

International Review

Music 'makes the brain learn better'¹

The hours spent mastering the violin or piano are worthwhile - music lessons boost children's memories.

Researchers from Hong Kong have found children who are given musical training have better verbal memories than those who have not had lessons. They say their findings could help people recovering from a brain injury as well as healthy children. Psychologists from the Chinese University of Hong Kong studied 90 boys between the ages of six and 15. Half had been given musical training as members of their school's string orchestra and had received lessons in playing classical music on Western instruments, for up to five years. The rest, all students at the same school, had received no musical training.

Stimulation

All the children were given verbal memory tests, to see how many words they recalled from a list, and a visual memory test for images. Those students who had been given music lessons recalled significantly more words than the untrained students, and generally learned more words with each subsequent test. They were also able to retain more words than the other group when tested 30 minutes later. And the longer the boys had been receiving music lessons, the better their verbal memory. However, no differences were found in visual memory between the groups.

The researchers suggest music lessons stimulate the left side of the brain, which also controls verbal learning. A year after the first study, the researchers studied the orchestra students again. Of the 45 original students, only 33 were still receiving lessons. They also studied 17 children who had started music lessons after the initial study. The beginner's group initially showed poorer verbal-learning ability than the more musically experienced boys. But after a year, they showed significant improvement in verbal learning.

However, the 12 boys in the original group who had stopped having lessons showed no further improvement, though they did not lose any of the abilities they had gained while they were being taught music.

¹ The BBC, Sunday, July 27, 2003. See <http://news.bbc.co.uk/2/hi/health/3095807.stm>

Parental interest

The researchers, led by Dr AGNES CHAN, said giving music lessons to children "somehow contributes to the reorganization [and] better development of the left temporal lobe in musicians, which in turn facilitates cognitive processing mediated by that specific brain area, that is, verbal memory." She added: "Students with better verbal memory probably will find it easier to learn in school."

Dr ALEXANDRA LAMONT, lecturer in the psychology of music at Keele University, told BBC News Online that research into the effect of music on other abilities was often complex and contradictory, and the Hong Kong study was important in adding new information to the debate. But she added: "Research has shown that children who have extra music lessons often come from higher socio-economic backgrounds, and their parents are therefore more likely to be better educated and take more interest in their children's development. "These children may simply be making better progress because they are getting more help and encouragement. If this is the case, we would expect to see similar improvements in other academic areas such as mathematics. "In comparison, visual memory is not seen as such an important academic skill, which could explain the lack of differences between the groups."

She added: "These results give us more information to consider, but we urgently need more research to know more about what it is that is having an effect. Music is an important and enjoyable activity in its own right, and many researchers working in this area strongly believe it would be dangerous to promote music only on the basis of the other skills it can bring."

The research is published in the journal *Neuropsychology*.

Trying to figure out why Math is so hard for some²

Valerie Strauss

Theories Abound: Genetics, Gender, How It's Taught

Three little words -- "math is hard" -- uttered a decade ago by Teen Talk Barbie drew enough protests of sexism that its maker, Mattel Inc., pulled the doll from stores. But researchers today say Barbie wasn't all wrong: Math is hard for many - male and female, children and adults. And while a "math gene" has not been discovered, experts say that early school-age boys and girls tend to approach the subject differently, influenced

² The Washington Post, Tuesday, December 2, 2003, p. A 13. See www.washingtonpost.com/wp-dyn/articles/A26826-2003Dec1.html.

by biological, environmental and educational factors. So why, despite this year's fanfare over SAT scores reaching a 30-year high, does math still stump so many?

"That's the question we are all asking and that is driving the research," said MICHELLE MAZZOCCO, director of the Math Skills Development Project at Baltimore's Kennedy Krieger Institute, a clinical and research facility for pediatric developmental disabilities. "There could be so many different causes leading to what we call poor math achievement and math disability, which are not necessarily the same thing," she said. "It has taken researchers decades to understand the fundamental difficulties of reading, and we are now at the place with math research where reading researchers were 20, 30 years ago."

Some say that learning math is similar to tackling a foreign language; others say it is different from all other subjects, because math is abstract and requires more logical and ordered thinking. There are battles over how to teach it, dissension over gender issues, questions about the causes of poor student performance, and no universal definition for "math learning disability," known as *dyscalculia*.

