



The Hearing Conservation Workshop

Teaching hearing awareness to the
audio, music and hearing science communities

The Hearing Conservation Workshop

With support from:

Columbia | School of
COLLEGE CHICAGO Audio & Music

ETYMŌTIC "true to the ear"

**HOWARD
LEIGHT** 
by Honeywell



Sensaphonics[®]
Hearing Conservation

 **SENNHEISER**

SHURE[®]

And on behalf of:

NHCA | The National Hearing
NATIONAL HEARING CONSERVATION ASSOCIATION Conservation Association



AES Technical Committee
Hearing and Hearing Loss Prevention

Hear Tomorrow seeks to educate and promote awareness of hearing and damage caused by continued exposure to loud sounds. Hear Tomorrow acknowledges the unique pleasures that sound gives us, but also the need for individuals to take responsibility to care for what is one of our least understood senses. We want to encourage everyone to continue to enjoy sound in all its beauty and diversity, but without forgetting safety.

We live in an increasingly noisy world. We are constantly bombarded by sounds both pleasant and unpleasant. But *any* sound is potentially damaging if it is loud enough. Worse, we often try to drown out “noise” with sounds we like; a classic cause of hearing loss.

Most workplaces are under the scrutiny of government regulation to maintain safe noise levels for workers. Management and employees are educated about the hazards of noisy environments and instructed in effective methods of hearing protection.

No such attention is given to sound levels in entertainment or recreation, and noise hazards certainly exist outside the workplace. Concerts, dance clubs, sporting events, and many forms of outdoor recreation pose a threat to our hearing. With no regulation, it is up to us to be aware of the potential hazard and take steps to protect ourselves.

HearTomorrow.org is dedicated to communicating this issue to those who will be in the best position to act as role models of “sensible listening” to the general public. Through this touring seminar/workshop, students, teachers and professionals in the audio, music and hearing science communities around the country will be invited to better understand hearing, hearing disorders, and hearing conservation.

This is a daunting challenge for us all.

We are no more ready to jump into a totally hearing-safe world than we were ready to enter a smoke-free world in the mid-60’s when warnings went on packs of cigarettes. But we can begin the process of respecting our ears and limiting hearing injury. We will find new ways of analyzing and managing volume levels that are less taxing but every bit as satisfying.

And so, this initiative is dedicated to better learning, better hearing, and better sound.

About the Workshop

The “Hear Tomorrow” workshop offers a new approach to promoting awareness of the ever-increasing problem of noise and music-induced hearing loss. This program is specifically targeted to students and professionals in audio, acoustics, music and the hearing sciences. Because many of the principles and theories of the hearing mechanism are the same as those governing music, audio and acoustics, these groups have an easy time understanding this information. In addition, they are quick to understand the importance of developing their own safe listening habits, and equally quick at developing sensitivity to and concern for the health and safety of their clients and the listening public.

The workshop is a 1.5-hour presentation, including images and animations reflecting the latest in hearing research. It is divided into three distinct but interrelated units. The first unit focuses on hearing physiology, providing a basic understanding of how the ear translates acoustic energy (via hair cell transduction) into what we perceive as sound. This leads to the second unit, hearing loss, which addresses the mechanics of noise-induced loss. Finally, the unit on hearing conservation examines currently accepted noise exposure limits and, ultimately, what can be done to protect hearing. We look at everything from the latest developments in “high-fidelity ear plugs” to concert in-ear monitoring systems, both of which are finding a high degree of acceptance in the professional audio and music performance industries.

The Workshop receives occasional funding from institutions that support such missions, otherwise it is totally self-funded, relying on hosts to help with travel and other expenses.

Please feel free to write to us to discuss hosting a workshop, or if you would like a Hearing Conservation Workshop information packet.

