

*The Foundation for  
Music Literacy*

*presents*

**“How Music  
Can Dramatically  
Effect  
Your Child’s  
Development  
and  
Life-Time Success”**

**A Summary of the  
Current Scientific Literature  
Concerning Music and the Mind.**

# *Foundation For Universal Music Literacy*

## **Organization**

We are a fully funded 501(3)c foundation.  
Operating under the umbrella of the National Heritage Foundation.

## **Web site:**

<http://www.LearnToReadMusic.org>

## **Our Goal**

To make music literacy accessible to everyone so that they can learn the language of music as easily as they learn to read their native language.

## **Our Methodology**

We are a research resource - locating and distributing information concerning;

- music,
- music literacy,
- music instruction and training,
- music education,
- music appreciation,
- music advocacy,
- adult and child learning

We welcome your recommendations to add to our resource lists.  
Please feel free to send us recommendations concerning; internet resources, research articles, topics that should be researched, teachers, or individuals we should have in our data base.

*“The More We Know - The More We Can Share.”*

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## **How We Distribute Information**

We try to make our resources available for no cost - by having the information on our web site in a FREE downloadable PDF format.

Anyone may use and download our resources. We encourage people to re-distribute this information to their friends and family for their personal use.

Starting In October of 2003 we will have a regular newsletter, you may sign up to receive that free newsletter at our web site in the near future. Your privacy and information will be kept in the strictest confidence.

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## Did You Know?

### A Series of Info-Briefs About “The Power of Music in Shaping Our Children’s Lives”

*Did You Know...*

- ***That Playing An Instrument Can Improve Your Child’s Grades & Test Scores?***

High school music students score higher on SATs in both verbal and math than their peers. In 2001, SAT takers with coursework/experience in music performance scored 57 points higher on the verbal portion of the test and 41 points higher on the math portion than students with no coursework/experience in the arts.

**Source:**

*Profile of SAT and Achievement Test Takers,  
The College Board, compiled by Music Educators National Conference, 2001.*

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Middle school and high school students who participated in instrumental music scored significantly higher than their non-band peers in standardized tests. University studies conducted in Georgia and Texas found significant correlations between the number of years of instrumental music instruction and academic achievement in math, science and language arts.

**Source:**

*University of Sarasota Study, Jeffrey Lynn Kluball;  
East Texas State University Study, Daryl Erick Trent*

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Students who were exposed to the music-based lessons scored a full 100% higher on fractions tests than those who learned in the conventional manner.

Second-grade and third-grade students were taught fractions in an untraditional manner — by teaching them basic music rhythm notation. The group was taught about the relationships between eighth, quarter, half and whole notes. Their peers received traditional fraction instruction.

**Source:**

*Neurological Research, March 15, 1999*

## *Did You Know...*

### • *That Playing An Instrument Can **Improve Your Child's Grades & Test Scores?***

A ten-year study, tracking more than 25,000 students, shows that music-making improves test scores. Regardless of socioeconomic background, music-making students get higher marks in standardized tests than those who had no music involvement.

The test scores studied were not only standardized tests, such as the SAT, **but also in reading proficiency exams.**

*Source:*

*Dr. James Catterall, UCLA, 1997.*

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Young children with **developed rhythm skills perform better academically** in early school years. Findings of a recent study showed that there was a significant difference in the academic achievement levels of students classified according to rhythmic competency.

Students who were achieving at academic expectation scored high on all rhythmic tasks, while many of those who scored lower on the rhythmic test achieved below academic expectation.

*Source:*

*"The Relationship between Rhythmic Competency and Academic Performance in First Grade Children," University of Central Florida, Debby Mitchell*

### • *That Playing The Piano Can **Improve Your Child's Self Esteem?***

A McGill University study (Costa-Giomi, 1999) found that children who had taken three years of piano instruction had significantly higher self-esteem than children who were not enrolled in piano lessons. These results were not related to family income, sex, family structure, or parental employment.

In addition to piano lessons, students in this study owned a new piano, played in recitals, and received individual attention from a caring teacher. While these elements could also have had an impact on the improvement in self-esteem, the overall effect of piano instruction could not be disputed.

## *Did You Know...*

### • *That Playing Music Can Help Your Children **Understand Math Better?***

Research shows that piano students are better equipped to comprehend mathematical and scientific concepts.

A group of preschoolers received private piano keyboard lessons and singing lessons. A second group received private computer lessons. Those children who received piano/keyboard training performed 34% higher on tests measuring spatial-temporal ability than the others — even those who received computer training.

“Spatial-temporal” is basically proportional reasoning — ratios, fractions, proportions and thinking in space and time. This concept has long been considered a major obstacle in the teaching of elementary math and science.

#### *Source:*

*Neurological Research February 28, 1997*

### • *That Playing Music Can Help Your Children **Get Into Medical School?***

Music majors are the **most likely group** of college grads to be admitted to medical school. Physician and biologist Lewis Thomas studied the undergraduate majors of medical school applicants. He found that 66% of music majors who applied to med school were admitted, the highest percentage of any group. For comparison, (44%) of biochemistry majors were admitted.

Also, a study of 7,500 university students revealed that **music majors scored the highest reading scores** among all majors including English, biology, chemistry and math.

