology.arizona.edu/honors99/group5/default.htm)

A neuron typically has many dendrites and one axon. The dendrites branch and terminate in the vicinity of the cell body. In contrast, axons can extend to distant targets, more than a meter away in some instances. Dendrites are rarely more than about a millimeter long and often much shorter. Neurons communicate through specialized junctions called *synapses*. Axons typically make synapses with other neurons through specialized enlargements near their terminals. These synapses can occur on the cell bodies or the axons of other neurons, but most frequently they occur on dendrites. Thus, the dendrites of a neuron provide a surface for receiving synaptic inputs from other neurons. The arbor formed by the dendrites of a neuron often has a characteristic shape as determined by the spatial domains into which the dendrites family. (From Morphology of Dendrites - http://synapses.mcg.edu/anatomy/dendrite/dendrite.stm - The Human Brain Project.)





Brain Activity Hotspots

Brain Websites

- The Slice of Life - Images of the Brain - http://medlib.med.utah.edu/kw/sol/sss/subj2.html
- Brain Waves Center - http://www.brainwaves.com/memory.html
- The Brain Place - http://www.brainplace.com/bp/brainsystem/default.asp
- Synapses Web - http://synapses.bu.edu/
- Synapse Web - http://synapses.mcg.edu/

Music and the Brain Resources

- Musicality from Birth to Five - http://music-research.org/Publications/V01N1_musicality.html
- Research on Music Teaching and Learning During Elementary School Years - http://music-research.org/Publications/V01N1_research.html
- Music and the Brain - http://www.epub.org.br/cm/n15/mente/musica.html
- Music and the Brain - http://www.brainplace.com/bp/music/default.asp
- Music and Literacy Articles - http://www.menc.org/networks/genmus/litarticles.html

Educational Articles from Educational Leadership (ASCD)

- The Brain and Learning - Education Topics
- Connecting Brain Research with Dimensions of Learning - 2001
- The Brains Behind the Brain - 1998
- Art for the Brain's Sake - 1998
- ASCD Books to Browse - http://www.ascd.org/readingroom/books/list.html (Entire Chapters Available Online)

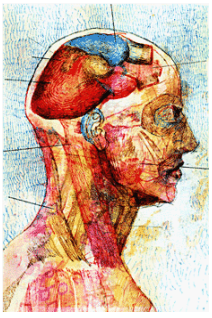
Research on Child Development

- Society has historically placed emphasis on the arts as a way to develop and stimulate the senses of young children at various stages of development.
- Concepts of developmentally appropriate practice with young children came out of the European scientific research which resulted in "kindergarten" and early childhood education.
- Human Intelligence Historical Influences from University of Indiana - http://www.indiana.edu/%7Eintell/map.shtml

Music Cognition

- MARC – Music Cognition Lab - http://marcs.uws.edu.au/research/music/projects.htm
- Society for Music Perception and Cognition - http://www.musicperception.org/pages/links.html
- Music and Research Links - http://members.aol.com/dspondike/mnr/mnrmusicog.html
- Music Cognition Resource Center - http://www.music-cog.ohio-state.edu/Resources/
- Music Cognition at Ohio State - http://www.musiccog.ohio-state.edu/

Emotional Impact of Music



The Biology of Music

Music may soothe the troubled breast. It might even be the food of love. But how does it cast its spell? Romantics can take comfort from the fact that science does not yet have all the answers. But it has some.

When philosophers debate what it is that makes humans unique among animals, they often point to language. Other animals can communicate, of course. But despite the best efforts of biologists working with beasts as diverse as chimpanzees, dolphins and parrots, no other species has yet shown the subtleties of syntax that give human languages their power. There is, however, another sonic medium that might be thought uniquely human, and that is music. Other species can sing (indeed, many birds do so better than a lot of people). But birdsong, and the song of animals such as whales, has a limited repertoire—and no other animal is known to have developed a musical instrument.

Music is strange stuff. It is clearly different from language. People can, nevertheless, use it to communicate things—especially their emotions. And when allied with speech in a song, it is one of the most powerful means of communication that humans have. But what, biologically speaking, is it? Music's effect on the outer layers of the brain—the temporal and even the visual cortex—is only half the story, however. These are the places in which the signal is being dissected and processed. The place where it is having its most profound effect is in the brain's emotional core—the limbic system.

