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Best Practices for Young Children's Music Education: Guidance From Brain Research

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Abstract

This article reviews best practices for young children's music experiences in light of developments in brain research. The first section reviews research music and brain topics including neuromyths, effect of music on structural brain changes and general intelligence, plasticity, critical and optimal periods, and at-risk student populations. The second section applies brain research to development and instructional strategies in the elementary music classroom.

Keywords

brain research, music, movement, neuroscience, young children

During the past two decades educators have seen implementation of standards, focus on academic fundamentals, and increased interest in brain research. It is unfortunate that in many districts across the country, the ways in which music enhances learning for students are often ignored to the extent that viable programs are cut from budgets. The purpose of this article is to review best practices for young children's music experiences in light of developments in brain research. The first section reviews research music and brain topics, including neuromyths, effect of music on structural brain changes and general intelligence, plasticity, critical and optimal periods, and at-risk student populations. The second section applies brain research to development and instructional strategies in the elementary music classroom.

Music and the Brain

The brain is part of a much larger system that includes the central nervous system (brain and spinal cord) and peripheral nerves (afferent nerve fibers and their receptors, which send messages to the brain, and efferent nerve fibers and their muscles and glands, which take messages from the brain). In addition, the brain regulates release of hormones into the bloodstream, so that in effect, the brain extends throughout the body. The brain appears to be more malleable during the first decade of life than in adulthood. However, as indicated in a later section on plasticity, the brain is adaptable throughout life. Also, positive or negative early experiences can alter both structure and function of the brain. It is important to remember that a child's brain is not the same as an adult brain. Our human brain develops significantly during the first years of life and also during adolescence. Much brain development occurs in early childhood, but the brain continues to change throughout life. The brain makes connections during the prenatal period and throughout life and while some connections are found to be predetermined genetically, other connections develop from environmental influences (Flohr & Hodges, 2006).

Neuromyths

It is important to keep results of recent brain research in perspective, because neuroscience findings can be overstated. However, it is also easy to discount neuroscience findings because of problems with our use of new technology, difficulties interpreting data, and unproven brain theory. Brain research has made large advances during the past 20 years in improving understanding the workings of the human brain, and these advances are promising to music education. However, research gives us more questions than answers, as well as more fascinating "what if?" scenarios than provable learning strategies. A gulf between classroom application and research findings is not the only difficulty. Possibly biased data and what some authors call *neuromyths* complicate attempts to apply brain research to

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education. Neuroscience technologies are complicated and in a state of constant evolution.

The term neuromyths is used to describe misinformation, oversimplification, or overinterpretations of findings in brain research (Goswami, 2006; Hall, 2006). Hall (2006) lists several well-known neuromyths covered in this article, including critical periods, localization of functions within specific areas of the brain, and left- and right-brained individuals. Neuromyths are not necessary untrue, but the findings have either not yet been replicated in humans, or they are overstated or oversimplified. For example, it is common to confuse the terms *critical periods* and *optimal periods*. Authors often write about optimal periods as if they were critical periods. Critical period refers to the idea that there are time frames during which there will be no development or stunted development if certain stimulation is not present. An optimal period is used to refer to those periods in which development will be faster or easier (Flohr & Hodges, 2006).

Another problem in interpreting research is found in quickly developing techniques for measuring ways in which the brain changes. In an article entitled, "Brain imaging skewed," Abbott (2009, p. 1) writes "Nearly half of the neuroimaging studies published in prestige journals in 2008 contain unintentionally biased data that could distort their scientific conclusions, according to scientists at the National Institute of Mental Health in Bethesda, Maryland." With the complexity of brain imaging techniques (e.g., electroencephalogram [EEG], positron emission tomography [PET], and functional magnetic resonance imaging [fMRI]), it is not surprising that vast amounts of data are sometimes misinterpreted or biased (Vul, Harris, Winkielman, & Pashler, 2009).

Structural Changes, Localization, and Plasticity

Several studies demonstrate types of music experiences that have an effect on the structure of the brain and demonstrate the power of music experiences on development. One early study in the 1990s gave researchers a clue that being actively involved in music activities, such as violin instruction, changes physical development of the brain (Schlaug, Jänke, Huang, Staiger, & Steinmetz, 1995). Schlaug and others have since launched several studies that demonstrate how experiences change the morphology (form and structure) of the brain (Elbert, Pantev, Wienbruch, Rockstrub, & Taub, 1995; Gaser & Schlaug, 2003; Johnson, 2005; Norton et al., 2005). For example, professional keyboard players were found to have significantly more gray matter than amateur musicians and nonmusicians in several brain regions (Gaser & Schlaug, 2003). More gray matter and size increases in other parts of the brain are not confirmed as being advantageous in many life endeavors, but the finding that music experiences change morphology of the brain is important for teachers and parents.

