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ECHOES

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Vuvuzelas and their impact

Kenneth A. Cunefare, Richard Ruhala, and Tina Ortkiese

Vuvuzelas are inexpensive horns that became a part of the American and world vocabulary during the 2010 World Cup held in South Africa, though horns of the style have been used for decades in the States and elsewhere. During the World Cup, spectators played these horns throughout the games, causing noise complaints from athletes and spectators alike, including television listeners; enthusiastic fans playing them at all hours outside of the stadiums was also an issue. The Vuvuzelas and similar horns are sold in the U.S. and other countries, and there is concern that they will create a related noise problem at future sporting events. Indeed, the lead author's first experience with Vuvuzela's pre-dated the World Cup, when he attended an "International Friendly" match between Club America and AC Milan at the Georgia Dome in Atlanta (Club America won, 2-1); the number of horns in play at that match was a foreshadowing of what was seen during the World Cup.

Fig. 1. A collection of Vuvuzelas; the one on the far right was used at matches during the 2010 World Cup in South Africa.

But what is a Vuvuzela? Figure 1 depicts several examples of these inexpensive horns. These horns were purchased from internet-based vendors, as well as at the 2010 World Cup. There is no standardized form for these horns; they examples in the figure range from 0.6 to 0.75 m in length, and their profiles (their geometric shape or "flare") are not the same. Since the horns are each different, each will have a somewhat different sound when played. While the recent popular name for these horns, Vuvuzela, appears to be of South African origin, horns of this style have existed for centuries, and have long been available even in the United States as "stadium horns." What has happened, though, to increase their visibility is their massed use at sporting events and the attendant publicity, especially related to soccer as occurred during the 2010 World Cup in South Africa.

But beyond the possibility that the sound of the horns may be considered annoying by some spectators and television viewers, is there a risk of hearing damage associated with the playing of Vuvuzelas? When individual players sound a horn, the mouth of the horn is at some distance removed from their own ears; but what about the person in the row in front of them? And what happens when there are many, many people sounding horns at the same time? These concerns were raised before the 2010 World Cup (e.g., by Swanepoel *et al.*), which motivated us to perform a variety of precision measurements to characterize the horns' acoustic performance, including their spectral content and sound power. We performed controlled measurements in a special acoustic test room, called a hemi-anechoic chamber, which suppresses echoes. Figure 2 is an image of one of our players sounding a 2010 World Cup Vuvuzela while in the test chamber.

When played, the horns have a particular "droning" quality to them, and some listeners have described the sound of massed horns as akin to a swarm of angry bees. Recordings of the sound produced by these horns reveal that they have a strong "fundamental" tone as well as many strong harmonics or overtones of the fundamental, as seen in Figure 3 which depicts the frequency content of a number of different horns and soundings of those horns (differences between the horns and how they may be played can be appreciated by listening to the sound sample that accompanies the figure; the sample corresponds to the spectrogram in the figure). And, players of different ability, playing horns of different character, starting and stopping at differ-

continued on page 3

We hear that . . .

• At its November 20 meeting, the Greater Boston Chapter of ASA honored four recipients of ASA awards: **Amar G. Bose**, honorary fellowship (May 2011); **Eric E. Ungar**, Gold Medal (May 2011); **James E. Barger**, Helmholtz-Rayleigh Interdisciplinary medal (May 2011); **J. Christopher Jaffe**, Wallace Clement Sabine Medal (November 2011).

• ASA members honored at the American Speech, Language and Hearing Association convention in San Diego November 17-19 include **Robert Burkard** (Honors of the Association), **Peggy Nelson** and **Susan Blaeser** (Outstanding contribution to *ASHA Leader*).

• The 11th **Congrès Français d'Acoustique** and the 2012 Annual **Institute of Acoustics Meeting** will be held in Nantes, France from 23 to 27 April 2012. Co-chairs are Michel Bérengier and Keith Attenborough. This congress is also supported by the European Acoustics Association (EAA).

• ASA member **Martin Klein** received the Arnold O. Beckman Founder Award from the International Society of Automation (ISA) at the ISA Honors and Awards Gala, 17 October 2011 in Mobile, Alabama. Klein was recognized for "invention and development of the dual channel side scan sonar instrumentation that has opened the world's oceans for exploration, safe navigation, and underwater recovery."

• **Edgar Villchur**, inventor of the acoustic suspension bass loudspeaker, died October 17 at age 94, according to a story in the October 18 issue of *The New York Times*. Villchur realized that if a loudspeaker cabinet were completely sealed, the air trapped inside would act like a spring to control the cone vibrations, greatly enhancing the low-frequency performance. In its 50th anniversary issue in 2006, Hi-Fi News ranked him No. 1 among its 50 most important audio pioneers. In later years, Villchur started the Foundation for Hearing Aid Research where he pioneered in development of multicheannel compression hearing aids.

• **Manell Zakharia** received the "European Acoustics Association Award 2011 for contributions to the promotion of acoustics in Europe."

• ASA members receive *Physics Today*, the monthly magazine of the American Institute of Physics, but the magnazine also has an online version, available at http://blogs.physicstoday.org/thedayside.

