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The Acoustical Society of America

ECHOES

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The ABCs of Acoustics

by Eric E. Ungar

During the March 1999 joint meeting of the Acoustical Society of America with the European Acoustics Association, held at the Technical University of Berlin, I had the opportunity to visit the Institute of Technical Acoustics of that university. Prominently posted on a bulletin board in a corridor, I found an eleven-page 1958 article, which was co-authored by Lothar Cremer, the late former director of the institute.

The unusual publication, whose title may be translated as "The ABCs of the Acoustics of Buildings," consists of brief verses. There is one verse for each letter of the alphabet; each deals light-heartedly with some aspect of acoustics; each is illustrated by a cartoon structured around the letter; and each is followed by a brief summary of related facts. I was so intrigued with this article's approach that I resolved to translate it and asked the director of the Institute, Professor Michael Möser, to send me a copy. Soon after he kindly complied with my request, it became clear that translating the article without losing its basic spirit was beyond me. So, I decided to give up and start, from scratch, developing my own verses and discussions, but maintaining the spirit.

This is the first installment of my attack on the acoustical alphabet. I would be pleased to consider any verses that you would care to contribute, provided these are in the appropriate meter and are rhymed well. I would also be pleased to entertain your ideas for appropriate cartoons. Art Director Jerry Garfield will render them into publication format.*

So here we go...

Acoustics deals with sound and noise;
One may be pleasant, one annoys.
How sound's produced and propagated,
And put to use, attenuated,
And how perception plays its part–
It is part science and part art.

The story is told about George Washington Carver, the famous African-American scientist who studied peanuts and developed many uses for them, that as a young man he prayed that God reveal to him the secrets of the universe. Because God replied that "the peanut is more your size," Dr. Carver focused on a more limited field.

Many of us who work in acoustics also had ambitions to know all about acoustics, but we soon learned that the field is much too diverse. Acoustics, as Ira Dyer of MIT has said, deals with "anything that moves and many things that don't." That statement may be a little far-fetched, but it does convey the breadth of this art and science. To get an idea of this breadth one merely needs to look at the *Journal of the Acoustical Society of America*, for example. The topics covered there range from physics and engineering–aeroacoustics, underwater sound, ultrasonics, transduction, vibration, signal processing –through physiological and psychological acoustics–including speech production and perception, as well as human and animal bioacoustics–to noise effects and noise control, architectural acoustics, music and musical instruments. Many other fields are closely tied to acoustics–sound systems, audiology, acoustic oceanography and ultrasonic instrumentation to name a few. You can undoubtedly think of many others.

Clearly, the science of acoustics is well developed, and research is progressing on many fronts. The news lately has been rife with talk about such things as acoustic microscopy, acoustical refrigerators with no moving mechanical parts, and cochlear implants that enable people that have severely damaged hearing to hear again. Often, however, more than science is needed. In cases involving the noise exposure of communities or work areas, human relations and politics also play major roles. And, the artful application of judgment is usually needed to solve practical problems. Typically, they involve tradeoffs between conflicting requirements.

**You can send your contributions to me at Acentech Inc.,33 Moulton St., Cambridge, MA 02138; fax 617-499-8074; or e-mail eunger@acentech.com.*

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We hear that...

Gerhard Sessler and **James West** are among the 10 new inductees in the National Inventors Hall of Fame honored at the enshrinement ceremony in Akron, Ohio, September 18. Sessler and West were honored for inventing the electret microphone. Other honorees included Bryan Molloy and Klaus Schmiegel, who invented the antidepressant drug Prozac, and Percy Spencer, who patented the first microwave oven.

Phil Marston is the new ASA representative to the International Union of Pure and Applied Physics (IUPAP).

Academic Press and the *Journal of Sound and Vibration* have begun a new online repository *JSV+* for fast communication and exchange of results. Both readers and authors are invited to contribute to *JSV+*. Website is <www.academicpress.com/jsv>

Wanted: Reporters

Next to readers and advertisers, the most critical persons in a newspaper or news magazine are reporters. Here at *Echoes* we have an editor, a publisher, lots of readers, no advertisers, and a handful of "reporters." We would like to add many more of you as reporters to assure coverage of all areas of acoustics. Friends of *Echoes* such as Bill Cavanaugh, Ben Stein, Elaine Moran, and Charles Schmid regularly send us clippings from newspapers and especially news items about ASA members. We spend a lot of time in the library pouring over journals and newspapers, but we miss a lot of noteworthy news.

Have you ever thought of writing a story about some new discovery in your own field of acoustics or a comment about some event that you would be willing to share with your colleagues? Our only requirements are: keep it interesting, keep it short. We love good photos and cartoons. Acoustical humor...why not?

