AVOIDING THE INEVITABLE:

OVERCOMING NOISE-INDUCED HEARING LOSS IN

UNIVERSITY ATHLETIC BANDS

HONORS THESIS

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by

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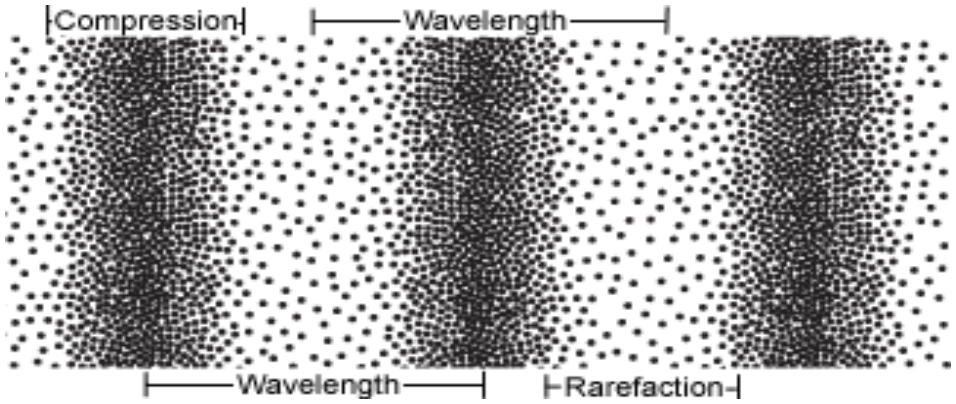
ABSTRACT

Any permanent, sensory hearing loss affects an individual's vocational, social, and home life as it disrupts the ability to communicate with others. A permanent hearing loss in a musician breaks ties with other human beings as well as with a career that he or she has spent years learning. Yet this disability is unnecessary. Noise-induced hearing loss (NIHL) is the most preventable type of hearing loss but the prevention must start at the beginning of one's musical career. The purpose of this study is to investigate the attitudes collegiate musicians have towards using high-fidelity hearing protection. The participants were members of Texas State's athletic bands. The musicians engaged in an educational intervention that incorporated dosimeter sound level percentages, distortion product otoacoustic emissions testing, and a video from Etymotic's Adopt-A- Band hearing conservation program. Each musician was issued high-fidelity hearing protection and educated on its proper use. Pre-study and post-study surveys were conducted to determine how attitudes and behaviors toward the prevention of NIHL changed over time. Findings showed all band members felt that optimum sound quality was worth the increased risk of hearing loss. However, all subjects reported they would continue wearing the earplugs after learning of its importance.

INTRODUCTION

If a tree falls and no one is around to hear it, does it make a sound? To those who know the fundamentals of hearing science, the tree does indeed make a sound. When molecules are displaced from their original position, they create sound waves (Yost, 2007). Although the sound waves were not perceived by a human ear, the molecules were still displaced. When we do identify hearing, the flowing molecules rattle our eardrums and spark signals through our hair cells that our brains perceive as sound. Humans are constantly exposed to all levels of sound, whether at work, school, or home. Unfortunately, most people are unaware of the detrimental effects that occur with continual, intense sound exposure.

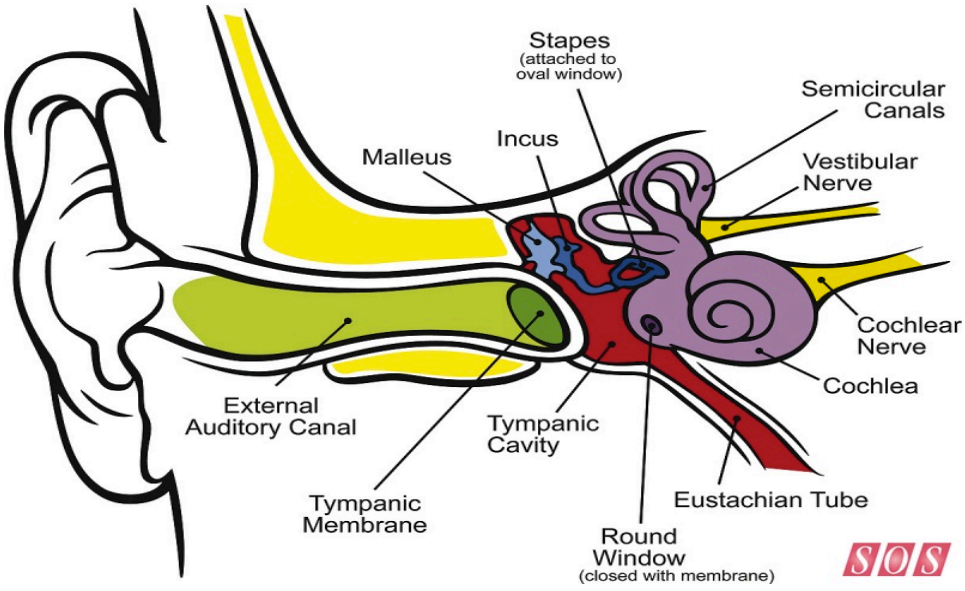
Sound is defined as a series of disturbed molecules that create frequency waves (Yost, 2007). Simply put, sound is vibration. A medium must be present for these sound molecules to be set into vibration. Most commonly, the medium is air; however, water is also a medium. These mediums allow for inertia and elasticity to be present. These two properties are essential for vibration to occur. The interchanging patterns of compression and rarefaction cause the wave motion of molecules and is termed oscillation. It is a back and forth movement from an equilibrium, this movement is also known as sine waves or Simple Harmonic Motion (SHM). Sound waves are a type of longitudinal waves since they have a parallel oscillation from their source. Meaning, the molecules move in the same plane that the sound is coming from. Sound waves radiate from their source until they reach the ear.



