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CLASS PRESENTATION ON A RESEARCH PAPER

Music and Neuroscience
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<u>The New Handbook of Research on Music Teaching and Learning</u>
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Delimitation: While our understanding of the brain and behavior has increased exponentially over the past ten years, even so, theories of brain functioning and our understanding of the neurobiological forces that shape musical behavior are still in their infancy.

I. Strategies for Conducting Neuromusical Research
The reader is told to keep in mind that the brain is part of a much larger system that includes the central nervous system (brain and spinal cord) and peripheral nerves (efferent nerve fibers which deliver messages back and forth from brain to muscles and glands). In addition, the brain regulates the release of hormones into the bloodstream, so that, in effect, the brain extends throughout the body.

<u>Animal Research</u>: Investigation of the way animals process sound. Animals analyze a sound for meaning and then act accordingly, e.g. a cat runs to the kitchen at the sound of the can opener. (When humans listen to music, the process is similar in that we analyze the sound for meaning and that meaning shapes our response.)

Animals communicate by means of sight, smell, and sound. Sound has advantages over sight because it can travel long distances rapidly, operate during day or night, and encode complex and changing messages. Many animal species have developed sophisticated sound-making behaviors (not only vocalizations but also other noises, such as chest-thumping among gorillas.) ***To assume that animal sounds have nothing to do with human music would be to ignore a significant amount of information and would be counter to linkages found in other types of behavior, e.g. language and social organization.***

The variety in birdsong is attributed to a competing for "airspace" in a cacophonous habitat. Distinctiveness is an advantage. Krause's (1987) niche hypothesis is that each species produces sounds that occupy a particular bandwidth in the overall acoustic spectrum, along with unique rhythm patterns, tonal qualities, etc.

Various animals can be trained to choose between 2 songs, but they fail miserably if the songs are transposed. They rely on absolute pitch. They don't have relative pitch as humans do.

Biophony, the sounds of nature, exerted strong influence on early hominids.

Fetal and Infant Research: The brain in a "pure" state.

In the last trimester before birth, the fetus is capable of responding to sounds in the womb. Researchers can gauge fetal responses by monitoring the heart rate and bodily movements.

Almost immediately after birth, babies can orient toward sounds and soon after that can pick out the sounds of the mother's voice. "Motherese" is a type of baby talk that emphasizes pitch, timbre, dynamic inflections and rhythm patterns in order to convey meaning. The baby does not understand the words but learns the emotional content.

While learning takes place from the outset, babies do not need systematic, formal instruction in order to respond to music, speech, and other sounds.

Research on Brain-Damaged Individuals:

_____Some tumor, stroke, and brain lesion victims suffer from aphasia (loss of language) but not amusia (loss of music). The lends support to the theory that music and language are represented, at least to a large degree, by separate neural systems.

Brain-damaged individuals may be asked to do a variety of musical tasks. The inability to do the tasks, as compared with normal human beings, will then point to anatomical lesion sites. Care has to be taken, however, to know whether the person had those musical skills before the brain damage occurred.

Musical savants are cognitively impaired but can do music quite well, particularly those with Williams syndrone. One of the symptoms of Williams syndrome is hyperacusis, sensitive hearing.

Dementia and Alzheimer's patients with prior musical backgrounds retain procedural skills (singing or playing an instrument) in spite of declining linguistic fluency. In at least one case, an Alzheimer's patient was able to sing the words to familiar songs even though she could no longer communicate via language. The presence of musical skills, in the absence of linguistic and other skills, once

again denotes neural structures devoted to musical processing.
Music is being recommended to elders as a means of staving off the ravages of Alzheimer's.

Hemispheric Asymmetry Research:

Dichotic listening tasks have been used as a means of comparing one side of the brain's performance with the other.

In the 1970's, much was made of music being in the right side of the brain. This oversimplification has since been modified. ***Music is not in the right side of the brain alone; both sides are involved. In fact, sophisticated musical processing most likely involves the front-back, top-bottom, and left and right sides of the brain in widely distributed but locally specialized neural networks.***

Brain Imaging Research

Some of the tools being used: electroencephalography (EEG), event-related potentials (ERP), derived from EEG, magnetoencephalography ((MEG), superconducting quantum interference device (SQUID), magnetic resonance imaging (MRI), positron emission tomography (PET), and transcranial magnetic stimulation (TMS).

Neuromotor Research

Musical responses are both expressive (i.e., performing) and receptive (i.e., listening). Musical performance activates motor control areas in the brain to such a high degree that musicians may be considered small-muscle athletes.