#### *Sources:*

*“The Comparative Academic Abilities of Students in Education and in Other Areas of a Multi-focus University,” Peter H. Wood, ERIC Document No. ED327480*

*“The Case for Music in the Schools,” Phi Delta Kappan, February, 1994*

## Did you know ...

### • *Playing Music Can Make A Person Emotionally Healthier?*

College-age musicians are **emotionally healthier** than their non-musician counterparts. A study conducted at the University of Texas looked at 362 students who were in their first semester of college.

They were given three tests, measuring performance anxiety, emotional concerns and alcohol related problems. **In addition to having fewer battles with the bottle, researchers also noted that the college-aged music students seemed to have surer footing when facing tests.**

*Source:*

*Houston Chronicle, January 11, 1998*

### • *That Playing Music Helps Under-Achievers?*

**Music training helps under-achievers.** In Rhode Island, researchers studied eight public school first grade classes. Half of the classes became “test arts” groups, receiving ongoing music and visual arts training.

In kindergarten, this group had lagged behind in scholastic performance. After seven months, the students were given a standardized test. The “test arts” group had caught up to their fellow students in reading and surpassed their classmates in math by 22%.

In the second year of the project, the **arts students widened this margin even further.** Students were also evaluated on attitude and behavior. Classroom teachers noted improvement in these areas also.

*Source:*

*Nature May 23, 1996*

### • *That The World’s Top Academic Countries Place A High Value On Music Education.*

Hungary, Netherlands and Japan stand atop worldwide science achievement and have strong commitment to music education. All three countries have required music training at the elementary and middle school levels, both instrumental and vocal, for several decades.

The centrality of music education to learning in the top-ranked countries seems to contradict the United States' focus on math, science, vocabulary, and technology.

*Source:*

*1988 International Association for the Evaluation  
of Educational Achievement (IAEEA) Test*

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## **Paul Harvey on Music Education in our Public Schools**

Music is everywhere in bird song and in bubbling brooks and in laughter, even in the stars. Music is the universal language that transcends time and space.

Music is one of the seven forms of human intelligence, all equal in stature and in potential. And yet education -- as is -- is almost totally geared to nurturing linguistic and logical-mathematical abilities along, leaving the other five forms -- including music -- neglected.

An elementary-school level more than half of all school districts in the United States have no full-time music teacher. And thus our schools tend to refine intellects but neglect to discipline emotions, and undisciplined emotions keep getting us into trouble.

The ugliest headlines are about somebody who may have been smart as all get-out -- smart enough to be a bank executive or a politician or a scientist. But if emotionally color blind, he's an unguided missile inevitably destined to self-destruct. Without the arts -- including music -- we risk graduating young people who are "right-brain damaged." **"for anyone to grow up complete, music education is imperative."**

Case histories on file with the **National Commission on Music Education** uncover exciting correlation between the study of music and such critical work-place performance factors as self-esteem, self-discipline, the ability to work in groups and higher cognitive and analytical skills.

Music in schools, what little there is, is considered ancillary to "real education", as something of a "curricular icing". If it is to be re-established as basic to education, as fundamental to being "an educated person", then educators and performers, composers and publishers -- and those in music-related industries -- must close ranks to restore educational balance in schools.

The National Commission on Music Education is such a coalition. Already, in its first year, it has won the support of 75 national organizations, willing, under a slogan of "Let's Make Music", to work together toward the music enrichment of public schools' curricula.

How does one plausibly argue for spending school money on music when we are graduating illiterates? Should we not be putting all our emphasis on reading, writing and math? The "back-to-basics curricula", while it has merit, ignores the most urgent void in our present system -- absence of self-discipline.

The arts, inspiring -- indeed requiring -- self-discipline, may be more "basic" to our nation survival than traditional credit courses. Presently, we are spending 29 times more on science than on the arts, and the result so far is worldwide intellectual embarrassment.

**-- Paul Harvey --**



## What Famous and Accomplished People Say About Music

-- Henry Van Dyke

"Use the talents you possess, for the woods would be very silent  
if no birds sang except the best."

--Albert Einstein:

"It occurred to me by intuition, and music  
was the driving force behind that intuition.  
My discovery was the result of musical perception."  
(When asked about his theory of relativity)

If I were not a physicist, I would probably be a musician.  
I often think in music. I live my daydreams in music.  
I see my life in terms of music.

"He often told me that one of the most important things in his life was music.  
Whenever he felt he had come to the end of the road or into a difficult situation in his work,  
he would take refuge in music and that would usually resolve all his difficulties."  
(quoted in interview with Bernard Mayor, in Whitrow, Einstein, p.21).

"I took violin lessons from age 6 to 14, but had no luck with my teachers for whom music did not  
transcend mechanical practicing. I really began to learn only when I was about 13 years old,  
mainly after I had fallen in love with Mozart's sonatas."  
-- (as quoted in Kantha, An Einstein Dictionary, p. 135).

--Ursula K. Le Guin:

"It had never occurred to me before that music and thinking are so much alike.  
In fact you could say music is another way of thinking,  
or maybe thinking is another kind of music.

-- Plato: (428-348 BC)

"Music gives a soul to the universe, wings to the mind,  
flight to the imagination, and life to everything."

"The music masters familiarizes children's minds with rhythms and melodies,  
thus making them more civilized, more balanced, better adjusted in themselves,  
and more capable in whatever they say or do,  
for rhythm and harmony are essential to the whole of life."

"Music is a moral law.  
It gives soul to the universe, wings to the mind, flight to the imagination,  
a charm to sadness, gaiety and life to everything.  
It is the essence of order and lends to all that is good and just and beautiful."

-- **Albert Schweitzer:**

“There are two means of refuge  
from the miseries of life: music and cats.”