(A-Plus, 2015)

The periphearal hearing mechanism consists of three parts: the outer ear, the middle ear, and the inner ear (Yost, 2007). The outer ear begins with the auricle or pinna. This is the outward projection that catches the sound waves and the part most associate with the ear. The pinna is the only external projection of the ear. It functions as a resonator and generates a more detailed description of the sound. This is helpful when determining the source of a sound, or localizing. As the sound waves bounce off the pinna, they enter the External Auditory Meatus, or ear canal for short. This section is air filled and contains sweat and sebaceous glands. The combination of these secretions create cerumen, or ear wax. Cerumen is a protective mechanism and rids the ear canal of bacteria and fungi. Wax must be present in order to maintain healthy ear function. Q-tips push the wax further down the ear canal, ultimately causing more damage than good. The temporary relief leads toward future hassles. Excessive use of Q-tips can lead to hearing loss because of the cerumen build-up or worse, a puncture of the tympanic membrane. The tympanic membrane, or eardrum, sits at the end of the canal and separates the outer ear from the middle ear. Although treatable, a ruptured eardrum negatively affects one's hearing and overall health.

The middle ear begins with the tympanic membrane and consists of three small bones or “ossicles”. These ossicles are the three smallest bones in the human body. As sound vibrations rattle the tympanic membrane, the acoustic energy converts to mechanical energy and sets the three bones into motion. The ossicles named is descending order are the malleus, incus, and stapes. The middle ear is where sound waves are amplified. The vibrating bones intensify and clarify the sound. These bones ultimately create pressure differences at the inner ear footplate of the stapes, or oval window, which leads to the next physiological stage of the hearing process (Yost, 2007).



(Sound, 2011)

The inner ear is the one of the most intricate systems of the human body besides the brain. The mechanical impulses created in the middle ear are converted to electrochemical nerve signals that are then sent to the brain. There are two structures of the inner ear, the semicircular canals and the cochlea. However, hearing is confined to the

cochlea. The semicircular canals are responsible for balance. The cochlea is the snail-shaped portion of the inner ear and is the primary auditory organ. The cochlea is divided into three sections: scala vestibuli, scala media, and scala tympani. These are responsible for creating and transporting the nerve impulses from the ear to the brain. The organ of corti, located within the scala media, is where hearing perception stimuli are generated. The organ of corti has a basilar (lower) and a tectorial, (upper) membrane. As the stapes pushes on the oval window (the thin wall separating the middle and inner ear), hair cells located on the basilar membrane brush across the tectorial membrane creating the stimuli spark. This nerve signal is what the brain perceives as sound. When someone is exposed to highly amplified sound for extended periods of time, the hair cells start to deteriorate and cannot regenerate. This explains why most hearing impairments are irreversible (Yost, 2007).

(Hearing, 2016)

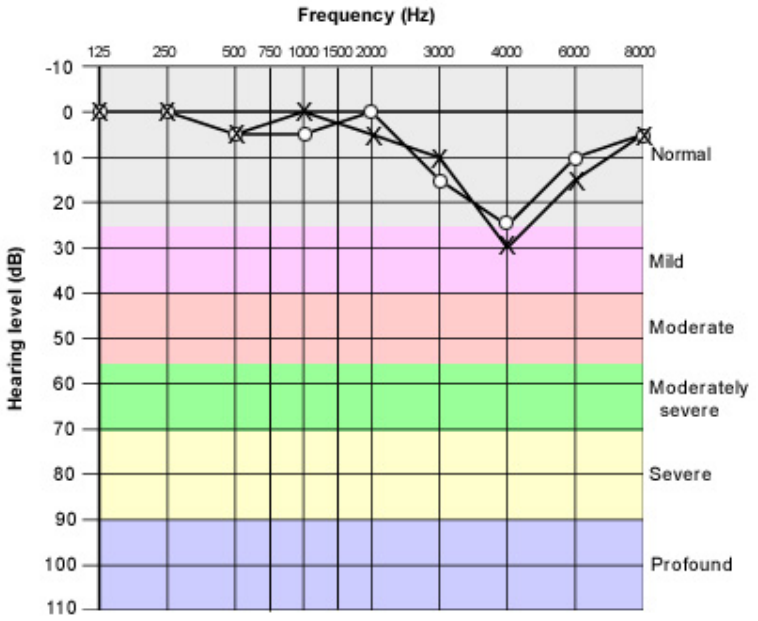
Hearing impairment occurs when there is a problem with any of the structural or nerve components of the ear (Yost, 2007). Persistent use of the cochlear hair cells results in their wearing away. Without these cells to send signals to the brain, little to no sound is perceived. Imagine hair cells as blades of grass. Walk on them and they can recover. Run

or stomp on them and they will die. Musicians are constantly running, as they play their instruments in numerous rehearsals and performances.

According to the American Speech-Language Hearing Association, audiology is the science of hearing, balance, and its related disorders (2016). Audiologists test, diagnose, and treat a vast array of hearing and vestibular impairments (Martin & Clark, 2015). One of the main tests an audiologist performs is a pure-tone assessment. This is the "beep test". As students who attended elementary school, we were all required to take this test. The tones are presented at different volumes and pitches, more formally known as intensity and frequency. Volume, or intensity, is measured in a unit called decibels (dB HL) and is a measure of sound pressure. The pitch, or frequency, is measured in Hertz (Hz). Audiologist look for the softest level of volume, or the lowest dB HL, a person hears. The frequencies tested in a standard pure-tone assessment are 500, 1000, 2000, 4000, and 8000 Hz. The higher frequencies can also be noted as 1K, 2K, 4K, and 8K. The values are recorded on a graph called an audiogram. A person with normal hearing has thresholds that can range from -10 to 20 dB HL at each frequency.

