

THE EFFECT OF HEARING CONSERVATION COUNSELING USING  
INDIVIDUALIZED OSHA AND ACGIH NOISE EXPOSURE DATA  
ON MUSIC MAJORS' PERCEPTION OF SOUND EXPOSURE

by

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A THESIS

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## **ABSTRACT**

The purpose of this study was to examine the effect of hearing conservation counseling using individualized OSHA and ACGIH noise exposure data on music majors' perception of sound exposure in rehearsal environments. A secondary purpose was to assess music majors' awareness of hearing health issues. Seventy-one undergraduate music majors were asked to rate their exposure to various intensities of sounds experienced during university band rehearsals and surveyed as to their knowledge about common hearing ailments and conservation practices. During 2 regularly scheduled 90-minute concert band rehearsals, half of the participants wore dosimeters designed to collect sound intensity data, once per second, while the other subjects participated without dosimeters. Data from the dosimeter-wearing experimental group was summarized and presented at a counseling session. Additionally, a brief video designed to simulate hearing loss was shown. 1-week later, all participants again rated their perceived exposure during rehearsals. Results indicated that the music majors generally understood the conditions that cause hearing damage. However, participants were less likely to accurately identify everyday audio hazards found in concert ensembles and individual environments. Additionally, participants rarely took steps to prevent hearing loss, even though many experience symptoms related to the condition. Counseling sessions resulted in negligible changes in participants' responses.

## **DEDICATION**

This thesis is dedicated to all of the music educators who helped and guided me throughout my endeavors to reach my full potential as a musician and teacher. In particular, I want to thank my father Joel Vincent for taking me to band rehearsals and performances with him as a child and first instilling in me a love for music that continues to this day.

## LIST OF ABBREVIATIONS AND SYMBOLS

$df$	Degrees of freedom: number of values free to vary after certain restrictions have been placed on the data
$F$	Fisher's $F$ ratio: A ratio of two variances
$\eta^2$	Eta-squared: indicates the effect of the independent value in the variance of the dependent value
$\chi^2$	Chi-square: statistical method to test whether variables are: independent or homogeneous
$MS$	Sum of squares divided by the degrees of freedom
$N$	Number of participants
$n$	Number of sub-group participants
$p$	Probability associated with the occurrence under the null hypothesis of a value as extreme as or more extreme than the observed value
$SS$	Sum of squares
$<$	Less than
$=$	Equal to

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## **CHAPTER 1**

### **INTRODUCTION**

The Occupational Safety and Health Association (OSHA) approximates that there are thirty million workers regularly exposed to hazardous sounds because of their occupation. One in four of these people will develop a permanent hearing loss as a result. OSHA works to protect workers in manufacturing, construction, transportation, agriculture, and the military to ensure employees in these areas have a safe work environment. Interestingly, OSHA does not regulate the conditions in which professional musicians, music teachers, and music students work.

Even though OSHA does not protect employees in a variety of music fields, musicians are at risk for the same noise induced dangers. In an article about hearing loss and musicians Henoeh (2004) explains, while data is limited, it is estimated as many as one in five musicians experience problems with noise induced hearing loss (NIHL). Even if the hearing loss is slight, it can have a profound effect on the sensitive hearing of musicians. Henoeh goes on to state:

Musicians have vocational hearing demands that are much greater than those required in other occupations. The demands require more than simply understanding speech.

Musicians must possess the highly developed ability to accurately match frequencies over a broad range, including frequencies outside the range of those required for speech comprehension. They must also be able to detect and manipulate changes in loudness levels, complex timbres, and blends. Even mild pitch distortion may make it difficult for

a musician to perform in tune, and elevated high-frequency thresholds may lead to excessively loud, and therefore unacceptable, performances at higher pitches.

Clearly musicians, no matter what field or level of expertise, need to have an understanding of the dangerous work environment they are exposed to when performing their art.

Previous studies examined a plethora of topics in a variety of populations related to NIHL and sound exposures, as musicians' unique relationship with sound provides researchers with a wealth of opportunities to explore the dangers of music making. These investigations have explored the influence of instrument type, genre of music, and profession on musicians' risk of hearing loss due to sound exposure, as well as the prevalence of hearing loss among musicians.

For example, Chesky and Hensch (2000) found the highest rates of hearing loss occurred in rock/alternative musicians and those from nonclassical groupings. Musicians who played amplified instruments, drum set, and brass instruments generally reported high instances of hearing problems. Hoffman, Cunningham, and Lorenz (2006) found that 39% of percussionists reported a hearing loss. Factors that seemed to increase the risk of hearing loss include the use of amplification systems, playing rock/pop music, many years of experience, and considering oneself a professional.

