

MUSIC AND ARTS EDUCATION:  
IT'S EFFECT ON BRAIN DEVELOPMENT AND  
ACADEMIC ACHIEVEMENT

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## ABSTRACT

This literature review is an examination of the connections between arts education, brain development, and academic achievement. The questions posed examine these relationships and look for the further benefits of arts education. An exhaustive search of the literature was attempted in order to examine these relationships further. Music Education journals, Science journals, and Physiology journals were searched. Reports indicated that arts education does impact brain development in unique ways. There were basically two types of studies found: those that studied the brain development effects of listening to music and those that studied the brain development effects of making or creating music. Secondly, arts education has positive relationships to academic achievement. Finally, arts education has several important benefits for students in our public and private schools including creativity and motivation.

## INTRODUCTION

A fine arts education is needed in our public schools. There are many reasons for this and the topic of this review is one of those. Creating art, all forms of art, is a process that involves many aspects of being human. However, many people rarely consider how large of a role the brain plays in creating music. In fact, it would be safe to say that the majority of people do not ever consider how the arts affect the development of the brain. In addition, it is beginning to become evident that an arts education can affect academic achievement. It is the purpose of this literature review to consider the relationship of arts education to brain development and academic achievement. Specifically, how does arts education affect brain development and academic achievement?

Throughout this literature review, the term “arts education” will refer to all types of fine arts classes that are taught in the public schools. This includes general music classes in elementary, middle, or high school. It also refers to general art, drama, band, and orchestral classes. The studies examined cover all of these types of fine arts classes. The term will be a broad description of these classes. Often when school systems consider budgets, the fine arts are the first to feel the cuts. This review will provide a rationale for why this should not happen. Children need an education in the fine arts because of the topics considered in this review.

Recent advances in technology have made it possible to study these concepts. Many studies in the public domain make use of these new technologies. Electroencephalograms (EEG), functional magnetic resonance imagery (fMRI), and Oxygen-positive emission tomography (O-PET) are examples of these new technologies

that have been created in the last 15 years. EEG methods allow researchers to measure and record the brain's electrical activity (Flohr, Miller, & DeBeus, 2000). fMRI is the use of magnetic resonance imaging to measure dynamic blood flow in the brain. O-PET is a method for "mapping the neuronal networks active during perceptual-cognitive processing"(Platel, et al., 1997, p.230). As a result of the described techniques, researchers can now scientifically study how an arts education affects brain development. This review will focus on the following questions.

## RESEARCH QUESTIONS

1. How is being exposed to an arts education related to brain development in students?
2. How is an arts education related to academic achievement in students?
3. What are the most beneficial aspects of an education in the arts?

## AN ARTS EDUCATION AND ITS EFFECT ON BRAIN DEVELOPMENT

Music would not happen without the brain. Creation of art is enabled by the power of the brain. It is the view of some people that expressing self through art or music is what makes people human. Human beings purposefully create art and it is the brain makes this possible, or as Hodges (1980, p.208) states "there would be no music without man and there are no men without music." Our brain gives us the ability to

create, yet neurological research is now demonstrating that humans are born with musical brains. Research also demonstrates that all humans have the ability to appreciate and learn music (Demorest and Morrison, 2000).

Making music and creating art is a process that originates from the physical workings of the brain. It would seem that emotions are a big part of this process; however, it must be remembered that emotions also originate in the brain. Making music is a cognitive process that comes from within humankind. It does not come from without (Serafine, 1988). This means that the brain conceptualizes music in a way that is difficult to describe. Zbikowski (2002) describes this process as “image schemata”(p.71). This brain process “provides the basis for the concepts and relationship essential to metaphor. An image schema is a dynamic cognitive construct that functions somewhat like the abstract structure of an image and thereby connects together a vast range of different experiences that manifest this same recurring structure” (p.68). This is a way of conceptualizing the cognitive process of the brain when meaning becomes “grounded in repeated patterns of bodily experience” (p.68). The kinesthetic learning mode, which is related to music cognition, is a vital component of music instruction in the public schools. Some of the cognitive processes that seem to be enhanced through music education are “pattern recognition and development, mental representations of what is observed or imagined, allegorical and metaphorical representations, careful observation of the world, and abstraction from complexity” (Sousa, 2006, p. 26).

