4:10

2pAA8. Composition and performance as outgrowth of synthesis techniques. Richard Boulanger and Greg Thompson (Berklee College of Music, 150 Massachusetts Ave., Boston, MA 02215)

New methods of controlling and interacting with synthesizers are increasingly available to the composer. Advances in input devices enable a large range of gestural parameters to be translated into musically-relevant data, which can then be used in synthesis environments like Csound and Max/MSP. This paper will examine such input devices, including the radio baton, and show how this technology may be combined with existing synthesis techniques to produce exciting new sounds, algorithms, and compositional works.

Contributed Paper

4:30

2pAA9. Violin acoustic radiation synthesis: A source model for direct sound enhancement in musical acoustic environments. Jacob Waxman and Mark Bocko (Dept. of Elec. and Comput. Eng., Univ. of Rochester, Rochester, NY 14627, jw001j@mail.rochester.edu)

Within the context of immersive acoustic environments (real or virtual) for purposes of musical performance, it is useful to recreate the acoustic field radiated by real musical instruments. Given the popularity of wave field synthesis for direct sound enhancement and other methods of holophonic sound imaging, source modeling is a desirable development for such musical applications. There exist careful directivity measurements of the sound radiation of the violin in the frequency range from 1 to 5 kHz, over which the far field directivity changes rapidly as a function of frequency [L. M. Wang, ''Radiation Mechanisms from Bowed Violins,'' Ph.D. thesis, Pennsylvania State University, 1999]. Source models based on these measurements using a cylindrical harmonic decomposition are presented. With this preliminary approach to violin acoustic radiation modeling, issues regarding further auralization of this synthesized field are subsequently addressed.

TUESDAY AFTERNOON, 16 NOVEMBER 2004 PACIFIC SALON 1, 1:25 TO 5:10 P.M.

Session 2pAB

Animal Bioacoustics: Marine Mammal Acoustics: Session in Honor of Ron Schusterman II

Colleen Reichmuth Kastak, Chair

Long Marine Laboratory, University of California, Santa Cruz, 100 Shaffer Road, Santa Cruz, California 95060

Chair's Introduction—1:25

Invited Papers

1:30

2pAB1. Temporal integration in a California sea lion and a harbor seal: Estimates of aerial auditory sensitivity as a function of signal duration. Marla M. Holt (UC Santa Cruz Long Marine Lab., 100 Shaffer Rd., Santa Cruz, CA 95060), Brandon L. Southall (NOAA Fisheries Acoust. Program, Silver Springs, MD 20910), David Kastak, Ronald J. Schusterman, and Colleen Reichmuth Kastak (UC Santa Cruz Long Marine Lab., Santa Cruz, CA 95060)

Stimulus durations shorter than some critical value result in elevated signal-detection thresholds due to temporal integration (or temporal summation) properties of the auditory system. These properties are important from a theoretical perspective in terms of the trade-offs of stimulus duration and intensity on sensitivity. From a methodological perspective, temporal integration is important because absolute detection thresholds measured using signal durations shorter than the temporal integration period may underestimate hearing sensitivity. In this study, aerial sound-detection thresholds were estimated at 2500 and 3530 Hz in a California sea lion (*Zalophus californianus*) and a harbor seal (*Phoca vitulina*). Thresholds were measured for each frequency at seven stimulus durations ranging from 100 to 500 ms using behavioral psychophysics in a hemianechoic chamber. In general, thresholds increased as tone duration decreased for durations shorter than approximately 300 ms. For tone durations longer than 300 ms, thresholds were not different from those measured with the longest duration tested. These results suggest temporal integration times of approximately 300 ms for these species, which are consistent with data collected on other mammals. Our findings suggest that tone durations longer than 300 ms should be used in estimating pinniped auditory sensitivity.

1:50

2pAB2. Noise-induced temporary threshold shifts in pinnipeds: Effects of noise energy. David Kastak (UCSC Long Marine Lab., 100 Shaffer Rd., Santa Cruz, CA 95060), Brandon Southall (UCSC Long Marine Lab and NOAA Fisheries Acoust. Program, Silver Spring, MD 20910), Marla Holt, Colleen Reichmuth Kastak, and Ronald Schusterman (UCSC Long Marine Lab., Santa Cruz, CA 95060)

Auditory pure-tone thresholds were obtained in air and in water from three pinnipeds before and immediately after exposure to octave-band noise. Noise exposure durations were 1.5, 12, 22, 25, or 50 min, and noise levels were 65, 80, or 95 dB referenced to each subjects pure-tone threshold. In air and in water, pre- and postnoise thresholds were obtained at the center frequency of the octave band. In water, thresholds were also obtained at a frequency octave higher than the octave-band center frequencies. Maximum

threshold shifts for each species were about 15 dB in air and in water. Under all exposure conditions hearing sensitivity recovered within 24 h. In both media, a curvilinear function best predicted the magnitude of threshold shift from noise energy flux density. At TTS magnitudes greater than 10 dB, this function predicts a 2-dB increase in threshold shift for a 1-dB increase in noise energy, agreeing well with data collected from other mammals.