A PET study of eight professional pianists confirmed this as motor systems in the brain were strongly activated during performance.

TMS, a technique for mapping neuromotor pathways, was used with 15 subjects to show
that the motor cortex controlling the fingers increased in response to piano exercises, both actual and imagined. A similar effect was found with a group of string players. The effects were greater for those who started playing at a young age.

Highly precise and rhythmically coordinated movements are critical for musical performance, and investigators are beginning to identify timing mechanisms in the brain. A related issue is *focal dystonia,* a neuromotor problemn in which the brain and hands (or other body parts) fail to communicate properly. Several concert pianists have had major careers curtailed by a focal

dystonia in one hand. Highly practiced movements seem to be most affected, while other uses of the hand remain functional.

Read elsewhere, on the Internet, focal dystonia represents a failure of the brain's learning processes, a "blurring" in the brain. A similar kind of "blurring" can be seen in the brains of those suffering from dyslexia.

Affective Research:

Music can elicit changes in such biochemicals as endorphins, cortisol, adrenocorticotropic hormone, interleukin-1, and secretory immunoglobin A. Studies are being done to document the physiological effects, (e.g.as in blood chemistry), that music has on the body. Fear and anxiety can be reduced in many clinical situations through the use of music.

Overall Development:

The brain appears to be more plastic and malleable during the first decade after birth than in adulthood.

There is agreement that during the first decade of life a child typically has up to twice as much neural activity and connections as an adult. Levels of myelin and glial increase in early childhood and may be influenced by environment. Einstein's brain was found to have significantly more glial cells than the average human brain.

Four concepts central to brain development:

***Critical period*: a sort of biological clock that only works during a certain period of development.**

***Optimal period*: in which development is faster or easier.**

***Window of Opportunity:* there are general time frames in which Optimal or Critical development will take place.**

Plasticity*: refers to the notion that the brain is very adaptable, fluid, or plastic in the way in which it can adapt. *Involvement with music may help keep the brain fluid, or more fluid, as opposed to no musical involvement throughout the human lifespan.

Theories and Theoretical Frameworks:

There are developmental stages, or shifts, similar to Piagetian stages. Much research is needed to answer questions for music teachers, e.g. when it is appropriate to introduce certain aspects of music, such as notation.

Expert or Habituation:

One would expect to find more brain activity in certain cognitive tasks. However, some studies show that less energy or brain electrical activity may be used to perform a task in an expert's brain than in the brain of a novice performing the same task.

**The brain of a novice learner is less efficient and expends more energy when confronted with a challenging task than the brain of an expert learner. Thus, music instruction should
enable children to expend less energy during musical tasks.**

Habituation in an expert musician can be thought of as the musician going on "automatic pilot" while performing.

Cerebral blood flow in a musician's frontal cortex decreased as the musician performed music on a keyboard, as opposed to rest.

Modularity and Connectionism:

Theory of modules: processes relating to music or language, e.g., are carried out in distinct structures. The theory of extreme modularity says they are autonomous.

Connectionism takes a holistic view of the brain, saying that it functions as a whole, and that a part of the brain can be recruited for multiple tasks.

Current neuroimaging data suggest that the neural mechanisms supporting music are distributed throughout the brain.

The term "coherence" refers to a theory of connectionism, that "cognition occurs through a network of linked nodes." Coherence reflects the number and strength of coordination between different brain locations.

Brain imaging studies have shown a relationship between music listening or music instruction and increased coherence activities in children.

Music training *may* affect the actual size of brain area that are important modules in music-making. For example, the left planum temporale is larger among musicians with absolute pitch, musicians who started serious study before the age of 7, and those with Williams syndrome.

Coherence studies lend support to the idea that music instruction for children at an early age will promote more profuse and more efficient connections.

Multiple Intelligences

Performing, listening to music, improvising, or composing music may require the use of at least 8 intelligences.

Neurological research has indicated that many parts of the brain are utilized as children are engaged in music making activities. The multiple intelligences idea may help explain why other types of intelligence are apparently affected by music instruction.

Neural Networks and Wiring:

One research problem: we don't know the extent to which music affects connections.

Music is more than sonorous stimuli; it is connected to cognitive, affective, kinesthetic, and social processes of each individual.

Future Directions: increased infant research; music, emotion, and temperament; focus on music cognition; strategies for teaching young children; better education of the public and music education professionals so that sophisticated findings are not reduced to "sound bites."