In a study examining band ensembles, Presley (2007) used personal dosimeters to monitor the sound exposures of members of a drum and bugle corps drumline. Results indicated that all of the subjects experienced over 100% of the daily allowable dose of noise according to the National Institute for Occupational Safety and Health (NIOSH). Moreover, some of the subjects experienced noise levels over ten times the allowable dose.

Multiple studies have examined the risks and incidence of NIHL in teachers such as band directors, college studio teachers, and general music teachers. Because they spend an especially

high amount of time in high noise environments, the dangers to music teachers are elevated in relation to other music professionals.

Behar, MacDonald, Lee, Cui, Kunov and Wong (2004) recorded noise exposures of eighteen teachers from both elementary and secondary settings. The study found 39% of the teachers would have exceeded NIOSH standard over an 8-hour period.

In a study by Cutietta, Klich, Royse, and Rainbolt (1994) one hundred four music teachers were tested for evidence of hearing loss that could possibly be attributed to NIHL. Results indicated that the task of high school band directing has some risk of NIHL; however the degree of risk is highly individualized.

Royer (1996) and Owens (2003, 2004) used intensity measurements taken in band rooms to determine the level of sound band directors were exposed to during rehearsals. Results indicated that the sound levels did not exceed OSHA standards; however, when other standards from organizations such as the American Conference of Industrial Hygienists (ACGIH) and NIOSH were used, directors were at considerable risk for NIHL.

Pisano (2007) suggested that NIHL was a possible reason for the hearing loss found in a majority of band directors. Indeed, it seems that nearly 66% of band directors suffered signs of hearing loss with 41% attributed to NIHL that was not the result of aging (Cutietta, Millin, and Royse, 1989).

A study by Mace (2005) examined the risks of NIHL as it relates to studio teachers in a university setting. Thirty-five percent of the subjects experienced sound levels exceeding standards recommended by NIOSH, and 87% of subjects' audiograms indicated hearing loss in at least one ear.

Teachers are not the only people in the classroom exposed to dangerous levels of sound. Students are also at risk for NIHL. Miller, Stewart, and Lehman (2007) used dosimeters to log sound exposures of student musicians as they performed at football and basketball games. The study found that the students were at risk for NIHL. In addition, the study found the students' performance environment was similar to an industrial site in regards to the levels of sound pressure. Hensch and Chesky (2000) found students' exposure to sound differed according to the location of their seat in a jazz band setting. All players in the ensemble were exposed to sound which could potentially cause NIHL, however, lead musicians (i.e., playing first part) sitting in the middle of the ensemble were at the greatest risk. Libbin (2008) tested members of a college marching band before and after practice and noticed a shift in auditory function, often referred to as a temporary threshold shift (Wagner, 1994). While the students did recover after a period of rest, the shift may be a sign that auditory problems might develop later in life. Zeigler (1997) found that when compared to nonmajors, music majors were more likely to report tinnitus, a phantom ringing in one or both ears. Six percent of the subjects described the tinnitus as being continuous – evidence of a permanent hearing loss. Percussionists and those attending large national universities were more likely to report hearing loss. The study also found music majors were more likely to exhibit risky behaviors in regards to the recreational listening of music. Philips, Shoemaker, Mace, and Hodges (2008) found that over half of classically trained student musicians in a college setting exhibited hearing damage. Interestingly, the distribution of reported hearing damage was found equally among students in all instrument groups.

Professional musicians are not immune to NIHL either. Royster, Royster, and Killion (1991) found that the hearing health of members of the Chicago Symphony Orchestra was better than that of a nonindustrial noise-exposed sample of non-musicians. However, 52.5% of the

symphony members tested showed *notched* audiograms consistent with NIHL. Two other studies paint a different picture (Lee, Behar, Kunov, & Wong, 2005; Kähäri, Axelsson, Hellström, & Zachau, 2001). The first found that, when following the requirements set forth by the 1999 International Organization for Standards (ISO), the Canadian Opera Company Orchestra members were not endangered during their 3-hour rehearsals, dress rehearsals, and performances. The other study found that, despite sixteen years of additional noise exposure, members of a European orchestra developed no extended negative progress on their pure-tone hearing threshold values.

Seating is an important consideration when investigating the risk of NIHL among musicians. Hensch and Chesky (2000) found noise exposure levels varied according to where musicians sit in an ensemble. Those who sat in the center of the “chair placement” had a higher risk of NIHL. Garofalo and Whaley (1976) wrote an article aimed at practitioners about the seating of the wind ensemble—a group usually reserved for the top musicians at schools and within the music profession. They discussed how the wind ensemble uses the placement of its musicians to enhance the intonation, balance, blend, and ensemble sound. The article recommended seating musicians close together in rows similar to a jazz band, where musicians play directly into other musicians.