What is known is that math is hierarchical, so that "if you hit a hurdle somewhere along the way, it's tough to catch up," said JULIE SANDERS, a math teacher at Episcopal High School, a private school in Alexandria.

Yet researchers are only beginning to grasp why someone such as MIKE ZAYDMAN, a senior at Thomas S. Wootton High School in Rockville, seems to be a natural -- completing advanced calculus last year and now having a "pretty good time" with multivariable calculus/differential equations -- while LESLEY ANN HECHT, a junior at the University of Massachusetts at Amherst, has always struggled with math.

HECHT was diagnosed with a math learning disability after she had trouble figuring out multiplication tables as a child in Avon, Conn. She recalls working harder than other students to earn a B in high school geometry, but her problems didn't end there. She nearly had to drop her psychology major in college because it required taking a math test, which she failed. After retaking the test with approved special help, she passed.

HECHT, who excels in others subjects, attributes her math difficulties to genetics, anxiety and poor teaching. But she doesn't think she is any worse at math than some friends who were never diagnosed. "I really don't see myself as having a disability," she said. "I just think I'm not good at math." MAZZOCCO and other researchers say they don't know at what point difficulty with math becomes a learning disability. There is no specially designed test for diagnosis, and estimates about how many children have *dyscalculia* range from 5 percent to 8 percent.

But one thing is clear, said DAVID C. GEARY, a researcher and psychology professor at the University of Missouri: The human brain is not designed to accept math easily.

"Much of what kids are expected to learn has been developed in the past 1,000 to 2,000 years, sometimes much more recently, and thus people's brains aren't really designed to learn much of it -- except, for instance basic counting and simple arithmetic," GEARY said. "Language, including foreign languages if they are introduced early enough, is a completely different matter, as the brain is pre-wired to learn this."

New neuroimaging techniques are making clearer how different areas of the brain are tapped for various visually and linguistically based mathematical tasks, which helps explain the ways someone can trip over math. Fact retrieval appears to be the most common type of problem for elementary school students, for instance, and spatial difficulties may interfere with geometry learning, researchers say.

JOANN DEAK, a psychologist and author of "Girls Will Be Girls: Raising Confident and Courageous Daughters," said most schools approach math in the early grades "as if there is one kind of brain" -- though neuroimaging suggests that most girls develop language skills faster and most boys develop spatial and visual abilities faster. This helps explain why boys traditionally have been seen as "better at math," and why some girls have steered away from it. Different teaching approaches early in a child's life can make up for these gender differences, DEAK said, but most teachers don't try.

Researcher ART BAROODY, a professor of curriculum and instruction in early childhood and elementary mathematics education at the University of Illinois at Urbana-Champaign, said he is "willing to bet the ranch" that the primary culprit for students' math struggles is poor instruction.

"Children with genuine organic dysfunction probably make up a small portion of the children struggling with math, or even of those labeled 'learning disabled,'" BAROODY said. As for whether it is ever too late to learn math, he said: "It is probably never too late, if the spirit has not been broken."

That underscores the fierce battles over how to teach the subject; a nearly 2,000-page history of school mathematics, recently published by the National Council of Teachers of Mathematics, details decades of conflict with different eras of math instruction.

Applause recently sounded when U.S. math scores rose on the National Assessment of Education Progress, often called "the nation's report card," coming on the heels of last summer's SAT results. JOHNNY LOTT, president of the National Council of Teachers of Mathematics, said he credits reform math programs that help children learn by finding the meaning of problems themselves rather than learning by rote memorization.

Others, including W. STEPHEN WILSON, a Johns Hopkins University math professor, believe that those programs confuse as many students as they help and that rising test scores are unrelated.

ANTHONY BELBER, a third-grade teacher at the private Georgetown Day School in the District, said some children are asked to learn concepts before they are developmentally

ready. He still remembers, he said, "that panicky feeling about math, always trying to get by and never really understanding what I was doing" while attending St. Albans School in the District. "Kids are sometimes exposed to things a year or two years before they are ready," said BELBER, who noted that he didn't fully become comfortable with math until he started teaching. "If they start thinking they aren't good in a topic because it is too soon, they are always behind."

Why computers have not saved the classroom³

Bob Blaisdell

A new book says technology - from TV to the laptop - delivers less than hoped for by schools

What impact has computer technology had on public education in the US? That's the question journalist TODD OPPENHEIMER sets out to answer in "The Flickering Mind."

