mother–offspring recognition, both otariid females and their pups use acoustical cues for mutual recognition. In contrast, reunions between phocid females and their dependent pups depend mostly on pup vocalizations. In terms of signal reception, audiometric studies show that otariids are highly sensitive to aerial sounds but slightly less sensitive to underwater sounds. Conversely, except for deep-diving elephant seals, phocids are quite sensitive to acoustic signals both in air and under water. Finally, despite differences in absolute hearing sensitivity, pinnipeds have similar masked hearing capabilities in both media, supporting the notion that cochlear mechanics determine the effects of noise on hearing.

4:30

1pAB7. Cognitive processes in bird song. Jeffrey Cynx (Dept. of Psych., Vassar College, Poughkeepsie, NY 12604, chaos@vassar.edu)

Anthropomorphic hypotheses can alter previous ethological concepts. Songbirds have been traditionally categorized as open- or close-ended learners. Open-ended learners such as canaries and starlings continue to learn new songs throughout life. Close-ended learners such as song sparrows and zebra finches appear to learn song once and then repeat this song in a stereotyped or crystallized manner for the rest of their lives. Research over the last dozen years or so has produced evidence that whatever is close-ended in songbirds may be more than a little ajar. It is clear that adult song is a highly dynamic and closely monitored act. In these regards, it has a number of cognitive processes similar to human speech. Birds appear to continually monitor their own song, being able to stop in midsong if necessary. They also regulate the song amplitude given environmental and social conditions, and show song perturbations when experiencing delayed auditory feedback. However, so far as is known, close-ended learners cannot learn new song elements from a model, although there are hints to the contrary, including both behavioral and physiological results.

Contributed Papers

4:50

1pAB8. Human listening studies reveal insights into object features extracted by echolocating dolphins. Caroline M. DeLong (New College of Florida, 5700 N. Tamiami Trail, Sarasota, FL 34243, cdelong@ncf.edu), Whitlow W. L. Au (Hawaii Inst. of Marine Biol., Kailua, HI 96734), and Herbert L. Roitblat (DolphinSearch Inc., Ventura, CA 93001)

Echolocating dolphins extract object feature information from the acoustic parameters of object echoes. However, little is known about which object features are salient to dolphins or how they extract those features. To gain insight into how dolphins might be extracting feature information, human listeners were presented with echoes from objects used in a dolphin echoic-visual cross-modal matching task. Human participants performed a task similar to the one the dolphin had performed; however, echoic samples consisting of 23-echo trains were presented via headphones. The participants listened to the echoic sample and then visually selected the correct object from among three alternatives. The participants performed as well as or better than the dolphin ($M = 88.0\%$ correct), and reported using a combination of acoustic cues to extract object features (e.g., loudness, pitch, timbre). Participants frequently reported using the pattern of aural changes in the echoes across the echo train to identify the shape and structure of the objects (e.g., peaks in loudness or pitch). It is likely that dolphins also attend to the pattern of changes across echoes as objects are echolocated from different angles.

5:05

1pAB9. Biosonar performance of foraging Blainvilles beaked whales (*Mesoplodon densirostris*). Peter T. Madsen, Mark Johnson, Peter L. Tyack (Woods Hole Oceanogr. Inst., Woods Hole, MA 02543), Natacha Aguilar de Soto (La Laguna Univ., Tenerife, Canary Islands, Spain), and Walter M. X. Zimmer (NATO Undersea Res. Ctr., 19138 La Spezia, Italy)

Echolocating animals like bats and toothed whales navigate and locate food by means of echoes from sounds transmitted by the animals themselves. Toothed whale echolocation has been studied intensively in captivity, but little information exists on how echolocation is used by wild animals for orientation and prey location. To expand on this issue, a noninvasive, acoustic Dtag (96-kHz sampling, 16-bit resolution) was deployed on two Blainvilles beaked whales. The tagged whales only clicked at depths below 200 m during deep foraging dives. The echolocation clicks are directional, 250-ms transients with peak energy in the 30–40-kHz band. Echoes from the seafloor and from prey items were recorded. The regular click rate is not adjusted to the decreasing echo delay from incoming prey until the target is within an approximate body length of the whale after which the click rate is increased rapidly akin to the buzz phase of echolocating bats. This suggests that the whales use different sonar strategies for operating in near versus far field modes. Changes in received echo intensities from prey targets during approaches are compared to the active gain control in the receiving system of bats and in the transmitting system of dolphins.

5:20

1pAB10. Aerial hearing sensitivity in some pinnipeds is comparable to that of humans. Colleen Reichmuth Kastak, David Kastak, Marla M. Holt, Ronald J. Schusterman (Univ. of California, Long Marine Lab., 100 Shaffer Rd., Santa Cruz, CA 95060, coll@ucsc.edu), and Brandon L. Southall (NOAA Fisheries Acoust. Prog., Silver Spring, MD 20910)

Aerial hearing sensitivity was measured in pinnipeds in a sound attenuating, hemi-anechoic chamber. Thresholds at 12 frequencies between 0.1 and 32.5 kHz were obtained behaviorally for three individuals (a California sea lion, a harbor seal, and a northern elephant seal) and compared to thresholds obtained using headphones in less controlled testing environments. The thresholds measured in the chamber revealed the expected relative changes in sensitivity with frequency; however, the absolute sensitivities were much better than had been previously measured. Harbor seal thresholds were on average 25 dB lower with best sensitivity of -2 dB (re: 20 μPa) at 3.2 kHz. Elephant seal thresholds averaged 23 dB lower with best sensitivity of 27 dB (re: 20 μPa) at 0.4 kHz. Thresholds for the California sea lion were also much lower than expected, with best sensitivity of 1 dB (re: 20 μPa) at 12 kHz. The thresholds measured for the sea lion and harbor seal rival those of human subjects at some frequencies, and suggest that previously reported aerial hearing thresholds in pinnipeds wwere significantly noise limited. Further, the results indicate that these pinnipeds have greater sensitivity in air than in water when comparisons are made in terms of sound pressure.

5:35

1pAB11. A computational model of echolocation: Transformation of spectrogram into the reflected intensity distribution for range discrimination of multiple closely spaced objects. Ikuo Matsuo, Kenji Kunugiyama, and Masafumi Yano (Res. Inst. of Elec. Commun., Tohoku Univ., 2-1-1 Katahira, Aoba-ku, Sendai 980-8577, Japan, matsuo@riec.tohoku.ac.jp)

Using frequency-modulated echolocation, bats can discriminate the range of objects with an accuracy of less than a millimeter. However, the echolocation mechanism is not well understood. The delay separation of three or more closely spaced objects can be determined through analysis of the echo spectrum. However, delay times cannot be properly correlated with objects using only the echo spectrum because the sequence of delay