pairs of phonic lips; and two hydrophones revealed acoustic pressure during target discrimination. Sonar pulses can be generated at the left and right phonic lips, independently or simultaneously. Air pressure in both bony nasal passages rises and falls together, even if the activity patterns at the two pairs of lips are different. Increasing pulse repetition rate or sound pressure levels are all normally accompanied by increasing nasal air pressure. The bilateral arrangement of sonar sources in the odontocete nose provides a basis for reinterpretation of previous findings; reevaluation of physiologic limits and on pulse repetition rate, signal bandwidth, frequency composition, and transmission beam geometry; and the evolution of this system.

Contributed Papers

3:05

3pAB7. The creative walrus: Novel sound production via contingency learning. Ronald J. Schusterman, Colleen Reichmuth Kastak (Inst. of Marine Sci., Long Marine Lab., Univ. of California, Santa Cruz, 100 Shaffer Rd., Santa Cruz, CA 95060), Debbie Quihuis (Six Flags Marine World, Vallejo, CA 94589), and Marla M. Holt (Univ. of California, Santa Cruz, Santa Cruz, CA, 95060)

Walruses (*Odobenus rosmarus*) have a range of anatomical specializations that can provide plasticity to their vocal emissions. These include respiratory adaptations related to breath-holding and buoyancy and soft tissue adaptations of the mouth, lips, and tongue related to suction feeding. The aim of this study was to examine the extent to which contingency learning using food reinforcement could modify the sound production of walruses. One male and three female captive walruses participated in the current study. Animals were first trained in air in a series of four experimental steps: (1) induce and reinforce natural sound production, (2) establish stimulus control over sound production and inhibition, (3) establish stimulus control over different sound types by mapping them to different discriminative stimuli, and (4) encourage the production of novel sounds by withholding reinforcement for previously emitted sounds and reinforcing only novel variants. Subsequently, two of the walruses were transferred from airborne to underwater testing. In the absence of additional training, both individuals, when prompted to vocalize, emitted a range of underwater sounds, many of which were qualitatively different from those produced in air and those recorded in baseline conditions under water. Thus, walruses, like cetaceans, can learn to modify their sound production.

3:20–3:35 Break

3:35

3pAB8. Acoustical development of the human baby cry: Anatomical and social factors. Yulri Nonaka, Noriko Kudo, Kazuo Okanoya (Lab. for Biolinguistics, RIKEN Brain Sci. Insitute, 2-1 Hirosawa, Wako, Saitama 351-0198, Japan, ynonaka@brain.riken.jp), Noriko Kudo, Kazuo Okanoya (Chiba Univ.1-33 Yayoi-Cho, Inage, Chiba 263-8522, Japan), Noriko Kudo (JSPS), and Kazuo Okanoya (PRESTO, JST)

We investigated the acoustical development of the human baby cry based on our two-stage hypothesis, which holds that two distinct factors affect the development of the baby cry. First, humans possess the corticobulbar pathway connecting the face motor cortex and the medullary respiratory and vocal centers. This pathway is absent in nonhuman primates and other mammals. We postulate that the myelinization of this pathway would change the acoustic characteristics of the baby cry. Second, after neuroanatomical maturation enabled variable cry patterns, the social relationships with caregivers should differentiate the acoustical patterns of the baby cry. This should lead to family-specific cry patterns. To test the two-stage hypothesis, we recorded ten newborn babies until they were 1 year old. In all babies, the cry pattern was very simple up to 2 weeks, while after 1 month, the pattern became temporally and spectrally complex, suggesting neuroanatomical changes. At three months, we asked the mothers to classify the cries of their own babies into three categories: sleepy, hungry, and wet diaper. There were no acoustic patterns common to their classifications, suggesting that baby cry semantics are family-specific. These results support our two-stage hypothesis of cry development. [Work supported by JST and JSPS.]

3:50

3pAB9. Is the squirrel monkey larynx lateralized biomechanically? Charles H. Brown (Dept. of Psych., Univ. of South Alabama, Mobile, AL 36688, cbrown@usouthal.edu) and Fariborz Alipour (Univ. of Iowa, Iowa City, IA 52242)

Squirrel monkey larynges were dissected, mounted on a pseudotracheal tube, and phonated via the flow of compressed heated and humidified air. Synchronized audio and video signals were digitized and analyzed with a signal processing workstation. Image analysis algorithms measured the change in glottal area due to the movement of the left and right vocal folds, respectively, and measured the change in location of both vocal folds during phonation. The results show that the squirrel monkey larynx is capable of both unilateral and bilateral oscillation. In the unilateral case, oscillation is virtually confined to the left vocal fold. The converse of this has not been observed. In the case of bilateral oscillation, the folds may oscillate synchronously in phase, asynchronously out of phase, or at different fundamental frequencies. The results are consistent with the idea that the biomechanical properties of the left and right vocal folds differ with the left fold capable of oscillation at lower subglottal pressures and greater amplitudes. Changes in vocal fold elongation and adduction change the coupling between the two folds and produce different regimes of oscillation. Squirrel monkeys appear to employ intentional shifts between different regimes of phonation to expand the size of the vocal repertoire.

4:05

3pAB10. Measuring emotional arousal in the voiced sounds of two mammals, the rhesus monkey and African elephant. Joseph Soltis, Christina Wesolek, Anne Savage (Education and Sci., Disney's Animal Kingdom, Lake Buena Vista, FL), Kirsten Leong (Cornell Univ., Ithaca, NY), and John Newman (NICHD, Poolesville, MD)

Emotional arousal is expressed in the voiced sounds of primates and other mammals, but there are no consistent acoustic measures used and few comparative analyses. We apply a representative suite of source and filter measurements to rhesus macaque (*Macaca mulatta*) coo calls on Cayo Santiago, Puerto Rico, and African elephant (*Loxodonta africana*) rumble calls at Disney's Animal Kingdom, Florida, U.S.A. Based on social context, calls were classified into high and low arousal categories. In both species, MANOVA showed that the 15 measures taken together separated calls across arousal categories. In rhesus macaques, high arousal was associated with increased and more variable fundamental frequencies, increased amplitudes in the lower frequencies, and a shift in formant locations. In African elephants, increased arousal was associated with a shift of energy from lower to higher frequencies. In addition, low ranking females expressed a greater magnitude of acoustic change compared to high ranking females. The suite of acoustic features used here may successfully characterize arousal state in a variety of mammals, but the specific acoustic features that reflect arousal and the specific pattern of acoustic response may vary by species and individual. [Work supported by Grant Nos. NIH CM-5-P40RR003640-13 and NSF-IIS-0326395.]

4:20

3pAB11. Antiphonal exchanges in female African elephants. Katherine Leighty, Joseph Soltis, Anne Savage (Education and Sci., Disney's Animal Kingdom, Lake Buena Vista, FL), and Kirsten Leong (Cornell Univ., Ithaca, NY)

Female African elephants (Loxodonta africana) engage in antiphonal exchanges of rumble vocalizations. In this study, female African elephants ($N=7$) housed at Disney's Animal Kingdom were outfitted with audio-recording collars and videotaped during 50 1-hour observation sessions