Noise-induced hearing loss (NIHL) is hearing loss that arises from repeated exposure to excessive sound levels. Some common etiologies include loud work environment, attending concerts, going to clubs, blasting music through headphones, shooting firearms, and the list goes on. Since the cause of NIHL is prolonged and intense sound exposure over a period of time, this is the most preventative form of hearing loss. Audiologists diagnose NIHL by assessing pure-tone thresholds which indicate a 4K Hz notch. This means a patient has normal hearing except for the frequencies around 4000 Hz. A clear, distinct notch is present on each NIHL audiogram. Being that NIHL is a

sensory hearing loss, hearing aids are required to restore hearing to the normal range (Martin & Clark, 2015).

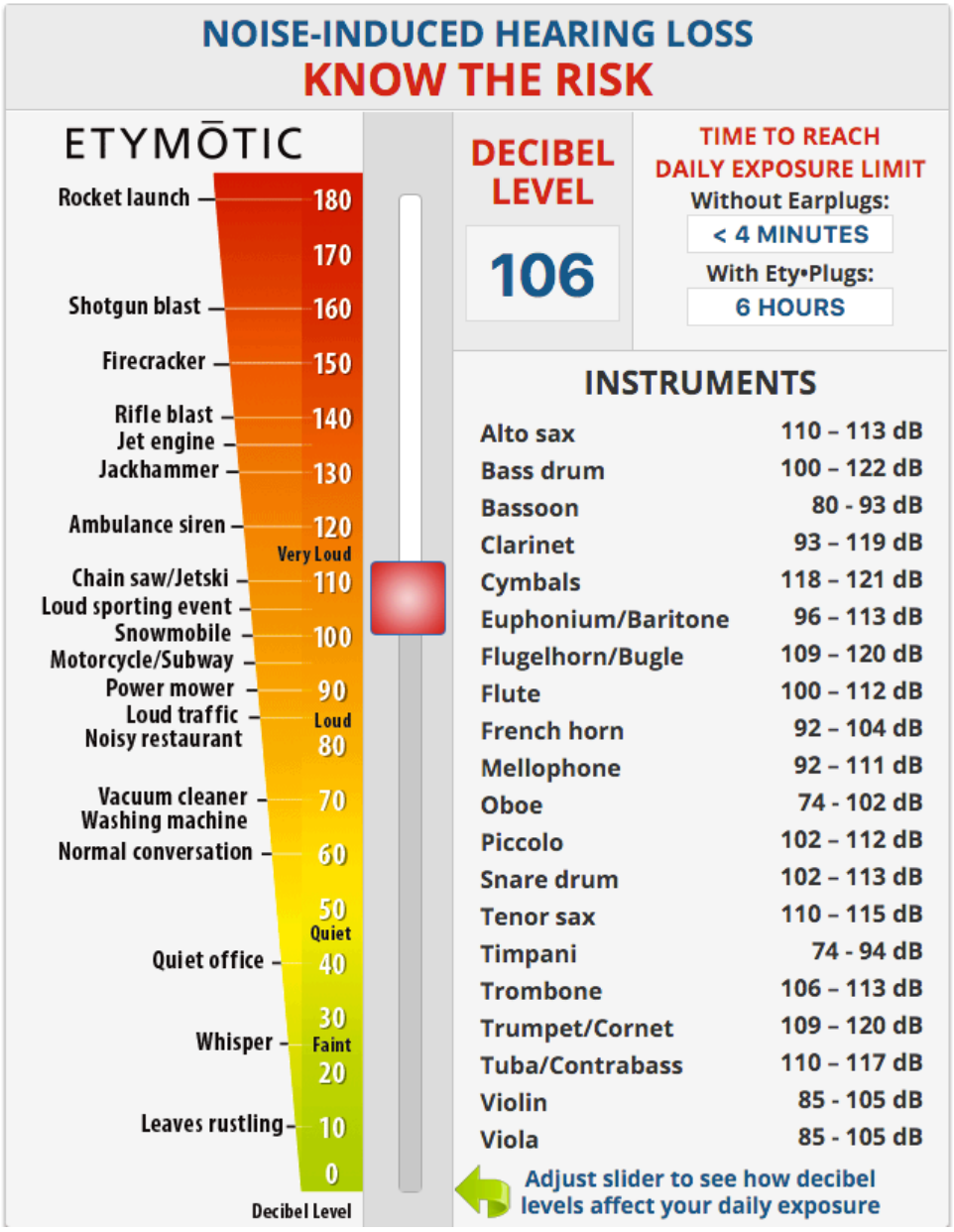


(Rabinowitz, 2000)

Etymotic is a research company dedicated to improving the lives of those with hearing loss, protecting hearing, and enhancing the listening experience for musicians. The term "etymotic" translates to "true to the ear" (Etymotic, 2016). Recently, Etymotic has developed a program called Adopt-A-Band. The aim of this program is to educate high school musicians on the effects of NIHL and provide students with high-fidelity earplugs. High-fidelity means the earplugs reduce the level of sound to an appropriate volume without distorting the quality of the sound.

