Music and Early Literacy

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Abstract

We have likely all heard of the so-called "Mozart Effect," the claim that listening to music increases intelligence. While the often-cited 1993 study never actually claimed such a profound conclusion, the resultant publicity focused the nation's attention on the evidence of music's positive effect on various types of cognitive skills. Such an effect is desperately needed. The National Center for Education Statistics released in March 2010 the "Nation's Report Card: Reading 2009," which examines the literacy skills of our nation's fourth- and eighth-grade students. The results are sobering. Only 33% of students scored at or above Proficient, while 33% scored below Basic. For Black and Hispanic public-school children, the situation is much more dire: just 15% and 16% (respectively) scored at or above Proficient, while over half, 53% and 52% (respectively), scored below Basic.

We must do better, and we can. The last two decades have seen an explosion of research concerning the effects of musical training on brain development: how it creates new neural networks, strengthens existing ones, and strengthens the synaptic connections. All the research supports the notion that early music training can be a critical component in the development of verbal, reading, comprehension, mathematical, and spatial-temporal reasoning skills in children, thus providing solid evidence for fully integrating music as a core component of early childhood education.

Introduction

We have likely all heard of the so-called "Mozart Effect," the claim that listening to music increases intelligence. While the authors of the often-cited 1993 study that created the controversy surrounding this idea never actually claimed such a profound conclusion, as was widely and erroneously touted in the media, the resultant publicity nevertheless focused the nation's attention on the evidence of music's positive effect on various types of cognitive skills.[1] Such an effect is desperately needed.

Statement of Problem

The National Center for Education Statistics (NCES, the primary federal entity for collecting and analyzing data related to education) released in March 2010 the "Nation's Report Card: Reading 2009," which reports on the literacy skills of our nation's fourth- and eighth-grade students, as

[1] Frances H. Rauscher, Gordon L. Shaw, and Katherine N. Ky, "Music and Spatial Task Performance," *Nature* 365 (1993): 611. In this study, carried out at the University of California, Irvine, students who listened for 10 minutes to the Mozart Sonata in D for Two Pianos, K. 448, performed better on spatial tasks than those who listened to either a relaxation tape or silence, thereby causing some to speculate that listening to Mozart increases intelligence. See also Frances H. Rauscher, Gordon L. Shaw, and Katherine N. Ky, "Listening to Mozart Enhances Spatial-Temporal Reasoning: Towards a Neurophysiological Basis," *Neuroscience Letters*, 185 (1995): 44-47.

measured by the National Assessment of Educational Progress (NAEP).[2] The results are sobering, to say the least. As stated in the Executive Summary, 67% of fourth-graders scored at or above the Basic level, but only 33% of students scored at or above Proficient, and just 8% scored at an Advanced level. Consequently, 33% scored below Basic, and 59% were below Proficient, as shown in Table 1.[3]

Table 1. Average scores and achievement-level results in NAEP reading for all fourth-grade students: 2009

Average score	Percentage of Students			
	Below *Basic*	*Basic*	*Proficient*	*Advanced*
221	33	26	33	8

The figures are slightly different when considering only public school students, as shown in Table 2.[4]

Table 2. Average scores and achievement-level results in NAEP reading for fourth-grade public school students: 2009

Average score	Percentage of Students			
	Below *Basic*	*Basic*	*Proficient*	*Advanced*
220	34	34	24	7

For Black and Hispanic public-school children, the situation is much more dire: only 47% and 48% (respectively) scored at or above Basic, but just 15% and 16% (respectively) scored at or above Proficient, with a tiny 2% scoring at an Advanced level. Consequently, over half, 53% and 52% (respectively), scored below Basic, and a whopping 83% and 82% (respectively) were below Proficient, as shown in Table 3.[5]

[2] National Center for Education Statistics (2009), "The Nation's Report Card: Reading 2009" (NCES 2010–458). Institute of Education Sciences, U.S. Department of Education, Washington, D.C. Nationally representative samples of more than 178,000 fourth-graders and 160,000 eighth-graders participated in the 2009 National Assessment of Educational Progress (NAEP) in reading. At each grade, students responded to questions designed to measure their knowledge of reading comprehension across two types of texts: literary and informational. NAEP is "the largest nationally representative and continuing assessment of what America's students know and can do in various subject areas. Assessments are conducted periodically in mathematics, reading, science, writing, the arts, civics, economics, geography, and U.S. history. When NAEP results are reported, they become part of "The Nation's Report Card. http://nces.ed.gov/nationsreportcard/pubs/main2009/2010458.asp.

[3] Ibid., http://nces.ed.gov/nationsreportcard/pdf/main2009/2010458.pdf: 1.

[4] Ibid., 15. Information extracted from Figure 11 of the Report Card.

[5] Ibid., 55. Extracted from Table A-12.