ECHOES

Newsletter of the Acoustical Society of America
Provided as a benefit of membership to ASA members

The Acoustical Society of America was organized in 1929 to increase and diffuse the knowledge of acoustics and to promote its practical applications.

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Foundation Receiving and Giving

by Bob Frisina

The Acoustical Society Foundation was established solely to be the focal point of fund raising efforts for the Acoustical Society. A major goal of the Foundation is to establish a strong endowment for the Acoustical Society to ensure the continuity and diversity of its many fine programs well into the next millennium. The Foundation's establishment came at an opportune time for allowing givers to receive significant benefits by making charitable donations to the Foundation. Current tax laws offer many rewards for philanthropic giving. Donating appreciated property is a wonderful way to help others by helping yourself and family. The Foundation's Pooled Income Fund is a great example of this type of planned giving mechanism. Donating appreciated property, such as shares of stock or of a mutual fund that have been held for some time, is quite favorable to the donor for several reasons. The capital gains tax on the appreciated portion of the shares' value can be avoided or minimized. A portion of the principal can be taken as a charitable tax deduction (based on the donor's age and anticipated rates of return of the Pooled Income Fund), and the donor or his/her family can receive regular interest payments on the donated principal for life. Many of these benefits can be apportioned over several tax years. The Foundation can also receive similar donations utilizing the Charitable Remainder Trust mechanism, which in principle, is similar to the Pooled Income Fund, but involves larger amounts to be donated. For more information on ways to share in the Foundation's goals and mechanisms for making donations that allow you to give while receiving, please contact Dr. Bob Frisina at 716-275-8130 or asf@q.ent.rochester.edu. Thank you.

To the Editor

Thank you for providing 200 copies of your *Echoes* newsletter (Volume 9, Number 1, Winter 1999) for use by the National Park Service (NPS). The newsletters will be included in a package of informational materials about natural and cultural sound environments that will be distributed to National Park Service staff throughout the nation.

This effort is part of a broader NPS "Sound Education Plan" developed to describe the importance of natural sounds in parks and to foster public appreciation of natural sounds, natural quiet, tranquility, and solitude and contribute to the understanding that these are diminishing resources in need of protection. Providing information internally is a key ingredient in helping the National Park Service to reshape its management policies and actions so that park operations encourage the restoration and preservation of natural sound environments.

With the assistance of the Acoustical Society of America's *Echoes* newsletter, the NPS can achieve its goals in providing important information about sound environments to its employees and the general public. Thank you.

Diane Liggett, Editor, National Park Service

Something for Everyone in Columbus!

The 138th Meeting of the Acoustical Society in Columbus (November 1-5) will be a lively meeting with lots of features to attract all ASA members to the Buckeye State. A visit to the ASA website <ASA.aip.org>, which lists many features, along with 837 abstracts, will certainly verify this.

Distinguished lecturers include B. T. Khuri-Yakub of Stanford University ("Smart Structures and Microelectromechanical Systems") and Malcolm Crocker of Auburn University ("Acoustics at the End of the 20th Century–An Overview of the State of the Art"). A Tutorial Lecture on "The Families of Musical Instruments: Physics and Performance" will be given by Uwe Hansen of Indiana State University, James Pyne of Ohio State University and "friends," including the Ohio State University String Quintet, the Ohio State University Woodwind Quintet, the Ohio State University Brass Ensemble, Stephen Glaser, piano, Michael Bump, percussion, and the Ohio State University Chamber Orchestra.

In the Fall, Columbus means football. On Nov. 6 the Buckeyes will be on the road (thank goodness, you say, or we'd never get near the airport), although if you have ticket "connections," you can come early and see them play Iowa on Oct. 30. The really good news, however, is that you won't even have to leave the hotel or fight the crowds at Buckeye stadium to hear the famed Ohio State Marching Band. A performance and technical session featuring "The Pride of the Buckeyes," one of the few all-brass and percussion bands in the country, will be held on Thursday from 4:25 p.m. to 5:30 p.m. in the Regency Ballroom. The performance will include concert pieces as well as several of Ohio State's school songs. Oh yes, wear something red!

The Technical Group on Signal Processing will again sponsor a Gallery of Acoustics, featuring the best of posters, videos, and audio clips of images and/or sounds generated by acoustic processes or resulting from signal processing of acoustic data. Two special lectures on the history of acoustics will be given by Gabriel Weinreich ("History of Musical Acoustics") and by Robert Beyer and David Blackstock ("History of Physical Acoustics"). Murray Campbell from Edinburgh, Scotland will give a lecture on early music instruments, and Murray's fans in musical acoustics know that when he is on the premises there will probably be impromptu jam sessions (have you ever heard jazz played on a Medieval cornett?)