-- **Henry David Thoreau:**

“When I hear music, I fear no danger.  
I am invulnerable. I see no foe.  
I am related to the earliest times, and to the latest.”

-- **Pythagoras:**

"There is geometry in the humming of the strings,  
there is music in the spacing of the spheres."

--**John F. Kennedy:**

"The life of the arts far from being an interruption, a distraction,  
in the life of a nation, is close to the center of a nation's purpose-and  
is a test of the quality of a nation's civilization."

--**William Shakespeare:**

"The man that hath no music in himself  
Nor is not move'd with concord of sweet sounds,  
Is fit for treasons, strategems, and spoils;  
The motions of his spirit are dull as night,  
And his affections dark as Erebus:  
Let no such man be trusted."

"If music be the food of love, play on:  
give me excess of it..."

--**Martin Luther:**

“I have no pleasure in any man who despises music.  
It is no invention of ours: it is a gift of God.  
I place it next to theology.  
Satan hates music: he knows how it drives the evil spirit out of us.”

-- **Oliver Wendell Holmes:**

“Take a music bath once or twice a week for a few seasons,  
and you will find that it is to the soul what the water-bath is to the body.”

--**Hans Christian Andersen:** (1805-1875) Danish short-story writer, poet

“Where words fail, music speaks.”

**--Maya Angelou:**

“Music was my refuge.  
I could crawl into the space between the notes and curl my back to loneliness.”

**--Igor Stravinsky:**

"Music is given to us with the sole purpose of establishing an order in things,  
including, and particularly, the coordination between man and time."

**-- Ludwig van Beethoven:**

"Music is a higher revelation than all wisdom and philosophy.  
Music is the electrical soil in which the spirit lives, thinks and invents."

**-- Thomas Carlyle:** (1795-1881), *The Opera*

“Music is well said to be the speech of angels.”

**--E.Y. Harbug:**(1898 - 1981)

“Words make you think a thought.  
Music makes you feel a feeling. A song makes you feel a thought.”

**--Anais Nin:**

“Music melts all the separate parts of our bodies together.”

**--J.S. Bach:**

“It's easy to play any musical instrument:  
all you have to do is touch the right key  
at the right time and the instrument will play itself.”

**-- Unknown:**

"Bach gave us God's Word.  
Mozart gave us God's laughter.  
Beethoven gave us God's fire.  
God gave us Music that we might pray without words."  
-- quote from outside an old opera house

**--Oscar Hammerstein:**

"All the sounds on the earth are like music."

**--Ralph Waldo Emerson:**

"Sugar is not so sweet to the palate  
as sound to the healthy ear."

## What Science Knows ... About The Benefits of Playing Music?

### “Music **Students Perform Better** on Their College Entrance Examinations **(SAT’s)!**”

Students of the arts continue to outperform their non-arts peers on the SAT, according to reports by the College Entrance Examination Board.

In 2002, SAT takers with coursework/experience in **music performance** scored 57 points higher on the verbal portion of the test and 41 points higher on the math portion than students with no coursework or experience in the arts.

Scores for those with coursework in **music appreciation** were 64 points higher on the verbal and 43 points higher on the math portion.

Data for these reports were gathered by the Student Descriptive Questionnaire, a self-reported component of the SAT that gathers information about students' academic preparation.

*Sources:*

The College Board, Profile of College-Bound Seniors  
National Report for 2000, 2001, and 2002.

Also reported at:

The National Association for Music Education  
<http://www.menc.org/information/advocate/sat.html>

Course Title	Verbal Mean Scores			Math Mean Scores		
	2000	2001	2002	2000	2001	2002
Honors Courses	n/a	565	563	n/a	564	564
Acting/Play Production	542	541	539	532	531	530
<b>Music: Study or Appreciation</b>	<b>538</b>	<b>539</b>	<b>537</b>	<b>537</b>	<b>538</b>	<b>537</b>
<b>Music Performance</b>	<b>532</b>	<b>533</b>	<b>530</b>	<b>534</b>	<b>535</b>	<b>535</b>
Studio Art/Design	524	525	522	528	528	528
Photography/Film	526	527	524	526	526	526
Drama: Study or Appreciation	534	534	531	522	523	521
Art History/Appreciation	517	518	515	518	518	517
Dance	514	512	509	510	510	508
<b>No Arts Coursework</b>	<b>477</b>	<b>476</b>	<b>473</b>	<b>496</b>	<b>494</b>	<b>494</b>

## **Ten-Year Study Shows Music Improves Test Scores**

“Regardless of socioeconomic background, music-making students get higher marks in standardized tests.”

UCLA professor, Dr. James Catterall, led an analysis of a U.S. Department of Education database. Called NELLs88, the database was used to track more than 25,000 students over a period of ten years.

The study showed that students involved in music generally tested higher than those who had no music involvement. The test scores studied were not only standardized tests, such as the SAT, but also in reading proficiency exams.

The study also noted that the musicians scored higher, no matter what socioeconomic group was being studied.

Reference: Dr. James Catterall, UCLA, 1997.

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## **Band Members Get Better Math Science And Language Grades**

“Studies find link between music instruction and academic achievement as measured by standardized tests.”

In a 2000 University of Sarasota Study, Jeffrey Lynn Kluball explored the relationship of instrumental music instruction and academic achievement for the senior class in Lee County High School, Leesburg, Georgia.

