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More noise than signal

Some data suggest that portable music players may damage hearing, but it will take years to settle the issue. In the meantime, it would be prudent to pursue educational efforts to help users choose their volume sensibly.

Tens of millions of portable mp3 players have sold in the past few years. We can now carry entire music collections in our pockets to entertain us while traveling or during long hours in laboratories and offices. These toys may have a sinister side, though.

Audiologists have reported cases of unprecedented noise-induced hearing loss in young people, with the most plausible explanation being long-term exposure to loud music through earphones.

Hearing experts raised similar concerns in the early 1980s, when portable cassette players entered the market, but long-term studies have not revealed any hearing loss attributable to these devices. Nevertheless, William Martin from the Oregon Hearing Research Center cautions that current mp3 players are likely to be played louder and longer because they store much more music, produce less distortion at high volumes and have longer battery life than older players. In addition, hearing perception adapts to noise. The temptation to crank up the volume is greater in noisy environments, increasing the risk of potentially dangerous exposure.

Animal studies and human epidemiology leave no doubt that loud noise can damage hearing by killing sensory hair cells, especially those that respond to high pitches. Hair cells do not regenerate in mammals, so losses are permanent. Based on this research, the National Institute of Occupational Safety and Health (NIOSH), part of the US Centers for Disease Control, issued stringent workplace noise recommendations in 1998. Exposure to 85 decibels (dBA) is deemed safe for up to eight hours per day. Every three additional decibels cut the safe exposure time in half, as the decibel scale is logarithmic. At a recent conference, Cory Portnuff and Brian Fligor reported that all common mp3 players can produce sound pressure levels of more than 100 dBA using their stock earbuds (<http://www.hearingconservation.org/docs/virtualPressRoom/portnuff.htm>). The NIOSH recommends no more than 15 minutes daily exposure to such sounds.

Noise-induced hearing loss typically takes many years to manifest, and portable mp3 players are relatively new on the market, so no solid data links the new players to hearing loss. Experts' estimates of potentially affected users vary greatly, from 0.5% to up to 20%. Charles Liberman, Director of the Eaton-Peabody Laboratory at the Massachusetts Eye and Ear Infirmary, believes that available data do not allow any serious estimate. He argues that nearly all studies of hearing loss in young people (typically schoolchildren or military recruits) rely exclusively on pure-tone audiograms that would not reflect more complex loss of hearing discrimination. Individual susceptibility to noise-induced hearing loss is highly variable, and this variability

is poorly understood. In a longitudinal human study, pre-existing noise-induced hearing loss seems to exacerbate age-related hearing loss¹. Similarly, in mice, exposure to 100 dBA for 2 hours at 4–8 weeks of age (adolescence), but not after 16 weeks of age, triggers delayed degeneration of cochlear neurons—not hair cells—in the same mice at advanced ages².

Thus, the epidemiological extent of hearing loss induced by mp3 players remains unclear, but they can achieve sound levels that are considered dangerous for industrial noise. Unfortunately users of personal music players cannot determine how many decibels pound their eardrums, as this depends on the music's dynamics, the volume setting and the earphones used. Apple Inc., whose iPods hold about 70% of the market, last summer amended its software to allow users to set an upper limit on iPod volume. This move may be related to a lawsuit filed a few months earlier, alleging that the company knowingly and with insufficient warning sells devices that endanger customers' hearing (<http://hbsslaw.com/frontend?command=Lawsuit&task=viewLawsuitDetail&iLawsuitId=1101>). Although the volume limit is not perfect (it is easily overridden and does not give listeners decibel information), it should help to guard against

maximal loudness. We hope other makers of personal audio devices will follow suit. Other technical options might involve signaling users when volume and/or listening time enter the potential danger zone.

For now, education is probably the best way to minimize possible damage to hearing from these devices. James F. Battey, Jr., Director of the National Institute on Deafness and Other Communication Disorders, shares this simple rule of thumb: turn the music down if you cannot understand a person at arm's length distance. (This rule will not work with noise-reducing headphones, however.) Martin, in collaboration with the Oregon Museum of Science and Industry and others, has developed Dangerous Decibels®, a public health and outreach campaign about hearing loss aimed mainly at teenagers and schoolteachers. Jolene, the fashionable lady in the photo, was built by his daughter Genna Martin. Jolene sports life-like rubber ears with microphones inside connected to a \$50 sound level meter from RadioShack—a setup that allows reasonably accurate measurement of the decibels sent into the ear canal by individual players. Jolene would be a great science project for any middle school, and also a draw at street fairs—where adults, too, could see what they may be doing to their ears.

1. Gates GA, et al. *Hear Res.* **141**, 220–228 (2000).
2. Kujawa SG, & Liberman MC. *J. Neurosci.* **26**, 2115–2123 (2006).

View more background material on Connotea at <http://www.connotea.org/user/NatNeurosci/tag/editorial200707>.



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Erratum: More noise than signal

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In the version of this article initially published, the name Genna Martin was misspelled, and an incorrect URL link was included. The correct link is <http://hbsslw.com/frontend?command=Lawsuit&task=viewLawsuitDetail&iLawsuitId=1101>. This error has been corrected in the PDF version of this article.