The Ear's Three Sections

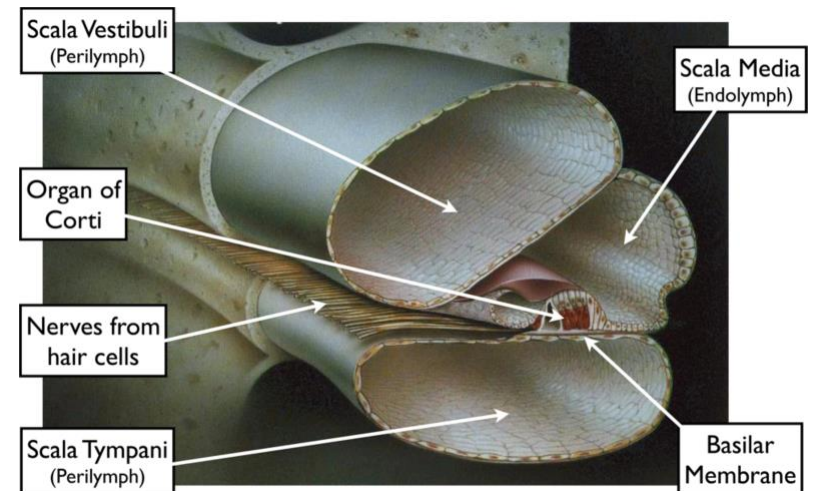
Gross Division	Outer Ear	Middle Ear	Inner Ear	Auditory Nervous System
Anatomy	pinna concha external auditory canal	malleus incus stapes tympanic membrane	semicircular canals vestibule vestibular n. cochlea round window eustachian tube	facial n. cochlear n. internal auditory canal
Mode of Operation	Air Displacement	Mechanical Displacement	Hydraulic Displacement Electrochemical (cellular)	Electrochemical (neural)
Function	Amplification Protection Localization	Impedance Matching Protection Pressure Equalization	Filtering Amplification Transduction	Information Distribution & Processing

Outer Ear: Acoustic amplification and coding for localization. Here, acoustic energy is delivered to the tympanic membrane.

Middle Ear: Impedance matching [air to fluid] and limited protection from loud sounds. The energy is now mechanical, delivered from the tympanic membrane to the fluid-filled cochlea.

Inner Ear: Frequency & Amplitude analysis. The cochlea converts the now hydraulic/fluid energy into neural signals for the brain to "interpret".

Inside the Cochlea

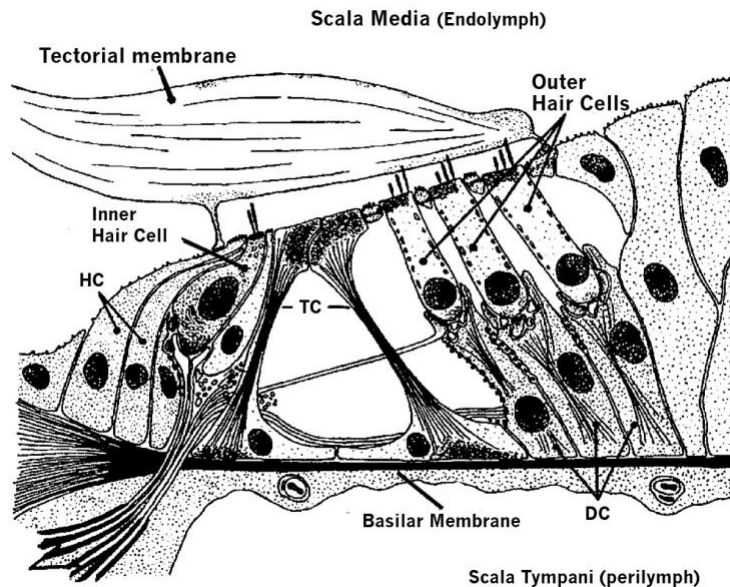


The basilar membrane responds to different frequencies at different points along its length.

The hair cells in the Organ of Corti, above each section of the basilar membrane, are then "stimulated" and send the "amplitude value" of that frequency range to the brain.

The cochlea works like a real-time analyzer, sending amplitude-per-frequency-band information to the brain.

