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Ear implants resound in deaf cats' brains

The outer layer, or cortex, of a young brain exhibits a remarkable knack for reorganizing itself in the wake of injury or new experiences. In the latest example of this neural shiftiness, kittens born deaf due to an ear abnormality were then exposed to sounds through an ear implant. The animals sustained brain changes that rendered them able to perceive sounds about as well as cats with full hearing do.

The findings help to explain why kids who are deaf from birth can often learn to hear and speak using devices known as cochlear implants, according to a team of neuroscientists led by Rainer Klinke of the University of Frankfurt in Germany. In contrast, adults who have been deaf from birth generally find such implants useless, apparently because their brains no longer respond with sufficient flexibility to piped-in sound stimulation.

Deaf kittens given the chance to hear by using ear implants display marked alterations of electrical activity in the auditory cortex, a brain region devoted to sound perception, the researchers say. Nonetheless, the organization of the auditory cortex in these cats differs from that of felines who have heard meows, electric can openers, and other vital sounds from birth.

Klinke's group placed ear implants in six deaf-from-birth kittens, all 3 to 4 months old. The animals lacked part of the cochlea, a swirly tube in the inner ear that transforms sound waves into electrical signals carried by auditory nerves.

Each deaf kitten received continuous, environmental sound input through a microphone and sound processor connected by a wire to the cochlear implant, which electrically stimulated the auditory nerves. The animals moved about freely.

Immediately after the cats received implants, sounds elicited reflexive outer-ear movements that are controlled by the brain stem. To reinforce a reliance on artificially provided sounds, the researchers taught the kittens to take a food pellet from a dispenser after the delivery of a tone with a specific frequency.

Within 1 to 3 weeks, the animals consistently retrieved food pellets when exposed to the tone. They also reacted spontaneously to other sounds, the researchers report in the Sept. 10 SCIENCE. For instance, they responded to voices and awoke to the clang of loud sounds.

Electrical activity in the auditory cortex changed markedly as the kittens' sound perception improved. The investigators made measurements via electrodes inserted through surgical openings in the skull. They recorded activity after 1, 2, and 5 1/2 months of sound stimulation.

As the kittens gained experience with sounds, electrical activity covered successively larger brain areas. By the end of the study, kittens exhibited auditory-cortex responses that signal complex sound perception. Although overall activity did not mimic that of cats with full hearing, responses far exceeded those of five deaf-from-birth kittens who received cochlear implants but no incoming signals.

Two kittens with normal hearing also received stimulation through ear implants after a substance applied to the cochlea temporarily deafened them. The brain area activated in these animals was smaller than that in the experimental kittens. While temporarily deaf, the animals did not react to sounds transmitted via the implant, suggesting that the cortex of deaf-from-birth kittens undergoes alterations that allow for later artificial sound perception, the researchers theorize.

Even if cochlear implants provide electrical stimulation unlike that delivered during normal hearing, "the brain is clever enough to figure out the rest," comments neuroscientist Josef P. Rauschecker of Georgetown University Medical Center in Washington, D.C., in the same journal. "The Klinke study shows that the remarkable plasticity of the auditory cortex in young individuals is a major factor in this process."

—B. Bower