• The American Physical Society (APS) has a new open access journal called *Physical Review X* which will span a broad spectrum of fields. The inaugral issue, which hit the virtual newstands on September 30, includes a paper on acoustic levitation applied to medicinal drugs (see Scanning the Journals in this issue).

• On August 1-5 2011, the Cornell University Bio-acoustics Research Program hosted the **Third International Symposium on Acoustic Communication by Animals**. Sponsors included the Acoustical Society of America, the Office of Naval Research, the National Oceanic and Atmospheric Administration, and the National Science Foundation. Invited speakers included Peter Narins, Whitlow Au, Christopher Clark, Robert Dooling, Sandra Blumenrath, Kurt Fristrup, Timothy Genter, Robert Dooling, Ronald Miles, Cynthia Moss, Daniel Robert, Annemarie Surlykke, Peter Tyack, and Edward Walsh

ECHOES

Newsletter of the Acoustical Society of America

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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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Best Student Paper Awards (San Diego)

Acoustical Oceanography
First: Adam M. Metzler, Rensselaer Polytechnic Institute
Second: James Traer, Scripps Institution of Oceanography, University of California

Animal Bioacoustics
First: Delphine Mathias, Scripps Institution of Oceanography, University of California
Second: Jennifer L. Keating, San Diego Zoo

Architectural Acoustics
First: Lauren Ronsse, University of Nebraska--Lincoln
Second: Ari M. Lesser, University of Hartford

Musical Acoustics
First: Miles Faaborg, Coe College
Second: Nicholas J. Eyring, Brigham Young University

Speech Communication
First: Erin Rusaw, University of Illinois
Second: Hyunjung Lee, University of Kansas

Structural Acoustics and Vibration
First: Micah Shepherd, Pennsylvania State University
Second: Alan T. Wall, Brigham Young University

Underwater Acoustics
First: Olivier Carriere, Université Libre de Bruxells
Second: Craig Dolder, University of Texas, Austin

Best Paper Awards for Young Presenters

Noise
Martin Brummund, École de Technologie Supérieure (ETS), Montreal
Kieran Poulain, Pennsylvania State University

Signal Processing in Acoustics
Martin Gassmann, Scripps Institution of Oceanography, University of California

ASA returns to San Diego

Vuvuzelas, *continued from page 1*

ent times, yield a complex sound signature in both frequency and time that give the playing of massed horns its particular drone, as may be appreciated by the spectrogram of Figure 4.

Fig. 2. Vuvuzela player

Our measurements included placing a microphone next to the ear of the horn's player; the level of the sound at that position ranged from 90 to 105 dBA. But, imagine if there was someone in the row in front of the horn player; that person would be exposed to the sound that comes directly out of the horn. Measurements taken 2.5 meters away from horns, and analyzed to predict what would be experienced at 0.5 meters from the mouth of the horn, revealed levels from 96 to 110 dBA (spot measurements closer to the horn supported the analysis); levels close to the mouth of a horn hit 125 dBA.

When many horns are played together, their combined sound output will lead to even higher levels than for a single horn, impacting the surrounding audience members, the horn players, and even players on the field. By applying basic noise modeling techniques, within a group of horn players it is not unreasonable to expect sound levels to approach or even exceed 120 dBA (depending on how many people within an area are sounding horns, and their positions relative to each other).

One indicator of the potential risk associated with these levels is to compare them to recommendations for noise exposure, such as the U.S. Occupational Health and Safety Administration (OSHA) standards. OSHA prohibits exposure to occupational noise above 115 dBA without hearing protection, and would limit the time of exposure for levels below 115 dBA. For example, the permissible exposure to a 110 dBA level is 30 minutes, which is less than the time for a complete soccer match. Other bodies recommend a much shorter time of exposure to high noise levels, for example, recommending exposures of only 28 seconds to levels of 115 dBA.

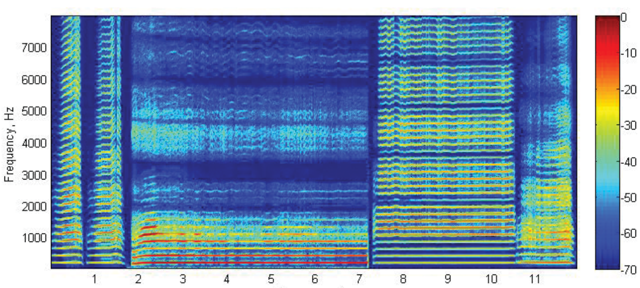

Fig. 3. Spectrogram showing frequency vs. time for different horns overlaid on each other, as would be during a game.

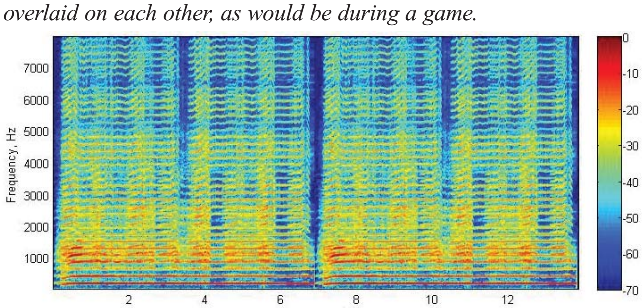

Fig. 4. Spectrogram showing frequency vs. time for different horns played in sequence.

