Hearing For your Career:  
Education, Tips & Tools  

Sara Neumann, Au.D., CCC-A

What I do...  

Audiology Consultant to Drum Corps Medical Project  
Promote hearing conservation in music programs  

Music background  
High School  
College  
Drum Corps

An Overview

Purpose/Rationale  
How we hear  
Noise/Loud Music  
Music Induced Hearing Damage  
Ways to protect yourself

Invest Now

Optimal time to protect your hearing is when you are young

How We Hear...
Your Cochlea is **TONOTOPICALLY** arranged... its almost like it is it's own instrument

**Note to Frequency**

- A = 440 Hz (on second space of treble clef)
  - An octave above is 880 Hz
  - An octave below is 220 Hz
- Middle C = 262 Hz
- Top note on piano keyboard “C” = 4186

**Even more Amazing...**

- The ear as a “sound enhancer”?
- Designed to
  - Boost treble notes
  - Damp very low-frequency bass notes
  - Protection from overly intense sounds
  - Sound “translator” that takes sounds and interprets them

**The Good...and the Bad**

[Image of healthy and damaged hair cells]

**EAR OR BRAIN?**

- Speaker analogy
- You hear with your brain, your ears are just the way in...
- With damage, what can your brain do or not do with that signal that you rely on.

[Image of brain plasticity: Younger and better hearing, the easier it is to adjust]
Music & the Ear

- Sound is measured by decibels (dB)
  - dB SPL (sound pressure level) (AKA dB C)
    - Treats all frequencies the same
  - We measure noise and music in dB A
    - Estimates what actually gets through to the cochlea
    - Especially for music with significant low-frequency energy

Noise

- “Noise” = loud levels of sound in our lives.
  - Different meanings for different people
  - Leq= average of sound intensity over a period of time.

LOUD SOUNDS IN OUR SOCIETY

- *Normal conversation speech ~ 50-60 dB
- - 85 dB = busy city traffic
- - 95 dB = lawnmower, hairdryer
- - 115 dB = leaf blower, rock concert, chainsaw
- - 135 dB = jet plane from 100 ft
- - 145 dB = other gunshots, fireworks
- - 165 dB = 12 gauge shot gun

Sound levels

- If normal conversational speech is 60 dB and...
  - A lawnmower is 95 dB
  - A rock concert is 115 dB
- What about a snare drum?
  - Alto Sax?
  - Trumpet?
  - Piano?

http://www.etymotic-media.com/sliderule/
Dynamics Meets DECiBELs

- Loose representations of decibels to dynamics (a range)
  - **ppp** = 40-50 dB SPL
  - **pp** = 45-55 dB SPL
  - **p** = 50-60 dB SPL
  - **mf** = 55-70 dB SPL
  - **f** = 70-80 dB SPL
  - **ff** = 80-90 dB SPL
  - **fff** = 90-110 dB SPL

Exposure:

It’s ABOUT HOW LOUD (Intensity) and HOW LONG (DURATION)

- **85 dBA** = 8 hour dose
- This is given in "dose percentage"
  - 100% is the acceptable dose percentage.
  - Over 100% = at risk for noise induced hearing loss (NIHL)

Calculating Safe Sound level exposures

For every 3 dB you add, you cut your exposure time in half

- 85 dBA = 8 hrs
- 88 dBA = 4 hrs
- 91 dBA = 2 hrs
- 94 dBA = 1 hr
- 97 dBA = .5 hr

Exposures that are considered illegal in the workplace are accepted as commonplace in educational environments.

- Keefe, 2004

Noise Doses HS Band Directors

- 5 Band directors in NE Illinois
  - Used ER200D during normal day of teaching + extracurricular ensembles
- All directors exceeded recommended noise doses (re: NIOSH)
  - 3.4x, 7.3x, 11x, 14x and 20x
Music Induced Hearing Damage

Myths

“If it doesn’t hurt then I’m ok.”