Significant correlations were found between the number of years of band instruction and academic achievement as measured by the Georgia High School Graduation Test (GHSGT) Mathematics and GHSGT Science tests.

An East Texas State University study by Daryl Erick Trent revealed that high school seniors who participated in instrumental music in grades 6-12 score significantly higher in language arts and math on standardized tests than do students involved in non-music extra-curricular activities or with students not involved in any school related extra-curricular activity.

### *Sources:*

U of S study by Jeffrey Lynn Kluball, 2000;  
ETSU study by Daryl Erick Trent

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## Music Improves Reasoning in Preschool Children

The hypothesis that music training significantly and specifically enhances spatial-temporal reasoning in young children has recently found strong support.

Rauscher, Shaw, Levine, Wright, Dennis and Newcomb (*Neurological Research*, 1996, in press) studied 78 children (3-4 years old) divided into three groups.

Thirty four children received private piano keyboard lessons, 20 received equally frequent private computer lessons and 24 served as other controls, receiving either singing lessons (n=10) or no special lessons (n=14) for six months.

Four standard, age calibrated, spatial reasoning tests were given before and after training; one test measured spatial-temporal reasoning and three tests assessed spatial recognition.

Post-treatment test scores showed a significant improvement on the spatial-temporal test only for the keyboard group.

No group improved significantly on the spatial recognition tests. That the computer group showed no effect provides a control for extra attention, involvement, etc.

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The authors suggest that the improvement in spatial reasoning may be related to the linear spatial layout of the keyboard.

They propose that keyboard training may enhance the learning of standard subjects, such as mathematics and science, in which spatial-temporal reasoning is particularly important.

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### Source:

Rauscher, Shaw, Levine, Wright, Dennis and Newcomb  
(*Neurological Research*, 1996, in press)

The following articles are from...

**The American Music Conference.**

<http://www.amc-music.org>

**The American Music Conference** is a national non-profit educational association founded in 1947. AMC is dedicated to promoting the importance of music, music-making and music education to the general public. AMC's goal is to build credibility for music and music education, especially at an early age, and to expand that portion of the population that enjoys and makes its own music.

**Executive Summary:**

**Researchers Find Music Is A Superior Way  
To Teach Elementary Students The Concept Of Fractions.**

Second-grade and third-grade students were taught fractions in an untraditional manner — by teaching them basic music rhythm notation.

The group was taught about the relationships between eighth, quarter, half and whole notes. Their peers received traditional fraction instruction.

When tested, the students who were exposed to the **music-based lessons scored a full 100% higher** on fractions tests than those who learned in the conventional manner.

One of the researchers, Dr. Frances Rauscher, said, “It has been clearly documented that young students have difficulty understanding the concepts of proportion (heavily based in math and science) and that no successful program has been developed to teach these concepts in the school system.”

Reference: Neurological Research, March 15, 1999

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Full Article:

**Piano and Computer Training  
Boost Student Math Achievement, UC Irvine Study Shows**

*—Second-Graders in Study Scored Higher  
than Others on Fractions and Proportional Math—*

**Taking piano lessons and solving math puzzles on a computer significantly improves specific math skills of elementary school children**, according to a study by University of California,

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Irvine researchers. The results of the study, published in the March 1999 issue of the journal *Neurological Research*, are the latest in a series that link musical training to the development of higher brain functions, said UCI physics professor emeritus Gordon Shaw, who led the study.

Researchers worked with 135 second-grade students at the 95th Street School in Los Angeles after conducting a pilot study with 102 Orange County students. Children given four months of piano keyboard training, as well as time playing with newly designed computer software, scored 27 percent higher on proportional math and fractions tests than other children. The study was funded through grants from the Texaco Foundation, The Gerard Family Trust and Newport Beach philanthropist Marjorie Rawlins.

"Piano instruction is thought to enhance the brain's 'hard-wiring' for spatial-temporal reasoning, or the ability to visualize and transform objects in space and time," Shaw said.

Music involves ratios, fractions, proportions and thinking in space and time. At the same time, the computer game – called Spatial-Temporal Animation Reasoning (STAR) – allows children to solve geometric and math puzzles that boost their ability to manipulate shapes in their minds.

"Children who took piano lessons and played with the math software performed better on tests of fractions and proportional math than children who took English language instruction on the computer and played with the math software, and better than those who had neither piano lessons nor experience with the math software," Shaw said. Puzzles in the STAR game allow children to apply the type of mental acuity that appears to be heightened by piano practice. The findings are significant because a grasp of proportional math and fractions is a prerequisite to math at higher levels, and children who do not master these areas of math cannot understand more advanced math critical to high-tech fields.

"Proportional math is usually introduced during the sixth grade, and has proved to be enormously difficult to teach to most children using the usual language – analytic methods," Shaw said. "Not only is proportional math crucial for all college-level science, but it is the first academic hurdle that requires the children to grasp underlying concepts before they can master the material. Rote learning simply does not work."

"Students who used the software and played the piano also demonstrated a heightened ability to think ahead," Shaw said. "They were able to leap ahead several steps on problems in their heads," he noted. These findings offer not only new insight into the theory of mental development, but also a potentially powerful teaching tool, capable of stimulating second-grade children to master critical sixth-grade reasoning concepts. The piano teaching and software helped children regardless of income level, boosting achievement of students in low socioeconomic settings.

The study is only the latest in a series linking musical training to the learning process. Prior UCI studies based on a mathematical model of the cortex predicted that early music training



would enhance spatial-temporal reasoning, and a 1997 study indicated that preschool children given six months of piano keyboard lessons improved dramatically on such reasoning.