But the horns have impact beyond just the stands; the sound can impair communications between team members on the field of play, or limit their ability to hear calls by officials. Using our data for sound power levels of the horns as a starting point, and estimating the numbers of individuals within a stadium's audience who are sounding horns at once, then we predict levels on the field that can approach 90 dBA, which would strongly interfere with voice communication (searching the web for news coverage of the 2010 World Cup one can find comments from players indicating that the horns did interfere with communication). This simple calculation is borne out by a more sophisticated model which yielded the results depicted in Figure 5; by any measure of speech interference, the predicted levels on the field (and in the stands) indicate that intelligible speech would be well nigh impossible.

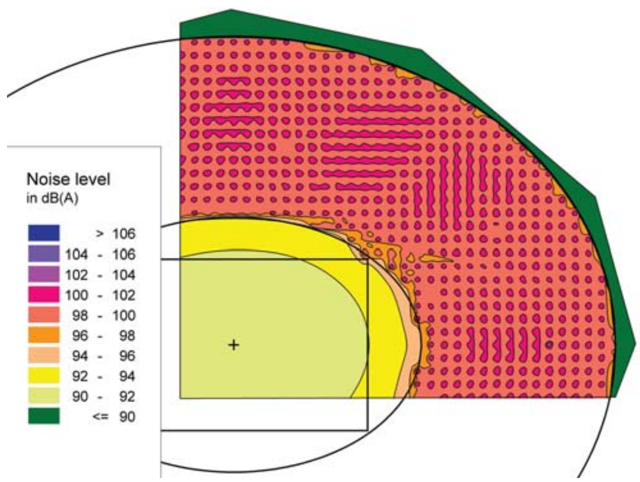

Fig. 5. Levels in the stands and on the field if 2% (1,683) of a stadium with 84,125 spectators sounding Vuvuzelas.

At the end of the day, though, the use of these horns at sporting events may be is as much a cultural and participation choice as anything else. Perhaps there's a product-marketing opportunity here; hearing protectors for sale at sporting venues in each teams' colors and dress?

References

De Wet Swanepoel, James W. Hall III, and Dirk Koekemoer, "Vuvuzela – good for your team, bad for your ears," South African Medical Journal, February 2010, Vol. 100, No. 2, pp. 99-100.

The authors are with The Georgia Institute of Technology, Southern Polytechnic State University, and Arpeggio Acoustic Consulting, LLC. This article is based on paper 5aNSb1 presented at the 162nd meeting of the Acoustical Society of America in San Diego. Email addresses are ken.cunefare@me.gatech.edu, rruhala@spsu.edu, and tortkiese@arpeggioacoustics.com.

ASA awardees honored in Boston

Left: ASA award winners James Barger, Amar Bose, Chris Jaffe, and Eric Ungar honored at Greater Boston chapter meeting (photo by Greg Tocci)

Right: Dr.Amar Bose receives Honorary Fellowship certificate (awarded May 2011) from Charles Schmid, ASA Executive Director, at Greater Boston chapter meeting (photo by Greg Tocci)

Left: ASA office staff (Melville) Front Row: Elaine Moran (Director, Headquarters); Ewa Koguciuk (Standards), Susan Blaeser (Director, Standards), Caryn Mennigke (Standards) Back Row: Jolene Ehl (Headquarters), Louise Vollmer (Headquarters), Kelly Quigley (Headquarters)

New fellows

ASA President Mardi Hastings, New Fellows Keith A. Gillis, Mark Hasegawa-Johnson, Veerle M. Keppens, Masao Kimura, Michael J. Owren, Elizabeth A. Strickland, Zhaoyan Zhang, ASA Vice President Brigitte Schulte-Fortkamp

Echoes from San Diego

ASA 5K fun run at the San Diego meeting (photo by Daniel Tam)

Howard Levy (harmonica) and Christopher Adler (khaen) perform at mouth organ concert

Charles Schmid and Halloween friend at San Diego meeting

Echoes from San Diego

Linda Hunt discusses the Vibrational assessment of ice hockey goalie sticks at the undergraduate poster session (photo by Charles Schmid)

Jace Harker (Springer) acts as docent at demo session

Concert by the Hutchins Consort

Conversing at a cocktail party: Linking individual abilities to neural coding

Barbara G. Shinn-Cunningham

Imagine yourself at a trendy restaurant on a busy Friday night. Boisterous conversations ebb and flow, glasses clink, chairs scrape, and all of these sounds reflect off the floor, walls, and tables, adding to the cacophony. In order to converse with your witty dinner companion, you have to be able to tune out other sounds, including the oenophile opining about the hint of apricot is his chardonnay and the businessman arguing with the maitre d' over his reservation time. No existing machine algorithms are able to accomplish what you do in these settings: segregating the speech you care about from the mixture of sounds reaching your ears, and analyzing its content to extract meaning.