## Timing is important

This cognitive event identified as “creating art” appears to have an impact on the brain development of human beings, especially children. Neuroscience research demonstrates that the preschool and elementary school child’s brain is at its crucial stage of development. The neural synapses of the brain are growing rapidly and changing at this point in life. It seems from research that the younger the child begins to be exposed to an arts education the more the development of the brain is impacted. A child’s early years are a crucial time for exposure to the arts (Flohr, Miller, & DeBeus, 2000). Timing is important as the child’s brain is making neural connections at a rapid rate. When children play they sing, draw, and dance. These are natural art forms. These activities engage all the senses and wire the brain (Rauscher, Shaw, & Ky., 1993). Research has demonstrated that infants are able to “use music as a retrieval cue, differentiate between two adjacent musical tones, recognize a melody when it is played in a different key, and categorize rhythmic and melodic patterns on the basis of an underlying tempo” (Sousa, 2006, p.700). It is evident from the findings that even infants are ready for exposure to music and art play.

The child’s brain is quite different from an adult’s in that there is twice as much neural activity and twice as many connections. When a child is involved in music education synaptic growth occurs in different areas of the brain. Shore and Strasser(2006) state that when a child participates in music, advanced brain technology reveals that brains light up like a “Christmas tree in many different areas” (p.62) Greenough and Black (as cited in Strickland, 2001) describe two types of synaptic growth; “experience-expectant growth and experience-dependent growth”(p.100-101).

Experience-expectant growth refers to the early years of life and the fact that there is an overproduction of synapses preparing the brain for learning from environment experiences. Experience-dependent growth is synaptic growth from environmental stimulation. Both types are a direct result of environmental experiences such as music education.

Brain plasticity is another important concept when considering this time of growth. This refers to how the brain retains its new knowledge. The new synaptic growth creates new areas of the brain that retain rhythm or melodic concepts as well as other knowledge. One study concludes adults who started playing instruments before the age of eight have fibers in the corpus callosum that are “as much as 15% larger” than non-musicians (Jensen, 2001, p. 18).

When this synaptic growth occurs in a child, many areas of the brain are affected. What specific regions of the brain are impacted by exposure to music? One study on music perception using PET techniques found that the anterior parts of the left hemisphere were activated during the identification of a melody task. This is a musical semantic processing task. In addition, rhythmic experiences seemed to affect the Broca’s area, which is an area connected to the sequencing of auditory stimuli. The right hemisphere was highly involved in the timbre perception task and well as changes in pitch. The left precuneus-cuneus regions were active during a pitch task, which leads researchers to believe that this area is involved in visual mental imagery (Platel, et al., 1997). Visual mental imagery is a source of discussion with many researchers when referring to spatial-temporal tasks. This will be addressed later in this paper. Another study indicated left hemispheric activity in phonological, lexical, and semantic language

task performance. Melodic and pitch perception causes right hemispheric activity ( Schlaug, 1995). The conclusion that can be derived from all of the studies is that specific areas of our brain are impacted by music and the arts. Studies indicate that early exposure to music may have the potential to impact the development of the brain for a lifetime. A good example of this is a study where a skilled artist allowed his brain to be scanned using fMRI technology while drawing a portrait. The brain of a non-artist was also scanned while performing the same task. The brain of the skilled artist showed less activity in the regions used. This was due to the fact that this region of his brain was a more efficient and skilled region due to his training. This study indicates that practice and study caused the artists' brain to have certain brain areas that were more skilled and efficient than the non-artists'. The artist seemed to be able to visualize the picture while he drew (Solso, 2001). This indicates that the study of the arts impact visualization abilities. A study needs to be done to see if other types of artists' brains react similarly.