From The Biology of Music - http://cogweb.ucla.edu/Abstracts/Music_00.html

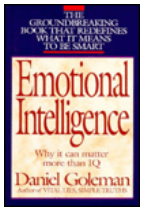
From Mind's Eye to Emotion's Seat

HUMPBACK WHALES use many of the same rhythms and patterns as human composers in their songs, tempting some scientists to speculate that a universal music awaits discovery.

"Music goes much deeper than that—below the outer layers of the auditory and visual cortex to the limbic system, which controls our emotions. The emotions generated there produce a number of well-known physiological responses. Sadness, for instance, automatically causes pulse to slow, blood pressure to rise, a drop in the skin's conductivity and a rise in temperature. Fear increases heart rate; happiness makes you breathe faster. By monitoring such physical reactions, Carol Krumhansl of Cornell University demonstrated that music directly elicits a range of emotions. Music with a quick tempo in a major key, she found, brought about all the physical changes associated with happiness in listeners. In contrast, a slow tempo and minor key led to sadness.

From Music and the Brain: Processing and Responding - http://serendip.brynmawr.edu/bb/neuro/neuro99/web1/Sancar.html

Emotional Intelligence



Daniel Goleman wrote "Emotional Intelligence: Why it Can Matter More than IQ." Goleman describes emotional intelligence as "a different way of being smart. It includes knowing what your feelings are and using your feelings to make good decisions in life. It's being able to manage distressing moods well and control impulses. It's being motivated and remaining hopeful and optimistic when you have setbacks in working toward goals. It's empathy; knowing what the people around you are feeling. And it's social skill--getting along well with other people, managing emotions in relationships, being able to persuade or lead others.

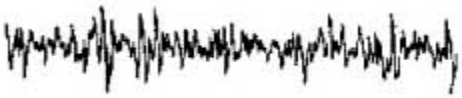
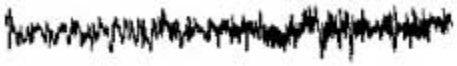
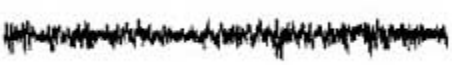
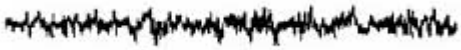
He describes the "physiology of the brain and the relationship between the emotional brain and the brain's executive areas....The prefrontal lobes just behind the forehead are where working memory resides. Working memory is what you are paying attention to at any given point. So everything you are mulling over, making a decision about, or are learning, is at first in working memory. All learning is in working memory. And the emotional centers that control moods like anxiety or anger have very strong connections to the prefrontal areas. So if a child is chronically anxious or angry or upset in some way, he experiences that as intruding thoughts. He can't keep his mind off the thing he is worried about."

Emotional Intelligence Skills (Jensen lists specific research conducted on each of the following skills in his book - *Music with the Brain in Mind*)

- Identifying and labeling feelings
- Expressing feelings appropriately
- Understanding and managing feelings
- Controlling impulses and gratification
- Reducing Stress
- Knowing the difference between feelings and actions.
- See website resources below.

Effects of Music on Emotions

- Exposure, may help children identify and manage their emotional states.
- Enhances ability in children to detect emotion.
- Teaching how to listen to music (for tone, rhythm, pitch, volume, lyrics, etc.) may increase their attention and focus.
- May foster self-confidence.
- Can be used to regulate mood by altered states.
- Enabled students to draw out, relax, unify, and perform in social interactions.
- Improved engagement and socialization
- Music has mood-enhancing effects.
- The emotive-aesthetic experience is important as listening and appreciation skills improve.

Brainwave	Cycles Per Second (CPS)	Brainwave Activity
Delta 	**1-4 cps**	**deep sleep state**
Theta 	**4-7 cps**	**twilight zone - half awake and half asleep**
Alpha 	**8-12 cps**	**relaxed alertness, reflection, calm, prepared**
Beta 	**12-25 cps**	**busy classroom activities, discussion**
Super Beta (no example)	**25+ cps**	**intensity, drama, exercise, simulations**

Music and Relaxation (from Jensen)

- There's a strong connection between the mind and the body.
- Music modulates our body's stress responses.
- Music can decrease or increase stress levels.
- Music is a strong and powerful mood enhancer.
- Music strengthens our immune systems and enhances wellness.
- Sounds connect us to our sympathetic and parasympathetic (stress/distress response) nervous systems.
- Music impacts blood flow in the body.
- Evidence exists that music can be helpful in healing.
    - Possible Explanation - Music can help the body get back in synch since the body emits and responds to sounds and vibrations.
    - Natural state of rest - 8 cycles per second (8 cps) - corresponding with alpha brainwave state
    - Every function in the body has a modifiable, basic rhythmic pattern and vibratory rate that impacts our nerves through sound.
    - Body is maintained through rhythmic vibration.
    - Changes in harmonic patterns, tonal sequences, rhythmic patterns might affect physical and mental health.