In order to accomplish this kind of *selective attention*, your brain relies on the detailed structure of natural sound, grouping together sound elements that turn on and off simultaneously, share a common fundamental frequency or pitch, come from the same location, or have other spectro-temporal features that suggest they were generated by the same source. Since different sources are independent of each other, they typically do not share spectro-temporal features; this enables your brain to segregate the sources from each other and then analyze each of the different perceived objects in the auditory scene, one by one. Unfortunately, you may often find that your ability to selectively attend is diminished in a restaurant with hard, reflective walls: the reflected sound energy smears out the spectro-temporal structure in sound, weakening the features that support perceptual segregation and interfering with selective auditory attention.

Figure 1 illustrates these concepts through visual analogy. When sources are too similar to each other (Fig. 1a), the brain has difficulty separating out individual words in the scene and instead tends to analyze the entire scene at once as one mass of overlapping letters; as a result, extracting the meaning of any given word is difficult and time consuming. However, if independent sources are different in some attribute (such as their pitch, somewhat analogous to visual color; see Fig. 1b), the brain perceives each word as a separate object, and can more quickly focus on and analyze each word. When the scene's structure is smeared out (Fig. 1c, analogous to the effects of reverberant energy), selective attention is challenging, as different objects are less distinct.

Anecdotally, some listeners with normal hearing thresholds seem to have more difficulty with selective attention than others; moreover, listeners in early middle age often complain that it is harder for them to converse in restaurants and other noisy settings than when they were younger. Inspired by the work of Nina Kraus and her research group at Northwestern University, Dr. Dorea Ruggles, PhD candidate Hari Bharadwaj, and I wondered whether these individual differences in normal-hearing listeners relate to the fidelity with which early sensory portions of the auditory pathway encode spectro-temporal structure. Specifically, we noted that typical hearing screenings assess hearing sensitivity by simply asking listeners to *detect* the presence of pure sinusoids at different frequencies. To carry the visual analogy further, imagine a vision test in which, rather than describing what letter you see on a chart, all you are asked is whether or not there is some kind of letter present! We realized that a physiological measure of how well spectro-temporal details in audible (supra-threshold) sound are *encoded* in the auditory pathway might better reflect the ability to extract the meaning of real-world sounds. Indeed, Prof. Kraus and her colleagues have found a clear relationship between brainstem encoding (measured by analyzing the voltage on the scalp of the listener) and many factors, including musical training, familiarity with a tonal language, and even reading proficiency.

We recruited a large number of listeners, ranging in age from young adult to middle aged, and tested their ability to understand one talker in the presence of two competing talkers in both a simulated anechoic space (with no reflected energy) and in a simulated room with ordinary walls. We also measured how well the brainstem of each listener encoded a period-

Fig. 1. In a loud setting like a coffee bar, lots of competing sounds add up acoustically to create the auditory scene. a) If the sources are too similar in their acoustic attributes, it is difficult to segregate the sources and analyze them, as visualized here by words of identical color. b) When the sources are different in pitch or other attributes, each word is perceived as a distinct object, and is easy to analyze. c) When the scene is blurry (such as from reverberant energy), objects are less distinct and harder to analyze.

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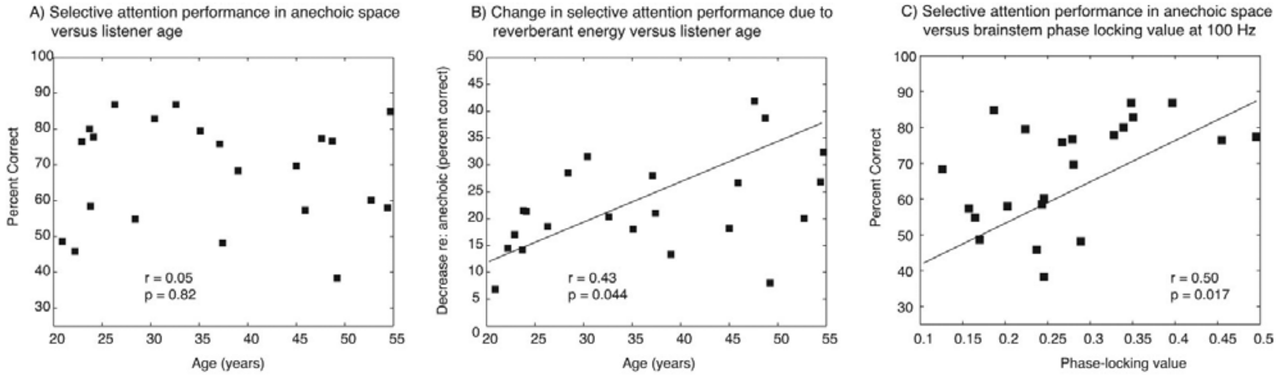

Fig. 2. a) Selective attention performance in anechoic space varies greatly from one listener to another, but is unrelated to age. b) For all listeners, selective attention performance decreases when reverberant energy is added to the scene; importantly, the effect of reverberation increases with age. c) Across all listeners, selective attention performance is correlated with the strength of the auditory brainstem encoding of the fundamental frequency of an input periodic sound (a synthesized syllable "dah" with a pitch of 100 Hz).

ically repeating sound.