Table 3. Average scores and achievement-level results in NAEP reading for fourth-grade public school students, by race/ethnicity: 2009

	Average scale score	Percentage of Students			
		Below *Basic*	At or above *Basic*	At or above *Proficient*	At *Advanced*
White	229	23	77	41	10
Black	204	53	47	15	2
Hispanic	204	52	48	16	2
Asian/Pacific Islander	234	21	79	48	17
American Indian/Alaska Native	206	48	52	22	5

The situation is somewhat better for eighth-graders. According to the Executive Summary, 75% of students scored at or above Basic, 32% at or above Proficient, and 3% Advanced, but that still leaves 25% of students scoring below Basic, and 68% below Proficient, as shown in Table 4 (all students)[6] and Table 5 (public school students).[7]

Table 4. Average scores and achievement-level results in NAEP reading for all eighth-grade students: 2009

Average score	Percentage of Students			
	Below *Basic*	*Basic*	*Proficient*	*Advanced*
264	25	43	29	3

Table 5. Average scores and achievement-level results in NAEP reading for eighth-grade public school students: 2009

Average score	Percentage of Students			
	Below *Basic*	*Basic*	*Proficient*	*Advanced*
262	26	43	28	2

[6] Ibid., 1.
[7] Ibid., 33. Data extracted from Figure 23.

And once again, the scores for Black and Hispanic public-school children are considerably less favorable, with 44% and 41% (respectively) scoring below Basic, and 87% and 83% (respectively) scoring below Proficient, as shown in Table 6.[8]

Table 6. Average scores and achievement-level results in NAEP reading for eighth-grade public school students, by race/ethnicity: 2009

	Average scale score	Percentage of Students			
		Below *Basic*	At or above *Basic*	At or above *Proficient*	At *Advanced*
White	271	17	83	39	3
Black	245	44	56	13	#
Hispanic	248	41	59	16	1
Asian/Pacific Islander	273	18	82	44	6
American Indian/Alaska Native	252	37	63	21	2

Rounds to zero

Even in my home state of Massachusetts, which had the nation's fourth-highest scores, the 2009 MCAS[9] reading test results showed that 43% of third-graders were still below proficient, or grade level, and the figure jumped to 65% for low-income third-graders.[10] As literacy expert Nonie Lesaux points out: "Third-grade reading proficiency is an indicator of later academic success, and a large majority of children who struggle with reading in the third grade are less likely to graduate from high school."[11] Furthermore, she says: "There is a limited window of time in which to prevent reading difficulties and promote reading achievement. . . . For most children what happens—or doesn't happen—from infancy through age 9 is critical. By

[8] Ibid., 64. Data extracted from Table A-20

[9] MCAS is the Massachusetts Comprehensive Assessment System, designed to meet the requirements of the Education Reform Law of 1993 (http://www.doe.mass.edu/mcas/overview.html). A total of 553,635 Massachusetts public school students in grades 3–10 participated in a total of 17 MCAS tests in English Language Arts, Mathematics, and Science and Technology/Engineering in spring 2009. For complete results, visit: http://www.doe.mass.edu/mcas/2009/results/summary.pdf

[10] June Wu, "Grade 3 Students Lagging on Reading," *Boston Globe*, June 10, 2010, http://www.boston.com/lifestyle/family/articles/2010/06/10/grade_3_students_lagging_on_reading/; and Matt Murphy, "Sounding Alarm on Childhood Literacy," *Lowell Sun*, June 11, 2010, http://www.lowellsun.com/. These two newspaper articles were reporting on a study by Nonie Lesaux, a leading expert on literacy at the Harvard Graduate School of Education. The study was commissioned by Strategies for Children, a Boston-based nonprofit organization.

[11] Wu, "Grade 3 Students Lagging," and Murphy, "Sounding Alarm."

third grade, reading struggles are strongly linked to later school difficulties, as well as behavioral problems, depression, and dysfunctional and/or negative peer relationships."[12]

A lack of proficiency in third-grade reading sets a child up for failure. As pointed out on the "Literacy Instruction for Texas" website, "From first through third grades, children are learning to read. From fourth grade on, children are reading to learn."[13] A look at adult literacy rates drives home the point even further. In 2003, the last year for which this data is available, a report by the National Assessment of Adult Literacy (NAAL) [14] reports that the literacy rate among adults is staggeringly low: [15] just 13% are Proficient (28 million people), 44% are Intermediate (95 million), 29% are Basic (63 million), and 14% (30 million) are below Basic, as shown in Table 7.

Table 7. NAAL Literacy Rates of Adults, 2003

Below Basic	Basic	Intermediate	Proficient
30 Million	63 Million	95 Million	28 Million
14%	29%	44%	13%

According to the NAAL report, "Below Basic" means having "no more than the most simple and concrete literary skills;" "Basic" means a person "can perform simple and everyday literacy activities;" "Intermediate" means a person "can perform moderately challenging literacy activities;" and "Proficient" means a person "can perform complex and challenging literacy activities." Of those who are below basic, 55% did not graduate from high school. And 7 million of the non-literate adults could not answer simple test questions. Clearly, only a small percentage of the population has the reading proficiency and education to work and prosper in a technologically complex world.