“My hearing came back, I’m ok” (i.e. after a concert).

“But I’m young!”

How does hearing loss happen?

Exposure time +
Average and peak sound levels =

Hearing Damage

Hearing loss due to
• exposure to loud levels of sound for prolonged periods of time or
• repeat exposure to impulsive sounds.
• Changes are subtle over time

What happens?

• Prolonged exposures create exhaustion in the auditory system
• Hair cells degenerate b/c they don’t receive proper oxygen and blood flow.
• Once this damage is done, there is no going back!

(Shargorodsky, J. et al., 2010)

Amplified music/Loud sound & hearing damage

• Measurable changes in hear ability can be seen after less than 90 minutes of listening to amplified music
• Changes in hearing thresholds resolve, but physiologic damage persists
  • Linked to perceptual changes including tinnitus, dyplacusis, and hyperacusis
  (Kujawa & Liberman, 2009)

Evaluating Hearing

Hearing Test - Audiogram

Measures your ability to hear sounds of varying pitch and loudness

Normal Hearing

Range of Normal Hearing

Moderate Hearing Loss

30 year old percussionist/music educator

SIGNS/SYMPTOMS TO LOOK FOR

- Ringing/buzzing in your ears (Tinnitus)
- Feeling of pressure/fullness in your ears
- Pain in your ears
- Voices and sounds seem muffled and softer after loud sound exposure (Temporary Threshold Shift {TTS})
  - Repeated TTS can result in a permanent shift in your hearing!

http://m.youtube.com/watch?v=OE5fIoveLoM
Study results (2010)

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<th>OAE results</th>
<th>% experienced</th>
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<tbody>
<tr>
<td>Passed Both Ears</td>
<td>30.4%</td>
</tr>
<tr>
<td>Passed Right Ear</td>
<td>30.4%</td>
</tr>
<tr>
<td>Passed Left Ear</td>
<td>10.1%</td>
</tr>
<tr>
<td>Failed Both Ears</td>
<td>29.0%</td>
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</table>

Neumann et. al (2013)

HOW CAN HEARING LOSS ADVERSLEY AFFECT YOU?

- Difficulty communicating with others
  - Hearing loss in the range where noise damage occurs affects your ability to understand speech over time.
- Difficulty with perceiving music/pitch
  - Diplacusis
- Hearing loss caused by noise cannot be fixed or cured by any means, even medication and surgery.

THE GOOD NEWS!

Noise-Induced Hearing Loss is 100% preventable!

WHAT CAN YOU DO TO HELP PROTECT AND CONSERVE YOUR HEARING?

- Annual hearing evaluations
- Wear hearing protection (i.e. earplugs or custom-made ear pieces for earbuds & microphone systems.
- Limit the amount of time in noisy environments
  - take “quiet breaks” if you can.
- Distance yourself from the source of the noise if possible (i.e. speakers).
- Doubling your distance from the sound source = reduced sound by 6dB!

The “ability to make changes and the responsibility for doing so belong to the person who holds the baton”

– Chesky, 2008
Hearing Protection

- Earplugs
  - Foam
  - Non-custom musician’s earplugs
  - Custom-musician’s earplugs

Dosimeters

Hearing Protection for MUSICIANS

- Not all created equal
- Risk of Hearing Damage from Lack of Low-Frequency Attenuation [Killion & Haapapuro, 2015]
- Know your product
  - NRR (required by the EPA)
    - Only required on non-custom products
    - Formula that estimates minimum amount of noise reduction achieved by 98% of lab subjects
    - Pay attention to averages as well
  - Response curves/specifications

Non-custom musician’s earplugs

- Specially filtered for even frequency response (flat frequency attenuation).
- (18-22 dB reduction)
- Reduce harmful sounds without distorting speech and music.
- Reduces noise, preserving sound quality; in effect, to turn down the noise but not muffle voices, environmental sounds or music.

What is filtered?