The idea of left- and right-brained individuals was very popular during the 1980s and 1990s was. A teacher may have attended a workshop in which a clinician would say, "Now here is an activity for the right side of your brain." This idea, unfortunately, oversimplifies the way in which the brain processes music. Neuroimaging data suggest that neural mechanisms supporting music are distributed throughout the brain. In the module theory, music engages several different brain areas in a coordinated activity and is composed of submodules (e.g., musical syntax operators, timbre operators, and rhythm operators). Submodules are in various regions distributed throughout the brain. At this point of the theory, each submodule appears to be a specialized piece of neural machinery. For a music task such as playing a C-major scale on the piano, the musical brain would integrate several submodules in a coordinated activity. There may be modules or supermodules or mechanisms that coordinate among different modules (Flohr & Hodges, 2006).

Not too long ago scientists thought we were born with all the brain cells we would ever have. In the past 20 years an idea of brain plasticity—that the physical structure of the brain changes as a result of experience—changed the way we think of our opportunity to learn grow and develop. Plasticity refers to the notion that the brain is very adaptable, fluid, or plastic in the way in which it can adapt. After accidental brain damage, for example, the brain may reassign function from a damaged part of the brain to an uninjured area. Involvement in music may help to keep the brain fluid or more fluid than no musical involvement throughout the human lifespan (Caine & Caine, 1994; Thulborn, Carpenter, & Just, 1999). A study of 678 nuns has indicated that rich experiences, including music, in older age will help keep the brain pliable and adaptable. The nun study suggests that an adult brain can reorganize in response to positive experiences in the environment as well as negative experiences in case of injury (Snowdon, 1997).

Critical and Optimal Periods

Critical period refers to an idea that there are set time frames in which there will be no development or stunted development if proper stimulation is not present. There are examples from animals in which experience must be timed very precisely to have an impact. For example, if a kitten's eyes are inhibited from visual stimulation at a certain time of development, the kitten will not be able to see (Hubel & Wiesel, 1970). One way of looking at critical periods is to imagine a sort of biological clock that only opens during a certain period of development. It is

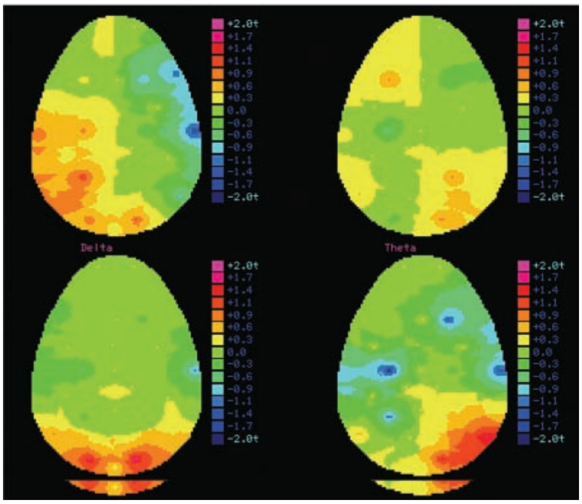

Figure1. This image of an EEG Brain scan is courtesy of Daniel Miller and John Flohr

Figure 2. Image courtesy of the NIH www.ninds.nih.gov

presently unknown if the critical period is due to biological clock mechanisms, the brain structures that have developed, or an interaction of the two. There may be critical periods in musical development, and the search for these periods provides a fertile ground for research.

Authors often write about optimal periods as if they were critical periods. An optimal period is used to refer to those periods in which development will be faster or easier. For example, it is easier to learn to sing in tune during the ages from 3 to 6 years than it is between 25 and 28 years of age. There are indications of possible critical periods in music. An optimal period and possible critical period were seen in a study of violin training in which in a sample of 60 musicians and nonmusicians those who started training before the age of 7 years exhibited increased *corpus callosum* size (Schlaug et al., 1995). For more detail see Flohr and Hodges (2006).

Music Enhances General Intelligence

Since the 1993 "Mozart effect" first hit our newsstands, many researchers investigated effects of music study and listening on learning (Rauscher, Shaw, & Ky, 1993). The idea is that music training (doing music) equals better performance in some areas of learning. Music certainly does not make everyone smarter, but there is a documented effect of positive gains in some domains of learning. In her meta-analysis, Hetland (2000) revealed a modest effect of music training. In a recent study Catterall and Rauscher (2008) analyzed data from the work of Schellenberg (2004, 2005) and found that music instruction showed gains in general intelligence with a stronger effect in visual-spatial skills than in verbal skills.