Functional illiteracy, or low literacy, also has negative implications for the health care of our population, because low literacy levels equate to low health literacy levels as well.[16] The National Institutes of Health points out on their website that the Department of Health and Human Services, in its "Healthy People 2010" initiative, defines health literacy as, "the degree to

[12] Murphy, "Sounding Alarm."
[13] Literacy Instruction for Texas, http://literacyinstructionfortexas.blogspot.com/2009/03/food-for-thought.html.
[14] U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, "1992 National Adult Literacy Survey and 2003 National Assessment of Adult Literacy," http://nces.ed.gov/naal/kf_demographics.asp.
[15] Adults are defined as people 16 years of age and older living in households or prisons.
[16] "Health Literacy," U.S. Department of Health & Human Services, Office of Behavioral and Social Sciences Research, National Institutes of Health; http://obssr.od.nih.gov/scientific_areas/social_culture_factors_in_health/health_literacy/index.aspx.

which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions."[17]

The NIH website goes on to state: "Low health literacy is a wide-spread problem, affecting more than 90 million adults in the United States, where 43% of adults demonstrate only the most basic or below-basic levels of prose literacy. Low health literacy results in patients' inadequate engagement in decisions regarding their health care and can hinder their ability to realize the benefits of health care advances. Research has linked low or limited health literacy with such adverse outcomes as poorer self-management of chronic diseases, fewer healthy behaviors, higher rates of hospitalizations, and overall poorer health outcomes."[18]

And, not surprisingly, literacy rates among incarcerated individuals are even lower. According to the 2003 report, "Literacy Behind Bars," in the three areas tested (Prose literacy, Document literacy, Quantitative literacy), only 2-3% of prisoners tested Proficient, with the majority testing at Basic or Below Basic.[19] Why should this concern us? At the time the survey was done, "some 62 percent of prison inmates expected to be released within 2 years."[20] This would probably not be so different if the survey were done today. These individuals will need to find employment after their release from prison.[21] We should all be very concerned.

Discussion

We must do better at raising the literacy rate in our population, beginning with young children, and we can. The last two decades have seen an explosion of research concerning the effects of musical training on brain development: how it creates new neural networks, strengthens existing ones, and strengthens the synaptic connections. Neuroscientist Daniel Levitin aptly titled his first book on the subject, "This is Your Brain on Music."[22] This new field, sometimes referred to as neuromusicology, is providing all kinds of provocative findings and raising ever more interesting questions.

All the research supports the notion that early music training can be a critical component in the development of verbal, reading, comprehension, mathematical, and spatial-temporal reasoning skills in children, thus providing solid evidence for fully integrating music as a core

[17] U.S. Department of Health & Human Services, Office of Behavioral and Social Sciences Research, National Institutes of Health; http://www.healthypeople.gov/document/HTML/Volume1/11HealthCom.htm.
[18] "Health Literacy,"
http://obssr.od.nih.gov/scientific_areas/social_culture_factors_in_health/health_literacy/index.aspx.
[19] Elizabeth Greenberg, Eric Dunleavy, Mark Kutner, "Literacy Behind Bars: Results From the 2003 National Assessment of Adult Literacy Prison Survey," (NCES 2007-473), U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics: 13, http://nces.ed.gov/pubs2007/2007473_1.pdf; http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2007473
[20] Greenberg, "Literacy," http://nces.ed.gov/pubs2007/2007473_1.pdf: 72
[21] To set the record straight on a related matter: The "statistic" that has been floating around the internet for several years, claiming that several states base their prison capacity projections on the number of third-grade children who are below proficient in reading, seems to have been debunked. See Maria Glod and Rosalind S. Helderman, "In Politics, Fact, Fancy Can Blur in Keystroke," Washington Post, June 4, 2009, http://www.washingtonpost.com/wp-dyn/content/article/2009/06/03/AR2009060303566.html. Nevertheless, it remains true that the literacy rates of incarcerated individuals are below the rates of the general population, and that should concern everyone.
[22] Daniel Levitin, *This is Your Brain on Music* (New York: Penguin Books, 2006).

component of early childhood education. Most such studies have examined children whose music lessons and/or music classes were a discrete adjunct to the curriculum, not explicitly tied to the rest of the curriculum.[23] And while all music instruction has been shown to be beneficial, I wish to advocate for a music-infused elementary and middle school curriculum in which the regular classroom teachers collaborate with the music teacher to use guided, attentive listening to support all learning.[24]

One remarkable example of just such an approach (and the earliest one I am aware of) involves a three-year pilot program at the Bolton Elementary School in Winston-Salem, NC (1994-97), a program begun by Peter Perret, then Music Director of the Winston-Salem Symphony (now Conductor Emeritus), and Robert Franz, director of its education programs. In 1992, Perret heard a report on NPR about neuroscientists investigating the influence of music on learning, and how young children who played piano scored higher on spatial-temporal reasoning tests than their peers.[25] Perret, whose father taught neurosurgery, and who himself had considered a career as a scientist, was intrigued, and wanted to apply the core principles to education. While he suspected that the act of playing an instrument was the prime contributor to this improvement, he realized it would not be easy to insure that all primary school students would have regular access to an instrument and a music teacher. Perret wondered if consistent exposure and attentive listening to live music in and of itself could also have a measurable, beneficial effect.[26] To test out this hypothesis, Perret and several colleagues wrote a grant proposal, with seven goals:

1. to infuse live music into the basic curriculum;
2. to teach by example the musician's creative work process of practice, revision, refinement, and then presentation;
3. to improve the young child's ability for abstract reasoning;

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[23] For example, see Marie Forgeard, Ellen Winner, Andrea Norton, and Gottfried Schlaug, 2008 "Practicing a Musical Instrument in Childhood is Associated with Enhanced Verbal Ability and Nonverbal Reasoning," *PLoS ONE* 3 (10): e3566. doi:10.1371/journal.pone.0003566. In summary, their results "showed that instrumental children outperformed their control counterparts in verbal ability (Vocabulary) and in non-verbal reasoning (both Raven's Standard and Advanced PM)." See also Eric Jensen, *Music with the Brain in Mind* (Thousand Oaks, CA: Corwin Press, 2000), 32-36, 55, where he discusses a number of such studies, including those where children were trained on an instrument, and others where they were simply exposed to music.