One study asked subjects to rate their preference of recordings of a wind ensemble performing an electronically altered Bach chorale designed to imitate different seating arrangements (Murray, 2006). The study found subjects preferred ensemble sounds that placed the instruments “farther apart” rather than close together. Balance and blend were the musical factors that most significantly contributed to participants’ preference responses.



In addition to balance and blend, another musical factor that influences preference of music is dynamics. One of the reasons musicians are exposed to such dynamic extremes is the desire to create effects within music. Dynamics enhance preference for music for all levels of musicians, from elementary students in the beginning stages of their education to experienced conductors. Humans are attracted to variations in volume. While music can only be played so quietly, loudness of music can be infinite especially with the technological advances we have today.

Three studies have dealt with the effect of dynamic nuance on music preferences with a variety of populations (Burnsend, 2001, 1998; Burnsend & Sochinski, 1995). Conductors, middle school students, and elementary school students all preferred versions of American folk songs with dynamic variations over songs where the volume held constant. Crist (1998) found college aged music majors rated the level of expressiveness “exceedingly high” for performances with both tempo and dynamic changes. Geringer (1995) found loudness judgments of musicians were significantly smaller than nonmusicians. Nakamura (1987) found musician’s intention of observing dynamics marks was conveyed to listeners, even though the marks did not correspond to a fixed-intensity level. An early study found bands that played with more dynamic contrast rated higher at a music festival (Gordon, 1960). Another study investigated the effects of differing loudness levels on 101 undergraduates’ discernment of pitch, rhythm, duration, loudness, timbre, and tonal memory (Haack, 1971). Results indicated loudness significantly influenced the perception and discrimination of rhythm duration, loudness, and timbre.

The environments people live in today cannot be ignored when discussing NIHL. Personal stereo players are used more and more to listen to music, especially with young people. Several studies have examined personal music players. Hellström and Alexson (1988) found

personal cassette players produced sound levels that were damaging to hearing. However, in a later study, results indicated there was no significant increase in the risk of potential noise injury from personal stereo player use alone (Williams, 2005)

Other studies have looked at young people's awareness of hearing loss due to over exposure to loud sounds. Chung, Des Roches, Meunier, and Eavey (2005) used a web-based survey to examine young people's awareness of hearing loss due to exposure to loud music. Hearing loss was categorized as a "very big problem" by only 8% of respondents.

Young people's listening habits and sound exposures have also been examined. Using a questionnaire, Mercier and Hohmann (2002) sought information on listening habits, on the kinds of events attended, and on whether the music at these events was too loud or not, as well as if the respondents considered their hearing to have been impaired. Based on the response to the questionnaire, the researchers estimated over half the respondents (56.6%) have a sound exposure over 87 dB(A) from music. Smith, Davis, Ferguson, and Lutman (2000) found 18.8% of young adults in England had been exposed to significant noise from social activities. This indicated that exposure had tripled since the 1980s. Another study suggests that the presence of a dangerous pattern of music-listening behavior similar to that exhibited by substance abusers (Florentine, Hunter, Robinson, Ballou, & Buus, 1998). The study used a survey based on the Michigan Alcoholism Screening Test [MAST].

Several studies have examined the relationship between noise and hearing loss as well as the attitude towards wearing hearing protective devices. Bogoch, House, and Kudla (2005) surveyed rock concertgoers in Canada about their understanding of NIHL risk and the use of hearing protection while at a concert. While 34.3% of attendees thought it was somewhat likely noise levels at music concerts could damage their hearing and 39.8% thought it was very likely,

80.2% said they never wore hearing protection. Crandell, Mills, and Gauthier (2004) questioned college-aged young adults and found they exhibited considerable knowledge about the effects of noise on the auditory system. Of the respondents, 70% indicated they knew wearing hearing protection devices (HPDs) could prevent hearing loss. However, 72% never actually used HPDs.

Another study tried to alter behavior in a way that would encourage wearing HPDs. The results of the Williams, Purdy, Murray, Dillon, LePage, Chanllinor, and Storey (2004) study showed that the subjects held healthier attitudes towards noise and hearing loss prevention after hearing testing. Viewpoints were sustained for twelve months. However, the willingness to use hearing protection was not significantly changed by the hearing testing.

Musicians have also been reluctant to wear HPDs. Laitinen and Poulsen (2008) found musicians were aware of the dangers of loud music, yet they rarely use HPDs. Another study offered free custom musician earplugs at no charge to 102 professional orchestra musicians (Goodman, 2001). Only forty-two took the earplugs, while sixty rejected the service. Results indicated use of HPDs was linked to individual acknowledgement of risk of hearing loss, and younger musicians fitted with HPDs reported no significant change in their musical perception. Curk and Cunningham (2006) found most percussionists are aware of the benefits of HPDs as well as held a good knowledge of the dangers of high-level noise exposure. However, only 67% of percussionist used hearing protecting while practicing and 56% used it when performing.

