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### Though volume drops, hearing loss continues

Abram Katz , Register Science Editor

#### **Kids who listen to high-volume MP3 players and go to ear-shattering rock concerts sustain short-term auditory damage start a neurological chain reaction that continues to cut off sound.**

Dr. Kent Morest, professor of neuroscience at the University of Connecticut Health Center, hypothesizes that overworked hearing sections of the brain responsible for making sense of sounds. Consequently, hearing loss worsens over time even with additional exposure to loud sounds, Morest asserts.

Not all hearing specialists agree with Morest's theory, but almost all warn that today's booming earbuds are apt to leave a future generation of adults hard of hearing.

Sound begins as waves of air pressure that vibrate the eardrum. Three tiny bones transmit the vibration to the cochlea, snail-shaped organs in the inner ears that convert mechanical movement into electrical signals.

Each cochlea is lined with "hair" cells and filled with fluid. As the fluid vibrates it pushes the hairlike projections back and forth.

The stimulated cells send signals to the auditory cortex in the brain, which interprets sound.

Noise can damage hair cells by bending them too far. While this is happening, the cells release abnormally large amounts of the stimulatory neurotransmitter glutamate, Morest said. Glutamate at high levels is toxic to cells. The hair cells are damaged by glutamate and recent research suggests that the cells self-destruct, Morest said.

"Often, there is more hearing loss than the hair-cell loss would predict. A tiny amount of damage causes no hearing loss, but a great amount of damage causes a great amount of hearing loss," he said.

This is because minor hair cell loss, and the release of glutamate, can cause more severe nerve damage, Morest said. Specifically, synapses, where signals are passed from neuron to neuron, degenerate, he said.

Electronic cochlear implants can restore hearing if a sufficient number of synapses survive, Morest said.

These synapses are concentrated in a structure in the brain stem called the cochlear nucleus. The nerve center has excitatory and inhibitory neurons. The two sets of neurons normally balance each other. Morest believes, however, that noise damages the inhibitory neurons then become hyperactive.

One result is a condition called tinnitus, or ringing in the ears.

The excitatory neurons also cause a build-up of glutamate, which, Morest suspects, causes some people with hearing loss to be paradoxically sensitive to loud sounds.

"We discovered that once exposure to noise causes hearing loss, it gets worse over time without any additional exposure," Morest said. "This is bad, bad news."

Morest said people who habitually listen to MP3 players think: "I lost a little hearing, big deal." He added, "I'm afraid it could be a very big deal."

Morest considers hearing loss to be a neurodegenerative disease, and a difficult one to treat.

"Cell toxicity is hard to deal with," he said. Glutamate cannot be inhibited because it would cause havoc in other parts of the brain.



One possible approach is transplanting stem cells into the auditory system to restore the damaged neurons, he said. "We're working on ways of growing embryonic stem cells to transplant into animals, and eventually, perhaps, into people," he said.

Dr. Elias Michaelides, director of the Yale Hearing and Balance Center, said Morest's theory may apply to specific, narrow kind of hearing loss.

Susceptibility to hearing loss has a large genetic component, he said.

The cochlea are wider at the base and taper at the tips. Sound frequencies resonate at different places within the rolled-up tubes. The tubes are lined with a surplus of hair cells, he said.

The extra hair cells are the first to go when chronically exposed to loud noise. Eventually, the spare cells are used up and the inner cells start to self-destruct, at which time hearing loss begins.

Most ringing in the ears is caused by some degree of hearing loss, Michaelides said. However, ears try to compensate for loud sounds which is why ears ring temporarily after a loud rock concert. "Hair cells become overworked. Then they recover," he said.

Parents who are concerned about their children's ears should monitor the amount of time spent listening, and the volume. Sound software is now available for iPods and other MP3 players now offer similar features, he said.

Most people gradually lose hearing in the higher pitches, said Nancy Bruno, clinical audiologist at Yale-New Haven Hospital.

Subways, lawn mowers, power tools, auto engines, highly amplified music and other typically American sounds practically guarantee that most people 60 and older have some degree of hearing loss, she said.

Fortunately, speech covers a wide range of frequencies and the brain is able to fill in a lot of blanks.

So, there could be some hope for adolescents with permanently implanted ear buds.

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