For examples of music being integrated into the curriculum specifically to support other learning, see Peter Perret and Janet Fox, *A Well-Tempered Mind: Using Music to Help Children Listen and Learn* (New York: Dana Press, 2006), which I will be discussing presently; and also Douglas Fisher and Nan McDonald, "The Intersection Between Music and Early Literacy Instruction: Listening to Literacy!" *Reading Improvement* 38.3 (Fall 2001): 106+. Academic OneFile.

[24] For another interesting discussion of the reintroduction of Music as an integral part of a school curriculum, see Alma Espinosa's "Music: A Bridge between the Two Cultures," *Forum on Public Policy Online: A Journal of the Oxford Round Table*, Vol. 2007, No. 3, http://www.forumonpublicpolicy.com/archivesum07/espinoza.pdf. The article is an expanded version of a paper presented July 9, 2007, at the Oxford Round Table.

[25] Perret, *Well-Tempered*, 19-20. The test involved presenting to three-year-olds a picture of a familiar animal, cut into several pieces, and asking them to reassemble it. For the actual study, see Francis H. Rauscher, Gordon L. Shaw, Linda J. Levine, Eric L. Wright, Wendy R. Dennis, and Robert R. Newcomb, "Music Training Causes Long-term Enhancement of Preschool Children's Spatial-Temporal Reasoning Abilities," *Neurological Research* 19 (1997): 1-8.

[26] Perret, *Well-Tempered*, 19-21.

4. to help make learning an emotional as well as intellectual experience;
5. to develop a student's capacity for intellectual and aesthetic discernment;
6. to make classical music not only accessible but alive to students;
7. to contribute to the body of research concerning music's impact on cognition, creativity, and the development of motor skills and higher learning skills.[27]

Once Bolton was chosen as the school to test this pilot program, Perret and Franz (who was the first coordinator of the program and had major responsibility for developing the curriculum), recognized the importance of demonstrating to the classroom teachers, with whom they would be collaborating, how music employs and activates different learning modalities. The teachers were already familiar with Howard Gardner's Seven Intelligences,[28] so Perret and Franz explained how those seven intelligences are routinely used and developed in playing music, and how the prospective resident musicians would explicitly model these behaviors in their teaching:[29]

- Reading music employs both verbal/linguistic intelligence to comprehend a written musical score, and logical-mathematical intelligence to understand the rhythmic relationships involved.
- Playing music requires bodily-kinesthetic intelligence and motor control.
- Playing music in an ensemble requires visual-spatial intelligence, and also requires interpersonal intelligence in order to communicate both verbally and non-verbally with the others in the group.
- Interpreting the music emotionally, and communicating it to others, calls for intrapersonal intelligence.
- Finally, combining everything to create a satisfying musical whole requires musical intelligence.

Consequently, the classroom teachers were persuaded that music could indeed be used to help teach almost anything in the curriculum, from vocabulary to science to math to social studies. [30]

When this project began in 1994, Bolton was a school with significant challenges. The average student IQ was 92[31] ; 70% of the students qualified for free or reduced-price lunches; and a high proportion of students came from single-parent households, lived with other relatives or foster families, or were transient or homeless. Scores on standardized state tests were dismal. In 1996, the last cohort of third-graders who had not been through the program was tested. The percentage who tested competently, at grade-level and above, was only 36.5% in reading, and 38.1% in math.[32] One year later, the results for the first cohort of third graders who had been through the three-year pilot program were markedly different, astoundingly so. The percentage

[27] Ibid., 166-67.
[28] Howard Gardner, *Frames of Mind: the Theory of Multiple Intelligences* (New York: Basic Books, 1983). In 1995, he added "Naturalist Intelligence." See Gayle Gregory and Terence Parry, *Designing Brain Compatible Learning*, 3rd ed. (Thousand Oaks, CA: Corwin Press, 2006), 89-90.
[29] Perret, *Well-Tempered*, 42-44.
[30] Ibid., 42-44.
[31] Ibid., 25, 202, fn. 12.
[32] Ibid., 202-203, fn. 14.

of students at grade-level and above was 85.7% in reading, and 89.3% in math, an increase of 50 percentage points.[33] The Bolton school was reclassified from an "at risk" school, to an "exemplary" school.[34] So how exactly was this remarkable feat accomplished?