We found that the ability of our normal-hearing listeners to selectively attend to a listener in a room varied dramatically from listener to listener, ranging from 33% correct up to nearly 90% correct in anechoic space. While we thought we might see that early aging hurt selective attention ability, performance was unrelated to age (see Fig. 2a). As expected, we found that for every individual listener, adding reverberation hurt performance. Importantly, even though age didn't predict how well listeners could direct selective attention, we found the negative effects of reverberation increased with listener age (see Fig. 2b). In other words, middle-aged listeners, as a group, are no worse at understanding speech in the presence of competing speech than young adults; however, on an individual basis, reverberant energy interferes more with performance the older a listener is. We also found that the strength with which the brainstem encodes the fundamental frequency of a periodic input sound is related to performance (Fig. 2c). The greater the fidelity of the brainstem in encoding the spectro-temporal structure of input sound, the better an individual listener is deploying selective auditory attention.

These kinds of studies can help us to understand the reasons for large individual differences in how well a person can function in ordinary social settings. For instance, spectro-temporal structure, which is critical for segregating and selecting a sound source from an auditory scene, is not represented equally well in the sensory pathway of all "normal hearing" listeners, which in turn explains differences in how well listeners can understand speech in a complex acoustic scene. In addition, we now can say that middle-aged listeners most likely are having greater problems communicating in everyday settings than they did when they were younger: reverberation in everyday settings truly impacts an older listener more than it does a young adult. By teasing apart different factors that affect real-world communication, we may ultimately identify distinct mechanisms important to everyday function, and find new methods for aiding listeners with different forms of perceptual difficulties.

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Scanning the journals

Thomas D. Rossing

• By observing travel times of **acoustic waves within the sun**, it is possible to detect emerging sunspot regions in the solar interior (see Acoustics in the News in the Fall issue of *ECHOES*). The analysis technique, called "time-distance helioseismology," which is described in a report in the 19 August issue of *Science*, is similar to a technique used in earthquake studies. Acoustic waves (P-waves) traveling through the body of the sun are strongly influenced by internal magnetic fields which also give rise to sunspots. Sound waves travel faster through a sunspot than through the surrounding plasma, and can appear 12 to 16 seconds earlier. Emerging sunspots have been detected by analyzing data from two satellites, the Solar and Helispheric Observatory (SOHO) and the newer Solar Dynamics Observatory (SDO).

• A mathematical model of **neural propagation in the brain** in the 2 September issue of *Physical Review Letters* may help to explain harmony and dissonance. The key may be the rhythmically consistent firing of neurons in response to a harmonious pair of frequencies. The model considers a simple three-neuron system that likely reflects the way neural signals travel from the ear to the brain. Two sensory neurons, each of which is stimulated by a different audio frequency in the inner ear, each send their signals into a third "interneuron" which sends a signal to the brain.

• During courtship flights, some **male hummingbirds produce sounds with their tail feathers**. According to a paper in the 9 September issue of *Science*, these sounds are produced by aerodynamic flutter. Scanning laser Doppler vibrometry and high-speed video of individual feathers revealed multiple vibratory modes that produce a range of acoustics frequencies and harmonic structures. Aeroelastic flutter is intrinsic to stiff airfoils such as feathers and explains tonal sounds that are common in bird flight.

• In an effort to make medicinal drugs that dissolve more quicly on delivery, scientists are using **acoustic levitation** to prepare molecular gels and amorphous solids, according to a paper in the inaugural issue of *Physical Review X* (September 2011). Acoustic levitation uses the pressure from intense sound waves to suspend an object. High-energy x-ray experiments show that several viscous gels form from saturated pharmaceutical drug solutions after 10–20 min of levitation at room temperature, most of which can be frozen in solid form.

• The fundamentals of **power ultrasound** is the subject of a review paper in the August issue of *Acoustics Australia*. In the power ultrasound frequency range, from 20 kHz to around 1 MHz, the basis of many applications is acoustic cavitation, which is the formation, growth and collapse of microbubbles within an aqueous solution resultatnt from pressure fluctuations that occur in the sound field. The paper provides an overview of bubble behaviour during acoustic cavitation, including phenomena such as transient and stable cavitation, rectified diffusion, coalescence and sonoluminescence. Application to processes such as nanomaterial synthesis, emulsion formation and waste water treatment are described

• A moving potential **excited by a surface acoustic wave** can be used to carry a single electron along a one-dimensional channel according to a letter in the 22 September issue of *Nature*. When this channel is placed between two quantum dots several micrometers apart, a single electron can be transported from one quantum dot to the other with efficiencies of emission and detection of 96% and 92% respectively. The transfer of the electron can be triggered on a timescale shorter than the coherence time. The work opens new avenues with which to study interactions between qubits in a condensed-matter system. Future experiments should allow coherent spin transfer and provide insight on the potential scalability of spin qubits.

• The **density dependence of acoustic characteristics of silica nanofoam** is presented in a paper in the July issue of *Acoustical Science and Technology*. The speed of sound was determined by diffraction of He-Ne laser light by 500-2000 kHz ultrasound. Ramn-Nath theory allowed the sound speed to be calculated using the observed diffraction angle. The observed sound speed agreed with that calculated from the bulk density, Young's modulus, and Posson's ratio.

