11:45

2aPA15. Porosity effects in large wind screening structures. JohnPaul R. Abbott, Richard Raspet, and Jeremy Webster (Natl. Ctr. for Physical Acoust .-Dept. of Phys. and Astr., Univ. of Mississippi, Coliseum Dr., University, MS 38677, jrabbott@olemiss.edu)

Recently completed research indicates that the dominant source of wind noise for infrasonic microphones placed on open ground is the interaction pressure of the average wind velocity profile and the vertical turbulence. The source region at infrasonic frequencies is quite large and therefore can only be reduced with relatively large structures. It is hypothesized that such a structure does not need to completely block the wind from the source region; it only has to reduce the wind velocity gradient above the microphone and perhaps modify the turbulence field. If so then a porous wind barrier or screen may be used. To investigate this hypothesis a 3 m high decagonal wind barrier with variable porosity has been constructed. Initial results indicate that reductions are strongest for intermediate porosities and for frequencies between 0.5 and 7 Hz. In addition, a near constant 3–5 dB reduction was also observed for frequencies below 0.5 Hz. The noise reduction results will be related to the measured wind profiles and turbulence spectra inside the enclosure. The enclosure is quite open and should have little effect on acoustic waveforms, unlike pipe arrays and porous hose arrays.

TUESDAY MORNING, 24 MAY 2011 — GRAND BALLROOM C, 8:00 A.M. TO 12:00 NOON

Session 2aPP

Psychological and Physiological Acoustics and Animal Bioacoustics: Comparative Approaches to Peripheral Auditory Function

Christopher Bergevin, Chair
Columbia Univ., Otolaryngology, Head and Neck Surgery, 630 W. 168th St., New York, NY 10032

Chair's Introduction—8:00

Invited Papers

8:05

2aPP1. Lizard ears and simple solutions to auditory coding. Geoffrey Manley (Cochlear and Auditory Brainstem Physio. IBU, Faculty V. Carl von Ossietzky Univ. Oldenburg, 26111 Oldenburg, Germany)

The variety of lizard auditory organs provides an optimal substrate for examining structure-function relationships. What does an auditory organ need to perform the basic tasks in the coding of acoustic stimuli? The single-ossicle tympanic middle ears of lizards are connected through the head, providing for sensitive directional hearing with little neural processing. Lizards evolved hair cells whose frequency responses were determined by the morphological details of their stereovillar bundles and tectorial material, enabling a tonotopic arrangement of frequency sensitivity. Modern lizards achieve this with few hair-cell rows, showing that tonotopicity does not demand an extensive epithelium. Finally, different lizard families achieved dissimilar frequency selectivity through manipulations of anatomical features, especially of the tectorial membrane. There is a pay-off between the size of the auditory papilla and its ability to code different frequencies. Long papillae allow very local coupling of hair-cell bundles with very selective frequency tuning. Short papillae generally abandon tectorial coupling to allow for useful tuning but this results in poorer sensitivity and poorer tuning selectivity. Lizards demonstrate that sensitive and selective hearing organs need only a few hundred hair-cells organized along a straight axis. [work supported by the German Research Foundation DFG (MA 871-10.)]

8:30

2aPP2. The teachings of anurans: Mechanisms of auditory processing in the frog. Sebastiaan W. F. Meenderink (Dept. of Neurosci., Erasmus MC, P.O. Box 2040, NL-3000 CA Rotterdam, The Netherlands, swfmeenderink@yahoo.com)

Amphibians are one of the four classes of tetrapod vertebrates. The majority of amphibian species are anurans, better known as frogs and toads. Frog hair cells have served as a model for studying fundamental cellular processes including electrical tuning, forward and reverse transduction, and "cochlear" amplification. In most frogs, these processes act at much lower frequencies compared to the mammalian cochlea, and extrapolation of results to higher-frequency epithelia must be made with caution. The gross anatomy of the anuran inner ear is unique among vertebrates in that it possesses two distinct organs specialized in the detection of airborne sounds. Moreover, there is no analog of the basilar membrane in these organs; hair cells are situated directly over the stationary, cartilaginous labyrinth. These structural differences are reflected in how sounds propagate within the inner ear. Specifically, traveling waves seem absent in frog. Despite this, otoacoustic emissions in anurans and mammals share many characteristics, and their comparative study may help to elucidate universal mechanical properties of the inner ear. These examples, combined with numerous other types of experiments, have made the frog a useful substrate for the examination of cellular mechanisms, transduction, and macro-mechanical inner-ear properties underlying normal vertebrate hearing.