Positive effects from music instruction seem natural to many musicians and make sense in light of the modular theory of the brain. For example, if five areas of the brain are used during music instruction experiences, perhaps two or three of the same areas are activated during spatial or mathematical tasks. One problem, of course, is obvious: If music shares areas of activation with other subjects, then perhaps physical education experiences or other experiences might also influence overall learning (Smith & Lounsbery, 2009). If we try to justify music on the basis of the way it enhances general intelligence, we may find ourselves in a bad position, as other subjects, such as physical education, show similar results.

At-Risk Students

The idea that music and the arts may have a positive learning effect for at-risk students is important for education (Deasy, 2002). Studies are emerging that show a relationship between arts experiences and benefits for at-risk students. A study with middle school students in the program Health, Education in the Arts, Refining Talented Students (HEARTS) showed reduced risk of violence, significant improvements in self-esteem, overall grade point average, and other forms of school achievement (Respress & Lutfi, 2006). In their review of data from Schellenberg's study (2004), Catterall and Rauscher found that verbal and performance IQ measures were higher for the at-risk group.

Applying Brain Research to the Elementary Music Classroom

Guidance from neuroscience research and national associations, as well as teacher observations and assessment, provide information about what works in the classroom.

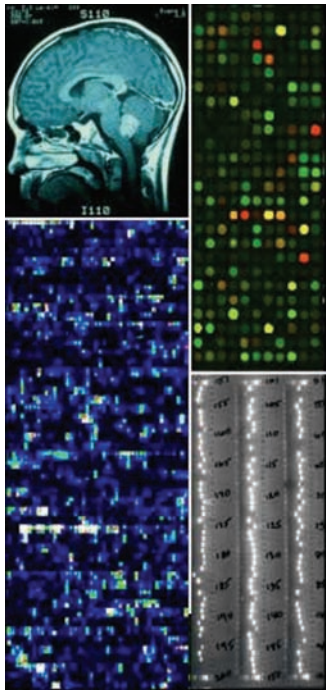

Figure 3. Image courtesy of the NIH www.ninds.nih.gov

The following section contains guidance for best practice based on brain research and national association information from the National Association for Music Education (MENC) and National Association for the Education of Young Children (NAEYC).

Musical Development and Movement

"Understanding movement is central to understanding development. Without movement we—by which I mean the animal kingdom—would not be able to eat, avoid harm, reproduce, or communicate by sound, gesture, or facial expression. We would not be able to perceive, because perception is an active process. Consequently, we would not be able to think, because there would be nothing to think about. We would not even be able to breathe or pump nutrients around the body. In short we would be dead" (Lee, 2005, p. 3).

Children acquire good musical skills through quality experiences. Highly developed musical skills require more than practice and quality experiences; an attachment to a responsive and appreciative teacher is necessary (Sloboda & Davidson, 1996). Flohr and Trevarthen (2008, p. 55) write, "Musical development, especially in early years, can best be fostered by supporting and encouraging the spontaneous vitality and inventiveness of human movement and gesture, by recognising children's rhythmic expression of motives and emotion, and their communication of affections, thoughts, ideas and cooperative activities in singing ways. Music can be taught in such a way that it supports how every young child is motivated, from within, to form collaborative and creative relationships in moving, and to pick up new ideas and elaborate rituals of performance from other people."

Human development hinges on the interplay between nature and nurture. Recent brain research challenges old assumptions about talent and innate ability—that the genes humans are born with determine how the brain develops. In general, neuroscience research has shown that neither nature nor nurture alone determines brain development. A complex interaction among innate abilities, environment, and the variability inherent in individual differences influence brain development. Although much growth and activity occurs during the early years, evidence shows that the brain has room for change during the later years. Early care and nurturing also have a decisive, long-lasting impact on how people develop, their ability to learn, and their capacity to regulate their own emotions. Music experiences for young children provide an optimal period for growth. The human brain has a remarkable capacity for change, but timing is often important and at some points crucial (Flohr & Hodges 2006). Evidence is accumulating that what most readily transfers between humans and their brains are the dynamics of intentions and emotions implicit in other people's forms of movement (Flohr & Trevarthen 2008; Gallese 2003; Schilbach et al., 2006).

Instructional Strategies

Do certain instructional strategies align themselves more with developments in brain research than others? There is evidence that a teacher's effectiveness is influenced by her or his repertoire of strategies (Stronge, 2007). Research often confirms what experienced teachers find useful. For example, using a wide range of strategies may reach more students by addressing the variety of student interests and learning styles.