The figure below is one of the procedures in the Adopt-A-Band program. The interactive slide allows students to move the decibel level up and down within their instrument's range to find out how long it takes to reach their daily sound exposure limit. The figure below displays the slide set at 106 dB, the same as a loud sporting event. Using myself as an example, I played clarinet in the Bobcat Marching Band and 106 dB

falls into my instrument's range of sound. Since I did not wear any hearing protection at rehearsals nor performances, I reached my daily exposure limit in less than 4 minutes. However, if I would have worn musician's earplugs, I would have been safe for 6 hours. A simple change in my practice routine would have made a substantial difference for my hearing.



(Etymotic, 2016)

LITERATURE REVIEW

Many adolescents are aware that they expose themselves to loud sounds, yet do not take any preventative measures. Chung, Roches, Meunier & Eavey (2005) surveyed the types of noise exposure young adults are exposed to in regards to entertainment. An online survey was administered and in three days, over 9500 responses were submitted. Only 8% of teenagers associate hearing loss as a big concern. These subjects noted the major health problems for their generation to be STDs, alcoholism, depression, drug use, and smoking. However, the majority of subjects said they would wear hearing protection in social scenarios such as at concerts or clubs if recommended by a physician. Some have experienced tinnitus or temporary hearing impairment from concert and club settings; therefore, they can be motivated to use preventative measures against hearing loss.

The Occupational Safety and Health Administration (OSHA) has set the maximum permissible noise limit at 90 dBA for an 8-hour work day (Cutietta, Klich Royse & Rainbolt, 2015). Band directors are exposed to much more than 90 dBA each day; however, due to the intermittent nature of music rehearsals, directors are not as high risk as other occupations. During rehearsals, directors will stop the piece and work on a particular section. These breaks allow for the ears to rest momentarily and return to a normal state. This lowers the risk for NIHL, but the chance of obtaining NIHL is still very present. Depending on the genre, a piece can reach over 120 dBA, which is louder than an ambulance siren. The study showed that the subjects who were instrumental music instructors had a greater presence of hearing loss (23%) when compared to vocal

instructors (7%). Important to note is 45% of the instrumental instructors that had hearing loss were under the age of 40. This rules out that the etiology being age-related. In addition, 19% of all subjects displayed the typical 4K Hz notch of NIHL, even if hearing was within the normal range.

Studies on symphonic winds were conducted to determine if placement and instrumentation are factors in the amount of noise exposure one experiences. One study showed that positioning in the band, the instrument one plays, as well as the repertoire chosen by the director plays a role in how much one is at risk for hearing loss (Rodrigues, Freitas, Neves, Silva, 2014). Another study enforced the importance of positioning in a concert band setting (Walter, 2009). The loudest and highest pitched instruments in a symphonic band had the greatest daily mean of sound exposure. Given that the loudest and highest pitched instruments are the piccolo and percussion, the musicians closest to them, no matter the instrument, received a greater daily exposure. Results showed over half of the members of the symphonic winds band (52%) experienced one or more rehearsals with doses over 100% the daily limit.

Adopt-A-Band is a commercial program designed to alter young musicians' behaviors and attitudes towards hearing protection. The program is targeted at high school marching band students and used to promote wearing high-fidelity earplugs. When put into action with two high school marching bands, Auchter and Prell (2014) showed earplug use ultimately increased by 39% because of the program. At the beginning of the season, only 23% reported to have previously worn earplugs. Whereas 94% of students reported to use high-fidelity hearing protection after the educational program. A few months later at the end of the season, 62% of participants maintained their use of the

earplugs. This Honors thesis incorporates the Adopt-A-Band *Generation Hear* video into the educational intervention (*see Procedures*). The video consists of interviews from band directors and drum corp leaders promoting the use of high-fidelity earplugs.

Approximately 18% of young adults have some level of hearing loss (Neumann, Bondurant& Smaldino, 2013). Many people are exposed to noise on a daily basis, but none are more at risk than those whose lifestyles revolve around noise and loud music. Drum and Bugle Corps are organizations of elite musicians who spend entire summers (80+ days) practicing and performing around the country. Neumann and colleagues examined the effectiveness of a comprehensive hearing conservation program for increasing awareness and willingness to wear hearing protection. The procedure consisted of a questionnaire before and after an intervention, training about noise exposure, simulations of hearing damage, and otoacoustic emission screenings. Prior to the intervention, 48% felt hearing protection was not necessary and after the intervention that percentage dropped to 35%.

Along with hearing conservation for drum corps, one initiative has been taken for athletic bands at the university level. An educational intervention on NIHL was done for the marching band at the University of Minnesota (Jin, Nelson, Schlauch & Carney, 2013). Although young adults are exposed to different kinds of loud sounds, band rehearsals often meet or exceed OSHA limits. Quantifying the hazards of music exposure is difficult for this group because the intensities fluctuate throughout each piece of music. Therefore, sound levels were recorded over a period of 3 years at the U of M. The subjects consisted of two groups, band members and other college students not involved in band. Hearing thresholds and transient otoacoustic emission were obtained from each

group. The band students were given musician's earplugs and a general overview about hearing loss. Results showed no significant differences in hearing thresholds for the two groups. Ultimately, no persistent notched audiograms were found yet a hearing conservation program is recommended for this population due to lengthy, high sound exposure rehearsals.