Research participants included Amy Graziano, a postdoctoral researcher in UCI's Department of Physics and Astronomy who designed and coordinated the project, and Matthew Peterson, a former student of Shaw's who is now a doctoral student in the Department of Vision Science at UC Berkeley. Shaw and Peterson administered the program through their non-profit Music Intelligence Neural Development (MIND) Institute in Irvine, and Peterson designed the STAR software. Graziano and Shaw are both part of the UCI Center for the Neurobiology of Learning and Memory, an internationally known institute dedicated exclusively to the multidisciplinary investigation of how the brain processes information and makes and stores memories.

The researchers planned to expand the study to six schools in the fall of 1999 to demonstrate its effectiveness in a variety of settings, and sought educators in Los Angeles, Orange, Riverside and San Diego counties who were interested in participating and could furnish a music teacher and computers. They also developed new written math tests with Michael Martinez, UCI associate professor of education, and prepared materials to integrate piano training and the STAR software into the standard second-grade math curriculum. They eventually would like to apply the findings to the K-12 math and science curriculum, as well.

Shaw also has written a book on the science of music and the brain. "Music Enhances Learning: Keeping Mozart in Mind" (Academic Press) was released in May 1999. Shaw is known for his 1993 research that showed college students scored higher on spatial-temporal reasoning tests after listening to a Mozart piano sonata. Dubbed the "Mozart Effect" by media, the phenomenon prompted further interest in research to explore the relationship between music, intelligence and learning.

For more information on the UCI Center for the Neurobiology of Learning and Memory, see [www.cnlm.uci.edu](http://www.cnlm.uci.edu).

For more information on the MIND Institute's research, see [www.mindinst.org](http://www.mindinst.org). Copies of the published Neurological Research article, entitled "Enhanced Learning of Proportional Math Through Music Training and Spatial-Temporal Training" (Forefront Publishing, © 1999), may be obtained by contacting Mary Rawlins at Forefront Publishing Group, 5 River Road, Suite 113, Wilton, CT 06897. Phone: (203) 834-0631 / Fax: (203) 834-0940).

A complete archive of press releases from the University of California, Irvine, is available on the Web at <http://www.communications.uci.edu/~inform/>

**Source:**

<http://www.amc-music.org/musicmaking/brain/irvine.htm>

**Piano and Computer Training  
Boost Student Math Achievement, UC Irvine Study Shows**

Neurological Research, 1999, Volume 21, March, pp. 139-152.

“Enhanced Learning of Proportional Math  
Through Music Training And Spatial-Temporal Training”

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\*\*\*Music Intelligence Neural Development Institute, Irvine, CA

**ABSTRACT**

It was predicted, based on a mathematical model of the cortex, that early music training would enhance spatial-temporal reasoning. We have demonstrated that preschool children given six months of **piano keyboard lessons** improved dramatically on spatial-temporal reasoning while children in appropriate control groups did not improve.

It was then predicted that the enhanced spatial-temporal reasoning from piano keyboard training could lead to enhanced learning of specific math concepts, in particular proportional math, which is notoriously difficult to teach using the usual language-analytic methods.

We report here the development of Spatial-Temporal Math Video Game software designed to teach fractions and proportional math, and its strikingly successful use in a study involving 237 second-grade children. Furthermore, as predicted, children given **piano keyboard training** along with the Math Video Game training scored significantly higher on proportional math and fractions than children given a control training along with the Math Video Game.

These results were readily measured using the companion Math Video Game Evaluation Program. The training time necessary for children to reach a high level of performance on the Math Video Game is very rapid.

This suggests that, as predicted, we are tapping into fundamental cortical processes of spatial-temporal reasoning. This spatial-temporal approach is easily generalized to teach other math and science concepts in a complementary manner to traditional language-analytic methods, and at a younger age.

The neural mechanisms involved in thinking through fractions and proportional math during training with the Math Video Game might be investigated in EEG coherence studies along with priming by specific music.

**Keywords**

Columnar cortical model; educational implications; EEG coherence studies; spatial-temporal math software; piano training

**Definitions:**

ST: Spatial-Temporal

EP: Spatial-Temporal Math Video Game Evaluation Program

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Or email: M.I.N.D. Institute

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Source

<http://www.amc-music.org/musicmaking/brain/mind.htm>

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## **University of Munster Research: Exposure to Music Is Instrumental to the Brain**

Building upon the pioneering work of Dr. Frances Rauscher, psychologist at the University of Wisconsin at Oshkosh, a recent study at the University of Munster in Germany revealed that ...  
**practicing the piano in early childhood expands the mind, literally altering the anatomy of the brain.**

In the study, conducted by Drs. Christo Pantev, Larry Roberts and Almut Engelien, researchers examined images of the auditory brain regions of 20 trained musicians and 13 non-musicians, all of whom were in their 20's. The musicians had played instruments for 15 to 21 years and now practiced 10 to 40 hours a week. When piano notes were played to both groups, the response to the piano sounds was 25 percent higher in the musician group. But when the same frequencies were heard as beeps rather than as piano notes, the two groups' brains looked the same.

The study also concluded that the younger the musicians were when they began their musical training, the larger their areas of brain activity. The increased response to piano tones was the same in those who played piano, woodwinds or stringed instruments, although most of the musicians said they had received early piano training.