With the support of the above articles, NIHL can clearly be seen in all parts of society. While there are no laws to protect them, musicians' work environments seem to put them at risk for NIHL. Young people's risk of NIHL is also high. Student musicians offer a population that can be helped before extreme hearing loss occurs and harmful behaviors become habit.

## ***Conclusion***

The purpose of this study was to examine the effectiveness of hearing conservation counseling using individualized OSHA and ACGIH noise exposure data on music majors' perception of sound exposure in rehearsal environments. A secondary purpose was to assess music majors' awareness of hearing health issues. The research questions to be examined were as follows:

### ***Research Questions***

*Question 1:* Are undergraduate music students worried about their hearing health?

*Question 2:* How accurate are undergraduate music students at identifying sound levels found in rehearsal and practice settings?

*Question 3:* Does hearing conservation counseling using individualized OSHA and ACGIH noise exposure data affect undergraduate music students' perception of sound exposure?

*Question 4:* How accurate are undergraduate music students at identifying sound levels found in rehearsal and practice settings to everyday experiences?

*Question 5:* What are the differences based on instrument grouping, presence of counseling, and research grouping on ability to accurately identify sound levels found in rehearsal and practice settings?

*Question 6:* What types of hearing health issues (e.g. tinnitus, distortion, diplacusis, etc.) exist among undergraduate music majors? How often do music majors experience these issues?

*Question 7:* How often do music majors take steps to prevent hearing loss?

*Question 8:* In which ensembles do participants use hearing protection, and how often are Hearing Protection Devices (HPDs) being used?

The results of this study may help music conductors and music teachers to develop simple and effective preventative measures to curtail slight and profound hearing loss among music students. Present research in this area is dominated by a wealth of descriptive studies examining musicians' degree of exposure to potential auditory hazards. However, no studies were found that attempt to experimentally affect musicians' awareness of the dangers of sound intensity exposure by counseling subjects using continuous data collected during a rehearsal. In other words, previous studies offered summary data or examined the degree of hearing loss musicians experienced after years of playing in ensembles. Results may also serve as a guide to schools of music in developing coursework that could potentially raise students' awareness of latent auditory hazards in rehearsal environments.

## CHAPTER 2

### LITERATURE REVIEW

#### *Musician's Risk of Hearing Loss*

Henoch (2004) states that musicians afflicted by NIHL are more disadvantaged than those in other occupations, as the condition has the potential to be career ending. With no published criteria for musician's sound exposure and little education available, there is a substantial risk of hearing damage to musicians. Many descriptive studies have documented musicians' exposure to auditory hazards and incidences of hearing problems. These studies have examined specific populations of musicians, such as instrument specific groups (Chesky & Henoch, 2000; Hoffman, Cunningham, & Lorenz, 2006; Presley, 2007), music teachers (Behar, MacDonald, Lee, Cui, Kunov, & Wong, 2004; Cutietta, Klich, Royse, & Rainbolt, 1994; Cutietta, Millin, & Royse, 1989; Mace, 2005; Owens, 2003 and 2004; Pisano, 2007; Royer, 1996), students of music (Henoch & Chesky, 2000; Libbin, 2008; Miller, Stewart, & Lehman, 2007; Philips, Shoemaker, Mace, & Hodges, 2008; Zeigler, 1997) and professional musicians (Royster, Royster, & Killion, 1991; Kähäri, Axelsson, Hellström, & Zachau, 2001; Lee, Behar, Kunov, & Wong, 2005).

#### *Instrument-specific Risk of Hearing Loss*

Chesky and Henoch (2000) examined the incidence of hearing problems reported by musicians using a web-based survey. Using the University of North Texas Musician Health Survey researchers found that 21.7% of the subjects (n=3292) believed they had a problem with

hearing. The highest occurrence of hearing loss was in rock/alternative musicians, musicians classified in non-classical groupings, and musicians who played amplified instruments, drum set, and primary brass instruments. Particularly of note is that music educators reported the third highest percentage of hearing loss (22.3%), well above the 19.7% response of classical/opera musicians.

Presley (2007) analyzed the sound level exposures of members of drum and bugle corps using personal dosimeters during a single day of rehearsal during spring training, which is pre-competition rehearsal that can last almost twelve hours. The study included eight “battery percussionists” and seven from the front ensemble. The study found that all subjects exceeded NIOSH standards of a 12-hour day. Eleven of the subjects experienced greater than 10 times the allowable sound level.