Mr. OPPENHEIMER's conclusion: Putting computers in classrooms has been almost entirely wasteful, and the rush to keep schools up-to-date with the latest technology has been largely pointless.

"At this early stage of the personal computer's history, the technology is far too complex and error prone to be smoothly integrated into most classrooms," OPPENHEIMER writes. "While the technology business is creatively frantic, financially strapped public schools cannot afford to keep up with the innovations."

Of course, this is not the first time US schools have been seduced by new technology, OPPENHEIMER points out. He summarizes the history of technological innovations in American schools and explains how each (TV among them) has been hailed as education's savior.

And yet, despite technology's lack of success in US classrooms, many Americans still prefer to invest in computers rather than in teachers, OPPENHEIMER charges. On the other hand, OPPENHEIMER cites SEYMOUR PAPERT, a computer-science professor at the Massachusetts Institute of Technology who beats the drum for more technology and urges a revolutionized concept of school. "School has probably changed less than other major institutions," says Professor PAPERT. "The evidence that we got it right in school and got it wrong everywhere else is pretty slight."

³ The Christian Science Monitor, Tuesday, October 14, 2003. See www.csmonitor.com/2003/1014/p20s02-lecl.html - Bob Blaisdell is an English professor at City University of New York's Kingsborough Community College. OPPENHEIMER, TODD: *The Flickering Mind: The False Promise of Technology in the Classroom* - by Random House, 512 pp., \$25.95.

While PAPERT's argument is at least debatable, OPPENHEIMER leaves any serious discussion of it behind to focus on the regrettable role of those he sees as charlatans in the computer and testing industries.

"One of the great secrets of the industry is that manufacturers of computer hardware and software often know their products are hampered by significant limitations," writes OPPENHEIMER. "Yet they rarely hold back from going to market with the gear, because they also know that most if not all of those problems will be fixed with the next upgrade, the release of which will simply net more sales."

OPPENHEIMER examines individual schools where technology has been useful, but there he largely credits the enthusiasm and devotion of individual teachers.

The most effective teachers, he argues, are those who know enough to ignore the latest technological products and rely on such hands-on technology as pens and paper, musical instruments, wooden blocks, and rulers.

Although he researched this book for more than five years (its genesis was in two articles in "The Atlantic Monthly"), OPPENHEIMER is for the most part reluctant to weigh in with his views. A good reporter, he allows the experts and insiders to sound off instead. "I have boiled down my feelings about the subject into a small set of hopes for schools," he writes. "I hesitate to turn these hopes into formal recommendations for a reason. For decades, teachers and administrators have been battered [by] ... all manner of 'experts' who do not spend their days cooped up in a room with dozens of unruly youngsters.... These teachers are doing God's work."

"The Flickering Mind" is an informative, insightful, and broad presentation of public education's ongoing struggle for survival in competition and in collaboration with all the next new things.

Girls surging past boys academically, new study says⁴

Alaina Sue Potrikus

Throughout the industrialized world, girls are better readers than boys, according to a startling new study of 42 countries. Girls also have higher expectations than boys of holding good jobs someday.

In addition, female college graduates - fewer than half of all graduates a decade ago - now outnumber their male counterparts in most industrialized countries, according to a 453-page report released this week by the Paris-based Organization for Economic Cooperation and Development.

⁴ The Seattle Times, Saturday, September 20, 2003. See http://seattletimes.nwsources.com/html/nationworld/2001737939_read20.html

"It just blows you away," said BARRY MCGAW, director for education at the organization, a think tank on global social issues. "Fifteen years ago, we were saying that girls don't stay in school and don't go on to post-secondary education. Look what they've done in 15 years."

The study's results jibe with U.S. reports showing strong educational surges by women.

For example, three of five members of high schools' National Honor Societies today are girls. Girls outnumber boys 124 to 100 in advanced-placement courses. As recently as 1987, boys outnumbered girls in those classes.

Girls also tend to make better grades. A survey of U.S. high-school seniors who took the SAT in 2000 found that 44 percent of the young women reported A averages. Among men, 35 percent did. And a count of Philadelphia-area valedictorians last spring turned up 106 females and 64 males.

Sociologist ANDREW HACKER, author of "Mismatch: The Growing Gulf Between Women and Men," isn't surprised by the surge in women's performance. According to HACKER, three of four high-school senior girls say they spend an hour or more on homework daily. About half of boys say they do. Conversely, boys report watching more television than girls do and spend more time on video games.