A program entitled "Health Promotion in Schools of Music" was created by Chesky, Dawson, and Manchester (2006) to provide a framework that implements occupational health concerns related to music into the curriculum of music majors. These researchers recommend that current directors in university schools of music are trained to be resources and motivators for hearing protection. Those professors then teach an introductory undergraduate course that covers how to avoid music-related injuries including physical, psychological, sociological, musculoskeletal, vocal, and mental health problems. The most widespread issue is noise-induced hearing loss. Thirdly, the professors educate students about hearing loss as part of ensemble-based instruction. Finally, the professors assist student through active engagement with health-care resources. The final step is crucial in order to maintain these initiatives.

PURPOSE

The purpose of *Avoiding the Inevitable: Overcoming Noise-Induced Hearing Loss in University Athletic Bands* is to educate collegiate musicians on the effects of noise-induced hearing loss and determine if an educational intervention would increase the use of hearing protection among band students. Currently, there is a negative stigma with wearing earplugs for the millennial generation. A possible explanation for the poor connotation of hearing protection is the lack of education on the topic. From a young age, we are taught to wear a helmet when we ride bike and to put on sunscreen if we will be outside for a good period of time. Teachers and parents ingrain this into our brains in order to protect ourselves from environmental dangers. NIHL is a very prevalent disability. Why are we not taught about its consequences along with injury and sun exposure? Inserting earplugs are just as easy as putting on a helmet or sunscreen.

Maintaining a habit is far easier than changing behavior as an adult. Once we reach late teen years, we have set our way of thinking and are not easily persuaded (Hodge, 2014). My goal is to create an educational plan strong enough to motivate this generation to wear hearing protection through trainings that band directors can implement in their lesson plans.

PROCEDURE

Ten subjects were recruited from Texas State's marching and basketball bands. Six subjects completed the entire educational intervention: two woodwinds, three brass, and one percussionist. The program consisted of a pre-intervention survey and interview, an educational intervention, and a post-intervention survey and interview. The intervention was comprised of four components: personal noise dosimeter sound levels, distortion product otoacoustic emission (DPOAE) testing, *Generation Hear* video, and high-fidelity hearing protection.

Subject Number	**Instrument**	**Major**
1	Clarinet	Elementary Education
2	Alto Saxophone	Music Education
3	Trumpet	Music Education
4	Trumpet	Music Education
5	Percussion (Drum Set)	Music Performance
6	Sousaphone	Communication Design

I. Pre-Intervention Survey

The pre-survey was administered to determine the subjects' general knowledge on noise-induced hearing loss and hearing protection. Subjects were encouraged to write as much or as little as they felt necessary. *Table I.I* provides the layout of the pre-intervention survey.

Table I.I

Initial Survey

1. Do you believe noise exposure can cause permanent hearing loss?
2. Do you experience a ringing sensation after practice?
3. Given the sounds you are exposed to, do you think you are at-risk for developing a permanent hearing loss? Why or why not.
4. Do you think your instrument and/or ensembles can generate sounds loud enough to cause a severe hearing loss?
5. Do you wear hearing protection?
    a. If so, what type? (i.e. earplugs) Do you also wear it outside of rehearsal?
    b. If not, do you think you should be?
6. How important is hearing protection to you? [explain]
7. Do you think wearing earplugs changes the way people play?
8. Are you aware of high-fidelity hearing protection available for musicians?
9. In school, did you learn about the damage noise exposure causes?
    a. If so, when and what did you learn?

II. Educational Intervention

a. Etymotic ER200DW Personal Noise Dosimeter

To measure the sound levels on the football field and in the basketball stadium, subjects wore a personal noise dosimeter made by Etymotic. This device records and averages the decibel levels present in that environment. The averaged sound levels are translated to a graph that compares them to the allowed daily limit of noise exposure percentage. Each subject wore a dosimeter for either one rehearsal or one performance. Marching band subjects wore one for a rehearsal and basketball band members wore one for a game. Each event lasted approximately two hours.

b. DPOAE

Distortion Product Otoacoutic Emissions (DPOAE) measure cochlea reverberations. Simply put, as sound enters the ear, a healthy cochlea will create echoes. If echoes are not created, this is an indicator of NIHL (Martin & Clark, 2015). The GSI Corti is a device that measures these echoes. A probe is placed in the subject's ear and emits various different frequencies and contains a microphone to detect any returning echoes. The frequencies tested in this study were 1600-8000 Hz. As mentioned earlier, a sign of NIHL is a deficit around 4000 Hz. If no DPOAEs are received when the probe emits frequencies close to 4000 Hz, further testing for NIHL is highly recommended.

c. Etymotic's *Generation Hear* Video

The *Generation Hear* video shows interviews with band directors and drum corps leaders about their experience with noise-induced hearing loss. This was used to show students

that successful leaders in their field strongly promote wearing high fidelity earplugs. Currently at Texas State, students are advised but not required to wear hearing protection. Watching people from organizations they know and are associated with is intended to encourage them to reconsider wearing earplugs.

d. Etymotic ER-20xs High-Fidelity Earplugs

High-fidelity hearing protection essentially turns down the quantity without diminishing the quality of the music. Each subject was given a pair of ER-20xs earplugs to trial and keep. Formal instruction on insertion and use was provided.

III. Post-Intervention Survey

A post-survey was administered two months after the education intervention. This survey reanalyzed subjects' knowledge on noise exposure and determined how often subjects' wore the hearing protection provided to them. *Table I.II* displays the format of the post-intervention survey.