Other features include an exhibition of equipment and books with a gala opening reception, an organ recital honoring the late Daniel Martin, and the inauguration of an Oceanography Workshop/ MiniTutorial series featuring two lectures on internal waves by Robert Pinkel of Scripps Inst. of Oceanography, San Diego and Lev Ostrovsky of NOAA ETL, Boulder. Pinkel will talk about the deep water internal wave field and Ostrovsky will discuss the shallow water internal wave field, with emphasis on the important nonlinear wave field.

Although Columbus may be what Charles Schmid calls a "typical smaller meeting" following the Seattle and Berlin blockbusters (see *Echoes*, Spring 1999), it features a very attractive technical program and lots of special features.

By the time you say "Goodbye Columbus," you'll be more than glad that you attended!

Best Student Papers Competition (Berlin)

Winners in the best student paper award at the Berlin joint meeting were:

First place: Nathalie Ramsauer
"Acoustic attraction of the parasitoid fly Ormia orhracea to the song of its host,"
Coauthor Daniel Robert, Univ. of Zurich, Switzerland

Second place: Oliver Wegner,
"On the relationship between auditory evoked potentials and psychophysical loudness,"
Coauthors Torsten Dau and Birger Kollmeier, Carl-von-Ossietzky-Universitat, Oldenburg, Germany.

Third place: Todd A. Pitts,
"Optical measurement of wide bandwidth ultrasound fields,"
Coauthor James F. Greenleaf, Mayo Clinic and Foundation, Rochester, MN.

Honorable mention: P. M. Hofman,
"Relearning sound localization with new ears,"
Coauthors A. J. Van Opstal and J. G. A. Van Riswick,
University of Nijmegen, The Netherlands.

Honorable mention: Dan Mapes-Riordan,
"Loudness recalibration and complex tones,"
Coauthor William A. Yost, Loyola Univ. of Chicago.

Honorable mention: Patrick C. M. Wong,
"The effect of reduced tonal space in Parkinsonian speech on the perception of Canonese tones,"
Coauthor Randy L. Diehl, University of Texas, Austin

What Does an ASA President Do?

Patricia K. Kuhl

After the Berlin meeting in March I became President of the ASA. Since then, my students have been asking me, "What does an ASA President DO"? I tell them there are two annual meetings to plan, numerous committees to run, an investment portfolio to worry about, a Journal to steer toward new frontiers in electronic publishing, acoustical standards to manage, educational activities at the K-12 level to guide, and media attention to direct toward the field of acoustics.

The initial "wow" this elicits from students is typically followed by a furrowing of brows as they begin to wonder when I'll get to their theses and letters of recommendation if I undertake all this work. It is then that I confess that I don't really have to do all these things.

I explain that the Acoustical Society of America has a dedicated and incredibly competent management team as well as an army of highly skilled and energetic volunteers who spend a great deal of their time, without pay, to make our Society function. I tell students about the important job played by the chair and technical program chair of our ASA meetings, who with their local organizing committees put on two very successful meetings each year. I describe the role of the ASA's thirteen technical committees/groups who shape the meeting programs and foster the intellectual interests of their particular branch of acoustics. I highlight the success of *JASA*, guided for the past 14 years by the late Editor-in-Chief Dan Martin and now by our newly appointed Editor-in-Chief Allan Pierce, who with a team of excellent Associate Editors, produces the premier journal in acoustics worldwide, and Bob Apfel who has created a new online journal named *ARLO* (Acoustics Research Letters OnLine). I talk about the many hardworking committees within the ASA that manage our investment portfolio, create and sell the best acoustical standards in the world, work on activities that benefit students K12 such as improving classroom acoustics and science education, and the ASA World Wide Press Room and *Echoes* which promote the public's understanding of acoustics. It's these individuals and groups who are responsible for ASA's success.

There is always one student in the crowd who persists by asking, "Well if all this work is already being done by ASA's managers and volunteers, what exactly are YOU doing"? I'm spending a lot of time thinking about the future, asking myself: What are the key components of ASA's 70 year success and what guarantees our future success? The answer has to come from individual members, like you. Why are you a member? What role does the ASA play in your career? And what will you want ASA to do in the future?

When I ask myself that question– why am I a member of the ASA – the answer is clear. For the last 31 years (I attended my first meeting in 1968 as a student), the ASA has been the best gathering place for scientists working in my area of specialization, speech communication, and JASA is the most prestigious journal in the world for the dissemination of this kind of research. As a student, ASA meetings provided a kind of intellectual excitement that set the standard for me. Most memorable were the spontaneous debates that erupted between two members on a hot topic.