Hair Cells In the Organ of Corti



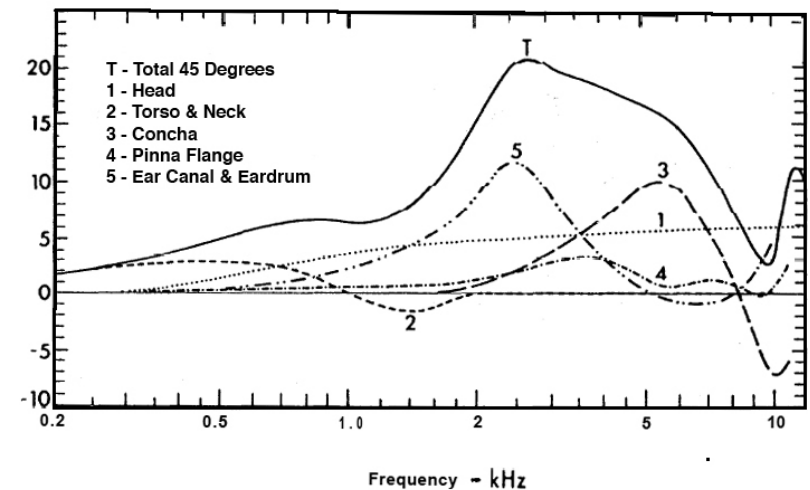
Hair cells are “activated” when their stereocilia are pushed back and forth by the movement of the basilar membrane. Nerve endings, connected at the cell bases, connect to the brain.

The inner hair cells actually do the “hearing”, sending information to the brain.

The outer hair cells mechanically amplify, enabling us to hear the quieter sounds in our environment.

Noise trauma first damages the stereocilia of the outer hair cells. So, damage first results in not being able to hear those quieter sounds. Severe trauma (explosions) can damage inner hair cells as well.

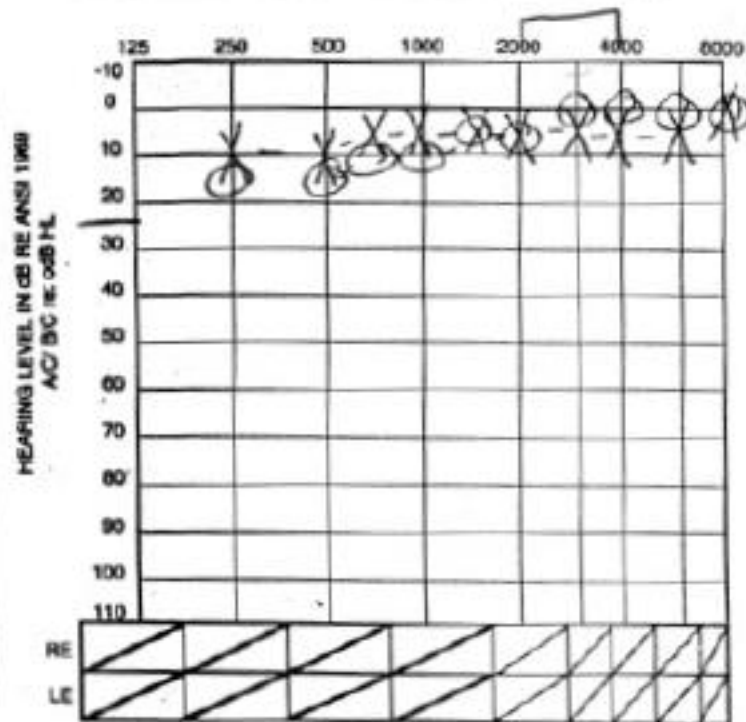
Acoustic Gain of the Outer Ear



This graph shows the actual amplification generated by the physical shapes of the pinna contours (concave resonator) and the ear canal (resonating tube). This produces a boost at frequencies between 2 kHz and 6 kHz.

This is the reason we see the “noise notch” in audiograms of people suffering from noise-induced hearing loss. The greatest loss will be seen across these same frequencies.