Websites

- The Autonomic Nervous System - Kid's Neuroscience Website - http://faculty.washington.edu/chudler/auto.html
- Music Reduces Stress in Surgery Patients - Kid's Neuroscience Website - http://faculty.washington.edu/chudler/surgm.html

- My Body - Kid's Health - http://kidshealth.org/kid/body/mybody.html
- American Music Therapy Association - http://www.musictherapy.org/
- Music Therapy - http://www.holistic-online.com/stress/stress_music-therapy.htm

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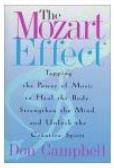


The Mozart Effect

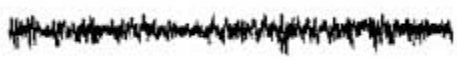
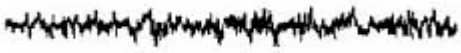
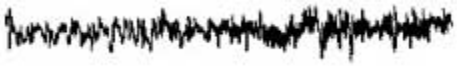
A controversial study of University of California Irvine students was conducted to determine if students who listened to Mozart's Sonata K. 448 for ten minutes prior to testing had higher test scores than those of a control group.

Some results of the "Mozart Effect"

- Evidence has been reported in 26 of 27 studies that were done to duplicate the effect.
- Effect is cross-species (occurs in rats brains as well),
- Music impacts neural firing patterns in epileptics as demonstrated in PET scans (improved spatial reasoning)
- Effect present in preschoolers and not dependant on musical talent
- EEG Studies demonstrated enhanced synchronization of neuronal firing activity of the right frontal and left temporal-parietal areas compared to students listening to a story.

Music Activities in the Classroom that Impact Emotions

(From Eric Jensen - Music with the Brain in Mind)

Alpha 	Alpha brainwaves are commonly recorded when one is quiet and relaxed. Music can induce this state and activate a kind of creative daydreaming. Usually the eyes are closed Alpha waives are formed in the frequency of 8-12 cycles per second. This state is induced with a slower beat.
Beta 	Beta brainwaves are the most common type of brain activity recorded in normal conscious states. These brainwaves undulate from 18-40 cycles per second. Beta means "active." You can induce this state with very upbeat music, such as pop, rock, or up tempo instrumentals. Some classical, jazz, and dance selections qualify as well.
Theta 	Theta brainwaves are often recorded in states of high creativity. These waves are formed at 4-7 cycles per second. This state is the twiglight zone between sleep and wakefulness. This music maintains a very ethereal slow beat.

- **Music for Arousal Effect**
  - Used to enhance and accelerate learning
  - Change in EEG brain activity and pulse rate
  - Engage multiple memory pathways and increase receptivity
  - Arousal states - calm, curious, expectant, energize, or mystify
- **Background Music**
  - Sounds from nature to soothe
  - Provide unobtrusive background accompaniment
  - Relaxing waterfall, ocean, rainforest sounds
  - Non-distracting sounds or music
- **Openings**
  - Establish a positive mode, state, tone, theme
  - Prepare for subsequent learning.
- **Unity**
  - Break down barriers between individuals
  - Selections from various cultures
  - Simple law of sound and distance - twice the distance, sounds must be 4 times louder

    - Music at moderate volume level
- **Focused Concentration**
    - Music in major key
    - Tempo usually 65-80 beats per minute
    - Predictable rhythm
    - Symmetrical form
    - Consistent volume level
    - No distracting variances or vocals
    - Often Jazz or Baroque music will meet these criteria
- **Transitions**
    - Music for mentally shifting gears
    - Musical interludes that mentally move you from one scene to another
    - Combine music with stretching for perfect transition activity
- **Punctuate an Activity**
    - Strengthen the emotional state of a theme
    - Cleaning up to William Tell's Overture
    - Piano or harp selection while stretching
- **State Management**
    - Evoke curiosity (Peter and the Wolf Theme)
    - Promote creativity
    - Fanfares for celebration
    - Accent a mood of anticipation (Jaws)
- **Music as a Primer**
    - Mozart Effect
    - Effective primer:
        - Have a target task in mind
        - Expose learner to specific piece of music for at least 10 minutes
        - Begin target task within 5 minutes