The purpose of a study by Hoffman, Cunningham, and Lorenz (2006) was to measure hearing thresholds in a large sample of percussionists and evaluate factors that might increase or decrease a percussionist’s risk for music-induced hearing loss. Percussionists (n=315) attending an international convention were asked to complete audiometric testing and recount their musical histories. When compared to an age- and gender-matched reference population, the hearing results of the percussionists were worse. Thirty-nine percent of percussionists indicated a hearing loss compared to 9% of the reference population. Factors that seemed to increase risk was the use of amplification systems, playing rock/pop music, having more years of experience, and considering oneself a professional.

### ***Music Teachers’ Risk of Hearing Loss***

Pisano’s (2007) study attempted to determine if high school band directors experience hearing loss. Results were found by comparing directors hearing examination results to the

audiometric results of the 1999-2004 National Health and Nutrition Examination Survey IV (NHANES). Additionally, the researcher investigated how the hearing of the director may be affected by musical environment. Forty-two high school band directors were given audiometric tests to evaluate if they were experiencing hearing loss or impairment. Twenty-five (59.5%) of the directors were found to have hearing loss in at least one of their ears attributed to over exposure to sound. When compared to the reference group, band directors exhibited significant differences in hearing thresholds. Results also found that there were not statistically significant relationships between music environments and band directors' hearing abilities.

Royer (1996) measured sound pressure levels in secondary public school band rooms during concert and jazz band rehearsals to determine the levels of sound exposure band directors experience. In twenty-three band rooms, fifty measurements were taken. Additionally, measurements were taken during sight-reading contests for high school and junior high school bands. The study found that when using the OSHA standard for noise exposure, sound levels were not considered dangerous. However, when more recent standards were used, 30% of the band directors studied were found to be at risk for NIHL.

Noise exposure of eighteen teachers, both elementary and secondary, from fifteen schools was measured using dosimeters in a study by Behar, MacDonald, Lee, Cui, Kunov, and Wong (2004). Equivalent continuous noise level ( $L_{eq}$ ) of each teacher was recorded during single classes in addition to the entire day. Also calculated was a normalized 8-hour exposure. The study found that the equivalent continuous noise level exceeded the 85 dB(A) threshold for 78% of teachers. The calculated normalized 8-hour exposure exceeded 85 dB(A) for 39% of teachers.

Using personal dosimeters, Mace (2005) examined sound-level exposures of thirty-seven university music performance teachers across a two-day period of typical activities. During this



two-day period, subjects kept a log of musical activity including type, location, and number of participants. Additionally the subjects completed a questionnaire that acquired information regarding each subject's age, years of teaching experience, primary and secondary instruments, ensemble experiences as a performer and conductor, and known hearing problems. The subjects also underwent audiometric testing to establish hearing thresholds. Results showed that 35% of the subjects experienced sound levels exceeding standards recommended by NIOSH. When both days of data were combined and calculated, only one subject fell from that category. When tested against OSHA standards, 14% of the subjects experienced sound levels in excess of the recommendations. Eighty-seven percent of subjects' audiograms indicated a hearing loss in at least one ear.

Cutietta, Millin, and Royse (1989) researched the evidence of NIHL in band directors. Thirty-two band directors who were attending an in-service workshop for instrumental music teachers were asked to complete a questionnaire asking the amount and type of exposure to ensemble sound they experienced. Afterwards, audiometric testing was done for hearing thresholds at 500, 1000, 2000, 4000, 6000, and 8000 Hz. 66% of the band directors tested showed signs of some hearing loss at one or more of the tested frequencies. Most of the subjects that exhibited signs of hearing loss met the criteria for NIHL. Presbycusis, or hearing loss due to ageing, was attributed to the rest of the participants.

Cutietta, Klich, Royse, and Rainbolt (1994) compared vocal, elementary instrumental, and high school instrumental music teachers' hearing accuracy. Music teachers (n=104) were tested for evidence of NIHL. Results indicate that one in five of the high school band directors in the study exhibited evidence of NIHL. Each of the subjects varied widely in the severity of the hearing loss.

Owens (2003 and 2004) investigated high school band directors' noise exposure using portable dosimeters. Additionally, sound reverberation times of the band rooms where the directors rehearsed were measured in order to determine the appropriateness of existing acoustic conditions. Sixty-three sound pressure measurements were taken at ten high schools. During rehearsal, 60% of the band directors experienced sound pressure levels at or exceeding 90 dB(A). While the sound pressure levels were within OSHA standards, the levels exceeded standards set forth by ACGIH and NIOSH.

### ***Music Students' Risk of Hearing Loss***

Miller, Stewart, and Lehman (2007) studied student musicians (n=27) who performed at football and basketball games. Using a nine-item survey, researchers obtained demographic data, musical practice habits, exposure to loud music, hearing conservation knowledge, and tinnitus status. Additionally, students wore noise-logging dosimeters before and during sporting events to monitor noise exposures. Results of the study found that the observed students appeared to be at high risk for permanent NIHL.