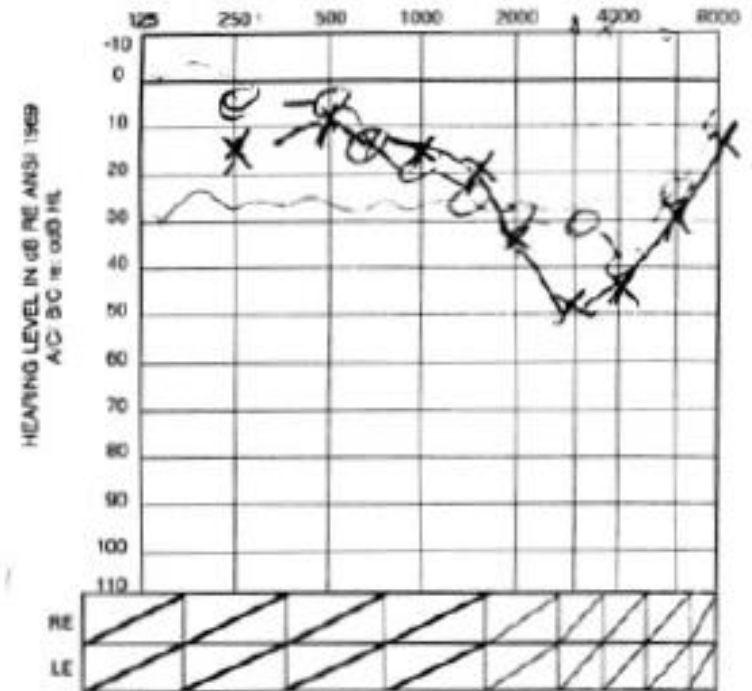
The Audiogram



This is an audiogram of a healthy set of ears.

“X” is for the left ear and “O” for the right. A mark on the “zero” line means that the patient can hear that frequency all the way down to the clinical “threshold of hearing”. Readings down to 25 dBHL (“Hearing Level”) are considered “nominal”. Readings below 25 dBHL are considered “impaired”.

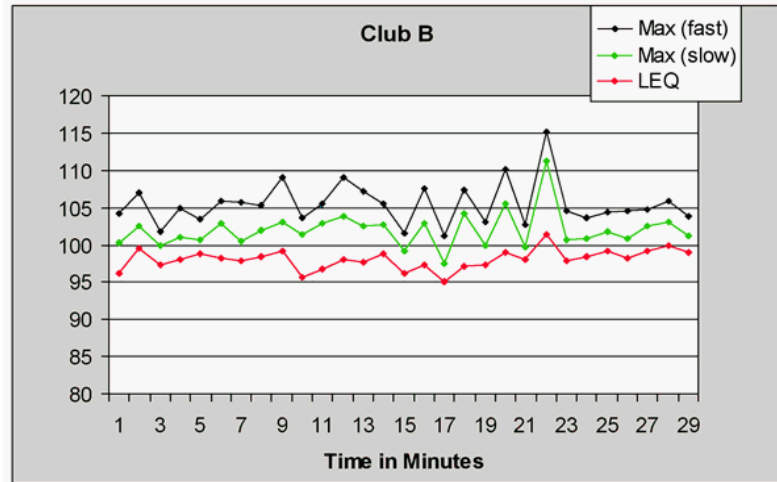
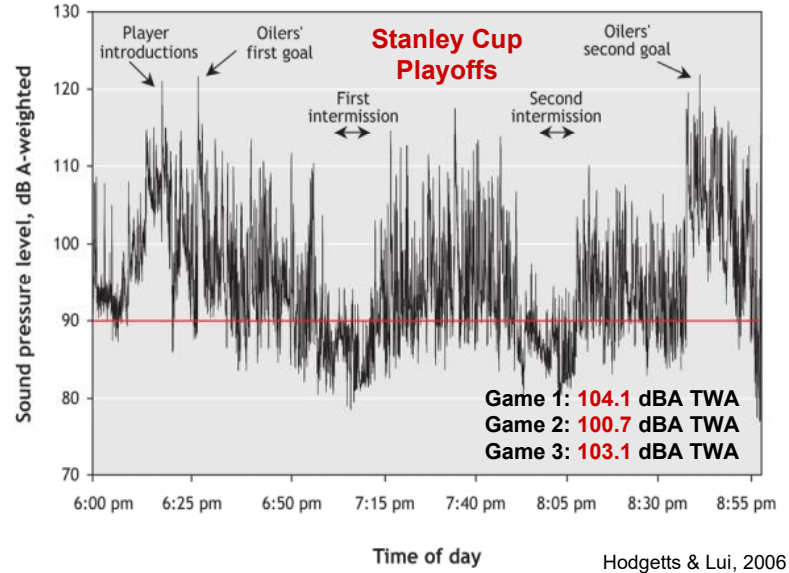
Music-Induced Hearing Loss