Debates were frequent in both the P&P (Psychological and Physiological Acoustics) and the Speech sessions I attended. As students, we'd gather in the hall afterwards to discuss how the senior members handled themselves, both intellectually and politically. Privately, we wondered whether we'd ever be able to stand up and defend an idea, or accept criticism with the grace that some (but not all) did. Then, and now, this is why I am a member of the ASA.

But what about you? Are we providing you with intellectual excitement? Could we improve some aspects of the ASA?

There are a number of ways that you can give me your perspective on the value of ASA's services and help me determine how these services might be improved.

(1) Vice President Mauro Pierucci designed a survey that we placed on the ASA Web page. As I write this, hundreds of you have already responded to the survey using instructions provided in my ASA email broadcast of September 1. By the deadline (September 17) we hope that many more of you will have participated in the survey. Results will be tallied and summarized in the Plenary Session in Columbus, and in *Echoes*.

(2) A "President's Mailbox" will soon be installed on the ASA web page so that you can send messages directly to me. This would be a way to advance a new idea, register a complaint, or simply react to something about the way the ASA conducts business.

(3) In Columbus I'll host a "Past Presidents' Dinner" at which our most senior members will be asked to help set the course for acoustics in the next Millenium.

In addition, I'm working very closely with the Societal Growth Committee to focus on ASA's development, both intellectually and in numbers. I want to increase the percentage of young people and women in the Society, and become increasingly diverse. More importantly, I want to invigorate our efforts to grow intellectually. If we are to remain the world's leading society in acoustics, we must advance new concepts and topics, encourage technological developments, and invite debate on emerging theoretical frameworks in our publications and at our meetings. That might mean we should devote more sessions at meetings and additional journal space to applied acoustics, or that we should more actively seek to identify and incorporate new and developing areas in acoustics. These ideas and many others will be discussed by the Committee, which is chaired by Larry Crum.

Fostering the intellectual growth of our members and the entire acoustics community is my top priority. Using ASA email broadcasts, *Echoes* editorials, and the plenary sessions at our meetings, I will continue to update you on our progress. In Columbus, I will give a "State of the ASA" address at the Plenary Session held on Wednesday, November 3.

The ASA needs your help to move forward. I hope you will take the time to convey your views to the ASA's officers and managers. Please let me know if you wish to join that army of volunteers. I hope to hear from you.

Sound and Light

Thomas D. Rossing

Son et lumiere. Sound and light form the basis for some very popular presentations at historical monuments all over the world. As a physicist interested in both sound and light, I never cease to be amazed at the remarkable parallels between acoustic waves and electromagnetic waves. They behave similarly sometimes, sometimes there are great differences.

For many years I have been emphasizing the fact that light, being a transverse wave, can be polarized, but sound, being longitudinal, cannot. Now it appears that I must qualify that statement. Although the celebrated Russian physicist Lev Landau predicted as early as 1957 that transverse sound waves might propagate in superfluid helium-3, no one had observed them, to my knowledge. Now a group at Northwestern University has confirmed their existence (see "Scanning the Journals") by observing that they could be polarized. They titled their paper in *Nature* (29 July) "Discovery of the acoustic Faraday effect in superfluid ^{3}He-B." The optical Faraday effect is well known, of course, and it has many applications, such as reading out the information from recordable compact discs and CD-ROMs. In some materials the plane of polarized light can be rotated by a magnetic field. Now it appears that a magnetic field does the same thing to transverse sound waves propagating in the mysterious superfluid helium-3 (composed of helium nuclei with only one, rather than two, neutrons). It's not likely that the acoustic Faraday effect will soon (if ever) find commercial application, but it tells us a lot about how quantum liquids (and sound) behave at extremely low temperatures.

More familiar to acousticians is sonoluminescence, the interesting process by which sound energy is converted to light. Nearly every recent issue of *Echoes* has included some reference to a new step in the road to understanding this mysterious phenomenon (see Scanning the Journals). The Acoustical Society has taken the lead in arranging conferences on sonoluminescence. Even Hollywood has discovered (or mis-discovered) sonoluminescence in the movie "Chain Reaction" (see the Spring 1998 issue of *Echoes*).

In the August issue of *American Journal of Physics* is my guest comment "Sound and light: An alternative route to science literacy." In this editorial, I argued that sound and light, which catch the attention of tourists at historical monuments, can also help us catch the attention of our physics-wary students. Although the study of sound and light was once included in most introductory physics courses, these subjects are generally short-changed these days (especially sound!). I have already received lots of positive comments from teachers who apparently agree.

