Session 2pAAb

Architectural Acoustics: Technical Committee on Architectural Acoustics Vern O. Knudsen Distinguished Lecture II: Acoustics as a Factor of Ergonomics

David Lubman, Cochair
DL Acoustics, 14301 Middletown Ln., Westminster, CA 92683-4514

William J. Cavanaugh, Cochair
Cavanaugh Tocci Associates, Inc., 327F Boston Post Rd., Sudbury, MA 01776

Chair's Introduction—4:40

Invited Papers

4:45

2pAAb1. Acoustics as a factor of ergonomics: Communication behavior and workload of pupils and teachers in highly absorbent classrooms. Markus Oberdoerster (Saint-Gobain Ecophon GmbH, Taschenmacher Str. 8, 23556 Luebeck, Germany, markus.oberdoerster@ecophon.de) and Gerhart Tiesler (ISF Bremen, 28199 Bremen, Germany)

This lecture refers to an interdisciplinary research project carried out from 2000 to 2006 by the Bremen University, Germany. A mixed team of acousticians, occupational and medical scientists, and pedagogues investigated the kind of work and communication behavior in classrooms in two elementary schools. Using a database of 175 examined lessons an analysis is made of how different kinds of work (frontal lessons versus differentiated lessons) affect the basic and working sound level in the classroom. Parameters are discussed, which can describe classroom acoustics appropriately. Also discussed are how altered room characteristics (e.g., increased absorption, shortened reverberation time, and improved speech intelligibility) affect the sound level in the context of each kind of work. A methodical examination of the database allows not only an assessment of mean values but also of the detailed teaching phases, as characterized by certain pedagogical factors. The results provide the basis for discussion of stress and work demands of teachers: Based on recordings of teacher's heart rate the effects of noise level on the workload of the teachers as a stress reaction and a factor of fatigue are analyzed.

TUESDAY AFTERNOON, 24 MAY 2011 ISSAQUAH, 1:25 TO 4:45 P.M.

Session 2pABa

Animal Bioacoustics: Memorial Session in Honor of Ronald Schusterman and David Kastak II

Patrick W. Moore, Cochair
National Marine Mammal Foundation, 2240 Shelter Island Dr., San Diego, CA 92106

Robert Gisiner, Cochair
OPNAV N45, Navy Energy and Environmental Readiness Div., Arlington, VA 22202

Roger M. Gentry, Cochair
ProScience Consulting LLC, 22331 Mt. Ephraim Rd., Dickerson, MD 20842

Chair's Introduction—1:25

Invited Papers

1:30

2pABa1. The nature and nurture of seeing with sound: The role of learning in biosonar. Robert Gisiner (Navy Energy and Environ. Readiness Div. (OPNAV N45), Arlington, VA 22202, bob.gisiner@navy.mil) and Colleen Reichmuth (Univ. of California, Santa Cruz, CA 95064)

Echolocating dolphins achieve performances in detecting and classifying components of their environment that rival the performances we typically associate with vision. Many researchers have referred to dolphins "seeing with sound" or forming internal "images" of the world via acoustics, implying a presumed isomorphy of sensory inputs and a common representation at higher levels of processing in the brain. But some aspects of acoustics do not translate into visual equivalents (hollow objects and objects of different materials) and some visual aspects of an object do not translate into acoustic equivalents (color and brightness). So, how is this cross-

modal sensory translation achieved? Is it hard-wired into the anatomy of the brain, learned through association, or is it some combination of the two? Experimental tests of nature versus nurture in cross-modal sensory performance are reviewed, as first explored by Schusterman and Kastak. Further studies are suggested to reveal the respective roles of neuroanatomy and associative learning in the formation of a dolphin's perceptual and conceptual world.

1:50

2pABa2. The dolphin's mental representation during echolocation: Ron Schusterman and the email debate between the "seeing through sound" and "associative learning" hypotheses. Brian K. Branstetter (Natl. Marine Mammal Foundation, 2240 Shelter Island Dr. #200, San Diego, CA 92106, brian.branstetter@nmmfoundation.org) and Jason Mulsow (U.S. Navy Marine Mammal Program, San Diego, CA 92152)

[Evidence suggests that detection, discrimination, and recognition abilities of dolphin echolocation are related to perceived differences in time, frequency, and amplitude information from received echoes. Although an acoustic analysis has proven successful for explaining simple experimental paradigms, no similar analysis has successfully accounted for the findings from a series of cross-modal matching experiments. In cross-modal "identity" matching, the dolphin is first presented with a sample object to either vision or echolocation only. The dolphin must then select a matching object from a number of nonmatching alternative objects presented to the opposite sensory modality. The "seeing through sound" hypothesis claims that immediate (i.e., first-trial) cross-modal matching is evidence that dolphins perceive object shape through echolocation while an alternative hypothesis states that successful performance is the result of the animal's "associative learning" history. Evidence against, or in support, of both alternative hypotheses is critically examined and the dolphin's mental representation during echolocation is discussed.