An audiogram of a musician with hearing loss

This is the audiogram of a drummer with 20 years experience playing in a nationally recognized band. Note the additional loss in the left ear. Typically, a drummer’s monitor speaker is on the left, behind the high-hat cymbal. The left ear has suffered more damaging exposure than the right.

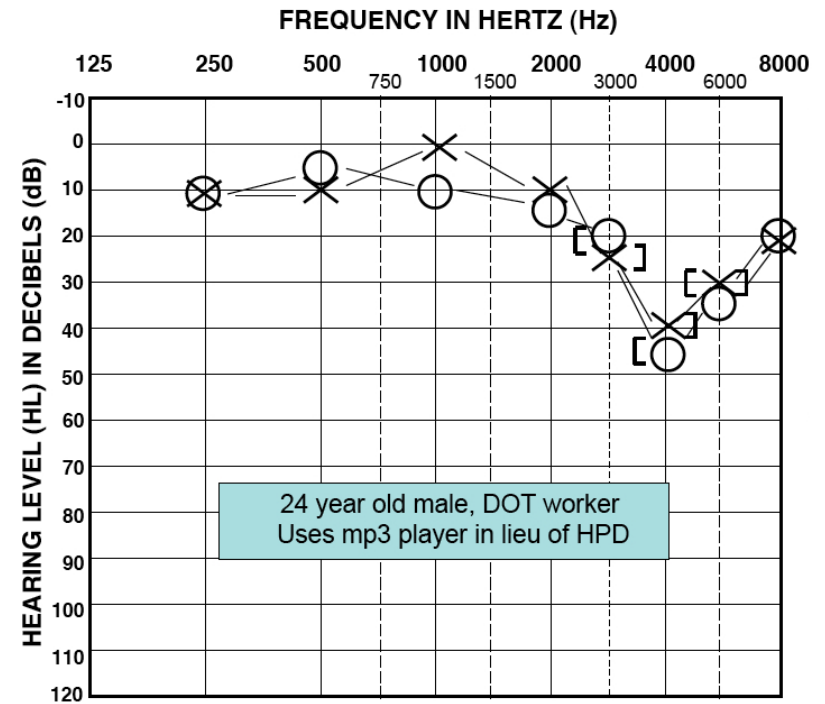
Entertainment



Popular Chicago Dance Club (Nichols et al, 2004)

**Safe exposure time at 95 dBA is one hour,
At 100 dBA, it's 15 minutes.**

Damage from Improper use of Earbuds



This person turned up his music player to drown out the noise of his workplace. He has suffered enough loss to be a candidate for hearing aids.

The danger of earbuds is that they allow ambient noise through, to the ear. Users generally raise the volume of the player to be louder than the ambient noises. The music is now at a dangerous level. A noisy subway train will be in the range of 90 to 95 dBA. It will take an average increase of 3 to 6 dB to make the music "loud enough".

Sound Exposure Limits

A combination of time and intensity

Average intensity in dB SPL, A-weighted
NIOSH figures are calculated “safe” for 97% of the
study sample (1968-1972 study).