Both brain research and research in early childhood development indicate that active engagement with the arts makes a significant difference in brain development indicating that lessons must be structured that use kinesthetic activities when studying music or art. Music for passive listening does seem to impact brain development; however, not nearly as much as actively making music (Hodges, 2000).

### The Mozart Effect

Gordon Shaw (Shaw, Peterson, & Matthew, 2004) published a study in 1993 that rocked the United States. It was dubbed the Mozart Effect. It was so exciting that the governor of Georgia decided that all infants would be receiving a compact disc of music

by Mozart. He urged parents to play it when their children were falling to sleep. Listening to a certain Mozart sonata appeared to cause increased brain ability in spatial-temporal reasoning. This type of brain activity is associated with the ability to form mental images from physical objects or to see patterns in time and space. Sousa (2006) describes these effects as “improved mental imaging, enhanced symmetries of inherent cortical firing patterns, and a greater natural temporal sequence” (p.26 ).

The Trion model of brain processing is the central component of the Mozart theory. This is a highly structured mathematical realization of the Mountcastle organizational principle. The theory describes seven different firing patterns in the human brain: one is analytic and one is creative. The cortical column is the basic neural network of the cortex and is comprised of subunit minicolumns call trions. These are the basic building blocks of the brain for the synaptic growth. The mathematical realization is a way to understand and picture this (Boettcher, Hahn, & Shaw, 1994, p.54). Primarily this was a way to explain the phenomenon of how music seemed to change the spatial-temporal activities of the brain. The problem with these studies is that the effects were short-term. The original study in 1993 has results that only lasted 10-15 minutes. However, many studies spiraled out of this work. Dr. Shaw established the MIND institute at University of California-Irvine where many of his doctoral students worked with him, including Rauscher and Zupan.

#### Studies involving passive listening

Out of the 1993 Mozart study came further research efforts. The first studies were limited to research on the effects of listening to music. Participants listened to

Mozart or other classical music and then took different kinds of tests that measured spatial-temporal abilities. Effects were always short-term; however, the longer the exposure over time, the longer the effects lasted. One study indicated that it was not the type of music listened to; but whether or not the music was motivating and positive to the listener. Hughdahl (1999) did a study on dichotic listening to compare hemispheric differences when using consonant-vowel (C-V) sounds as compared to music instrument excerpts. Using the OPET technology, he took measurements of regional cerebral blood flow. There was greater right hemispheric activity associated with the musical instrument listening examples and greater left hemispheric activation with the C-V syllables. It was concluded, “the C-V syllable and music instruments primarily activate bilateral areas in the superior gyri” (p.438). Music sounds stimulated different regions of the brain.

Malyarenko (as cited in Stickland, 2001) did a study that exposed a group of four year old males to classical music over a 6 month period. The control group did not have this exposure. The experimental group exhibited a “greater inter-hemispheric range coherence than did the controls, whose alpha level decreased” (p.101). Consequently, as these studies have increased and been replicated, it seems that there is some truth to the fact that listening to music influences the brain. Adults see improvements on IQ tests when listening to Schubert, 10-11 year olds experience this with pop music, and five year olds with children’s songs (Schellenberg, 2006, 457).

Spatial-Temporal skills have connections to higher math and visualization abilities. Well-developed spatial abilities have several advantages connected to decision-making, scientific and artistic thought, and clear reasoning (Rauscher & Zupan, 2000, p.

216). These brain activities take time to develop and are better addressed in childhood (Serafine, 1988, p.74). Rauscher & Zupan (2000) state that younger children's cortical plasticity can be affected the greatest when concentrating on ST tasks.

A recent meta-analysis by Hetland (2000) provides an excellent overview of these ST studies. She concluded that the Mozart effect is not limited to listening to Mozart but extends to other pieces of music as well. However, this moderate effect is limited to ST tasks. This supports the view that the brain is modular and that these modules process music and space cooperatively. She notes: "if future research continues to show that music's enhancing power is not due to general arousal but rather to the priming of neural networks that process spatial information in the brain, evidence will be gained for a link between two kinds of intelligence, music and spatial" (p.138). This effect on brain development is agreed upon by the studies considered in this review. The Mozart Effect should be renamed "the listening to music that you enjoy effect".