• In the auditory ephithelium of the cochlea, the **sensory hair cells and supprting cells are arranged in a checkerboard-like fashion**, but the mechnaism underlying this cellular patterning is unclear. A paper in the 26 August issue of *Science* reports that mouse hair cells and supporting cells are established by adhesion molecules nectin-1 and nectin-3. Similar mechanisms may be responsible for cellular patterning in other species.

• **Acoustic gravity waves** of periods about 3 and/or 5 minutes traveling equatorward with a phase speed of about 100 m/s in the ionosphere are described in *Geophysical Research Letters* **38**, L17109 (2011). These waves, which are likened to the bow and stern waves of a boat, were triggered by the Moon's shadow sweeping over the Earth's atmosphere with a supersonic speed during a solar eclipse on July 22, 2009. In 1970 computer models of the atmosphere predicted that, during a solar eclipse, two pockets of high-pressure air would be created, travelling at over 3200 km/h – one at 30 km above ground level, the other at an altitude of 80 km. Since this is much faster than the speed of sound in air, these "shadow boats" would create bow and stern waves in the atmosphere. However, they were first observed by scientists in Japan and Taiwan during the eclipse of 2009.

• **Musicians maintain hearing better with age**, according to a paper in the September issue of *Psychology and Aging*. Although musicians had no advantage when it comes to pure-tone thresholds, they performed significantly better in other tests, such as gap detection, frequency discrimination, speech and music, and the ability to hear conversation in a noisy background, all of which rely on higher-level processing in the brain.

• Singing the same songs as your neighbors may sound harmonious. But among song sparrows, it's more akin to flinging insults back and forth than it is to a team-building exercise, according to a paper in the June 20 online issue of *Behavioural Ecology and Sociobiology*. Using an **acoustic location system**, researchers found no general tendency either way among the male population as a whole. Instead, performance of highly shared songs was determined more by individual differences like age and the kind of neighborhood the sparrows live in.

• Birds that live in noisy urban areas **shift their songs to high-**

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Scanning the journals

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er frequency, according to a paper in *Proc. Natl. Acad. Sci.* **108**, 10.1073 (2011). However the shift comes with some costs. Low-frequency song is related to female fertility, and the mates of low-frequency-singing males are less likely to stray. In fact, males with higher-frequency songs were less likely to be the sole father of their mate's offspring. Species facing noisy conditions are faced with a trade-off: Sing high and be heard or demonstrate your quality by singing low and be drowned out by ambient noise.

- Animation and analysis of kinematic GPS data recorded during the 2011 **Tohoku-oki earthquake, Japan** are in a paper in *Geophysical Research Letters* **38**, L18308. The animations show growth of the earthquake rupture over time and make it possible to identify dynamic ground motion due to S-waves (body waves), Love waves and Rayleigh waves (suface waves) in this data set. Real time availability of such displacements could be of great use in earthquake response and tsunami warning and also in earthquake early warning.
- As an **echolocating bat closes in on a flying insect**, it increases call emission to rates beyond 160 calls per second, according to a paper in the 30 September issue of *Science*. This high call rate phase, dubbed the "terminal buzz," has proven enigmatic because it is unknown how bats are able to produce calls so quickly. The development of superfact muscles was crucial to the success of bats as aerial predators. Only toothed whales and laryngeal echolocating bats use echolocation to detect prey, and only these animals produce buzzes.
- Finite-difference time-domain analysis of the **sound insulation** of window sashes, doors, and movable partitions with narrow gaps at their peripheries is the subject of a paper in the September issue of *Acoustical Science and Technology*. The numerical results showed good agreement with the experimental results.
- The high-pitched ringing, whistling, and other noise that can drive **tinnitus sufferers** crazy may be the product of the brain turning up the volume to cope with subtle hearing loss, according to a paper in the September 21 issue of *Journal of Neuroscience*. Tinnitus is usually, but not always, tied to some degree of measurable hearing loss. Research focused on people with tinnitus who seem to have normal hearing. Electrodes picked up a subtle abnormality in one of the nervous system's initial electrical responses to loud, rapid-fire clicks.
- Large birds, which use low frequency sound to communicate, are apt to avoid areas where **low-frequency noise levels are high**, according to a paper published online November 9 in *PLOs ONE*. This explanation is supported by the observation that urban-tolerant species may be predisposed to occupy noisy urban areas because they have higher frequency signals that may suffer less acoustic interference from urban noise than birds that vocalize at lower frequencies.
- The smell of their pups alters the neural responses of lactating female mice, making the mothers more **sensitive to pup sounds**, according to a paper in *Neuron***72357** (2011). This was determined by recording the activity of single neurons in the primary auditory cortex.
- According to an article in the December issue of *Smithsonian*, biologists believe that the sperm whale's massive head functions like a powerful telegraph, **emitting sound pulses in distinct patterns**. The skull has two long nasal passages. To make its clicking sound, a whale forces air through the right nasal passage to the "monkey lips," which clap shut. The resulting click bounces off one air-filled sac and travels back through the spermaceti organ to another sac nestled against the skull. The most common pattern of clicks are used for long-range sonar.
- A story in the December 1 issue of *Physics World* (online) describes a path to nuclear fusion that combines magnetic and inertial confinement, yet can be achieved at a fraction of the cost of either. A plasma of tritium and deuterium is transferred along a magnetic vortex to the center of a rotating sphere of molten lead and lithium, where an **acoustic wave**, created by about 200 pneumatic pistons, compresses the plasma so that it will become hot enough and dense enough for the deuterium and tritium nuclei to fuse together.