Perret chose a woodwind quintet (flute, oboe, clarinet, bassoon, French horn), with its distinctive instrumental sounds, to come twice a week for one-half hour, 12-16 weeks per year, to work with the 1994-95 first graders.[35] The quintet continued working with those children through second and third grades, meanwhile beginning each successive class of first graders the same way and following them through third grade. Early on, teachers began noticing better attendance, better behavior, improved academic performance, and longer attention spans.[36]

The musicians coordinated their lesson plans with the classroom teachers, augmenting lessons on reading, arithmetic, poetry, story elements, teamwork, and so on. The quintet was not there to teach music specifically, "but to teach through music."[37] Each lesson began with the musicians playing a short piece, which would immediately command the children's attention and delight them. The musicians would then introduce the topic for the day and within minutes, have the students participating in various ways, such as clapping a rhythm to hear and feel the difference between a quarter note and a half note (thereby demonstrating the mathematical concept of fractions),[38] stamping their feet to feel a steady beat, using their bodies to physically represent opposites such as high and low, big and small, loud and quiet, smooth and bumpy, etc., or have the children "listening to a piece of music to learn about story elements like character, setting, conflict, and resolution,"[39] all of which can be portrayed in music through the use of different melodies, different instruments, different tempos, different dynamics, etc.

The musicians engaged the children by asking questions such as, "Which of these two instruments is bigger?" "Do bigger instruments sound higher or lower?" "Did the oboe play a high note or a low note?" "How is the clarinet different from the oboe?" "With your eyes closed, can you tell which instrument is playing?", and so on, thereby evoking the natural curiosity of the children, and engaging them in critical thinking by asking them to observe something and make an evaluation.[40] And, by asking questions such as "Does the music make you happy or sad?" the musicians were helping the children develop their abstract thinking: to associate something they heard, to a state of mind.[41]

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[33] Ibid., 202-203, fn. 14.
[34] Ibid., 166.
[35] Ibid., 177. Perret initially hoped to use both a woodwind quintet and a string quintet. When it became clear that that was not feasible, he chose the woodwind quintet with its distinctive instrumental sounds, over the more homogeneous sound of a string quintet.
[36] Ibid., 3, 64, 68; Peter Perret, *Methodology*, http://www.peterperret.com/bolton.html. All the students participated; there was no control group.
[37] Perret, *Well-Tempered*, 3.
[38] Ibid, 3.
[39] Ibid., 3, 84-86.
[40] Ibid., 9-11, 35-37.
[41] Ibid., 135. See also Gordon L. Shaw, *Keeping Mozart in Mind* (San Diego: Academic Press, 2000), xiv-xv.

Perret explains that their so-called "Soundscape" exercises proved to be pivotal.[42] In one, the children were instructed to sit silently with their eyes closed for one minute, and to listen carefully to all the sounds around them. When they opened their eyes, they reported what they heard: footsteps, wind, breathing, doors, stomachs growling, etc. With this exercise, they were becoming more aurally attentive.

In another exercise, they imagined a landscape and identified some of the sounds they might hear. A quintet member would write their responses on the board: water, wind, birds, bees, frogs, crickets, and so on, and then ask the children what instrument might be able to imitate that sound. For example, the flute can sing like a bird, the clarinet can buzz like a bee, the bassoon can croak like a frog. Then, the children closed their eyes and the musicians would walk them through the scene, calling their attention in turn to the bird, the bee, the frog, etc., while playing those sounds on their instruments. These Soundscape sessions became more complex at each successive grade level, and Perret reports that they changed dramatically the way the children attended to sound.

Another crucial exercise concerned pitch discrimination. A musician would play "Twinkle, Twinkle, Little Star," and the students would sing along. Then, the musician would play two notes at a time and ask the children if the second note of each pair was higher, lower or the same. With this exercise, they were learning what higher and lower meant with respect to pitch, as well as refining their sense of pitch discrimination, thereby developing a sense of relative pitch: the ability to identify a note or notes given a reference pitch.[43] This has important implications for speech. Neuroscientist Aniruddh Patel confirms that "pitch-related abilities in children predict phonological skills in language."[44] Learning to read necessitates distinguishing subtle differences in the sounds of phonemes. And, as Patel further points out, vowel sounds and phonemes are also defined by their timbre,[45] which is to say, their unique tone qualities.

To explain further: all sound is created by vibrations, and vibrations of a specific frequency produce a specific tone. Whether the vibrating body is a string, as on a violin, or a column of air, as in a horn, the vibrating body will produce a fundamental tone, plus overtones (also called harmonics, or partials), which is to say, vibrations of higher frequencies. For example, a vibrating string will vibrate in its entire length, and in its aliquot parts (½, ⅓, ¼, etc.), with some partials being more audible than others. Every instrument has a particular overtone profile, with respect to more- versus less-audible partials, giving it its characteristic sound, or timbre. This overtone series is also what distinguishes one vowel sound from another. Robert Jourdain explains: "The vocal cords produce a strong fundamental [sound] and an evenly graded series of harmonics….The vocal tract produces several formants (resonance ranges), of which the lowest two are quite strong….When both the first and second formants are set at about 1000 cycles per second, [or Hz, we hear] the 'ah' in 'balm.' Lower the first formant to 400 [Hz] and

[42] Perret, *Well-Tempered*, 61-71.
[43] Ibid., 92. With perfect pitch, or, more properly, absolute pitch, so reference pitch is needed.
[44] Aniruddh D. Patel, *Music, Language, and the Brain* (New York: Oxford University Press, 2008), 78-79.
[45] Patel, *Music, Language, and the Brain*, 50-62.

raise the second to 3000, and you'll hear the 'ee' in 'beet' instead."[46] And consonants are much higher yet. For example, the hiss of the letter 's' rings at 8000-11000 Hz.[47] Timbre is literally the sound of language.