I love music and I love art, and I suppose this was what drew me to acoustics and optics. Being asked to teach a course in the physics of music at St. Olaf College 40 years ago did much to shape my career as a teacher. It drew me into doing research in musical acoustics, and I began to write acoustics books (ten of them at last count), because few other physicists were doing so. More recently, I have begun teaching a course in the physics of light, aimed at visual artists. This led me to team up with Christopher Chiaverina, an extraordinarily talented and enthusiastic high school physics teacher, in writing a textbook *Light Science*, recently published by Springer-Verlag.

In our acoustical research, we employ several optical techniques. One of them is holographic interferometry, which gives us detailed information about how a musical instrument (or a noisy machine) vibrates. We frequently receive requests from popular magazines, as well as textbook authors, for permission to reproduce holographic interferograms of musical instruments, because they are eye-catching, and of course we encourage such use since it puts acoustics in front of the general public. We use a laser vibrometer to determine the velocity of vibrating systems, such as organ and harmonica reeds (the latter in collaboration with Jim Cottingham and his students at Coe College).

We also have, in our laboratory, several optical instruments that make use of acoustics. One is an acousto-optic modulator that uses 40-MHz sound waves in a glass plate to diffract light waves. (These have become standard items in every modern optical laboratory). In our holographic interferometer, we mount mirrors on piezoelectric crystals to modulate the phase of the light beam (I'll spare you the details). There are many other examples of acoustical instruments that employ light, and optical instruments that employ sound.

I have had lots of fun teaching the physics of sound and light to students majoring in music, visual art, speech and hearing, physics, engineering, and a wide variety of other fields. I enjoy teaching them to beginning and advanced students, and I enjoy teaching them to teachers who (hopefully) will teach them to their students!

Acoustics in the News

- After spending nearly $100 billion dollars in the past decade, the nation's major airlines are nearing the goal of having all airplanes meet Federal noise standards by the end of this year, according to a story in the *Boston Globe*, Aug. 20. The ten largest airlines, all of which met the goal of having 75% Stage 3 aircraft at the end of 1998, expect to have all of their fleet replaced or converted by the end of this year. At the beginning of 1999, only Alaska Airlines had completely converted their fleet, while Trans World brought up the rear with only 75%. During 1998, 479 Stage 2 aircraft were removed from service and 745 Stage 3 aircraft entered service.

- The "Mozart effect" continues to be in the news. According to an article in the *New York Times* of August 3, Governor Zell Miller of Georgia is providing CDS to every new mother in the state, and in Florida a new law requires that toddlers in state-run schools listen to classical music every day. But the truth is that the experiments that triggered this movement (see "Scanning the Journals") were based on college students, not young children, and many scientists question their validity. In a forthcoming book *The Myth of the First Three Years*, John Bruer argues that hype about the Mozart effect overstates what neuroscientists know about the

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Scanning the Journals

by Thomas D. Rossing

● Transverse sound waves in superfluid helium are reported in the 29 July issue of *Nature*. Although predicted in 1957 by physicist Lev Landau, this is the first time their existence has been confirmed. The experiment that confirmed their existence, carried out at Northwestern University, discovered the acoustic Faraday effect in the B-phase of superfluid ^{3}He by observing the rotation of the polarization of these waves in the presence of a magnetic field. This phenomenon is the acoustic analogue of the magneto-optic Faraday effect, whereby the polarization direction of an electromagnetic wave is rotated by a magnetic field applied along the propagation direction.

"Acoustic waves provide a powerful tool for studying the structure of matter," write the authors Y. Lee, T. M. Haard, W. P. Halperin, and J. A. Sauls. "For example, the speed, attenuation and dispersion of acoustic waves can give useful information on molecular forces and the microscopic mechanisms of absorption and scattering of acoustic energy. In solids, both compression and shear waves occur–longitudinal and transverse sound, respectively. But normal liquids do not support shear forces and consequently transverse waves do not propagate in liquids," with the notable exception of the quantum-liquid phase of helium-3.

Superfluidity in helium-3 results from the binding of the ^{3}He particles with nuclear spins s=½ into molecules called "Cooper pairs" (similar to bound electron pairs observed in superconductors). An applied magnetic field magnetically polarizes the spins of the Cooper pairs, which rotate the polarization of transverse sound waves excited by a quartz transducer at 82 MHz.

● Sonoluminescence and thermoacoustics are two acoustical topics that continue to attract the attention of the scientific community. The August issue of *Physics World* includes contributions from two well-known ASA members:

Seth Putterman calls attention to the 1970 master's thesis of Paul Temple at the University of Vermont that reports the discovery of sonoluminescence in a single gas bubble at a velocity node of a resonant sound field. Temple found that one flash was emitted with each cycle of sound and that the flash widths were shorter than could be determined by his instruments (20 ns). Putterman goes on to discuss reasons why Temple's work, which aroused great interest at the 81st meeting of the Acoustical Society in 1971, was more or less abandoned.