Table I.II

Follow-Up Survey

1. Do you know that loud sounds can cause a permanent hearing loss?

2. Do you know that the ringing and muffled sounds you hear after playing is the first sign of a permanent hearing loss?

3. Do you believe you are at risk for developing a permanent hearing loss given your exposure to loud sounds?

4. Do you think your instrument creates loud enough sounds to cause a permanent hearing loss?

5. Are you exposed to loud sounds outside of music practice and performance?

    a. Where?
    b. What are the sounds?
    c. How often?
    d. Did you wear hearing protection in these scenarios?

6. Please give your opinion on high fidelity hearing protection (the earplugs you received)—
    a. Did you wear the earplugs?
    b. If so, when?
    c. What do you think of the sound quality while wearing them?
    d. Did you notice a difference in your playing while wearing them?
    e. Were they comfortable?
    f. Were they easy to put in?
    g. How do you think they look?
    h. Is it "uncool" to wear them?
    i. Will you keep wearing the earplugs?
    j. If so, when?

7. How important is hearing protection to you after participating in this project?

8. If you plan on becoming a music educator, will you include hearing protection in your lesson plans?

RESULTS

I. Pre-Intervention Survey

Each subject completed both surveys to their full extent. *Table II.I* describes the short-hand answer to each question about the subjects' general knowledge on noise exposure and hearing protection.

Table II.I

	Sub No. 1	Sub No. 2	Sub No. 3	Sub No. 4	Sub No. 5	Sub No. 6
Do you believe noise exposure can cause a permanent hearing loss?	Yes	Yes	Yes	Yes	Yes	Yes
Do you ever experience a ringing sensation after rehearsals or performances?	Yes	No	No	No	No	No
Do you believe you are at risk for a permanent hearing loss given the sounds you are exposed to?	Maybe	Yes	Yes	Yes	Yes	Yes
Do you think your instrument can cause a severe hearing loss?	Yes	Yes	Yes	Yes	Yes	Yes
Do you currently wear hearing protection?	No	No	No	No	Rarely	No
How important is hearing protection to you?	Not very	Very	Very	Very	Very	Not very

Do you believe earplugs change the way people play?	Not sure	Possibly	Yes	For some	No	Yes
Are you aware of the high-fidelity hearing protection made for musicians?	No	Yes	No	Yes	Yes	No
Did you learn about the effects of excessive noise exposure in school?	No	No	No	One lecture	One lecture	Yes

Table II.II highlights noteworthy responses made by each subject in their initial survey.

Table II.II

Subject No.	**Response**
1	**How important is hearing protection to you?** *"Not very important. I've never put much thought into it or how it affects me."*
2	**Do you think wearing earplugs changes the way people play?** *"Possibly, since people can hardly hear, they may play louder to hear themselves."*
3	**How important is hearing protection to you?** *"Incredibly. It's my job to listen to everything pertaining to music, so protecting my hearing ability is crazy important."*

	Do you think wearing earplugs changes the way people play? *"Yes because of the inability to properly fix certain aspects of playing, tone, articulation, pitch tendencies, etc."*
4	**Given the sounds you are exposed to, do you think you are at-risk for developing a permanent hearing loss?** *"I do think I'm at risk, in fact I know I am. Every day I'm exposed to more noise than the average person."* **Do you wear hearing protection?** *"I do not wear hearing protection when playing as it can affect my ability to listen which is extremely important."*
5	**How important is hearing protection to you?** *"Very important, my ears are the key to my profession. I'm not Beethoven so I'm not sure if I can perform without ears."* **In school, what did you learn about the damage noise exposure causes?** *"I learned that it existed. That, and that a snare drum is louder than a chainsaw."*
6	**How important is hearing protection to you?** *"In band not too important. It's more important for me to be able to hear all the things happening within the ensemble."*

II. Educational Intervention

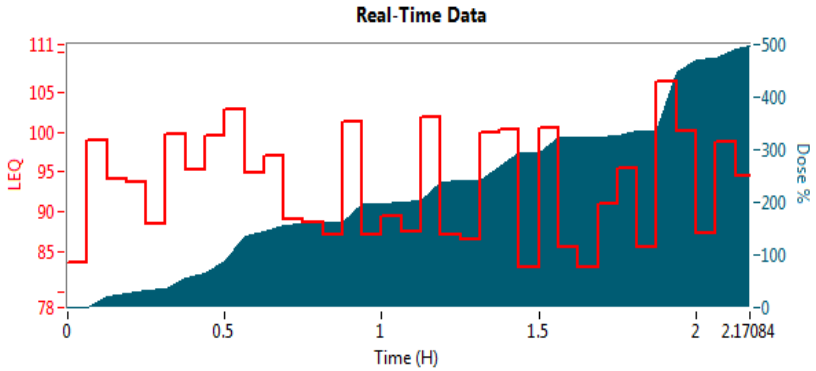
a. Personal Noise Dosimeter

For the marching band, subjects average 90% of the daily dose [clarinet: 70%, saxophone: 40%, trumpet: 160%]. As for the basketball band, subjects average 225% of the daily dose [trumpet: 225%, sousaphone: 200%, drum set: 250%]. The example below is of the percussionist at a basketball game in Strahan Coliseum. The subject wore a dosimeter for the length of the game, 2 hours. Results showed the subject was exposed to approximately 250%, or 2.5 times, the daily limit. This participant was not wearing hearing protection.

ETYMŌTIC RESEARCH INC.