All babies are born with the ability to learn any phoneme in any language, but if they do not learn those of their native language while still very young, they will have difficulty recognizing, remembering or reproducing them. In order to read, one has to match a visual, written symbol with an aural image.[48] Thus, when the Bolton students were learning to recognize the timbre of the individual instruments with their eyes closed, they were training themselves to pay attention to small differences in sound qualities. In working with the quintet, the children had become active listeners, using their ears to make comparisons, and "drawing on the complexity of classical music to fine-tune"[49] their aural awareness. Every lesson was in effect a phonics lesson, as well as a vocabulary lesson, reinforced as the musicians would write each newly-introduced word on the board and have the children sound it out.[50]

And, in a closely-related exercise, the musicians would model writing a "composition" on the board, with lines going up or down to represent pitch, left to right to represent its movement through time, connected or disconnected for smooth (*legato*) or detached (*staccato*) playing, and then play it. The children would then write their own such "compositions," which the musicians would play, and/or the individual students would proudly sing. Besides the implicit introduction to graphing on an x and y axis, and reading from left to right, this reinforced how sounds can be encoded in visual written symbols, and then "read," or decoded, by the musicians, just as in reading and writing. This is a simple and clear demonstration of matching the aural to the visual, and vice versa. [51]

Context and comprehension were also integral to the curriculum. A child who can pronounce words fluently but not comprehend what he or she is reading, is lacking context. Not all words have equal importance in a sentence or paragraph; a reader must differentiate the main idea from supporting ideas, embellishing clauses, etc. Similarly in music, not all notes have equal importance or prominence in a musical phrase; there are main melodies, secondary melodies, background accompaniment patterns, and so on. As the children were being asked questions about these different elements in the music, and guided through sorting them out, they were gaining valuable insights into contextual understanding, hierarchical structure, a sense of form, and a comprehension of the whole and its parts.[52]

The musicians also helped the children develop their problem-solving skills. For example, they might perform a short piece with everyone playing at the same volume and then ask who played the melody. The children, initially bewildered, would be led to suggest that each

[46] Perret, *Well-Tempered*, 92-95; Robert Jourdain, *Music, the Brain, and Ecstasy: How Music Captures our Imagination* (New York: William Morrow, 1997), 40-41.
[47] Jourdain, *Music, the Brain, and Ecstasy*, 18.
[48] Perret, *Well-Tempered*, 67.
[49] Ibid., 71.
[50] Ibid., 96, 123.
[51] Ibid., 139-44.
[52] Ibid., 146-51

instrument in turn should play louder than the others to determine which one had the melody and should therefore be more prominent.[53] This led to lessons on teamwork: students observed the musicians negotiating over how to play a passage, trying out each member's interpretation, and coming to a group decision, modeling how to disagree and resolve a conflict peacefully, without resorting to bullying, name-calling, and so on.[54] They also observed how people in a collaborative setting give and receive constructive feedback, and that being corrected in this way does not damage one's self esteem.[55] Furthermore, the children saw that in a performance, one cannot stop or go back to fix a mistake. The musicians must be flexible enough to recover and keep playing. When the performance is over, they can diagnose their error, enabling them to play it correctly next time.[56] This is an important life lesson.

Invariably, the children would ask the musicians how they came to play so well. This provided the musicians the opportunity to emphasize the importance of commitment and practice, the striving for both short- and long-term goals, and it enabled them to demonstrate how, through accomplishment, one builds true self-esteem. The musicians were inspirational models for the children.[57] And the musicians clearly loved what they were doing. Current brain research amply demonstrates that learning is a recursive process. It takes many repetitions to learn something, and paying attention and being emotionally involved play a significant role. Neuroscientist Joaquin Fuster says: "Contiguity, repetition and emotional load seem to be the most decisive strengtheners of synaptic contact in the making of a cognitive network."[58] And psychologist Michael Posner points out that "few other school subjects can produce such strong and sustained attention that is at once rewarding and motivating."[59]

Shortly after the initial Bolton test score results were released, similar residency programs began springing up in public, private and charter schools, all of which produced positive results.[60] For example, in 2002, the residency program moved to the Winston-Salem Arts Based Elementary School, a charter school where a full 20% of students had been diagnosed with learning disadvantages and disabilities, and almost a quarter were indigent. Half the students were Caucasian, one-third African-American, and one-sixth Hispanic. Here, this residency program was put to a rigorous scientific test.[61] During the four-month study (compared to the three-year program at Bolton), the test group received 18 half-hour lessons using the curriculum developed at Bolton, while a control group took chess lessons. Even in this

[53] Ibid., 49-50.
[54] Ibid., 49-52.
[55] Ibid., 55-56.
[56] Ibid., 57.
[57] Ibid., 58.
[58] Joaquin M. Fuster, *Cortex and the Mind: Unifying Cognition* (Oxford: Oxford Univeristy Press, 2003), 82, quoted in Perret, *Well-Tempered*, p. 136 and p. 208, fn. 64.
[59] Michael I. Posner and Brenda Patoine, "How Arts Training Improves Attention and Cognition," *Cerebrum* (The Dana Foundation), September 14, 2009, http://www.dana.org/news/cerebrum/detail.aspx?id=23206
[60] Perret, *Well-Tempered*, 167.
[61] Ibid., 112-115. The test was developed by a school psychologist, Shirley Bowles, who had approached Wake Forest University School of Medicine to inquire about doing a study to investigate the link between music and brain development for her Ph.D. dissertation.