2:10

2pABa3. Auditory scene analysis in the echolocating dolphin. Patrick Moore (Natl. Marine Mammal Foundation, 2240 Shelter Is. Dr., San Diego, CA 92106) and James J. Finneran (US Navy Marine Mammal Program, SSC Pacific, 53560 Hull St., San Diego, CA 92152-5001)

Auditory scene analysis (ASA) refers to an animal's ability to organize acoustic information in order to construct an understanding of its environment. In most mammals, vision is the primary sensory system and audition plays a secondary role; however, in the echolocating dolphin the reverse is likely true. One underlying tenant of ASA is *stream* analysis. This is the ability of an animal to integrate acoustic information over time and depends on short term memory for acoustic events. Moss and Surlykke [J. Acoust. Soc. Am. **110**, 2207 (2001)] demonstrated that the bat echolocation perceptual system possesses the minimum requirements for stream analysis. This experiment replicates the bat study and tests the dolphins ability to assemble information about changing echo delay by discriminating between phantom targets of varying delays. Phantom targets are presented using a Phantom echo generator system. Emitted signals are received via contact melon hydrophone and delayed echoes transmitted directly to the dolphin lower jaw. Will the dolphin perform as well as the bat?

2:30

2pABa4. Critical bandwidths in echolocating porpoises, dolphins and whales. Paul Nachtigall (Hawaii Inst. of Marine Biology, Univ. of Hawaii, P.O. Box 1106, Kailua, HI 96734)

Odontocete cetaceans may differ from most mammals in their response to noise. A close look at the published data [Popov *et al.* (2006)] of the critical bandwidths of two species of porpoises, the harbor porpoise (Phocaena phocoena) and the finless porpoise (Neophocaena phocaenoides), shows constant bandwidth critical bands in the high frequency area where echolocation signals are processed. A further look at harbor porpoise critical band data [Kastelein *et al.* (2009)] can be interpreted to show a mixture of constant Q bandwidths at lower frequencies and constant bandwidth data at higher frequencies. Data from Lemonds *et al.* [1997] indicate that the bottlenosed dolphin shows typical mammalian constant Q filters in lower frequency whistle areas but shifts to constant bandwidths in the areas of high frequency where echolocation discrimination processing is assumed to occur. Recent work (Kloepper *et al.*) has shown substantial loss in echolocation discrimination performance in the false killer whale with the loss of high frequency hearing. General high frequency hearing loss due to noise in the environment may particularly affect the echolocation processing capabilities of odontocetes and thus the foraging capabilities and fitness of odontocete echolocators. [Work funded by the Office of Naval Research.]

2:50

2pABa5. Dolphin response time in vocal reporting of echolocation targets. Ridgway Sam (Natl. Marine Mammal Foundation, 2410 Shelter Island Blvd., San Diego, CA 92106), Wesley Elsberry, Diane Blackwood (Florida Fish and Wildlife Conservation Commission, 100 SE 8th Ave., St. Petersburg, FL 33701), T. Kamolnick, Mark Todd, Don Carder (Natl. Marine Mammal Foundation, San Diego, CA 92106), and Ted Cranford (San Diego State Univ., San Diego, CA 92182-4614)

To study response time in echolocation, dolphins were trained to wear opaque suction cups over their eyes and to station on an underwater apparatus behind and acoustically opaque door. This put the dolphins in a known position and orientation. When the door opened, the dolphin produced clicks to identify the presence or absence of targets. Dolphin S emitted a whistle if the target was a 7.5 cm water filled sphere, she made a pulse burst if the target was a rock, and she remained quiet if there were no target present. Dolphin B whistled for the sphere but remained quiet for rock and for no target. Thus, S had to choose between three different responses, whistle, pulse burst, or remain quiet. B had to choose between two different responses, whistle or remain quiet. S gave correct vocal responses averaging 114 ms after her last echolocation click (range 18 ms before and 219 ms after the last click). Average response for B was 21 ms before her last echolocation click (range 250 ms before and 95 ms after the last click in the train). More often than not, B began her whistle response before her echolocation train ended.