#### Studies involving active engagement in the arts

The effects of creating music and art have recently been the subject of many studies. Specifically, playing instruments has been the focus of most of the studies. Many of these focused on playing the keyboard. One study by Rauscher in 1997 (as cited in Shaw, Peterson, & Matthew, 2004) examined the effects of music education on preschoolers in relation to ST tasks. There were three groups: a group that sang, a group that received training with specialized music computer software on the keyboard, and a group that received no lessons. In order to establish gains, a standardized test was used before and after the study. The group that used the computer with keyboards made the

largest gains, almost 8% . Rauscher and Zupan did another study in 1999 with 62 middle-income kindergartners from two mid-western public schools. One group had classroom keyboard instruction and one group had none. The children were tested at two-month intervals. The keyboard group scored higher on ST tasks than the control group after 4 months and even higher difference after 8 months (Rauscher & Zupan, 2000, p.215). Bodner (2002) recommends that teachers should employ the Music-Math ST computer program that uses keyboard training as an integral part of its plan.

There have also been many EEG studies that show us that active classroom instruction enhances brain development. These studies have revealed that much of the brain's connections come from environmental influences. Robert Thatcher's (as cited in Flohr, Miller, & deBeus, 2000) EEG studies used two groups of children. The control group received no active music classroom instruction and the experimental group received seven weeks of music instruction. The results showed that the experimental group demonstrated changes in "cortical activation patterns in the same areas of the brain that are associated with spatial-temporal reasoning" (p.30). The experimental group even illustrated activation patterns similar to musically trained adults. These patterns were less active and more efficient. This study supported the earlier statement that the brain of a novice learner is less efficient and expends more energy than the brain of the skilled artist when involved in creating art.

In the previously cited study the experimental group produced less activation in the right posterior region of the brain. Tramo (2001) postulates that boosting brain activity through music education can improve math, reading and spatial skills. The brain areas that are engaged during music performance can retain their neural plasticity well

into childhood. This study of hemispheric activation and music revealed a large interplay between the left and right hemispheres during music making.

## AN ARTS EDUCATION AND ITS EFFECT ON ACADEMIC ACHIEVEMENT

What does all this brain development information mean to real life? This question is important and leads to more research on the impact of an arts education on academic achievement. With all the information stemming from the ST studies correlating the creation of music to an increase in ST skills and brain development associated with these skills, researchers have begun to investigate the relationship of music to academic achievement.

A descriptive study of 13,000 students that compared music students' grades with non-music students was reported by the National Center for Educational Statistics. Music students had more A's and B's in English, math, history, and science with the largest difference in English. This does not indicate that music students are smarter; however, the researcher concluded that "the students we teach in music classrooms, rehearsal rooms, and on football fields (band) demonstrate academic behaviors above and beyond many of their counterparts outside the music curriculum (Morrison, 1994, p.36). Additional studies have revealed similar findings.

In 1997 30 undergraduates were tested in conditions with music and no music. It was a repeated-and-reverse design where the two conditions were repeated for each group and then reversed. Those who were listening to music while taking the test did better

than those in the silence condition (Jensen, 2001, p.27) leading to the conclusion that music in the background facilitates students achievement. But again, this is only a loose relationship. Most studies are reporting stronger relationships between achievement and actually being involved in making or creating music rather than simply passively listening, as the 1990 NCES study indicated.

The stronger relationships are associated with active participation in music education. Edward Kvet (1985) studied 6<sup>th</sup> grade instrumental students who were pulled out of their regular classroom to receive 70 minutes of instrumental instruction per week while their peers remained in the classroom and received academic instruction. Many middle schools use this plan for band or orchestra. The conclusion was that there was no difference in academic achievement for the students. On the surface it would seem that this is a negative relationship between academic achievement and music education; however, it also demonstrates that missing academic instruction had no effects on the music students. A weakness with this study is that little is known about what went on in the classrooms while the music students were out of the classroom. However, the music students did not suffer from missing class time and the classes were not disrupted.