ER-200D Report

Report Date	Wed, Feb 10, 2016
Report Time	9:52 AM
Serial Number	40221
Run	006
Run Type	Normal Run
Final Dose %	497% (4.97X)
Overall LEQ (dB)	97.58
Run Description	
Run Length (DD:HH:MM:SS)	00:02:10:15
Max Run Length (DD:HH:MM:SS)	00:16:00:00
Exchange Rate (dB)	3
Criterion (dB)	85
Threshold (dB)	75
Signal Source	Microphone
Calibration (dB)	1.6
Run Termination	Run ended due to manual shutdown.
Warnings	none
Software Version	4.04



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b. DPOAE

The results of the distortion product otoacoustic emission tests for the majority (83%) of subjects were normal. However, one subject (17%) displayed results indicative of NIHL. The figure below specifies the subject's results for the right ear. As one can see on the second graph, a notch is present at 3200 Hz (3.2 kHz). This unique shape on the plot graph is a supporter of NIHL.

DPOAE Test Report

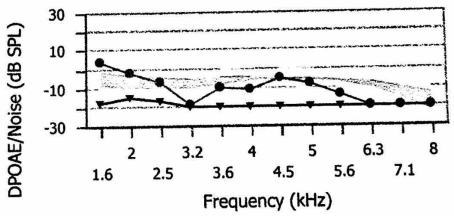
Right Ear:

Test Date: 11/23/2015 4:49:59 PM

Instrument: V103.05 GI1001285 GI2001215

Protocol: DP 1.6-8.0 **Avg Time:** 4

"Frequencies: 12, minimum for a pass: 0"



F2	L1	L2	DP	NF	SNR
1.6	64	55	3	-18	21
2.0	64	54	-2	-15	13
2.5	64	54	-7	-17	10
3.2	64	55	-19	-20	1
3.6	64	54	-10	-20	10
4.0	65	55	-11	-20	9

F2	L1	L2	DP	NF	SNR
4.5	65	55	-5	-20	15
5.0	65	55	-8	-20	12
5.6	70	58	-14	-20	6
6.3	67	61	-20	-20	0
7.1	70	64	-20	-20	0
8.0	74	65	-20	-20	0

III. Post-Intervention Survey

Table II.III shows how the subject's responses changed two months after the educational intervention. The gold represents the percentage for the pre-intervention surveys and the maroon represents the responses in the post-intervention surveys. An additional chart to further demonstrate these changes can be found in Appendix A.

Table II.III

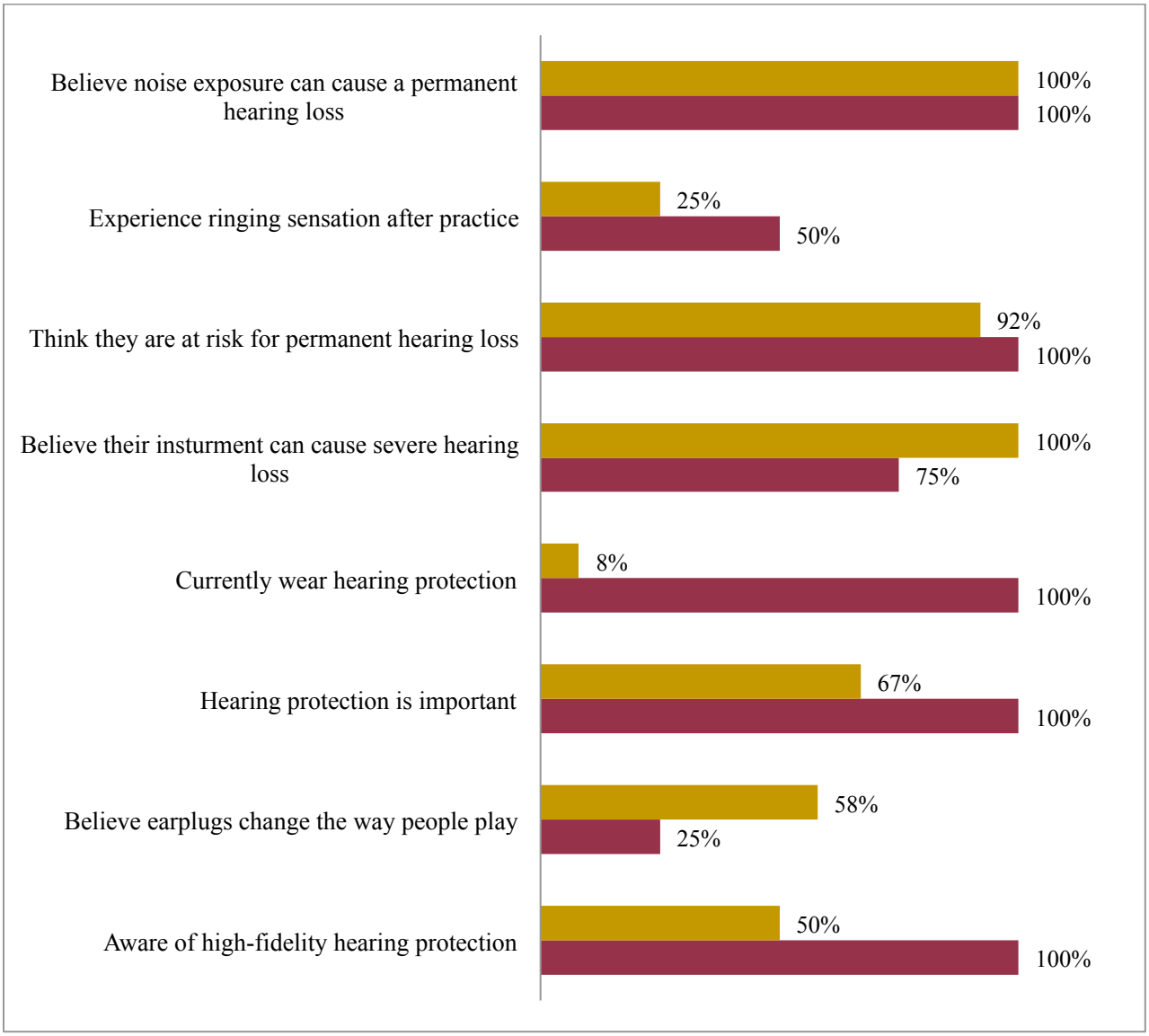


Table II.IV highlights noteworthy responses made by each subject in their follow-up survey.