8:55

2aPP3. Why bother looking at a range of species? Glenis R. Long (Speech-Lang.-Hearing Sci. Program, Graduate Ctr. of the City, Univ. of New York, 365 Fifth Ave., New York, NY 10016)

Most anatomical and physiological researches are conducted on a small subset of mammals, and there are many pressures on auditory researchers to limit their research to a limited number of species with the assumption that this will permit us to explain normal and impaired hearing in humans. Otoacoustic emissions (OAEs) provide a particularly useful comparative tool because very similar measures can be efficiently obtained from a range of species. A full understanding of OAEs in the ear canal can be enhanced when simultaneous measurements are obtained both in the ear canal and within the cochlea. This paper will provide evidence from psychoacoustic, evoked potential and OAE research that comparative research is essential if we are to fully understand human auditory processing.

9:20

2aPP4. Otoacoustic emission delays as a probe to measure cochlear tuning: Comparative validations. Christopher Bergevin (Dept. of Otolaryngol./Head Neck Surgery, Columbia Univ., 630 West 168th St., PS 11-452, New York, NY 10032, cb2811@columbia.edu)

The ear is not only sensitive to sound but selective as well: Tonotopic tuning of the inner ear provides a means to resolve incoming spectral information. Measurements of frequency selectivity have traditionally relied upon either subjective psychophysical or objective (but invasive) physiological approaches. Sounds emitted from a healthy ear, known as otoacoustic emissions (OAEs), have been proposed to both objectively and non-invasively estimate peripheral auditory tuning. Despite diverse inner-ear morphological variation across animals, OAEs are a universal feature and correlate well to an animal's range of *active* hearing. Recent studies focusing on emission delays in response to a single *stimulus frequency* (SFOAEs), conducted systematically across species in a variety of classes (mammals, aves, reptiles, and amphibians), support predictions relating emissions and tuning. Longer SFOAE delays presumably reflect the sharper tuning associated with resonant build-up time of the underlying auditory filters. Differences in tuning estimated from OAEs appear generally congruous with known anatomical and functional considerations: Larger sensory organs (i.e., more "filters") with smaller ranges of audition exhibit sharper tuning. Comparisons made both broadly (inter-class) and within phylogenetically-matched groups (intra-family) indicate that SFOAE delays in humans are longer than any other species so far examined, suggestive of exceptionally sharper tuning.

9:45—10:00 Break

10:00

2aPP5. Comparative cat studies: Are tigers auditory specialists? Edward J. Walsh (Developmental Auditory Physio. Lab., Boys Town Natl. Res. Hospital, 555 North 30th St., Omaha, NE 68131, edward.walsh@boystown.org), Douglas L. Armstrong (Henry Doorly Zoo, 3701 S. 10th St., Omaha, NE 68107), and JoAnn McGee (Boys Town Natl. Res. Hospital, 555 North 30th St., Omaha, NE 68131)

Although representatives of the 41 extant cat species inhabit nearly every biome on the planet and may have faced a highly diverse set of selection pressures during their evolution, relatively little effort has been made to compare commonly measured features of peripheral auditory function among species representing the family. Given their extensive geographic range, it is reasonable to suggest that auditory system adaptations may have occurred, leading to functional specialization in a subset of species. In that light, frequency-threshold curves and response latency-level and latency-frequency relationships will be compared in cats of widely varying body mass inhabiting a variety of habitats. The body mass of felids spans a range of more than two orders of magnitude, with small cats like the desert sandcat, *Felis margarita*, weighing as little as 2 kg and the Amur tiger, *Panthera tigris altaica*, weighing as much as 300 kg. While most cats studied thus far appear to satisfy the conditions necessary to be labeled auditory generalists, the tiger, and perhaps members of the *Panthera* genus generally, may be exceptions. We will consider the possibility that big cats are auditory generalists with regard to acoustic sensitivity, but exhibit a peripheral specialization affecting low-frequency neural latencies. [Funding provided by NSF Grant No. 0823417].

10:25

2aPP6. Interaural time difference processing in birds and alligators: Evolution of binaural circuits. Catherine E. Carr (Dept. of Biology, Univ. of Maryland, College Park, MD 20742, cecarr@umd.edu)

The auditory systems of birds and mammals use timing information from each ear to detect interaural time differences (ITDs). In birds, the circuits that encode ITDs are composed of delay lines and coincidence detectors. To determine if these circuits are evolutionarily conserved, we have compared the physiological and anatomical organizations of the auditory nuclei of birds and their sister group, the crocodilians. In both groups, precisely timed spikes in the first order nucleus magnocellularis encode the timing of sounds, and NM neurons project to neurons in the nucleus laminaris that detect interaural time differences. NL neurons act as coincidence detectors, and encode ITDs in both birds and crocodilians. In the crocodilians, however, the range of best ITDs represented in NL was larger than in birds, possibly because of the network of canals that connect the middle ear spaces. These interaural canals are also found in birds, and, for low frequency sounds, may in both groups provide a larger range of ITDs than predicted by actual head size.