"Women are proving themselves to be better at being good students and scholars than men are," HACKER concluded. "It's not in the genes. It's almost as if being a man and being masculine, macho and powerful is not conducive to being a good student."

MCGAW attributed the growing gap to a kind of obstinacy in boys, especially boys in lower-income families. "Working-class boys define themselves as 'not girls,'" MCGAW theorized. "So, if the girls value education, that's what boys don't do."

KAYE PETERS, who teaches English at Central High in St. Paul, Minn., said she sees it all the time. "Boys don't want to look too smart and don't want to look like they're pleasing the teacher," PETERS said. Her theory: "Girls can negotiate the fine line between what peers want of them and excelling at school. Boys have a harder time balancing being socially accepted and academically focused."

The study found that, except in Switzerland, Japan and Turkey, women now earn more university degrees than men. In all but Austria and Iceland, girls have higher occupational expectations than boys. And in tests of fourth-graders and 15-year-olds, girls were better readers than boys in every industrial country.

Generally speaking, the gap between American girls and boys was similar to the disparity in other countries. For example, 15-year-old U.S. girls scored an average of 518 on the study's reading test while boys scored an average of 490. Their gap of 28 points is close to the worldwide average of 32. Boys that age continued to score ahead of girls in math in about half of industrialized countries. Boys are "marginally but not significantly" ahead in the U.S., the study found.

Microbiologist ALICE REINARZ, associate dean for undergraduate studies at Texas A&M in College Station, said girls can close the gap. "A lot has to do with the way women are reared and socialized," she said. "If they get messages from families and teachers that they can do well in science, they will. If they get several messages that they can't do math or science, then they won't."

Dying Mathematician Spends Last Days on Area of Polygon⁵

Peter Landers

If you had just a short time to live, what would you do with it? DAVID ROBBINS, a mathematician, is solving a really tough geometry problem.

Dr. ROBBINS, 60 years old, was diagnosed in April with pancreatic cancer and was told he had less than two years to live, maybe much less. He reacted to the news by considering his options: He could stick to his normal work routine at a government research institute. He could search desperately for a cure for his disease, even though his doctors told him the cancer is inoperable. He could go home and wait to die.

Or he could finally get around to a math problem that has been bugging him for decades. The problem is in a category some mathematicians consider "recreational" math. Solving it would do nothing practical for mankind. But to Dr. ROBBINS, the choice was easy. "I wanted to finish it," he says.

Here's the problem: What is the area of a polygon if you know only the lengths of the sides? If the polygon happens to be a rectangle, the answer is easy: Multiply the height by the width to get the area. With a formula devised by the ancient Greeks, a triangle is easy enough to figure, too. But if the polygon has five sides or more, the math suddenly becomes gnarly.

Dr. ROBBINS came up with formulas for pentagons and hexagons that he published to little notice in 1994. He now wants to find the answer for a heptagon.

For everyday purposes, finding the area of a seven-sided figure is easy: One just divides the figure into triangles, physically measures the sides of the triangles and then uses the ancient formula to calculate the area of each triangle. But for Dr. ROBBINS that would be cheating.

If time allows, he wants to discover a general formula that would give the answer not just for a seven-sided figure but for any polygon no matter how many sides it has. "You'd think it would have a solution," he says. "Lots of people said they did want to do it. They just never got around to it."

⁵ The Wall Street Journal (Princeton, N.J.), Tuesday, July 29, 2003, p. 1.

Despite chemotherapy, Dr. ROBBINS is still in fairly good shape. Every morning at 7:30, he leaves home and walks two miles to his office at the Center for Communications Research in a leafy part of Princeton. His tools are pencil, paper, a computer and an old-fashioned blackboard with chalk. He bats around formulas and ideas with JULIE ROSKIES, a 35-year-old researcher who is also working on polygons full time.

Dr. ROBBINS's determination doesn't surprise his wife, Deborah, although she sometimes wishes she and her husband had time to take a few trips. "When you're facing the end of your life," she says, "the fact that he is so clear about what he wants to do - I really have to respect that." He is the sort of person, she says, who gets up in the morning complaining he didn't sleep because he was pondering a problem all night.