According to Dr. Rauscher, musical training, **specifically piano instruction appears to dramatically enhance a child's abstract thinking skills and spatial-temporal ability – skills necessary for mathematics and science – even more than computer instruction does.**

The combination of these scientific findings, plus ongoing research into the field, continues to point to one conclusion: music has an obvious impact on the brain and should be supported and encouraged in early childhood education.

Source:

<http://www.amc-music.org/musicmaking/brain/munster.htm>

## Music Brain Research Chronology

**1985** -- Gordon Shaw, Dennis Silverman and John Pearson present the trion model of the brain's neuronal structure. (Proceedings of the National Academy of Sciences, USA 82 [1985]: 2364-2368).

**1989** -- Experiments in which musicians perform mental rehearsals of music indicate that music and other creative skills, such as mathematics and chess, may involve extremely precise firing patterns by billions of brain neurons. (Leslie Brothers and Gordon Shaw, *Models of Brain Function*, edited by R. Cotterill. Cambridge: Cambridge University Press, 1989).

**1990** -- Computer experiments reveal that trion firing patterns can be mapped onto pitches and instrument timbres to produce music. This suggests that the trion model is a viable model for the coding of certain aspects of musical structure in human composition and perception, and that the trion model is relevant for examining creativity in higher cognitive functions, such as mathematics and chess, that are similar to music. (Xiaodan Leng, Gordon Shaw and Eric Wright, *Music Perception*, Vol. 8, No.1 [Fall 1990]: 49-62).

**1991** -- Xiaodan Leng and Gordon Shaw propose that music may be considered a "pre-language," and that early music training may be useful in "exercising" the brain for certain higher cognitive functions. (*Concepts in Neuroscience*, Vol. 2, No. 2 [1991]: 229-258).

**1993** -- Pilot study finds that preschool children given music training display significant improvement in spatial reasoning ability. (Frances Rauscher, Gordon Shaw) Experiment with college students finds that, after listening to a Mozart sonata, they experience a significant although temporary gain in spatial reasoning skills. (Frances Rauscher, Gordon Shaw and Katherine Ky, *Nature*, Vol. 365 [1993]: 611).

**1994** -- Stage II follow-up to pilot study again finds that music training improves spatial reasoning in preschool children. This gain does not occur in those without music training. (Frances Rauscher, Gordon Shaw, Linda Levine and Katherine Ky, Paper presented at the American Psychological Association, Los Angeles [August 1994]).

**1995** -- Follow up to first Mozart study confirms that listening to Mozart improves spatial reasoning, and that this effect can increase with repeated testing over days. However, the effect may not occur when music lacks sufficient complexity. (Frances Rauscher, Gordon Shaw and Katherine Ky, *Neuroscience Letters*, Vol. 185 [1995]: 44-47).

**1997** -- Study finds that keyboard training causes long-term enhancement of preschool children's spatial-temporal reasoning (Frances Rauscher, Gordon Shaw, Linda Levine et al, *Neurological Research*, Volume 19 [1997], 2-8).

**1999** -- A field experiment supports the earlier finding by demonstrating that classroom keyboard instruction improves kindergarten children's spatial-temporal performance. (Frances Rauscher, Mary Anne Zupan, *Early Childhood Research Quarterly*, 1999).

Enhanced learning of proportional math through music training and spatial-temporal training: children given piano keyboard training along with a specially designed Math Video Game training scored significantly higher on proportional math and fractions than children given a control training along with the same video game. (Amy Graziano, Matthew Peterson and Gordon Shaw, *Neurological Research*, Volume 21 [1999], pp. 139-152).

**2000** -- A study finds that a curriculum combining piano lessons, educational math software and fun math problems can help second graders achieve scores on advanced math concepts and Stanford 9 math scores comparable to those of fourth graders (Matthew Peterson, Mark Bodner, Stephen Cook, Tina Earl, Jill Hansen, Michael Martinez, Linda Rodgers, Sydni Vuong, Gordon Shaw, 2000, submitted for publication).

Source:

<http://www.amc-music.org/musicmaking/brain/chrono.htm>

## **Study Explains Why Music Can Help Stroke Victims Regain Language Capabilities**

*–Scientific Study First To Provide Insight For Future Research–*

A dramatic new study from the University of Texas at San Antonio has uncovered a link between the music right side of the brain function and the left side of the brain that is used in language processing.

The study also shows that music activates the cerebellum, challenging the 150-year-old hypothesis that this part of the brain (containing 70 percent of all brain cells) only controlled motor function.

Both of these findings are significant because they could aid in the rehabilitation of stroke and other brain trauma patients who have lost speech capabilities. Melodic Intonation Therapy, where people sing what they want to say to improve fluency of speech, is a primary method of language rehabilitation.

This new research provides insight into the function of the right brain areas, or music areas, which are recruited by the left side of the brain during therapy. Understanding the relationship between the two will give researchers the tools to develop other music-based speech rehabilitation therapies.

It is estimated that 80,000 people develop a speech aphasic condition, or speech delivery problem, from strokes or other brain trauma each year.

Source

<http://www.amc-music.org/musicmaking/brain/stroke.htm>

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Additional Studies on this topic...

### **Melodic Therapy Changes Brain Activation and Promotes Language Recovery After Brain Damage**

Music therapies are in widespread use for a variety of behavioral and neurological problems. When positive effects are obtained on behavior, the brain mechanisms involved remain a mystery.