Acoustics in the News

- A theme in a story in the September 6 issue of *The New York Times* is how "audio researchers are invoking the science of psychoacoustics." Psychoacoustics, the study of sound perception by the human auditory system, has become an invaluable tool in the design of hearing aids and cochlear implants, but it also helps to present reproduced sound "the way the brain prefers to hear it." Digital sound recording, reproduction, and signal processing can virtually eliminate noise from reproduced sound, but engineers still have a long way to go. As one prominent psychoacoustician has put it, "Because of psychoacoustics we know so much more, and therefore we can do so much more, but there is so much more to do."
- The September 9 issue of *The New York Times* reviews the inaugural concert in Montreal's new La Maison Symphonique de Montreal concert hall (see Summer issue of ECHOES). The hall is described in the review as having "mellowness and warmth." After the opening concert, a video replay was played in the new park next to the hall.
- Doctors in Glasgow, Scotland are using ultrasound to heal broken bones, according to a story on *BBC* October 11. Ultrasound was developed as a diagnostic tool in Glasgow in the 1950s, and now there is good evidence that it stimulates bone regeneration and healing by "shaking" the cells.
- A new speech synthesizer that combines unit selection with a hidden Markov model will make film critic Roger Ebert sound more like himself, according to an article in the September 13 issue of *Scientific American*. Ebert lost his ability to speak in 2006 due to a post-cancer surgery tracheostomy. Since that time he has communicated by Post-it notes, a hilarious array of hand gestures, and a laptop synthesizer with an English accent.

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• Reseachers at the University of Washington and elsewhere have used measures of brain response to study infant perception of sounds and words, according to a story in the October 11 issue of *The New York Times*. The studies, which have compared the responses of infants from bilingual homes with those raised in homes where only one language is spoken, are helping to explain not only how the early brain listens to language but how listening shapes the early brain. One of the key researchers quoted in the story is Patricia Kuhl, past president of ASA and recognized expert on early learning of language (see Summer 1997 issue of *ECHOES*).

• Manatees have no vocal chords and yet they vocalize with audible squeaks and whistles, as heard on a video posted Sept. 2 on the AAAS homepage http://membercentral.aaas.org/multimedia/videos/decoding-squeaks-manatees?elq=cb7427bdb3e44ea2a56d66b38646e8b0. The scientists, who drop microphones in the water and record the animals' squeaks hope to be able to use the recordings to identify certain individuals, a great advantage in the wild for tracking manatees because tags often fall off or get damaged.

• Whispering can cause more trauma to the larynx with laryngitis than normal speech, according to a study originally discussed in the February 7 issue of *The New York Times*. The study, which was carried out in 2006, showed that subjects squeeze their vocal folds together more tightly to produce a whisper, which is more traumatic. Talking softly in normal voice is the recommended technique for singers with laryngitis.

• The study of two-way communication between dolphins and humans is discussed in a story in the September 19 issue of *The New York Times*. Dolphins are known to make three types of sounds: whistles, clicks and burst pulses. Whistles are thought to be identification sounds, like names, while clicks are used to navigate and to find prey with echolocation. Burst pulses, which can sound like quarreling cartoon chipmunks, are a muddy mixture of the two, and scientists believe that much information may be encoded in these sounds, as well as in dolphins' ultra-high frequencies, which humans cannot hear. The research will soon employ a wearable underwater computer that can make dolphin sounds and also record and differentiate them in real time. It will distinguish which dolphin is making the sound, a common challenge since dolphins rarely open their mouths.

• Grant success rates at the National Institutes of Health (NIH) appear to have plunged to an all-time low in 2011 according to a story in the October issue of *Science Insider*. An early estimate from the NIH Office of Extramural Research (OER) puts the success rate for research grants at 17.4% for the fiscal year that ended 30 September.

• The kingly roar of lion is not just a matter of its lung capacity, according to a story in the November 8 issue of *The New York Times*. A fat layer on the unusual vocal cords of lions and tigers is fine-tuned for making loud and rough-sounding noises even without a lot of respiritory exertion. Computer models of the vocal cords, based on measurements from euthanized zoo animals, enabled the researchers to see how different exhalation strengths make them tremble.

• Startled goldfish dart away from sudden sounds because of sensory organs along their flanks that sense sound and vibrations, according to a story in the 6 October issue of *Nature*. Nerve cells in the goldfish detect sounds as vibrations and transmit these signals to a single pair of neurons in the brain in less than a millisecond. Each Mauthner cell triggers muscle contractions along one side of the body, directing the fish away from the sound.