Anthony Atchley reviews the current state of thermoacoustic engines and in particular the hybrid thermoacoustic-Stirling engine designed by Scott Backhaus and Greg Swift at the Los Alamos National Laboratory [*Nature* **399**, 335 (1999)]. In its simplest form, a Stirling engine consists of a cylinder filled with a gas or "working fluid" and two pistons. The working fluid transfers heat to and from hot and cold heat exchangers, driving the pistons that do the mechanical work. The Stirling engine achieves a high efficiency but is rather complex mechanically and costly. By contrast, thermoacoustic engines are much simpler and have fewer moving parts. They rely on thermal conduction to time the gas compression and expansion so that power is produced. The Backhaus-Swift design, Atchley explains, combines the advantages of both types into an efficient and mechanically simple heat engine.

● The acoustical aspects of throat singing are nicely discussed in an article entitled "The Throat Singers of Tuva" by a musical ethnographer (Theodore Levin) and a composer (Michael Edgerton) in the September issue of *Scientific American*, which includes a sidebar on "Forming Formants" by a staff writer. Video fluoroscopy and nasoendoscopy of both Tuvan and Western overtone singers at the University of Wisconsin hospitals have confirmed that singers manipulate the vocal tracts to shift the frequency of a formant and align it with a harmonic. By reinforcing different harmonics in succession, they can sing a melody. X-rays of throat singers in action illustrate different styles of throat singing: the *sygyt* style in which vocalists keep the tongue tip behind the upper teeth near the alveolar ridge; and the *khöömei* style in which the entire tongue moves from low and back to high and front as the pitch rises (movies are available at <www.sciam.com/1999/0999issue/0999levin.html>). The mechanism of harmonic reinforcement is not fully understood, but it seems to involve three components: tuning a harmonic in the middle of a very narrow and sharply peaked formant; lengthening the closing phase of the opening-and-closing cycle of the vocal folds; and narrowing the range of frequencies over which the formant will affect harmonics. Each of these processes represents a dramatic increase of the coupling between source and filter.

● Ever since Rauscher, et al. reported (1993) that listening to Mozart's music increased the reasoning ability of college students, as measured by IQ scores, sales of Mozart recordings have soared, and the "Mozart effect" has been explored by several research groups. The Scientific Correspondence section in the 26 August issue of *Nature* presents several negative reports on the effect along with a reply by Rauscher under the heading: "Prelude or requiem for the 'Mozart effect'?" One psychologist uses meta-analysis of 16 studies on the effect to demonstrate that any cognitive enhancement is small and does not reflect any change in IQ or reasoning ability. Instead, the reported enhancement "derives entirely from performance on one specific type of cognitive task and has a simple neuropsychological explanation." The explanation is that a shared right-hemisphere locus leads to a small positive "enjoyment arousal" in subjects that enjoy what they hear. Another group of psychologists attempted to replicate the original experiments and found no effect. Rauscher defends his earlier experiments, however, and presents arguments why the "enjoyment arousal" explanation is unlikely.

● Using functional magnetic resonance imaging (fMRI), a team at the Leibniz-Institute for Neurobiology and the Otto von Guericke University in Magdeburg, Germany and the University of Texas Health Science Center in San Antonio has located a higher-order field in the right auditory cortex that is activated significantly more by sound motion than are other fields, according to a Letter in the 19 August issue of *Nature*. This area distinguishes whether a sound pattern is moving or stationary. The researchers compared activation of the auditory cortex by two acoustic stimuli with identical spectral-temporal patterns but with different binaural timing. The pattern consisted of a tonal carrier that was amplitude modulated at slow rates (0.08 to 0.2 Hz). Since previous studies have found evidence of motion-sensitive auditory space maps in the midbrain, the

researchers say that these new results indicate that a missing neural link for this critical brain function may be a specialized area predominantly in the right posterior auditory cortex.

- Brain maps can show remarkable plasticity, undergoing reorganization after brain damage or changes in sensory stimulation. A report by Weimin Zheng and Eric Knudsen of Stanford University in the 7 May issue of *Science* offers new insight into how brain maps move. These investigators analyzed how the auditory space map of young barn owls changes in response to alterations in the visual space map. In previous work the authors demonstrated that a newly learned auditory map requires the formation of new excitatory connections. In this paper they show that the excitatory inputs for the old and new auditory maps coexist but that excitation from the old map is selectively overwhelmed by inhibition from γ-aminobutyric acid (GABA) receptors.