Philips, Shoemaker, Mace, and Hodges (2008) found that over half (52%) of the classically trained college music students (n=338) they studied exhibited damaged hearing, most frequently at 6000 Hz and in the right ear. All instrumental groups were found to have damage. Data was collected three ways: audiometric threshold test for frequencies 250-8000 Hz, sound exposure measurements (n=21), and a short questionnaire.

Another study found that members of a collegiate jazz band experienced noise exposure that could lead to hearing loss. Hensch and Chesky (2000) used personal dosimeters over a three-day period to measure noise levels in five different areas in the seating arrangement. The exposure level of the musicians exceeded the risk criteria of the OSHA (1983). Lead players,

who sat in the middle of rows in front of other players, were found to be most at risk.

Libbin (2008) evaluated temporary changes in college-aged marching band members' auditory function. Before and after two practices, twenty band members were tested. If changes in hearing were noted between the testing, researchers evaluated band members hearing the next morning to see if recovery had occurred. For those participants who showed clinically significant changes in auditory function, students were found to recover by the next morning. The results suggest that the changes of marching band members' auditory function are temporary in nature; however, they might be an early indication of future permanent changes.

Zeigler (1997) aimed to investigate the prevalence of tinnitus in college music majors compared to nonmajors. Music majors and nonmajor college students (n=498) attending school in Florida completed a survey. Results indicated that music majors were more likely to report tinnitus. Most music majors indicated that it was temporary, but six percent reported permanent ear noise. Percussionists and those who attended large national universities were also more likely to report hearing loss. When asked about recreational listening habits, music majors were more likely to exhibit hazardous behaviors. The majority of all students indicated that they do not take precautions, such as wearing HPDs, when faced with a hazardous situation.

### ***Professional Musicians' Risk of Hearing Loss***

Royster, Royster, and Killion (1991) used dosimeters to assess the risk of NIHL among members of the Chicago Symphony Orchestra. The study used sixty-eight noise exposure measurements that were taken during rehearsals and concerts. Additionally, fifty-nine musicians received an audiogram where hearing threshold levels were measured. Results showed that the mean hearing of the musicians was better than the hearing of an unscreened nonindustrial noise-exposed population. However, 52.5% of the musicians showed notched audiograms consistent

with NIHL. Left ears of violinists and violist showed significantly worse thresholds. The study also found that audiogram results and dosimeter measurements were related.

Kähäri, Axelsson, Hellström, and Zachau (2001) conducted a follow up to a 1979 study aimed at evaluating the risk of progressive hearing loss associated with work in classical orchestras. Sixteen years later in 1995, the same fifty-six classical orchestra musicians assessed were using pure tone audiometry. Even after sixteen years of additional noise exposure, this follow-up study showed no profound or progressive hearing deterioration.

Lee, Behar, Kunov, and Wong (2005) measured the sound exposures of the Canadian Opera Company orchestra players to determine risk of hearing loss of players in orchestra pits. During the entire duration of eighteen sessions, including rehearsals, dress rehearsals and actual performances of two operas, the noise exposures of seventy-three musicians were measured using five dosimeters. Results indicated that, playing for the company does not pose risk of hearing loss when using the ISO 1999 Standard.

### ***Attitudes and Perceptions of Hearing Protection Devices***

Multiple studies have examined the use of hearing protection devices, including the attitudes and perceptions of their use. Many different groups have been examined, including those whose career are in music (Goodman, 2001; Curk & Cunningham, 2006; Laitinen & Poulsen, 2008) and those who are not (Bogoch, House, & Kudla, 2005; Crandell, Mills, & Gauthier, 2004; Williams, Purdy, Murray, Dillon, LePage, Chanllinor, & Storey, 2004).

Bogoch, House, and Kudla (2005) examined the perceptions of concert attendees about the risk of NIHL and that use of hearing protection while at a rock concert venue. Attendees (n=204) of four rock concerts completed and returned questionnaires. The 28-item questionnaire took approximately three to five minutes to complete and included questions about basic

demographic information, frequency and location of concert attendance, perception of the risk of hearing damage at rock concerts, auditory effects actually experienced at rock concerts, use of hearing protection, barriers to the use of hearing protection, and readiness for behavioral change to increase the use of hearing protection in the future at rock concerts. Results of the questionnaire show that 34.3% of attendees thought that it was somewhat likely and 39.8% thought it was very likely that noise levels at music concerts could damage their hearing. However, 80.2% said they never wore hearing protection at such events. Tinnitus was experienced by 84.7% of attendees. Other hearing disturbances were experienced by 37.8% of attendees. Concert attendees' use of hearing protection was associated with hearing disturbances and concern about developing hearing loss.