Helping Students Understand Musical Impact

- Noticing Sensations - Invite them to notice comforting sensations in their body - pleasant heaviness, warmth, calm, steadiness, etc.
- Progressive Relaxation - Ask student to visualize thier feet, ankles, calves, knees, and so on, successively relaxing each area of the body.
- Tension Release - Have learners tense and hold rigid successive body parts for a few seconds at a time - then let go of the tension seeing the tension leave their body.
- Physical Relaxation - Help them induce a state of relaxation that increases receptivity.
- Semi-guided Imagery - Ask learners to close their eyes as you describe a peaceful setting. Invite the learners to let their imagination finish the story.
- Unguided Imagery - Encourage your students to allow their imaginations to take flight stimulated by the images and emotional nuances in the music.
- Image Streaming - Have student describe images, thought, impressions, feelings, associations, etc. in a journal or to a partner or into a tape recorder.

Music to Use in the Classroom

Classical Music MIDI and Audio Files

- Classical Music Audio Files
  - Great Collection of Real Audio Files you can access online - http://www.classicsforkids.com/teachers/audio/music.asp
  - Lesson Plans - http://www.classicsforkids.com/teachers/lessonplans/
- Classical Music MIDI Archives - http://www.classicalarchives.com
- MIDI music files of all composers - http://www.classical.net/music/links/midiarch.html
- Classical Music MIDI files - http://www.midiworld.com/classic.htm

Songs for Teaching Audio Files - http://www.songsforteaching.com/

- Using Music in Classroom Management
- See our music for classroom
  - Transitions
  - Energizers
  - Relaxers
  - Positive Attitudes.
- Action Songs that Call for Physical Movement - Research indicates that children learn best when they can be physically active!
- Social and Emotional Learning
  - Friendship
  - Character and Conflict Resolution
  - Diversity
  - Etiquette
  - Family Life

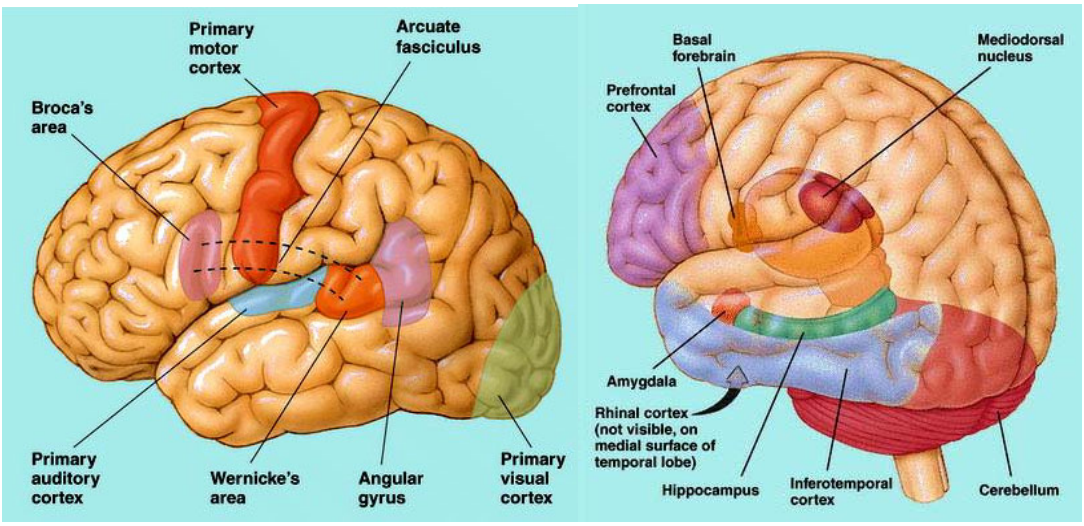
Reflection: Enhancing the Classroom Emotional Atmosphere with Music - Orchestrating your Classroom Environment

Try some music you've never used before! Think of 3-4 examples of music you can use in your classroom and explain how and why.