The link between math achievement and keyboard lessons has already been cited in this review. Several studies explored this link using special math-music software and achievement testing. In 1999 the Shaw research group (as cited in Jensen, 2001) used three groups of 29 students each to study this effect. The control group received no piano instruction or computer based instruction. Experimental group number one received piano instruction and a math video game instruction. Experimental group number two received computer-based English training and the math video game instruction. The

piano group scored 27% higher on the 16 questions that were spatially oriented. This is one of several studies that have confirmed the positive relationship of keyboard instruction and math achievement.

There has also been some research that establishes a link between music instruction and language skills. As mentioned earlier in this review, the phonemic area of the brain, Broca's region, was activated during specific types of music instruction. Music instruction may enhance children's language literacy. Research was completed in 2004 that analyzed data from kindergarten children who received four months of advanced music instruction from a nearby university. This was compared against kindergartners at another elementary school who received none of this instruction. The kindergartners in the experimental group showed greater development in phoneme segmentation than the control group. Phonemic awareness is one of the best predictors of how well children will read (Gromko, 2005, p.199). This important study deserves to be replicated to establish this link.

SAT studies are one of the most widely used measures of high school achievement. A study was completed in 1998 that compared twelve years of SAT scores to item 1 of the Student Descriptive Questionnaire. This question asks the student to indicate the total number of years of high school courses in art and music they have completed or will take. The analysis was repeated three times, once for composite scores and then again for verbal and math scores separately. There was a correlation between SAT scores in math and reading scores and the number of years music or art was taken. The more arts education the student had, the higher the scores were as compared to students who had no art or music instruction (Vaughan & Winner, 2000). This would

seem to suggest a positive relationship between SAT scores and length of music instruction. However, when the researcher looked at SAT scores and duration of other academic studies, such as four years of math, the scores were even higher than music. What this suggests is that “it is just as likely that this result is more a reflection of attrition than achievement.” (Demorest & Morrison, 2002, p.38) In other words, the more focused a student is on one area of study, the better they do academically across all scores. On the other hand the arts, when being the main focus of students, appear to be just as beneficial.

There is a study that illuminates the effects of music instruction on creative thinking. This is a debated topic now in the United States as demonstrated by the National Center for Educational Statistics. This confirms the need for education that stimulates creative thinking. Comparisons of students in the United States with those in other countries reveal limitations in the creative thinking of U.S. students. According to the study using the Spectra (music-math) program, it was found that the students who were exposed to this program of instruction performed higher on the Torrance Tests of Creative Thinking than the control group. Creativity and self-esteem as well as an appreciation for the arts were the biggest gains when using this study (Luftig, 2000). Creative thinking involves many regions of the brain and affects many academic subject areas including science, language, and math.

It is tempting to make dramatic statements concerning an arts education and academic achievement in light of the above studies. Yet, it would not be wise to do this. Cautious statements are more appropriate. The above studies all demonstrate positive relationships with the arts and academic achievement, not causal links. Winner and

Cooper (2000) examined experimental and correlational studies from 1950-1998. Their conclusion was that these studies reported levels of academic achievement in students who voluntarily chose to study the arts possibly reflecting more of an attitude of motivation and focus than the arts themselves. They acquiesce to the idea that a positive relationship does exist between studying the arts and academic achievement but no causal relationship.