The auditory and visual space maps of barn owls are closely connected so that the birds, which cannot rotate their eyes, are able to precisely locate their prey using either hearing or sight. Zheng and Knudsen reared young owls in prism spectacles that displaced the visual image of the world to the left or right. If the owls wear these spectacles during a critical period in early life, they learn to compensate and regain the ability to accurately locate prey. The compensation apparently takes place in the auditory space map which changes to become consistent with the visual map.

- Thermally induced ultrasonic emission from porous silicon is the basis of an experimental device reported in the 26 August issue of *Nature*. The acoustic element, developed at the University of Agriculture & Technology in Tokyo, exhibits a flat frequency response up to at least 100 kHz. Although the idea of a thermal sound generator (a "thermophone") was proposed 80 years ago, the possibility of using silicon transducers is especially attractive today, since integration with electronic circuitry should make it possible to fabricate phase arrays to control the emitted wavefront.
- In the past 5 years, 13 human genes have been identified that are responsible for hereditary nonsyndromic deafness (i.e., not grouped with other symptoms). A new type of nonsyndromic deafness in mice, caused by mutations in the gene encoding transcription factor Brn-4, is reported by a group of Japanese researchers in the 27 August issue of *Science*. In these mice, no gross defects were observed in the middle ear or cochlear structures, but severe pathological anomalies were seen in fibrocytes, cochlear cells that regulate potassium homeostasis. This deafness differs from many other forms in that it appears to arise from malfunction of a nonsensory cell type.
- Bowing a viola string at different positions along the string in order to note the effect on the harmonic spectrum, physics student/violist Johann Broomfield was surprised to find that any attempt to bow the string at the midpoint produced no sound at all, according to a paper by Broomfield and Michael Leask in *European J. Phys.* **20**, L3 (1999). Bowing just a centimeter away from the center did produce a sound. Broomfield and Leask were unable to make a detailed explanation of the phenomenon, but they did point out that the amplitude of the string's vibration is smallest at the bowing position.
- Humans and cats can localize a sound source accurately if its spectrum is fairly broad and flat, as is typical of most natural sounds. However, if sounds are filtered to reduce the width of the spectrum, they result in illusions of sources that are very different from the actual locations, particularly in the up/down and front/back dimensions. In the auditory cortex of cats, temporal firing patterns of neurons can signal the locations of broadband sounds, but such spike patterns systematically mislocalize sounds that have been passed through narrowband filters, according to a letter in the 17 June issue of *Nature*. Similar cortical mechanisms, if present in humans, could underlie human auditory spatial perception.
- An article entitled "Down with Noise" by Stephen Elliott, in the June issue of *IEEE Spectrum*, reviews practical systems for active noise control in aerospace, general aviation, and military roles. After reviewing the scientific principles, the article discusses two basic techniques for closed-loop active control: adaptive feedforward control and feedback control. Adaptive feedforward controllers have been used to control the predominantly tonal low-frequency engine noise inside automobiles and cabin noise in propeller aircraft. The passenger cabins of many propeller aircraft are now fitted with active control systems that control four harmonics of the blade-passing frequency. However, random noise in an aircraft due to air turbulence has no single source for a reference signal, and feedback is needed to control sound fields of this kind. Feedback control works best when the microphone is close to the loudspeaker to minimize acoustic propagation delay. The article also discusses active headsets used to reduce background noise while listening to music or speech, for example. Future emphasis, the article predicts, will be on controlling random noise and also on increasing the upper frequency range of control.
- Studies of friction are often carried out at relative speeds of about 1 cm/s. However, researchers have wondered whether new mechanisms might appear when surfaces slide against each other at higher speeds, such as those associated with friction between tectonic plates during earthquakes. Observing the jerky "stick-slip" motion of a steel block riding on a rotating steel table, Andrew Johnson and colleagues noted in *Physical Review Letters*, 21 June, that the significantly increased production of sound waves (largely ignored in past analyses) dissipates a large amount of energy, stealing away some of the energy of motion required for two surfaces to slide past each other and thereby amounting to an increase in friction. This suggests that the generation of sound waves between two sliding fault surfaces during an earthquake may provide a significant feedback mechanism that mitigates a quake's effects, by converting energy of motion into sound energy.
- The hair cells in the cochlea and vestibular organs in mammalian ears function as receptors to transduce sound and head motion, respectively; however, the molecular mechanisms underlying hair cell development and differentiation are poorly understood. Experiments reported in the 11 June issue of *Science* indicate that the gene Math1 is required for the genesis of hair cells. It is proposed that Math1 acts as a "pro-hair cell gene in the developing sensory epithelia.

