Center for Comparative and Evolutionary Biology of Hearing (C-CEBH)

What do bats, birds, ferrets, and fish all have in common? They are all enabling major progress in understanding the evolution of hearing, in determining how hearing affects behavior, and in developing cures for hearing problems.

At the University of Maryland’s Center for Comparative and Evolutionary Biology of Hearing (C-CEBH), experts from a wide range of disciplines study the auditory processes of animals to refine our knowledge of the structure and function of all auditory systems, including human hearing.

At C-CEBH, specialists in biophysics, brain imaging, molecular biology, computational modeling, and neurochemistry use state of the art electron microscopy, anechoic rooms, sound-proof suites, and intracellular recording devices to isolate and examine the complex auditory activities of different animals. These researchers are determining how hearing affects behavior and finding new cures for chronic human hearing problems.

This comparative/evolutionary approach is unique to the University and has made C-CEBH into a widely renowned world-class facility.

Cynthia Moss’ work with bat hearing explores the connections between sensory input and movement. The research demonstrates how animals choose sound-triggered behaviors by accessing sound memories in the brain.

Arthur Popper’s research with fish lends insight into the evolution of the human ear. His work will also help protect marine life from environmental threats.

Long-term auditory studies of ferrets have led Shihab Shamma to discoveries about how the brain adapts to experience, an ability called plasticity. His research has already improved hearing aids and may also one day help to cure deafness.

Robert Dooling is a nationally recognized expert in comparative studies of bird and human communication. His contributions include breakthroughs in our knowledge of how to reverse hearing loss.

C-CEBH is an integral part of the University’s Program in Neuroscience and Cognitive Science (NACS).
http://www.nacs.umd.edu/res/auditory.html

To the Bat Lab!

At the Auditory Neuroethology Lab, Cynthia Moss works with bats to understand how mammals integrate sensory input with physical responses. Bats are ideal subjects because they depend on their hyper-developed hearing to find food and avoid obstacles. In her BatLab, Moss conducts precision experiments to examine the fundamental principles of auditory information processing and adaptive behaviors.

The BatLab, a large anechoic flight room equipped with high speed digital cameras, captures the flight patterns of hunting bats. These patterns are then synchronized with the vocalizations bats emit while flying, thus revealing relationships between sound and action. The approach answers a number of key questions: How do mammals accumulate an auditory “data base” that provides crucial behavioral cues? How do biological systems perform complex signal processing, especially in terms of segregating, sorting, and re-integrating important information?
Dr. Moss’ research has isolated compartments of “specialization” in the vertebrate midbrain, a finding that could lead to new treatments for motor development problems.

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Understanding Auditory Evolution and Using Sound to Protect Marine Life

Arthur Popper, Co-Director of the C-CEBH, investigates the structure and function of both vertebrate and invertebrate auditory systems.

Popper's work with aquatic bioacoustics is offering new information about the evolution of hearing. Using a tank equipped with ultrasound speakers that mimic a variety of marine noises, he discovered that shad had a type of sonar detection system that enabled them to avoid a major predator, the echolocating dolphin. Combining this discovery with other knowledge about the ways fish react to sound can reveal important insights about the evolution of more complex auditory organs, like the human ear.

Dr. Popper also studies how sounds affect the movements of other fish and marine mammals. His findings help determine how to use sound to protect these organisms from dangers such as hydropower dams, intakes to power plants, and irrigation ditches. While considerable research exists regarding the effect of sound on marine mammals, much less so has been carried out in regard to fish and invertebrates. Dr. Popper's work redresses this imbalance.

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Ferrets and "Plasticity" as a Key to Improving Hearing

Shihab Shamma examines the connections between auditory systems and the brain to increase our ability to improve and even restore hearing.

In a long-term, multi-disciplinary study of ferret responses to sound, Shamma made critical discoveries about neural plasticity, or how the brain adapts to experience. For example, the brain works in one way to listen passively to the chatter of friendly ferrets, but it works differently to "segregate" specific "conversation" from a "stream" of other sounds. Shamma has also developed special microsensor systems for demonstrating how certain long-term adaptations in ferrets enhance sensitivity to critical sounds, such as those that signal danger.

Dr. Shamma 's research in other, related areas has numerous exciting applications. He has developed cochlear processing chips for robotics, sensors for improving computer speech recognition, and models for predicting the acoustic quality of architectural designs. He also works with soldiers at Walter Reed Hospital to improve the precision of hearing aid filters.

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Birds as a Key to Restoring Hearing and Speech

While we learn much about people from studying animal models, only humans speak, a fact that has limited our study of speech perception and hearing.

But birds sing. And they learn to sing like people learn to talk, by listening, memorizing, and repeating. Robert Dooling fuses these similarities to gain insight into human communication, speech perception, and hearing loss and regeneration.

Dooling's work has shown that both hearing and the resulting inability to sing can be reversed in birds. Like mammals, birds have sensory hair cells in the ear. When these cells are damaged, hearing loss occurs. In birds, however, those cells not only regenerate, but they also regain function. Using a sound deadened acoustic chamber, Dooling examines this phenomena by training birds to peck highly sensitive micro-switches when they detect auditory changes. His examinations into hearing regeneration could one day help lead to a cure for human deafness.

Dr. Dooling's research focuses on many other critical audiological concerns, including how we discriminate among sounds and the effect of environmental noise on hearing.

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