Simultaneous Processing

When we think about how we process information, the principle of simultaneous processing is evident—children (as well as adults) learn multiple items during a period of instruction (Flavell, 1981). However, intending that students will learn an objective during a period of instruction does not guarantee that they will achieve that objective. Children may learn more than the objective of a lesson. A child's brain does not always learn or work on the objective of the teacher. A 7-year-old child in a class of 25 children may miss the main objective of the lesson while learning that it is fun to tease class neighbors or to make a paper airplane. Intending that students will learn an objective during a period of instruction does not stop them from learning items other than the intended objective. A music teacher can enrich his or her music lesson and meet the guidance for using a wide range of strategies by designing instruction with both a music objective and an objective for another subject (for more information see Flohr & Trollinger, 2010).

For example, singing a song could include a musical objective for expressive and accurate singing as well as a language objective for pronunciation or rhyming. In "The Brain in Language and Singing" by Trollinger (2010) in this journal, we find that language, speech and singing are strongly physically related in terms of production. The brain, however, is very complex in the representation of these activities.

Children's Musical Culture

There is a phenomenon of children's musical culture, a way of exercising musicality and creating new forms of musical play that may not be much affected by ideas and practices of the adult world (Flohr, 2004; Flohr & Trevarthen, 2008; Moorehead & Pond, 1978; Bjørkvold, 1992). It is important to allow children to exercise their natural impetus to create music that is unlike adult music. For example, free exploration and play with instruments is an important part of early childhood and primary grade music education.

Movement and Development

Engaging the learner is necessary to ensure learning. Rote memorization, repetition, skimming of material, and drill (sometimes called "drill n' kill") do not do much to form connections—movement and challenging lessons are effective ways to form connections and ensure learning. Neurological research confirms that the nervous system is richly integrated and the brain functions as a dynamic system transferring information at great speed, faster than research techniques can track except locally in very limited regions, or for very short periods of time. Body and mind work in tight reciprocal coordination in the generation of movements and consciousness (Flohr & Trevarthen, 2008). Research also indicates the advantages of active learning over passive. Consider an elementary music classroom in which a teacher initiates several rhythm assessments to fourth graders to see if they can identify quarter, half, eighth, and sixteenth notes. Activities in which children identify rhythm patterns on paper-and-pencil assessments are not active but rather passive. A student of the author once exclaimed, "My son says music is not fun anymore!" What would you say to the mother of this child? Eric Jensen (2003) offers 15 tools for engagement based on brain research including call-response, walking fast to the music, and repetitive gross movement.

Improvisation is an important part of any elementary music classroom. Children become actively engaged when give an opportunity to freely explore sound-making materials and when given guided experiences exploring sound. Researchers find that the brain is more activate when improvising music than when reproducing music. Bengtsson, Csikszentmihalyi, and Ullen (2007) explored brain patterns and creativity during a study on improvisation with pianists. Brain-wave patterns of 11 pianists were recorded using magnetic resonance imaging as they played a small piano keyboard with their right hand. Subjects were asked to perform on a small piano keyboard with their right hand during three conditions: *improvise, reproduce,* and *rest.* Results demonstrated that the brain worked harder (more brain activation) during improvising than during reproducing phrase of the experiment. Results were similar to an earlier study by Haier and Jung (2006).

Imitation is a primary way in which children learn. Good modeling of vocal sound, healthy habits when singing or playing, ways to play instruments, and listening are essential in the music classroom. Studies with monkeys—and more recently, human subjects—find *mirror neurons* (Doidge, 2007, p. 276; Jossey-Bass, 2008, p. 13; Steen, 2007, p. 348). These are neurons that fire when we see or hear someone performing an action.

Summary

Neurological research provides guidance on brain development and teaching in the elementary grades. It is important to remember that new information is always available, much research is not yet confirmed, techniques for imaging are being developed and refined, and a prudent teacher will keep up to date and experiment with strategies to determine best practices.

The idea of mirror neurons is a good example of neurological research that is not yet confirmed. In a study of male dancers, researchers found that an area of mirror neurons showed more activity when a dancer saw movements that he had been trained to perform than when he observed movements he had not been trained to perform (Glaser, n.d.). Other researchers found no signs of adaptation for motor acts that were first executed and then observed (Lingnau, Gesierich, & Caramazza, 2009). Care in teacher application of research on mirror neurons is needed until more research confirms the ideas.

To keep up to date on neuroscience developments one of many Internet resources stands out as exceptional. The *Neuroscience for Kids Newsletter* site from Eric H. Chudler lists new developments and resources as well as encouraging interested students to explore the science of the brain–visit http://faculty.washington.edu/chudler/news136.html to view an example and sign up for the newsletter.

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