Now comes evidence that a certain type of music therapy has behavioral benefits via measurable changes in brain function. Dr. Pascal Belin and his associates, working at the Service Hospitalier Frederic Joliot in Orsay and other institutions in France report that Melodic Intonation Therapy (MIT) promotes recovery from aphasia, a severe language disorder subsequent to stroke.

MIT involves speaking in a type of musical manner, characterized by strong melodic (two notes, high and low) and temporal (two durations, long and short) components.

Reporting in the December 1966 issue of *Neurology*(vol. 47, pgs. 1504-1511), Belin *et al* studied seven patients who had a lengthy absence of spontaneous recovery. They also evaluated the effects of MIT on the brain by measuring relative cerebral blood flow (CBF) and PET scanning during hearing and repetition of simple words and of "MIT-loaded" words. MIT produced recovery of speech capabilities.

Of great interest, a critical regions of the brain was activated by "MIT-loaded" words but not regular words. This is Broca's Area in the left hemisphere, known for over 100 years to be critically implicated in language and speech. The authors believe that the reactivation by MIT of Broca's Area was critical to recovery of speech. These findings provide enormous promise for both the treatment of aphasia and understanding the role of music in normal and abnormal brain function.



*Scientific Research Indicates that  
Music Study Can Dramatically Effect Your Childs Positive Development in:  
Reading  
Math  
Self-Esteem  
Team-work  
In the Work Place*

**Does Music Have An Impact  
On The Development Of Students?**

by Tony Mickela

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Music educators feel, and have observed, that student involvement in school music has a positive impact on other areas of their lives. These educators will tell you that musical involvement improves a student's self-discipline, dexterity, coordination, self-esteem, thinking skills, listening skills, creative abilities and personal expression. Most music educators, however, are not aware of specific research that ill support these feelings and observations.

The Gemeinhardt Company conducted two major surveys in the 1980's about the school band movement. They interviewed band directors, music dealers, parents (band and non-band) and students (band and non-band).

In the first Gemeinhardt study, the responses indicate that the majority of people surveyed in all categories recognize many of the benefits a student can receive from being in a band program. Those benefits are: accomplishment, appreciation, discipline, fun, active participation and maturing relationships.<sup>1</sup>

The survey of band parents found that 96% of them agree that "many people don't know or understand the benefits of band." In fact, **95% of the non-band parents surveyed felt that band provides educational benefits not found in other classrooms and that 78% of the same group felt that band is more educational that extracurricular.**

Band directors surveyed talk in general terms about the benefits of a band education. **These directors list such benefits as: discipline, teamwork, coordination, development of skills, pride, lifetime skills, accomplishment, cooperation, self-confidence, sense of belonging, responsibility, self-expression, creativity, performance, companionship, builds character and personality, improves self-esteem, social development, and enjoyment.**

In the second Gemeinhardt study non-band parents, non-band students, drop-out band parents and drop-out band students were surveyed.<sup>2</sup> Among these four groups there is much agreement that band builds self-esteem, self-confidence, and a sense of accomplishment.

When given the choices of "Agree a lot," "Agree a little," and "Don't agree,": 91% of the not-band parents, 90% of drop-out band parents, 79% of non-band students and 82% of drop-out band students chose to "Agree a lot" with the above statement.

I agree that these benefits are positive. As directors we need to be more vocal about the benefits of participation in music and share this kind of information with school boards, principals, parents and students.

Combining this kind of information with the scientific data available concerning the positive impact of music is a powerful argument that needs to be shared with the public. Every music educator must do their part to share this kind of information with others if we are to keep our programs.

To paraphrase a recent commercial, the data show that  
**MUSIC HAS SOMETHING FOR EVERYBODY or EVERYBODY NEEDS MUSIC.**

## **MUSIC AND ACHIEVEMENT**

There have been a number of studies done on the effect of music on academic development. It has been shown that high school music students have higher grade point averages than non-music students in the same school. At Mission Viejo High School in Southern California in 1981, the overall grade point average of music students was 3.59 and for non-music students the overall grade point average was 2.91.

This same study also found that 16% of the music students had a 4.0 overall grade point average and only 5% of the non-music students had a 4.0 overall grade point average.<sup>3</sup> A study of graduates of the New York City School of Performing Arts found that 90% of them go on to college.<sup>4</sup>

Rees feels that involvement in high school music programs helps students develop the skills necessary for a variety of occupations. She states: "Successful music students tend to possess the qualities and skills that are generally considered essential to employers in business, education and service organizations."<sup>5</sup> She also recognizes that music education assists students in improving their writing, communication skills and DOES improve analytical skills. Rees further states that to be successful in music, takes a great deal of self-discipline and notes that "**music majors have the highest SAT scores in all areas.**"

Fred Hargadon, former Dean of Admissions for Stanford University, in a 1983 interview with Stauffer said, "We look for students who have taken part in orchestra, symphonic band, chorus and drama. It shows a level of energy and an ability to organize time that we are after here. It shows that they can carry a full academic load and learn something else. It means that these particular students already know how to get involved and that's the kind of campus we want to have."

Christensen (Biernat) has found that research studies have consistently shown that participation in student activities is beneficial to students.<sup>6</sup> Success in college can be more accurately predicted by levels of individual achievements in student activities (drama, debate, music etc.) than it can from SAT scores, class rank and grades in school. Conversely, studies of dropout students show that these students have had the least amount of participation in school activities.

