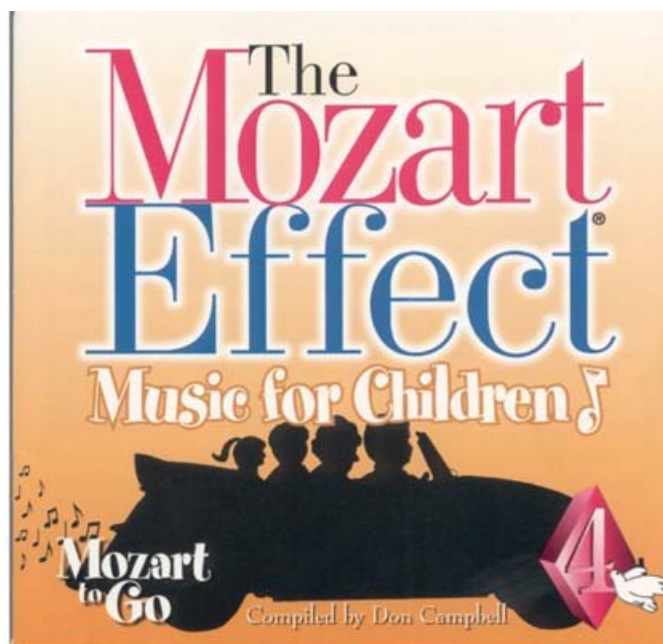


## The interesting connection between math and music

BY ARVIND GUPTA , SPECIAL TO THE VANCOUVER SUN APRIL 7, 2009



In the field of cognitive research, the mind-body connections between music and mathematics have fuelled continuing debate surrounding the so-called "Mozart Effect," which was first popularized in the early 1990s. In some studies, test subjects performed better on spatial-temporal tasks — such as visualizing a boat in one's mind and then building it with Lego pieces — immediately following exposure to a Mozart sonata.

**Photograph by:** ..., Vancouver Sun files

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From the rich complexity of the Bach fugues to the catchy songs of the Beatles, music and mathematics overlap in all kinds of interesting ways.

Beyond the basic uses of mathematics in music theory and notation (such as chords, time signatures, or dotted half-notes representing a count of three), music has also been the source of research in many areas of mathematics such as abstract algebra, set theory and number theory.

Would you believe that research has shown that certain pieces of music end up being more popular and mainstream due to their 'mathematical' structure?

For example, Pachelbel's Canon in D — sure to be a top choice for brides again this summer — is said to reach the masses because of its repetitive structure, a trend very apparent in music today. No doubt the amazing popularity of hip-hop music, with its rhythmic beats and looping breaks, is partially due to our innate mathematical need for rhythm and patterns.

Jason Brown, professor of mathematics at Dalhousie University, used a mathematical tool called a "Fourier Transform" to analyse and solve the decades-old mystery of which instruments and notes actually make up that wild opening chord of the Beatles' song A Hard Day's Night. Hint: it's more than George Harrison's 12-string guitar. Brown is now using his sound-wave analysis of Beatles music as inspiration for new songs. (Check out his piece A Million Whys online to see how it's working.)

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This might be explained by the fact that the same parts of the brain are active when listening to Mozart as when engaged in spatial-temporal reasoning.

Dr. Frances Rauscher of the University of Wisconsin Oshkosh has been heavily involved in research on music and cognitive performance. She gives far more credit to the active playing of instruments than simply passive listening.

In her 2006 article published in the *Educational Psychologist*, she explains that "young children provided with instrumental instruction score significantly higher on tasks measuring spatial-temporal cognition, hand-eye coordination and arithmetic." Part of this is due to the amount of overlap between music skills and math skills. For example, Rauscher says the part-whole concept that is necessary for understanding fractions, decimals and per cents is highly relevant in understanding rhythm. "A literate musician is required to continually mentally subdivide beat to arrive at the correct interpretation of rhythmic notation," she writes. "The context has changed, but the structure of the problem is essentially the same as any part-whole problem posed mathematically."

The visual and spatial skills that a child exercises every time he practises an instrument and plays music strengthen his mental-physical connection.

The link between the physical practice of music and strong mathematical abilities are demonstrated in studies that show that kids who play a musical instrument can perform more complex arithmetical operations than those who do not play an instrument. The slow work of practice, the attention to detail and the discipline it takes to learn an instrument are also excellent preparation for the practice involved in building strong math skills.

The math-music connection shines in the field of education as well. Research shows that children who learn their academics through music and dance retain the information better than children who learn the same concepts by verbal instruction.

You may have noticed this yourself if your children are in a school participating in the Learning Through The Arts program established by the Royal Conservatory of Music. In LTTA, teachers and professional artists collaborate on lessons using art, dance, story and song to explore math, science and other subject areas.

So the next time you find yourself wanting to get up and dance to the music, remember that those pleasurable patterns of rhythm, beat, harmony and melody are actually embodied mathematical expressions.