abbreviated amount of time, phonemic awareness and spatial-temporal abilities of the test group improved significantly at all grade levels, regardless of gender and ethnicity. This study indicated that "children in early elementary grades who have all the same opportunities as their peers develop stronger building blocks for reading with the addition of nine hours of special music instruction."[62] Thus, the results from eight years of having this program at Bolton were borne out again: ethnicity and socioeconomic levels were not important factors in the results. The improvement rate was the same across all groups.[63]

In a slight departure from the Bolton model, Parkview Elementary School, in neighboring High Point, NC, near the Bolton school, used a trio of professional singers instead of instrumentalists, because the singers can maintain eye contact with the students while they sing. The demographics of the school were similar to Bolton, as were the results: "After a two-year residency, 79% of the third graders tested at or above grade level in reading, and 76.2% tested at or above grade level in math. The previous third-grade class, which had no exposure to the music program, had tested about 20 percentage points lower: 54.4% at or above grade level in reading; 57.4% at or above grade level in math."[64]

The program was also adopted by the Hill Middle school in Winston-Salem, NC, a school with a similar demographic profile. In the middle school, where the educational goals were somewhat different, including more science and social studies, and lessons in teamwork and collaboration, the impact of the musicians was likewise noticeably different.[65] According to the principal, "the sound of classical music being played in the lobby had a calming effect,"[66] and opened up a whole new world, a whole new culture, a whole new type of music, a whole new view of employment, to these students, many of whom went on to study music in high school.[67]

Across the country from NC, as a result of a serendipitous encounter in 1999, a similar program took root in Tucson, AZ, and continues to flourish today. H. Gene Jones, then-president of the Tucson Symphony Board, was at an American Symphony League seminar and attended a workshop led by Peter Perret, who was discussing the Bolton project. Inspired by the impressive results, Jones was determined to use the Tucson Symphony to bring this program to the Tucson schools. He brought the idea to the Tucson Unified School District, which then developed its own arts-infused curriculum, "Opening Minds through the Arts" (OMA), a collaborative program involving the University of Arizona School of Music and Dance.[68] This arts-infused curriculum is used from kindergarten through eighth grade. According to the OMA website, teachers, artists and integration specialists are trained to collaborate to create arts-infused

[62] Ibid., 115.
[63] Ibid., 114.
[64] Ibid., 170-71.
[65] Ibid., 50-51, 167-68.
[66] Ibid., 168.
[67] Ibid., 168.
[68] Ibid., 168-70; Susan Felt, "91-Year-Old Uses Arts Program to Transform Struggling Students," *Arizona Republic*, September 12, 2007, http://www.azcentral.com/arizonarepublic/arizonaliving/articles/0912prize0912.html#

curricula for math, science, reading, writing and social studies, so even though the artists are in class just two days a week, the students receive arts-infused lessons every day.[69]

The results have been impressive. Susan Felt, writing for the *Arizona Republic* in 2007, reported: "By the third year, children who had been in the program since kindergarten were showing significantly higher scores (82 percent in reading vs. 49 percent in control schools, for instance) in the state-mandated AIMS test and the national Stanford 9 than those students without OMA in their schools. In September 2006, OMA was one of 12 programs nationwide chosen for inclusion in Harvard University's Project Zero exemplary arts education programs."[70] Fran Smith, writing for *Edutopia*, explains further:

In the first three years, the nonprofit research firm WestEd tracked the OMA schools along with demographically matched controls: All six schools had high percentages of low-income students, English-language learners, and children of transient families. OMA students significantly outscored their counterparts in reading, math, and writing, and although the benefits held across all ethnicities, Hispanic students, in particular, made substantial gains in writing. WestEd also found that teachers in OMA schools did better than their peers on every indicator, including lesson planning and design, arts-integrated instruction, and the creative use of varied learning activities. Today, 40 of Tucson's more than 70 elementary schools have at least some elements of OMA. Pilot projects are under way at 4 of the district's 20 middle schools…At fully implemented OMA schools…teaching artists—professionals from Tucson's cultural institutions—work with students on activities that dovetail with the classroom curriculum and state standards. An arts-integration specialist on the school staff also sees every class each week.[71]

What all of these programs have in common is that music is not treated as an adjunct to the curriculum, as has typically been the case in the past (and continues to be the common model in those schools that are fortunate enough to even have a music program), where a music teacher comes once or twice a week to teach general music and/or to conduct an elective choir, band or orchestra, or to give private instrumental lessons provided as an extra-curricular activity. Nor is it treated as the typical outreach program, where an ensemble comes to perform a short concert once or twice a year. Rather, music is an integral part of the curriculum: all subjects are taught through music and the other arts. And the results in all schools that have tried the program are most impressive.