OSHA figures are calculated safe for 75% of the same
study sample for industry compliance.

	NIOSH	OSHA
Exposure Time	dBA	dBA
8 hrs	85	90
4 hrs	88	95
2 hrs	91	100
1 hr	94	105
30 min	97	110
15 min	100	115
7.5 min	103	NOT SAFE
3.75 min	106	
< 2 min	109	
< 1 min	112	

Sound Measurement



The Gedaye
Sound Level Meter.

Average retail:

\$20



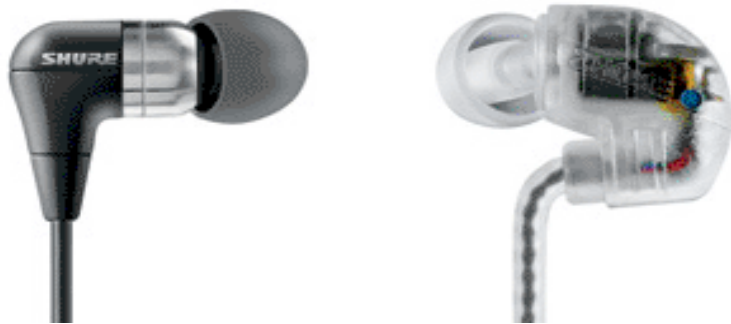
The *Sensaphonics*
“dB - Check”

Real-time in-ear monitor
sound level meter

With calibration settings
for many models of IEM’s

Also gives remaining
safe exposure time, by
NIOSH or OSHA criteria

In - Ear Monitors



Generic

Musician's Earplugs



Generic

Custom Molded



Custom Molded



3DME In-Ear Monitors with Smart Phone Control

Organizations

THE NATIONAL HEARING. CONSERVATION ASSOCIATION

To prevent hearing loss due to noise and other environmental factors in all sectors of society. We strive to accomplish this mission through a variety of strategies. Some of these strategies are:

- To provide professional development by improving the skills, practices, and services of the members of the Association
- To provide education and encourage research in noise and hearing conservation
- To stimulate the exchange of information among those involved with hearing conservation
- To promote the development of improved and more effective occupational hearing conservation programs
- To develop guidelines and monitor and participate in standards, regulatory, and legislative activity
- To advance the role and position of NHCA members as providers of hearing conservation services.

www.hearingconservation.org



AES Technical Committee

Hearing and Hearing Loss Prevention]

- Raising AES member awareness of the normal and abnormal functions of the hearing process
- Raising AES member awareness of the risk and consequences of hearing loss resulting from excessive sound exposure
- Coordinating and providing technical guidance for the AES supported hearing testing and consultation programs at US and European Conventions
- Facilitating the maintenance and refinement of a database of audiometric test results and exposure information on AES members
- Forging a cooperative union between AES members, audio equipment manufacturers and the hearing conservation communities for purposes of developing strategies, technologies, and tools to reduce and prevent hearing loss

www.aes.org/technical/hhlp/

Flat-attenuation earplugs by Etymotic and Howard Leight.

Both available in two sizes through many on-line retailers



Etymotic Research ER-20 "Ety-plugs"
Average retail \$15.00
www.etymotic.com

flat to 8 kHz



Howard Leight 1005329 "Clarity" plugs
Average retail \$4.00
www.howardleight.com

flat to 4 kHz

Workshop Hosts

2008 - 2025

Audio and Music Programs

New York University (14)
University of Michigan (2)
Michigan State University
Northwestern University
University of Chicago (2)
Penn State University
Syracuse University
University of Massachusetts @ Lowell
Berklee College of Music (2)
Southern Illinois University at Carbondale (4)
Northern Illinois University
University of Illinois @ Chicago
Loyola University, New Orleans
Concordia University Chicago
Columbia College Chicago (3)
University of Louisiana, Lafayette
Webster University
Metro State Univ. Denver
New England School of Communications (2)
University of St Thomas, St Paul MN