Schellenberg (2006) critically reviewed the literature before conducting two studies on long-term associations between music lessons and IQ. The study focused on how long in life the students took music lessons. Participants in study one were 6-11 year old children recruited from a middle class suburb of Toronto, Canada. A large percentage of the children had experienced music lessons of some kind. In this first study, the duration of music lessons had small, positive associations with IQ. In the second study, the long-term associations between playing music and IQ were examined, specifically whether these associations might last after lessons ended. The participants were undergraduates at a university in Toronto. Three quarters had received music lessons for an average of 3.7 years. A little over half had taken private music lessons. There were positive relationships between taking music lessons in childhood and IQ in young adulthood. This researcher goes beyond the point of cautious statements to even suggesting causality between music lessons and IQ. The implication between this opinion and Winner's opinion is that more research is still needed in this area. Strong to moderate relationships have been established between music lessons and IQ.

## BENEFICIAL ASPECTS OF ARTS EDUCATION

After reviewing the literature, it has been discovered that there are positive relationships between arts education, brain development, and academic achievement. In addition, there are many other benefits. First, an arts education provides a unique way of knowing and learning. It provides students with an environment of discovery and new challenges. The literature clearly supports the notion that music is dissociated from linguistic or other types of cognitive processes. Therefore, it provides unique means of processing and understanding a particular kind of nonverbal information. It has been established that music instruction impacts brain development and provides an important mode of learning. Howard Gardner (as cited in Santrock, 2006) gives attention to all of the different modes of learning, and music is now an accepted mode.

Joyce Eisner (1998) suggests three ways an arts education contributes to the learning of students: arts-based outcomes, arts-related outcomes, and ancillary outcomes. Arts-based outcomes are those contributions of the content of the arts curriculum. Arts-related outcomes are the “perceptions and comprehension of aesthetic features in the general environment” (p.12-13). Ancillary outcomes are the effects of arts education on student “performance in reading, math, or other academic subjects” (p.12-13). These contributions are all excellent benefits for any person. The ancillary outcomes are still the least well documented with only positive relationships being established. Students learn how to transform images, ideas, and feelings into art. Another benefit is that students become more aware of the aesthetic qualities of life. An arts education enables

students “to understand that there is a connection between the content and art form and the culture and time in which the work was created” (p.13-14).

Jensen (2001) enumerates other benefits for us that are crucial to a good education. The arts reach students who are not reached in other ways, help students relate to each other more positively, change the environment to one of discovery, and provide different and new challenges. Several authors mention motivational benefits such as self-confidence, perseverance, higher standards, positive mentors, and stress reduction.

The spatial-temporal studies still provide stark reminders that some kinds of music instruction definitely impact certain brain abilities. However, this should not be used as a justification for an arts education. A balance is needed between the purpose and the benefits of ST reasoning. Bennett Reimer (1999) suggests that there is a danger inherent in using this line of reasoning for justification. He enumerates a host of issues after hearing Frances Rauscher’s report at the MENC national convention on the 1998 study of the Mozart effect. “A host of issues related to Rauschers’ research arise in my mind, such as reversibility, interaction effects, measurement, and external validity” (p.38). Music educators must “not be rigid about their primary purpose of helping students better create and share the meaning and feelings that only music provides” (p.43). A rationale of ST effects can backfire if students do not progress. Music curriculum should not be altered to serve the ST benefits at the expense of so many other benefits previously enumerated.

## CONCLUSION

An arts education does affect brain development in people in a way that is different from and similar to other facets of education. The brain enables us to create art. Art creation and education, in turn, encourages brain growth, especially in children. Timing is important with exposure to music: the younger the better. The child's brain is optimal for growth and the arts uniquely impact brain growth. Further, an arts education impacts academic achievement positively. After surveying the studies included in this review, it can be concluded that there are positive relationships between arts education and academic achievement. Further, it does not interfere with or impair academics. However, studies indicate caution in moving past correlations.

There are several implications that need further study. More research needs to be done in order to establish causal connections between academic achievement and arts education. Also, more research needs to be done in the area of the effect of arts education on IQ. One study examined in this review indicates a positive relationship in this area. Finally, studies indicate many benefits to an arts education related to motivation, creativity, socialization, and self-esteem. Further studies examining these benefits would clarify this issue and emphasize that an arts education is necessary and important for every child holistically.

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