Custom Musician’s earplugs

- Sound quality is clear and natural
- Sound is not muffled
- Noise fatigue is reduced
- Fidelity is preserved
- Just the right amount of sound reduction
Earmolding Process

Not all created Equal

Both the TRU Custom-Fit and the Musician’s Earplugs are available for anywhere from $150 to $250

Westone’s TRL UNIVERSAL/Custm
Other Options with a CAVEAT

NRR = -2 dB

NRR = 0 dB

Benefits of musician’s hearing protection

- The ability to hear better
- Reduces distortion, improves sound quality
- Less fatigue
- Improved pitch perception on psychoacoustic based measure and/or no degradation in perception
- Early and consistent protection reduces risk of NIHL!

You can save the dying, but you can’t save the dead!
Now, how long can you listen safely?

- Choose your instrument and the dBA.
- How long can you listen to the sound safely?
- Now subtract 20 dB from that level.
- How long can you listen with high fidelity earplugs?

Insertion of Earplugs

This is key!
Improper placement means no protection or at best, reduced protection, rendering the earplugs ineffective.

1. Pull up on the ear,
2. Place earplugs in place with a slight twisting motion,
3. Let go of the ear and they should feel in place.
   * Wear in short increments to allow your ears to adjust *

In ear Monitors

Noise Dosimeters

- Remember: Sound Intensity + the amount of exposure time.
- A 100% dose = You reached the maximum noise exposure for the day, and continued exposure to loud sound could lead to hearing damage.
- Noise dose exceeds 50% = a person has reached half the maximum noise exposure for the day
  - Good idea to use hearing protection to prevent over-exposure, particularly if a 50% dose reading is reached early in the day.
- Dosimeters let you know when you need to start wearing your hearing protection.

The “How” of Hearing Protection

Common complaints:
“They hurt my ears”
  Break them in…If discomfort continues, consider custom plugs.
“Now my arms hurt b/c I’m playing harder.”
  Ask your instructors to help you monitor your playing and learn to adjust to the new sound level.
“I can’t hear directions from the instructor”
  Use cords to place in and out of ears as needed.
  Consider MusicPRO
Guidelines for Listening

<table>
<thead>
<tr>
<th>% of Volume with Headphones</th>
<th>MAXIMUM IPOD LISTENING TIME PER DAY GUIDE (Table Based on Fager and Pertsh, 2008)</th>
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</thead>
<tbody>
<tr>
<td>100</td>
<td>5 Minutes</td>
</tr>
<tr>
<td>90</td>
<td>18 Minutes</td>
</tr>
<tr>
<td>80</td>
<td>1.2 Hours</td>
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<tr>
<td>70</td>
<td>4.6 Hours</td>
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<tr>
<td>60</td>
<td>18 Hours</td>
</tr>
<tr>
<td>10-50</td>
<td>No Limit</td>
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Headphone Safety Tips

- 60/60 rule: Use 60% of volume for 60 minutes; break for an hour
- Noise-isolating earphones, NOT noise cancelling

(Shangorodsky, J. et al., 2010)

Classroom Acoustics

- Outdoor noise (traffic, playground)
- Electrical appliances
- Flooring
- Pass-through noise (adjacent rooms, corridors)
- Lighting ballasts
- Teacher’s location and positioning
- Chalkboard
- Class size
- HVAC units

Classroom Acoustics

- Factors
  - Ambient noise
  - Reverberation
  - Signal to noise ratio
- Students in today’s classrooms are unable to understand 25-30% of teacher instruction
- Normal hearing children require a SNR of +15 dB
- Average classroom signal to noise ratio is +4 dB or +5 dB but can fluctuate from -5 dB to +20 dB

Go forth, and be informed...

Questions???
REFERENCES


www.dangerousdecibels.org

Hearts for Hearing
One Corporate Plaza
3525 NW 56th, Suite A-150
Oklahoma City, OK  73112
(405) 548-4300
www.heartsforhearing.org