Contributed Paper

10:50

2aPP7. Response properties and local connectivity of the cochlear nucleus of the big brown bat. Andrea M. Simmons (Dept. of CLPS, Brown Univ., Providence, RI 02912, andrea_simmons@brown.edu), Seth S. Horowitz, Jonathan R. Barchi, and James A. Simmons (Brown Univ., Providence, RI 02912)

We characterized responses of the cochlear nucleus (CN) in big brown bats using local field potentials and extracellular unit responses to tone bursts, forward and reversed FM sweeps, and pulse-echo pairs. Neurobiotin-filled pipettes were lowered through the inferior colliculus of anesthetized bats to depths from 3.2 to 4.3 mm based on stereotaxic coordinates. Response properties were correlated with local anatomical connectivity as shown by transport of neurobiotin from the recording site and immunohistochemical localization of GABA and of connexin 35/36 in alternate brain sections. In dorsal AVCN, response properties were similar to those seen in the nuclei of the lateral lemniscus. Recording sites in ventral AVCN near the insertion point of the auditory nerve showed unique characteristics, including very short latencies (1.5–3 ms) and oscillatory responses extending past the duration of the sound. Most sites were sharply tuned to low frequencies corresponding to the first harmonic of the FM sweep, and responded equally well to forward and reverse FM sweeps. Data indicate that early stages of auditory processing in the big brown bat are critical to echolocation hyperacuity and may be dependent on anatomical specializations of the AVCN. [Work supported by the NIH, ONR, and RI Space Grant (NASA).]

11:05—12:00 Panel Discussion

TUESDAY MORNING, 24 MAY 2011 — DIAMOND, 8:00 TO 11:30 A.M.

Session 2aSA

Structural Acoustics and Vibration, Engineering Acoustics, and Noise: Advances in Vibroacoustic Treatments for Vehicles

Benjamin M. Shafer, Cochair
Serious Materials, 1250 Elko Dr., Sunnyvale, CA 94089-2213

Micah Shepherd, Cochair
Pennsylvania State Univ., Applied Research Lab., P.O. Box 30, State College, PA 16804

Invited Papers

8:00

2aSA1. Aircraft cabin noise control: Challenges and opportunities. Krishna Viswanathan, Herb Hoffman, and Alex Lin (The Boeing Co., M/S 0R-JF, P.O. Box 3707, Seattle, WA 98124)

Increasingly stringent limits on community noise from aircraft operations have been imposed over the past three decades. However, no comparable limits have been in place for cabin noise levels until recently. The introduction of regulations by the European Union on the allowable levels for noise exposure inside the aircraft cabin for pilots, flight attendants, and passengers has brought this problem to the forefront. Several noise sources contribute to high noise levels inside the cabin; the dominance of any particular source varies depending on the location. In addition to the noise due to the turbulent boundary layer, engine vibrations, and equipment, the noise from the engines plays an important role. The nozzles of a dual-stream turbofan engine are operated invariably at super-critical pressure ratios at cruise, thereby producing shocks in the jet plume. Consequently, broadband shock-associated noise is generated in addition to the turbulent mixing noise component. The engine noise impinges on the fuselage and is transmitted into the interior of the aircraft cabin. Control strategies typically focus on appropriate designs for reducing source noise and optimizing acoustic treatment, as the added weight is undesirable. This talk provides an overview and concrete examples for noise control.

8:20

2aSA2. Cockpit door module for A380 and AXP A340 aircraft. Mike Dickerson, Jr. and Michael Dickerson, Sr. (MD Acoustics, 1107 Rambling Rd., Simi Valley, CA 93065)

The cockpit door module for the A380 and A340 aircraft was assessed for specification compliance. Per the manufactures specifications, the noise/vibration levels exceeded performance specifications at various frequencies during the testing phases. Each noise contributor in the overall system was identified evaluated and assessed. The real world practical application of active/passive noise control was utilized in a superposition system. Due to strict FAA requirements, multiple paths of mitigation measures were explored. Mitigation measures include product redesign, material design, absorptive material, and constrained layer damping technology. Noise measurements were conducted to assess the results of the migration efforts. The data and results of this assessment are presented and discussed.

8:40

2aSA3. Reconstruction of normal surface velocities on a baffled plate using Helmholtz equation least squares method. Logesh Kumar Natarajan and Sean Wu (Dept. of Mech. Eng., Wayne State Univ., Detoit, MI 48202)