Curk and Cunningham (2006) investigated amateur and professional percussionists' attitudes and behaviors using a written survey or personal interview. Subjects (n=283) were asked how frequently they use hearing protection devices (HPDs), reasons for non-use, types of HPD used, the advantages and disadvantages of wearing HPDs from a percussionist's point of view, sources where percussionists obtained information regarding HPDs, time of their most recent purchase, and accuracy of percussionists' knowledge of music-induced hearing loss and HPDs. The findings found that most percussionists were aware of the benefits of HPDs. Additionally, 89% of the participants were aware that music induced hearing loss was irreversible, and 74% knew that it cannot be treated with medicine or surgery. Despite this knowledge, 82% of the percussionists had not had their hearing tested in the past year, used industrial style hearing protection, or wore HPDs inconsistently.

Laitinen and Poulsen (2008) investigated the use of hearing protectors, the prevalence of self-reported hearing disorders, and the importance of hearing disorders as it related to musicians

who play in three Danish orchestras. The researchers collected the data via a questionnaire after they administered a short lecture. The questionnaire included sections that inquired about hearing protection and sound level reduction, occlusion effect, health related questions about hearing disorders, work surroundings, and rehearsal and performance facilities. Results indicated that the musicians surveyed were aware of the dangers of loud music, yet they rarely used HPDs. When HPDs were used, they are not always used correctly. The study also found that those who suffer hearing disorders used HPDs more frequently.

In a study by Crandell, Mills, and Gauthier (2004), researchers aimed to determine the knowledge base concerning the auditory mechanism, NIHL, and the use of HPDs of 200 college-aged young adults. Differences and similarities in knowledge of these areas between African-American and Caucasian young adults were also of interest to the researchers. The knowledge, habits, attitudes, and perception of NIHL along with each participant's use of hearing protection were measured with a 17-item questionnaire. Results showed that both ethnic groups exhibited considerable knowledge about the effects of noise on the auditory system. The majority of the respondents exhibited knowledge that the inner ear was most vulnerable to noise, that there was no cure for hearing loss, and that hearing loss can occur due to noise at any age. Even though 70% of participants indicated that they knew wearing HPDs could prevent hearing loss, 72% never do. If HPDs were provided free in high volume environments, 85% of participants indicated that they would wear them.

Williams, Purdy, Murray, Dillon, LePage, Chanllinor, and Storey (2004) investigated the effect of different types of audiometric testing on rural Australian workers' behaviors as well as their attitudes regarding hearing loss. This study used two different groups of subjects. One group underwent a pure tone audiometric (PTA) hearing test. The other group also underwent a

pure tone audiometric (PTA) hearing test in addition to otoacoustic emission (OAE) testing. Immediately before and twice after hearing testing both groups completed a 20-item self-report questionnaire. The purpose of the multiple questionnaires was to monitor and evaluate the short and long-term effects of the two hearing tests. Results showed that after testing the subjects held healthier attitudes towards noise and hearing loss prevention. These attitudes sustained for at least twelve months. However, willingness to use hearing protectors was not significantly changed by the hearing testing.

Goodman (2001) examined professional musicians' motivational factors for HPDs regarding usage, as well as perceptions about hearing loss and its ability to influence the usage or rejection of free custom earplugs. Of the 102 professional orchestra musicians, only forty-two took the earplugs while sixty rejected the service. Results of a survey completed by all participants, both those who accepted hearing protection and those who did not, indicated that use of HPDs was linked to individual acknowledgement hearing loss risk. Younger musicians fitted with HPDs reported no significant change in their musical perception.

### ***Environmental Risk Factors of Hearing Loss***

Work environments, social scenes, and recreational habits affect a person's hearing. Portable stereo player use (Hellström & Alexson, 1988; Williams, 2005) and social noise exposure (Mercier & Hohmann, 2002; Smith, Davis, Ferguson, & Lutman, 2000) have been examined. In turn, behavior (Florentine, Hunter, Robinson, Ballou, & Buus, 1998) and awareness of dangers (Chung, Des Roches, Meunier, & Eavey, 2005) can also play a role in avoiding hearing loss. Presbycusis, defined as the inability of the ears to focus on high-pitched sounds due to aging, has also been examined as it relates to musicians and hearing loss (Cutietta, 1981).

Hellström and Alexson (1988) measured the maximum output sound pressure level (SPL) from different portable cassette players and headphones. The dB(A) level varied between 104 dB for a low cost set to 126 dB for a high quality personal cassette player with earbuds. Tapes in the study were recorded with music, white noise, narrowband noise and pure tones. Researchers then measured sound pressure level in the ear canal of fifteen young subjects listening to pop music from personal cassette players at the highest level they considered comfortable. They found sound pressure level measurements corresponded to 112 dB(A). One hundred and fifty-four seventh and eighth graders were interviewed about listening habits among young people using personal cassette players. During the year, participants used personal cassette players much less than expected. An increase of personal cassette player use was reported during the summer holidays.