• Egyptian fruit bats can widen or shrink the sonar beam they send out and adjust the distance the beam travels in order to find food amid clutter, according to a story in the September 20 issue of *The New York Times*. The bats generate sound by making a clicking noise with their tongue, and they can adjust the beam by changing the loudness of their clicks. Although clicking is unique to fruit bats, other bats may have similar control over their sonar beams.

• Using hull-mounted echosounders, U.S. Geological Survey (USGS) scientists at the Woods Hole Coastal and Marine Science Center in Woods Hole, Massachusetts, have been studying submarine canyons and landslides to assess the potential for landslide-generated tsunamis along the U.S. east coast, according to a story in the September/October issue of *Sound Waves*, a USGS newsletter. Preliminary analysis of these new data reveal the presence of sharp, stepped erosional escarpments rimming the upper slope around each of the mapped canyons, which may be submerged paleoshorelines cut during periods of lower sea level.

• Audio-based computer games are helping blind volunteers learn navigation skills, according to a story in the 30 September issue of *Science*. A knock in one earphone or the other indicates a door on that side, while the sound of footsteps ascends in tone as the player walks her avitar up stairs. Furniture pings when bumped. Blind volunteers at the Massachusetts Eye and Ear Infirmary play the Audio-Based Environment Simulator (AbES) and then successfully navigate the actual building. Using fMRI, researchers have mapped the brain activity of both blind and sighted people as they play the game. A top priority is to develop software that can create an audible map based on any floor plan.

• The four bells which hang in the north tower of the Cathedral of Notre Dame in Paris will be replaced, according to a story in the October 10 issue of *The New York Times*. They were the gift of Napoleon III in 1856, to celebrate his son's baptism and to replace the bells melted down during the French revolution. The new bells will attempt to recreate the sound of Notre Dame's original 17th century bells. The great 12,800-kg Bourdon Emmanuel bell in the south tower, which survived the revolution, will remain. This bell rang 84 times when Pope John Paul II died in 2005 at the age of 84.

• A ban on hearing aids is forcing out veteran New York City police officers, according to a story in the June 20 issue of *The New York Times*. Two of those who had to retire have filed a complaint with the federal Equal Employment Opportunity Commission, contending that the policy is discriminatory toward those with hearing loss.

• "Hearing loops," which have been popular in Europe and in parts of the United States, are now becoming popular in New York, according to a story in the October 24 issue of *The New York Times*. The basic technology includes an induction loop, generally installed in the floor, that transmits directly to tele-

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Acoustics in the News

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coils, now being included in an increasing number of hearing aids on the market as well as all cochlear implants. The low-noise clarity is especially advantageous in noisy environments, such as subway and train stations.

• Studies have found that roughly 40 percent of students planning engineering and science majors end up switching to other subjects or fail to get any degree, according to a story in the November 4 issue of *The New York Times*. That increases to as much as 60 percent when pre-medical students, who typically have the strongest SAT scores and high school science preparation, are included, according to new data from the University of California at Los Angeles. That is twice the combined attrition rate of all other majors.

• The Kauffman Center for the Performing Arts in Kansas City, which opened September 16, "reflects a new dawn on the prairie," according to a story in the November 21 issue of *The New York Times*. The $366 million center includes 1600-seat Helzberg Hall, which will be the new home of the Kansas City Philharmonic, as well as an 1800-seat theatre for opera and ballet.

• Chorus waves are bursts of radio waves that appear inside the Earth's magnetic field, according to a note in the October 22 issue of *Science News*. Chorus waves get their name from their sound; when played through a loudspeaker they sound like a chorus of birds chirping. They accelerate electrons in Earth's radiation belts to high energies, and these electrons can create pulsating auroras when they rain down on the atomosphere.

• An electronic music application called Ocarina converts an iPhone into an easy-to-play flute-like instrument, according to an article published November 23 in the magazine section of *The New York Times*. The app, produced by west-coast startup Smule, includes a representation of the globe, with little dots that light up to show where in the world someone is playing that app at the moment, so that it is possible to listen and possibly arrange a duet with an Ocarina user thousands of miles away. The Ocarina, invented by Stanford music professor Ge Wang, was downloaded half a million times in its first couple of months, making it the top-selling app for three straight weeks. "He's always had this notion that everybody is musical but they're just too embarrassed to do anything about it," a colleague is quoted as commenting.

• "Listening gets in the way of hearing" is the title of a story in the December 3 issue of *Science News*. Attending closely to a conversation creates a situation in which unusual, clearly audible background utterances frequently go totally unheard. This is similar to the "invisible gorilla effect" in vision, in which people intently watching a basketball scene failed to see a gorilla-suited person walking across the scene.

• A profiler that combines acoustic and optical sensors is being used to explore the seafloor, according to a story in the November/December issue of *Sound Waves*, newsletter of the U.S.Geological Survey. Optical profiles are difficult to make in the ocean because light is scattered and absorbed by water and particles in the water. Acoustics works much better, but sound and light respond differently to particles, the story points out. Light responds to the area of particles in the water (proportional to the number of particles times the square of their diameters), while sound responds to the volume of particles in the water. The profiler successfully collected data at the Martha's Vineyard Coastal Observatory from mid-September until mid-October.