For further statistical confirmation of music's positive impact, we can look at the SAT scores of college-bound students over the past 14 years, from 1996-2009 (available on the

[69] OMA Foundation, "How Does the OMA Model Work," http://www.omaproject.org/oma-model.html. See also the OMA factsheet at http://www.edutopia.org/pdfs/OMA/edutopia-OMA-FACTsheet.pdf
[70] Felt, *Arizona Republic.*
[71] Fran Smith, "Tucson Schools Enhance Learning with the Arts," *Edutopia.org: The George Lucas Educational Foundation*, January 28, 2009, http://www.edutopia.org/arts-opening-minds-integration.
This article was also published in the February 2009 Arts Education issue of *Edutopia* magazine as "Opening Minds Through the Arts."

College Board's website).[72] For every one of those years, students who had coursework in, or experience with music, outscored their peers with no music training or experience by as much as 60 points in some areas, as shown in Table 8.

Table 8. SAT 2009 Mean Scores for Students with and Without Music Study or Experience

Coursework or Experience	**SAT MEAN SCORES**		
	Critical Reading	**Mathematics**	**Writing**
Music: Study or Appreciation	533	535	524
Music Performance	529	537	521
No Music	475	497	464

Students with music experience also scored above the mean of the totality of students taking the SAT, as shown in Table 9.

Table 9. SAT 2009 Mean Scores for All Students (Including Those with Music Experience) Compared to just Those with Music Experience

	SAT MEAN SCORES		
	Critical Reading	**Mathematics**	**Writing**
All Students	501	515	493
Students with Music: Study or Appreciation	533	535	524
Students with Music Performance	529	537	521

Finally, for an "after-the-fact" perspective, we can look at how adults with prior music training perceive the benefits of that experience today, and how much of their adult success they credit to their early music training. For that, we can turn to a Harris Poll, conducted in 2007,

[72] "2009 College-Bound Seniors," Total Group Profile Report, © 2009 The College Board. All rights reserved. http://professionals.collegeboard.com/profdownload/cbs-2009-national-TOTAL-GROUP.pdf

from which I have quoted at length below.[73] The results should make everyone wonder why music is not at the center of every school curriculum:

Three-quarters (75%) of American adults were involved in some type of music program while in school. Half (51%) were involved in chorus while 42 percent had some type of formal instrumental lessons. Just over one-third (35%) were in a school instrumental ensemble, such as an orchestra or band while 14 percent were part of an informal group, such as a garage band and 12 percent had formal vocal lessons.

Music education is associated with those who go on to higher education. In looking at what groups may have participated more in music, education shows the largest differences. Two-thirds (65%) of those with a high school education or less participated in music compared to four in five (81%) with some college education and 86 percent of those with a college education. The largest group to participate in music, however, are those with a post graduate education as almost nine in ten (88%) of this group participated while in school.

Music education is also associated with higher incomes. Three-quarters of people (74%) with household incomes of $34,999 or less and 72 percent of those with incomes of $35,000-$49,999 participated in music, compared to 83 percent of those with incomes of $150,000 or more….

Participating in music programs can also provide people with certain skills that can be utilized in a job and career. Just under half (47%) of those who were in a music program say music education was extremely or very important in giving them the ability to strive for individual excellence in a group setting. A plurality (44%) say music education was extremely or very important in teaching how to work towards common goals and two in five (41%) say it was extremely or very important in providing them with a disciplined approach to solving problems. Just over one-third say music education gave them the skill of creative problem solving (37%) and how to be flexible in work situations (36%).

The more education one has, the more likely one thinks that music education was important in providing each of these five skills. In fact, almost six in ten (58%) post graduates say music education was extremely or very important as they strive for individual excellence in a group setting. Besides post-graduates, African Americans are also more likely to say that music education was important in providing them with each of these skills.

In looking at what the learnings and habits from music education provide, two-thirds of adults (66%), and 72 percent of those who were involved in music, say it equips people to be better team players in their career. Music education also helps one to solve problems – three in five adults (61%) and two-thirds (66%) of those involved in music say music education provides people with a disciplined approach to solving problems. Music also provides a sense of

[73] "Those with More Education and Higher Household Incomes are More Likely to Have Had Music Education Music education Influences Level of Personal Fulfillment for Many U.S. Adults," *The Harris Poll*® #112, November 12, 2007, Regina Corso, Director, Harris Interactive Inc. All rights reserved. http://www.harrisinteractive.com/vault/Harris-Interactive-Poll-Research-Music-Education-2007-11.pdf. Harris polled 2,565 adults in an online survey, conducted between October 9 and 15, 2007,. The survey was not commissioned by any organization.

organization. Three in five adults (59%) and almost two-thirds (64%) of those who had music education say that it prepares someone to manage the tasks of their job more successfully.

Conclusion

In summary, the jury is in. We cannot afford to delay any longer. We must recognize the cognitive, educational and social benefits accruing from a totally music-infused curriculum and demand that such a curriculum be put into place now. Our children (and country) deserve no less. And, in advocating for such a curriculum, I do not wish to suggest that music should be included in a curriculum *merely* to serve a utilitarian purpose. To quote Perret: "Music as an art form is a pinnacle of human culture and achievement. As such it does not need to justify its existence. It should be learned and appreciated for its own sake."[74] Nevertheless, I, as Perret (and so many others) recognize that music has the power to entrain us; we should not think twice about harnessing its power to carry our children along and teach through its captivating essence.

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[74] Ibid., 173.

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