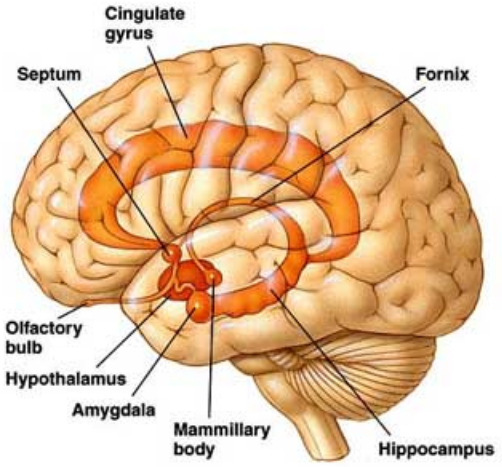
Describe ways you use instrumental music to alter the mood in your classroom. What types of instrumental music would you use to energize the students? List specific titles, composers, or CDs. What particular learning activities might be most effective with a musical component? Try out some of the free online music tracks listed above, or try a several selections from your own instrumental CD collection. Describe the purpose and student response. What instrumental music have you found useful for motivating students to stay on task. What music helps them mellow out? What background music have you tried with your students and explain its effectiveness in providing a soothing, unobtrusive environment? What music have you tried that seems to distract or agitate students? What music do you find relaxes students? If you were to prepare students for an exam by playing 10 minutes of music (like the "Mozart Effect" experiment), what piece of music would you choose?

How do you provide musical transitions between tasks and activities? What music do you like to use to punctuate events and activities in your room? Name any other effective musical selections you've found useful for creating a joyous, creative, and up-beat classroom. What songs do you like to sing with your students on a regular basis? Share music or songs that you have found useful for promoting a caring positive environment? What songs do you use to foster respect for diversity in your classroom? What songs do you use with dance, movement, or gross/fine motor activity? How do you orchestrate your classroom environment?

Major Components of the Limbic System - Emotional Center



▸ Location of Major Limbic System Structures



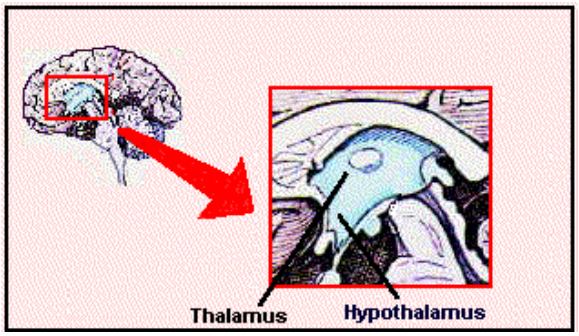
Brain Areas Involved with Emotions

Amygdala

A little almond shaped structure, deep inside the antero-inferior region of the temporal lobe, connects with the hippocampus, the septal nuclei, the prefrontal area and the medial dorsal nucleus of the thalamus. These connections make it possible for the amigdala to play its important role on the mediation and control of major affective activities like friendship, love and affection, on the expression of mood and, mainly, on fear, rage and aggression The amygdala, being the center for identification of danger, is fundamental for self preservation. When triggered, it gives rise to fear and anxiety which lead the animal into a stage of alertness, getting ready to flight or fight.

Hippocampus

Is particularly involved with memory phenomena, specially with the formation of long-term memory (the one that, sometimes, lasts forever).



Thalamus

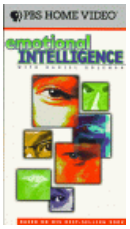
Lesion or stimulation of the medial dorsal and anterior nuclei of the thalamus are associated with changes in emotional reactivity. However, the importance of these nuclei on the regulation of emotional behavior, is not due to the thalamus itself, but to the connections of these nuclei with other limbic system structures. The medial dorsal nucleus makes connections with cortical zones of the pre-frontal area and with the hypothalamus.

Hypothalamus

The hypothalamus is also believed to play a role in emotion. Specifically, its lateral parts seem to be involved with pleasure and rage, while the median part is like to be involved with aversion, displeasure and a tendency to uncontrollable and loud laughing. However, in general terms, the hypothalamus has more to do with the expression (symptomatic manifestations) of emotions than with the genesis of the affective states. When the physical symptoms of emotion appear, the threat they pose returns, via hypothalamus, to the limbic centers and, thence, to the pre-frontal nuclei, increasing anxiety. This negative feed-back mechanism can be so strong as to generate a situation of panic.

Brain Stem

The brainstem is the region responsible for the "emotional reactions", (indeed, they are just reflex answers) of inferior vertebrates, like reptiles and amphibians. Even in humans, these primitive structures remain active, not only as alerting mechanisms, vital for survival, but in the maintenance of the sleep-awake cycle.