To colleagues with whom Dr. ROBBINS has shared a love of math, his philosophy seems perfectly natural. "That's what mathematicians do," says his boss, DAVID GOLDSCHMIDT, who runs the Princeton center.

His Princeton colleagues quickly organized a conference in his honor after his illness was diagnosed. According to Mrs. ROBBINS, Dr. ROBBINS at first tried to stop them, because he was worried he'd be too sick to appear. But she persuaded him to let plans go forward for June 29 and 30. At the gathering, he chose as the topic of his presentation an algebra problem that was first raised by the Rev. CHARLES DODGSON, a mathematician better known as LEWIS CARROLL, the author of "Alice's Adventures in Wonderland."

The work on the polygon problem can be frustrating. "Sometimes we'll sit and stare into space and say, 'Boy, we need an idea,'" says Dr. ROSKIES. But in recent weeks the pair have made significant progress. With the help of computer programs devised by Dr. Robbins, about half of the heptagon formula has come into view.

Why polygons? Mathematicians tend to disdain solving basic puzzles that are understandable to ordinary people who took math in school. "I happen to like the immediately intelligible," says Dr. ROBBINS, who reminds some people of WOODY ALLEN. There is a certain resemblance, in drab sweaters and unfashionable glasses. Also, both men grew up in Brooklyn. But Dr. ROBBINS seems to have happier memories of growing up. His father, a real-estate developer, used to quiz him on math problems. When he was 12 or 13, a discussion with his father about triangles led Dr. ROBBINS to figure out the general solution for the area of triangles.

Later he learned the Greeks got there first. He also learned that the solution for finding the area of four-sided polygons had been found around 650 A.D. by BRAHMAGUPTA, an Indian mathematician. BRAHMAGUPTA and Dr. ROBBINS both focus on a special group of polygons called cyclic polygons whose points all fall on a single circle.

But Dr. ROBBINS was intrigued to learn that no one had gone beyond BRAHMAGUPTA. Prior to the computer age, the only mathematician known to have even tried is August FERDINAND MOEBIUS, the German mathematician of Möbius strip fame. (The Möbius

strip is a one-sided geometric surface formed by giving a 180-degree twist to a long strip of paper and then connecting the ends.) In a 31-page 1828 treatise, Moebius discussed the cyclic-pentagon problem but didn't solve it.

Dr. ROBBINS is something of an odd bird in the math world. Despite his Ph.D. from the Massachusetts Institute of Technology, he spent seven years teaching high school.

Friends lured him to the Center for Communications Research - Princeton 23 years ago. It is a unit of the Institute for Defense Analyses, which provides technical and scientific analysis on issues of concern to the Defense Department. The center, according to its Web site, applies mathematics and computer-science research to "cryptology and related disciplines." Dr. ROBBINS won't discuss his work for the center.

Dr. ROBBINS says he enjoyed the practical side to his work as well as the freedom he was given to work in pure mathematics. Best of all was the group of kindred spirits he found at the center. For years he and colleagues would entertain themselves at lunchtime trying to solve questions from the Putnam exams, an annual college math competition. The custom died out a few years ago, he says. "People started complaining they didn't want to do problems at lunch."

Among mathematicians, Dr. ROBBINS's main achievement is something called the alternating-sign matrix conjecture, which has connections with fashionable subjects in math and physics. The polygon-area problem, says independent mathematician MICHAEL SOMOS, is "very theoretical and very difficult and you're not going to get a prize if you solve it."

GREG KUPERBERG, a math professor at the University of California, Davis, who once worked briefly with Dr. ROBBINS, is one of those who calls his polygon problem "recreational." In a phone interview, Dr. KUPERBERG said polygons are like a fluffy human-interest newspaper article, whereas alternating-sign matrices are like a "weighty story on clandestine nuclear-weapons research."

But after he reviewed Dr. ROBBINS's pentagon proof, Dr. KUPERBERG changed his mind a bit and e-mailed this remark: "Yes, this is considered recreational mathematics. But as he has done before, David elevates the problem. If he or someone else finds more time to work on this question, it could well lead to math research that goes beyond the merely recreational."

Dr. ROBBINS hopes he has enough time left. So long as his health holds up, he intends to commute to his office, where he pads about in an old pair of his father's slippers, and keep tackling the problem with Dr. ROSKIES. Dr. ROBBINS doesn't like to speculate about his cancer, but he says: "If I somehow turn too ill, Julie would be there to finish it."