The Mode of American Youth (Biernat) reported that the most frequent co-curricular activity in American high schools was participation in a musical group. They reported that 38.3% of all high school students say that they belonged to a band, orchestra or choir.<sup>7</sup>

## **MUSIC AND READING**

Music participation does have a positive impact on reading. a reading program in New York dramatically improved reading achievement scores by including music and art in the curriculum.<sup>8</sup>

Winston writes about how learning to read music enhances the student's ability to perform the skills necessary for reading, listening, anticipating, forecasting, memory training, recall skills, concentration techniques and speed reading.<sup>9</sup>

It has also been found that music students can out-perform non-music students on achievement tests in reading and math.<sup>10</sup> Referring to reading and communication skills, Kuffler recognized the contributions the arts can make to the development of perceptual and cognitive skills.<sup>11</sup>

There are similar studies in the area of mathematics that show gains in test scores in math for music students when compared to non-music students.<sup>12</sup> Maltester found that increased instruction in music can lead to increased learning in mathematics.<sup>13</sup>

A study conducted in the Albuquerque, New Mexico public schools concluded by comparing all areas of the California Test of Basic Skills (CTBS). It was found that music students in an instrumental class for two or more years scored significantly higher than non-music students.<sup>14</sup>

Grace Nash, an Arizona music educator, has found that incorporating music into mathematics lessons has enabled students to learn multiplication tables and math formulas more easily.<sup>15</sup>

## **MUSIC AND SELF-ESTEEM**

The Norwegian Research Council for Science and the Humanities has found a connection between students having musical competence and high motivation in that they were more likely

to achieve success in school. They concluded that there is a high correlation between positive self-perception, high cognitive competence scores, self-esteem and interest and involvement in school music.<sup>16</sup> Whitwell came to much the same conclusion and contends that creative participation in music improves self-image, self-awareness and creates positive attitudes about oneself.<sup>17</sup> Marshall found that involvement and achievement in school music builds positive self-image which is a motivation for academic learning among urban black middle school students.<sup>18</sup> It has also been found that through involvement in group music activities on the high school level, individuals learn to support each other, maintain commitment and bond together for group goals. The process is a significant part of improved self-esteem.<sup>19</sup> Sward, in writing about Fred Miller, president of the Miller Summer Clinics, says that Miller has found that musical experiences "instill:

- 1) positive attitude;
- 2) positive self image;
- 3) desire to achieve excellence;
- 4) co-operation;
- 5) group cohesiveness; and
- 6) ability to set goals."

Eisner writes about the importance of arts in education because they develop intellectual and aesthetic abilities.<sup>20</sup>

## **MUSIC AND THE BRAIN**

There are a number of studies that show a connection between music and the development of the brain. Dr. Frank Wilson is an assistant clinical professor neurology at the University of California School of Medicine, San Francisco. He reports that his studies show that instrumental practice enhances coordination, concentration and memory and also brings about the improvement of eyesight and hearing. He further reports that the process of learning to play an instrument refines the development of the brain and the entire neurological system (Mueller, 1984).

In a speech at the California Music Educators Association State Convention on March 17, 1989, Dr. Wilson said that he has found through music, people become an active participant in their own physiological development. He says that people can discover themselves and a sense of self in community through musical involvement. His research has shown that involvement in music connects and develops the motor systems of the brain in a way that cannot be done by any other activity.

In support of this, Dr. Wilson shared recent data from UCLA brain scan research studies which shows that music more fully involves brain functions (both left and right hemispheres) than any other activities studied. **Dr. Wilson feels these findings are so significant that it will lead to a universal understanding in the next century that music is an absolute necessity for the total development of the brain and the individual.**

A separate study shows that performance in music develops the intellect. These musical activities train the brain in aesthetic literacy and the students' perceptual, imaginative and visual abilities (Sinatra, 1986). Whitwell (1977) deals with the left brain/right brain issue. He says that when one talks about music, he is using the left side of the brain. To utilize the right side of the brain, one must creatively produce in an activity such as music. He says the "music is independent, separate unique from of intellect, a form of intellect through which man can communicate directly in its own inherent form" (p9).

This seems to confirm Wilson's contention that music does have a developmental impact on the brain. Whitwell chides the educational system for only educating half a brain. He points out that most attention or day-dreaming, the answer is to involve the right side of the brain in the learning process. Whitwell says that the complete man must have equal access to both domains (left and right brain) of understanding and this access has to include a creative activity such as the performance of music.

Tedd Judd in a speech at the 1984 conference on the Biology of Music-Making entitled, "A Neurologist Looks at Musical Behavior", comes to the conclusion that involvement in music involves many parts of the interconnected brain (Roehmann, 1988). **Dr. Jean Houston of the Foundation for Mind Research says that children without access to an arts program are actually damaging their brain. They are not being exposed to non-verbal modalities which help them learn skills like reading, writing and math much more easily (Roehmann, 1988).**

## SUMMARY

We, as music educators, must take the lead in sharing this information with the people that can make the difference in the future; school boards, administrators, parents, and legislative representatives. We must advocate for the arts.

It is vital that we become proactive in our support of the arts. By reviewing the studies involving music we have found that participation in school music has a positive impact on areas considered outside the realm of music.

As more people become aware of the research in this area, we should see increased enrollments in arts classes. The use of the arts throughout the curriculum, as a tool for better learning, is an area that will expand. With dropout rates being so high, educators need to combine resources and to use the tools available for a more effective method of education.

I feel that the arts will play a major roll in the future success of the education system. Don't stand on the sidelines and watch the profession dwindle away. Get involved and help it grow.

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## Research Organizations