Emotional Intelligence Websites

- Emotional Intelligence - Amazon Book Preview
- On Emotional Intelligence: A Conversation with Daniel Goleman (Educational Leadership) - http://www.ascd.org/readingroom/edlead/9609/oneil.html
- Edutopia - http://www.glef.org/index.html Click on Emotional Intelligence (Daniel Goleman Interview Video)
- EQ.org - http://www.eq.org/
- EQ Toolbox - http://www.eqtoolbox.org/
- Life Sounds Articles on Emotional Intelligence and Music - http://www.musicandlearning.com/resources.cfm
- EQ International - http://eqi.org/
- Emotional Intelligence Test Online - http://www.queendom.com/tests/iq/emotional_iq_r2_access.html
- Emotional Intelligence IQ - http://emotionaliq.com/
- All About EQ from 6 Seconds Emotional Intelligence Network - http://www.6seconds.org/
- EQ Today Emotional Intelligence Toolbox - http://www.eqtoday.com/archive/jpcs98activity.html
- Emotional Intelligence - What the Newest Research Says - http://www.thelearningweb.net/emotional-intelligence.html
- Teacher Net UK - http://www.teachernet.gov.uk/teachingandlearning/library/emotionalintelligence/
- Promotional Intelligence - http://www.salon.com/books/it/1999/06/28/emotional/
- Consortium for Research on EQ in Organizations - http://www.eiconsortium.org/
- Emotional Intelligence in Schools - http://www.connected.org/learn/school.html

The Brain and Emotions

- The Brain and Emotion - http://www.news.wisc.edu/packages/emotion/
- Exploring the Musical Brain - http://cogweb.ucla.edu/ep/Music_Leutwyler_01.html
- Intensely pleasurable responses to music correlate with activity in brain regions implicated in reward and emotion - Montreal Neurological Center - http://www.pnas.org/cgi/content/full/98/20/11818
- Neurobiology and Behavior 1999 Bryn Mawr - http://serendip.brynmawr.edu/bb/
- Serendip - Bryn Mawr - http://serendip.brynmawr.edu/
- The Sound of Music - http://www.new-mind.com/SoundMusic/sound_of_music.htm
- Tune your Brain - http://www.tuneyourbrain.com/
- Music and Science Information Computer Archive MUSICA- http://www.musica.uci.edu/
- International Foundation for Music Research - IFMR - http://www.music-research.org/
- The Limbic Center - Center for Emotions - http://www.epub.org.br/cm/n05/mente/limbic_i.htm

- The Limbic System - http://thalamus.wustl.edu/course/limbic.html Medial Temporal Lobe
- The Limbic System - http://www.driesen.com/brain_view_-_7.htm
- Somatic Sensory Cortex - http://www.driesen.com/brain_view_-_4.htm
- Brain Illustrations - http://www.driesen.com/images.htm
- The Limbic System - MindBrain.com - http://mind-brain.com/limbic.php
- MindBrain.com Music http://mind-brain.com/music.php
- Music and the Brain - Science Friday - http://www.sciencefriday.com/pages/2003/May/hour2_050903.html
- Music Training and the Brain - http://www.sfn.org/content/Publications/BrainBriefings/music_training_and_brain.htm
- Articles on Academic Achievement and Music - http://www.menc.org/publication/articles/academic/academic.htm
- Music and the Mind - http://www.menc.org/publication/articles/academic/dickins.htm
- The Cerebral Cortex - Neuroscience Lecture - http://www.clarkson.edu/~rcarlson/PY458Syllabus/Summaries/Cerebral%20Cortex.html

Mozart Effect Websites - Pro and Con

- The Musical Brain from Kid's Neuroscience Website - http://faculty.washington.edu/chudler/music.html
- Anxiety and Memory; Their Effects on Cognition and Musical Performance - from Kids Neuroscience Site - http://faculty.washington.edu/chudler/dl3.html
- What is the Mozart Effect? Don Campbell - http://www.mozarteffect.com/learn/read.html
- The Mozart Effect Website - http://www.mozarteffect.com/
- Articles on the Mozart Effect - http://www.mindinst.org/MIND3/indexresearchers.html
- More on Mozart Effect - http://parenting-baby.com/Parenting-Baby-Music-Research/Music-Research.html
- Gordon Shaw and the Mind Institute - http://www.mindinst.org/MIND2/research.html
- More from the Mind Institute - http://www.mindinstitute.net/MIND3/mozart/mozart.php
- The Mozart Effect - Shaw - http://skepdic.com/mozart.html
- Mozart Effect - BBC - http://www.bbc.co.uk/radio4/science/mozarteffect.shtml
- EdWeek - http://www.edweek.org/ew/vol-17/30music2.h17
- Mozart Heals - http://www.mozart-heals.com/