Audiology Programs

Indiana University (2)	University of Connecticut (2)
University of Florida (2)	City University of New York
University of Cincinnati	Rush University
Illinois State University	Univ. of Northern Colorado
Univ. of Colorado Boulder	Purdue University

Other

South By Southwest Music Conference – 2015 & 2017
Performing Arts Medicine Association – 2013 & 2016
American Academy of Otolaryngology – 2017 & 2018
Ann & Robert H Lurie Children's Hospital of Chicago
Illinois Academy of Audiology - 2015
Pennsylvania Academy of Audiology – 2010 & 2012
Mid-Atlantic Hearing Expo – 2011 & 2013
National Hearing Conservation Association Conferences
2009 – 2012, 2014, 2016 – 2020, 2025
American Medical Society of Sports Medicine - 2014
PopAkademie Baden-Wuerttemberg, Mannheim, Germany
United States Army Bands @ Ft Jackson & Ft Riley
2009 World Forum for Acoustic Ecology
Audio Engineering Society Conventions
New York City, 2009 & 2015 London, 2010, San Francisco, 2012
Audio Engineering Society Chapters – Chicago & New York

HearTomorrow Links

National Hearing Conservation Association

Specialists in hearing science, measurement and protection, as well as government agencies dedicated to promoting hearing health.
www.hearingconservation.org

Sensaphonics “Respect Your Ears”

Audiology clinic as well as developer/manufacturer of custom earplugs and in-ear monitor systems for musicians and engineers.
Known as “audiologist to the stars” Check out their music client list.
www.sensaphonics.com

Earlove

A wonderful company, offering the best quality, generic high-fidelity earplugs by Etymotic in a great aluminum key-fob carrying case.
www.earlove.net

Etymotic / Lucid Audio

Specializing in hearing products, including musicians’ earplugs (both generic and insert filters for custom-molded plugs) and in-ear monitors.
www.etymotic.com

Howard Leight by Honeywell

Manufacturer of hearing protection products for both industry and consumers. Makers of the excellent and inexpensive “Clarity” earplugs.
www.howardleight.com

Musicians’ Clinics of Canada

Site by Drs. Marshall Chasin and John Chong helping musicians develop healthy hearing practices, understand and cope with hearing disorders.
www.musiciansclinics.com

Aearo Technologies / 3M

Manufacturers of many types of hearing protection systems; well known for their “EAR” yellow foam plugs. This site has lots of information on hearing loss and protection.
www.e-a-r.com

H.E.A.R.

California-based site dedicated to building awareness of hearing and hearing loss issues for musicians and music lovers. Founder and colleague Cathy Peck has built a great site with a host of excellent resources and links.
www.hearnet.com

Teaching Resources

Videos, animations and books used by HearTomorrow
for the Hearing Conservation Workshop

Additional images and slides are available.
contact Benj@HearTomorrow.Org



“Auditory Transduction”
Animation video by Brandon Pletsch
Available on YouTube

Basilar Membrane “Bach Animation” link
<http://lab.rockefeller.edu/hudspeth/graphicalSimulations>

“Can’t Hear You Knockin”
and “Listen Smart”
DVDs available through www.hearnet.com

Hearing Loss in Musicians:
Prevention and Management
by **Marshall Chasin, et al**

The Bases of Hearing Science
by **John Durrant & Jean Lovrinic**
Out of print but available through Amazon.com

Introduction to the Physiology of Hearing
by **James Pickles**

This is Your Mind on Music –
The Science of a Human Obsession
by **Dan Levitin**
A brilliant look at how the brain “decodes” music.

Of Sound Mind by **Nina Kraus**
A wonderfully easy to read book by the leading researcher on
aural processing.

Contact Us

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Playing Through the Pain

Sometimes the love of the game blocks the pain.

We all just do what we do...

**Sometimes because we just don't have
the information...**

**Sometimes because we don't like
the information...**

**And sometimes it's a conscious decision to ignore
the information....**

Funny the choices we make in life.

• Mary Novak