2:10

2pAB3. Objective measures of steady-state auditory evoked potentials in cetaceans. James J. Finneran (US Navy Marine Mammal Program, SPAWARSYSCEN San Diego, Code 2351, 53560 Hull St., San Diego, CA 92152) and Dorian S. Houser (BIOMIMETICA)

Although behavioral methods provide the most direct means of assessing hearing capability, the time, access, and cost required to train individual marine mammal subjects has limited large-scale application of this technique. As an alternative to behavioral testing, auditory evoked potentials (AEPs) have been measured in a number of marine mammal species. AEP measurements using steady-state amplitude modulated tones allow rapid estimates of hearing threshold without extensive subject training. These stimuli result in sinusoidal AEPs, allowing frequency domain measures of AEP amplitude. Unfortunately, AEPs from near-threshold stimuli possess very low signal-to-noise ratios, making discrimination of AEPs from noise difficult. The most common procedures used for AEP threshold estimates in marine mammals have featured a subjective component, requiring an experienced observer to assess the presence or absence of the AEP. In this talk, the use of objective techniques to determine the presence of an AEP will be discussed. The focus of the talk will be on parametric and nonparametric methods within the frequency domain and the importance of AEP phase information. Steady-state AEPs measured in bottlenose dolphins will be used to evaluate the different techniques and compare to behavioral response measures. [Work supported by ONR and SSC San Diego ILIR.]

2:30

2pAB4. Hearing thresholds of a stranded infant Rissos dolphin. Paul E. Nachtigall, Michelle M. Yuen, T. Aran Mooney, and Kristen A. Taylor (Marine Mammal Res. Program, Hawaii Inst. of Marine Biol., P.O. Box 1106, Kailua, HI 96734, nachtiga@hawaii.edu)

The underwater hearing of an infant male Rissos dolphin that stranded off the coast of southern Portugal was measured using evoked auditory potentials (AEPs). Hearing thresholds were measured from envelope following responses to amplitude modulated pure tones ranging from 4 to 150 kHz. Acoustic signals were presented within the calibrated rehabilitation pool. Evoked responses were passively gathered from human EEG electrode sensors imbedded within rubber suction cups that were gently attached to the animal with slight suction and conductor gel. One sensor was placed behind the blowhole and the other reference sensor on the back. Tones were presented 1 m directly in front of the animal under water while the animal was held in a neutrally buoyant position. Unlike the previously published audiogram for an older Rissos dolphin, the audiogram, obtained by presenting 18 different frequencies, showed that this very young animal heard tones up to 150 kHz in a manner similar to other odontocetes. These data, collected within 4 days, are the first measure of the hearing of a neonate marine mammal, verify that very young dolphins likely hear better than older animals, and show the value of using AEPs to obtain hearing thresholds of stranded animals undergoing rehabilitation.

2:50

2pAB5. *In vivo* imaging correlated with otoacoustic emissions as a metric for ear disease in seals. D. R. Ketten (Woods Hole Oceanogr. Inst., Woods Hole, MA 02543; Harvard Med. School, Boston, MA 02114, dketten@whoi.edu), W. F. Dolphin (Boston Univ., Boston, MA 02115), R. William (Woods Hole Aquarium, Boston, MA 02110), J. Arruda, and J. O'Malley (Woods Hole Oceanogr. Inst., Woods Hole, MA 02543)

Otoacoustic emissions (OAEs) coupled with auditory brainstem responses (ABR) can help differentiate central, sensorineural, and conductive hearing losses. Pinnipeds with moderate bore canals are good OAE candidates, but OAE utility for assessing marine mammal inner ear health is not known. We examined three juvenile harbour seals (*Phoca vitulina*) with ear disease with computerized tomography (CT), OAE, and ABR. Combining CT, OAE, and ABR allowed simultaneous ear pathology documentation, quantification, and intracanal probe microphone position determination. Hearing was tested bilaterally from 500 Hz to 15 kHz. CT/OAE/ABR results were assessed independently. In two animals, CT showed middle ears occluded with fluid but normal auditory nerve anatomy, suggesting short-term circumscribed infection with no retrograde neuronal loss. OAE found moderately elevated response levels consistent with conductive hearing loss. ABR confirmed normal brainstem functioning. In the third animal, no OAEs or ABRs were obtainable up to 70 dB re 1 μPa, suggesting retrograde loss through brainstem level. CT for this animal showed inner, middle, and external ear occlusions consistent with aggressive, long-term disease. These data show volume and site of auditory pathologies are strongly correlated with OAE results in pinnipeds. [Work supported by Seaver Institute and ONR N00014-93-1-0940; N00014-94-1-1081.]

3:10–3:25 Break