**Next week:** *When you think about careers that use math, do you get stumped right after "accountant"? In next week's column, Dr. Gupta will highlight ten careers which require top-notch quantitative skills. I guarantee you'll be surprised!*

*Arvind Gupta is a father of three, a mathematician and scientific director of MITACS, a national research network focused on connecting university-based math researchers with companies and other organizations to solve real-world challenges. For more information on MITACS, visit [www.mitacs.ca](http://www.mitacs.ca).*

### **Arvind Gupta answers your math questions**

#### **Lee Woods**

This excellent series on math is long overdue! I have noticed with alarm my teenage daughter and her friends seem to be squeaking by in their math classes. They seem to believe that math is for boys only and they "dumb" down constantly. They all want to be famous like Beyoncé and don't seem to understand the importance of math and science.

In our cult of celebrity worship, this attitude is encouraged in school and society. I want my daughter and all young women to pursue the careers of their choice but not all these girls are going to be rich movie stars and rock stars. These are the same women that have trouble counting out change in their part-time retail jobs even when the cash register shows them the exact amount.

How can parents get their kids able to function at the standard level required in the real world while working towards their dream jobs? I am very worried about my daughter's future and worry she will be left behind. How can I get my daughter interested in math before it is too late?

Hi Lee,

*I'm glad you see the need to promote math, science, technology, and engineering with young women. And as you are aware, keeping your teenage daughter's interest and confidence in math is crucial. We all know what a big difference a little intrinsic motivation can make.*

*As a start, make it personal and find out what careers interest your daughter. Take a look at the math websites we posted with the March 31 "Math and Gender" article like [GirlsareIT](#), [Girlsgotech](#), and [girlstart](#) on the Vancouver Sun website and show your daughter some new possibilities while surfing together.*

*You will find career descriptions, bios of professional women, and tips for parents on how to encourage their daughters to pursue math, science, technology, and engineering.*

*Locally, Science World has a program called Opening the Door. This is a networking event for students in Grades 10-12 who are interested careers in science, technology, engineering or mathematics.*

*The program provides students with the opportunity to meet professional scientists, engineers, technologists and technicians who work in a variety of fields.*

*The key is to connect kids with real people who have careers which use math and science.*

*Science World also has a program called Scientists & Innovators in the Schools, which brings engineers technologists and technicians into B.C. schools to speak to children in Grades K to 12 about their research. Perhaps talk to your daughter's math teacher about inviting a local scientist or business person who uses math in their job into the classroom.*

*Another site that I came across that looks fabulous is the Expanding Your Horizons conference network in the United States. They provide support to professional women in sciences, technology, engineering, and mathematics, who want to plan and deliver a conference to encourage young women like your daughter to keep up their math and science studies for future opportunities. Suggest that your daughter search "Expanding Your Horizons" in YouTube to see how exciting the possibilities are.*

*Also very timely — next week's Math Matters article will reveal 10 fabulous careers that use math. And they are not the usual ones which you would think of!*

*On a daily basis, do all that you can to encourage and help her be successful in math at school. Check with her teacher to see what support you can help provide at home. You could also take a look back at our original Math Matters article about why we all need math. Don't despair and keep looking for that hook — that career or situation that will show her the connection between math and her future.*

### **Math tips for parents**

Are those struggles getting your child to practise her instrument every day worth your trouble? The simple answer: Yes! Not only is your child developing her ability to make beautiful music, but she is also strengthening her mind for mathematical thinking.

Keith Devlin in his book, *The Math Gene*, points out that musicians and mathematicians alike both use abstract notation to describe on paper the patterns that exist in their mind. A trained musician reading musical symbols moves straight to "hearing" in his mind the sounds that the symbols represent. Similarly, a trained mathematician reading mathematical symbols moves directly to think about the patterns that the symbols represent. It's not surprising then that medical imaging shows the brains of professional musicians when listening to music are similar to the images of brain activity of

professional mathematicians solving a mathematical problem. Although the imaging of amateur musicians and mathematicians has not always shown the use of similar circuits in the brain, the potential for mathematical and musical neural pathways to complement each other exists if your child keeps practising that guitar!

Whether your child practises and composes music daily, or just enjoys dancing around the house to music, providing the right music for the right purpose can help your child learn in general but potentially excel at mathematics.

Play music in the background during a lesson or homework session. Music can activate us emotionally, mentally and physically to help us remember the learning experience and information. Music can also create a highly focused learning state in which large amounts of content information can be processed and learned. Baroque music, such as that composed by Bach or Handel that is 50 to 80 beats per minute creates an atmosphere of focus that leads students into deep concentration in the alpha brain wave state. Learning vocabulary, memorizing facts or reading to this music is highly effective. On the other hand, energizing Mozart music assists in holding attention during sleepy times of day and helps students stay alert while reading or working on projects.

When helping your child with memorizing facts or figures, be they mathematical or not, try putting the information to rhythm or rhyme. These catchy, musical elements will provide a hook to help her recall those important details in stressful situations. These songs, chants, poems, and raps will improve the memory of content facts and details.

*Dr. Arvind Gupta*

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