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developing brain. One popular notion that Bruer challenges in his book is that the years from zero to 3 are a developmental window or "critical period" during which certain types of learning experiences must occur if they are to take place at all. What is ignored, he says, is the lifelong plasticity of the brain. Patricia Kuhl, author of the recent book *The Scientist in the Crib*, doesn't necessarily agree with Bruer. "Babies revise their views about people and things in the world based on new information, just as scientists do," Pat is quoted as saying. "A difference is that babies do it more quickly and more profoundly than adults, because their brains are less committed–literally less cluttered–than ours are."

- What does Mars sound like? No one knows, but a tiny microphone now speeding toward Mars aboard the Mars Polar Lander may record the sounds of wind, thunder, sandstorms—or nothing—once the lander gets to Mars in December, according to the June 4-6 issue of *USA Today*. Whatever the microphone "hears" will be offered for public listening on the Planetary Society website <planetary.org>. In the meantime, students are invited to enter an essay contest imagining how Mars might sound, now and a century hence when the planet might be inhabited. The contest winner gets a trip to Planetfest '99, the society's conference in December. More information at <tps.lh@mars.planetary.org>.
- The papers about the thermoacoustic Stirling engine in *Nature* (see "Scanning the Journals") inspired a story on the Scripps McClatchy Western Service, which ran in the May 28 issue of the *Seattle Post-Intelligencer*, among other places. The engine, developed by Scott Backhaus and Gregory Swift at the Los Alamos National Laboratory, is described as a "long, steel, baseball-bat-shaped resonator with an oval handle on the lower end, which is filled with compressed helium. Electronic devices generate sound waves, which stimulate the gas to alternately expand and contract." They quote Swift as saying that "small low-cost engines like this could be used in homes for electrical cogeneration."
- According to a new ordinance in Chicago, street musicians in the greater downtown area can not produce sound louder than "an average conversational level" at a distance of 200 feet. The distance applies vertically as well as horizontally, a provision designed to protect high-rise occupants, according to the *Chicago Tribune*, July 21.
- The Dayton C. Miller flute collection in the Library of Congress is the subject of an article in the June/July issue of *Civilization*. The collection of some 1400 instruments includes flutes of ivory, jade, Plexiglas, gold, silver, and platinum.
- The "Sounds of the Sea" exhibit at the New England Aquarium was described in the June 1 issue of *The Tab*. Visitors can get some idea of what fish sound like, and what sounds they hear in their dark, underwater environs. The exhibit was created in collaboration with MIT and the Wood's Hole Oceanographic Institute.
- The new sound-enhancement system in the New York State Theater at Lincoln Center is the subject of a recent story by Anthony Tommasini in the *New York Times*. Although amplification systems are common in movie houses, Broadway theaters, churches, and synagogues, an unwritten pact between classical music companies and their audiences has kept them out of concert halls and opera houses. However, the City Opera now uses the sound system in certain circumstances, such as spoken dialogue. "We view it as electronic architecture," board chairman Martin Oppenheimer is quoted as saying. It will "enhance the acoustics of the space, not amplify voices." Many believe the New York State Theater, designed primarily for dance, not opera, has inadequate acoustics for music, especially the singing voice. Beverly Sills, the chairman of Lincoln Center, who made her career in the New York State Theater as a leading soprano has reservations, although she endorses the move. "I hope it's temporary," she said. "I would not like it to become a way of life."
- The once-silent Earth is now a cacophony, according to an article in *The Christian Science Monitor* of July 8. Marine biologists complain that the throb of supertanker propellers creates such a din that whales, dolphins, and other sea creatures are at risk. The incessant chirp of radio waves from communications satellites interferes with radio telescope observations. Prospects of mitigating noise in space and in the oceans are slim at best, however. Demand for bandwidth seems insatiable as communication becomes ever more important for more people, and regulating Naval shipping traffic would require cooperation from all the countries of the world.
- Using drums to teach physics, as well as music, in the public schools is the subject of a story in the *Boston Globe* of June 6. Central to the "Science of Sound" project were workshops and concerts by World Rhythms, a five-piece band that plays ancient and contemporary West African music. Elementary students got a basic lesson in the science of vibration as well as how drums are made. At the high school level students got a lesson in the physics of sound.
- Low-frequency active sonar (LFA), a new technology for detecting submarines, is of concern to many marine scientists, according to a story in *USA Today*, July 6. LFA emits powerful low-frequency sound waves in the same range as many whale species' calls, at 250 Hz and below. LFA is generated by an array of 18 loudspeakers, each the size of a small bathtub, which a ship lowers 300 to 500 feet into the water. The intense tones register 140 decibels 300 miles away.

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