Music as Food for the Brain

Music can lift the spirit—and rewire the brain. Two studies presented in Los Angeles last week at the annual meeting of the Society for Neuroscience show surprising effects of music on the cerebellum, as well as intriguing new functions for this basic brain structure.

The cerebellum controls balance and muscle coordination in all vertebrates. But when neuroscientists Lawrence Parsons and Peter Fox of the University of Texas Health Science Center in San Antonio ran positron emission tomography scans on eight conductors as they listened to a Bach chorale while following the score, they found that the cerebellum is also involved in interpreting rhythm. When the rhythm was altered to differ from the score, the conductors' cerebellar blood flow surged, indicating that an unexpected sensory, nonmotor function was occurring in the region.

The cerebellum's ear for music doesn't end there. According to results presented by neurologist Gottfried Schlaug of the Beth Israel Deaconess Medical Center in Boston, it also responds to training. To test whether years of playing an instrument altered the brain, Schlaug and his colleagues compared cerebellum volume in 90 musicians and nonmusicians. The cerebella of male musicians, they found, were 5% larger than those of male nonmusicians, suggesting that many years of precise finger exercise had stimulated extra nerve growth. It appears that "processing of music is much more distributed than one would expect from simple anatomy," says auditory physiologist Hubert Dinse at Ruhr University in Buchum, Germany.

Juilliard string quartet exercises its cerebella.

Music is a tonic for another brain region, too. In a study of 60 female college students described in the 12 November *Nature*, scientists at the Chinese University of Hong Kong found that those who studied music as children remembered "significantly more" after a list of words was read to them than did those with no music training. This, they said, fits with earlier research showing that among musicians, the planum temporale, a brain region involved in language, is enlarged.

Making *e* Easy

Any study of exponential growth—from bacterial populations to interest rates—depends on a fundamental constant called *e*. Because this number (often rounded to 2.718) can't be expressed as a fraction, scientists must estimate it with an approximate formula. Now a self-taught inventor and a meteorology professor describe in the October issue of *Mathematical Intelligencer* several new formulas for *e* and use them to calculate it to thousands of decimal places with a desktop computer.

For both bankers and bugs, *e* describes a basic limit to exponential growth. For example, if you invested $1 at 100% interest, compounded monthly, you would have $2.61 in a year. If the interest were compounded every 30 seconds, you would end with about a dime more. No matter how frequently you earned interest, you could never take home more than *e* multiplied by the number of dollars you first deposited.

Harlan Brothers and John Knox, a meteorologist at Valparaiso University in Indiana, derived their first approximation by averaging a simple textbook formula, $(1 + 1/n)^n$, that slightly underestimates *e*, with another, $(1 - 1/n)^{-n}$, that slightly overestimates it. This doubled the number of correct decimal places (the higher the *n*, the more decimal places can be achieved). With further tinkering, they were able to improve the accuracy sixfold.

The new formulas would require too much computer memory to challenge the most accurate estimate of *e*, which is already known to 50 million decimal places, says numerical analyst Simon Plouffe of Hydro-Quebec in Montreal, holder of several numerical computation records. That doesn't worry Knox, who says "What we've done is bring mathematics back to the people," by demonstrating that amateurs can find fresh ways of representing *e*. "I'd like college math teachers to add it to the curriculum" to show students that the textbooks don't always have the last word.

From ESO To NRAO

Riccardo Giacconi, director-general of the European Southern Observatory (ESO) for the past 6 years, will move to Washington, D.C., next July to assume the presidency of Associated Universities Inc., which, with the National Science Foundation, manages the National Radio Astronomy Observatory (NRAO). His duties will include presiding over the start-up of the world's largest fully steerable radio telescope, in Green Bank, West Virginia, late next year.


Giacconi

PNAS's Flexible Embargo

The *Proceedings of the National Academy of Sciences* (*PNAS*) last week decided to lift an embargo and distribute an uncorrected manuscript so reporters could have access on the same day that a paper on a similar topic appeared in *Science*—a sign, some observers say, of stresses that are undermining the embargo system (*Science*, 30 October, p. 860).

Knowing that a paper on natural substances that block blood vessel formation, or angiogenesis inhibitors, was coming out in *Science* (13 November, p. 1324), molecular biologist Jun Liu at the Massachusetts Institute of Technology "suggested it would be appropriate" to let his paper out early even though it's not due for publication until January, explains academy press officer Susan Turner-Lowe. "We couldn't see the logic" of withholding it, she says—although she admits that "it would drive us crazy" if *PNAS* decided to distribute every draft paper at an author's request.

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