Table II.IV

Subject No.	Response
1	**Are you exposed to loud sounds outside of music practice?** *"Yes, at work I make calls in a loud room while wearing a headset so voices and ringing are both loud in my ears."*
2	**Did you wear the earplugs provided to you?** *"I did indeed! More so than I thought I was going to actually. I was very surprised at how it retained sound quality. It just reduced the noise."*
3	**Do you believe you are at risk for developing a permanent hearing loss given the sounds you are exposed to?** *"Yes but it's worth it."*
4	**How important is hearing protection to you after participating in this project?** *"My knowledge and understand have increase dramatically because of this survey and my hearing protection is now more of a priority than before."* **If you plan on becoming a music educator, will you include hearing protection in your lesson plans?** *"In my field I will not include hearing protection in my lesson plan because I want to teach high school and the earplugs can affect the students ability to listen to themselves will be affected."*
5	**Will you keep wearing the earplugs?** *"Yes."*

	How important is hearing protection to you after participating in this project? *"Just as important as I have always thought."*
6	**How important is hearing protection to you after participating in this project?** *"Very. I do not want to suffer hearing loss and will be more conscious of dangers to my hearing."*

CONCLUSION

The results above show that the majority of participants consider themselves at a high risk for noise-induced hearing loss, yet continue to possess some of the same attitudes toward hearing protection. Optimum sound quality is seen as significantly more important than hearing protection. Interestingly, all participants said they would continue to wear the high-fidelity earplugs. These results suggest that simply knowing about the damage that intense sound exposure causes is ineffective in changing overall attitudes. Against prior suspicions, the basketball band was exposed to significantly more sound than the marching band. Environmental acoustics had an immense influence on the sound levels the participants were exposed to. There are over 300 members in the marching band, yet the basketball band, which is comprised of approximately 30 members, achieved more than twice the decibel levels. The marching participants averaged 90% of the daily exposure limit and the indoor participants experienced 225%. During the basketball game, the sound had nowhere to escape; therefore, returned to the musicians' ears.

Studies have shown that student attitudes and behavior do not change after one lesson (Hodge, 2014). The targeted behavior must be practiced and reinforced. Therefore, a new educational intervention on noise-induced hearing loss should be drafted. The first step is having directors introduce and reinforce the use of earplugs while modeling the intended behaviors consistently from the beginning of their students' music careers. Starting in middle school, music teachers should incorporate hearing protection into their lesson plans and emphasize it in ensemble rehearsals and during one-on-one lessons.

Reinforcing the importance of hearing conservation is the first step to changing attitudes towards hearing protection..

It is crucial for this generation of future music educators to change their attitude and behavior, otherwise the next generation will continue to be indifferent about wearing earplugs. High-fidelity earplugs are an inexpensive way to conserve this vital sense for musicians. For less than $13 on Amazon, students can add hearing protection to their repertoire of necessities for their instrument. Woodwinds are required to purchase reeds, brass require grease, and percussionists require sticks. High-fidelity earplugs are an easy addition that will save students irreversible hearing problems in the future.

As I pursue a graduate degree in Audiology, I would like to continue researching NIHL in the athletic and concert band settings. I believe a modified educational intervention would change results in the way this thesis intended. One lesson got the participants' attention, but if repeated, these lessons would reinforce the targeted behavior of wearing earplugs. Although more expensive, custom hearing protection is a beneficial option for dedicated musicians. A few subjects in this study reported that the Etymotic high-fidelity earplugs became irritating after a few hours of use. Custom molds eliminate this discomfort since they fit perfectly to the musician's ear while performing the same function. Due to the increased risk collegiate musicians in the athletic bands have for NIHL, they should at the very minimum be educated on its effects.

Appendix A

	Sub No. 1	Sub No. 2	Sub No. 3	Sub No. 4	Sub No. 5	Sub No. 6
Do you believe noise exposure can cause a permanent hearing loss?	Yes	Yes	Yes	Yes	Yes	Yes
Do you ever experience a ringing sensation after rehearsals or performances?	Yes	No	No	No	Yes	Yes
Do you believe you are at risk for a permanent hearing loss given the sounds you are exposed to?	Maybe	Yes	Yes	Yes	Yes	Yes
Do you think your instrument can cause a severe hearing loss?	Maybe	No	Yes	Yes	Yes	Yes
Do you currently wear hearing protection?	*No longer in band*	Yes	Yes	Yes	Yes	Yes
How important is hearing protection to you?	Important	Very	Fairly	Very	Very	Very
Do you believe earplugs change the way people play?	No	No	Yes	Slightly	No	No
Are you aware of the high-fidelity hearing protection made for musicians?	Yes	Yes	Yes	Yes	Yes	Yes
Did you wear the earplugs given to you?	Yes	Yes	Yes	Yes	Yes	Yes

Will you incorporate hearing protection into your lesson plans, if applicable?	N/A	Yes	Yes	Yes	N/A	N/A

The highlighted sections indicate a change in response from the pre-intervention survey to the post-survey.

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