Williams (2005) examined a sample of fifty-five subjects who use personal stereo players in what could be considered noisy backgrounds as part of their daily activity. The average, A-weighted, 8-hour equivalent, continuous noise exposure level was determined to be 79.8 dB. Therefore, the measurements did not show a risk of potential hearing loss due to use of personal stereo players. There was a statistically significant difference between males, who had an average of 80.6 dB, and females at 75.3 dB. There was no correlation between self-reported hearing loss and incidence of tinnitus. Results indicated that there was no significant increase in the risk to potential noise injury from personal stereo player use alone.

Mercier and Hohmann (2002) surveyed and tested the hearing of attendees ages sixteen to twenty-five at a vocational training centre (n=700). Information on listening habits, the kinds of events attended, on whether the music at these events was too loud, and if the respondents considered their hearing had been impaired was acquired via questionnaire. Results of the survey



indicated that 79% of the subjects attended discotheques, 52% pop and rock concerts, and 35% techno parties. At discos 42% considered the music to be too loud, while 35% thought pop and rock concerts too loud. At techno parties, 39% held a similar view. Sound levels at these events were considered too low in less than 3% of attendees. It is estimated that over half of the respondents (56.6%) have sound exposure damage from music of over 87 dB(A). Following attendance at a music event, 71% of participants reported they had suffered tinnitus. When the hearing capacity of the sample was measured by audiometry, results found hearing loss in 11% of the participants. A link between hearing loss and increased exposure to loud music could not be established.

Smith, Davis, Ferguson, and Lutman (2000) investigated the prevalence and types of significant social noise exposure experienced by British young adults. Three hundred and fifty-six 18-25 year-olds were studied. In addition to noise measurements in nightclubs and personal cassette players, participants were interviewed about noise exposure in all facets of life. The results of the study found that young adults had been exposed to significant noise from social activities (18.8%), occupational noise (3.5%), and gunfire (2.9%). Temporary effects on hearing or tinnitus were reported in 66% of subjects attending nightclubs or rock concerts.

Florentine, Hunter, Robinson, Ballou, and Buus (1998) developed the Northeastern Excessive Music Listening Survey to study the behavioral characteristics of people who listen excessively to loud music. The 32-item survey was developed from the Michigan Alcoholism Screening Test [MAST], a widely used tool for the screening of alcohol addiction. Results indicate that 9% of the ninety participants scored “within a range that would suggest the presence of a maladaptive pattern of music-listening behavior similar to that exhibited by substance abusers.”

Chung, Des Roches, Meunier, and Eavey (2005) used a web-based survey to examine adolescents and young peoples' awareness of hearing loss due to loud music exposure. A 28-question survey presented at random to visitors at the MTV website contained questions about subjects' views toward general health issues, including hearing loss. Hearing loss was categorized as a "very big problem" by only 8% of respondents. Respondents experienced hearing impairment attending concerts (61%) and clubs (43%). Only 14% of respondents had used earplugs. Respondents noted that they could be motivated to use ear protection if they were aware of the potential for permanent hearing loss (66%) or were advised by a medical professional (59%).

Cutietta (1981) wrote an informative article about presbycusis, the progressive loss of hearing due to aging starting with the upper frequencies. Presbycusis begins around age forty but is usually not noticed until it affects the range of tones associated with speech near age sixty. Sounds to a person with presbycusis will sound hollow or tinny because of the reduction of overtones. Another effect of presbycusis is deterioration of one's ability to discriminate between neighboring tones. Two theories exist regarding the cause of presbycusis. One theory posits that the dying off of ear tissue causes hearing loss. The other suggests a lifetime of noise exposure gradually damages the ear. The later theory is supported by the fact that hearing loss occurs more in men exposed to high levels of noise at industrial jobs. Everyone with presbycusis experiences unique symptoms, and some studies suggest the disorder may be hereditary.

### ***Expressiveness in Music***

Previous studies examined the role dynamics play in the perception of expressiveness in music (Burnsed, 2001; Burnsed, 1998; Burnsed & Sochinski, 1995; Crist, 1998; Gordon, 1960), the perception of dynamic change (Geringer, 1995), and how well dynamics are communicated

from musician to listener (Nakamura, 1987). Some studies also analyzed the role of dynamics on musicians' ability to discriminate other musical elements (Haack, 1975).

Other studies examined the role of timbre on intonation (Ely, 1992) and balance (Killian, 1985). Researchers also examined the effectiveness of conductor communication regarding dynamics (Skadsem, 1997).

Crist (1998) aimed to determine whether any significant differences existed in the rankings of subjects' perception of changes in tempo and dynamics using a Continuous Response Digital Interface (CRDI), as well as in their perception of expressiveness across four musical examples. Subjects (n=120) were undergraduate college music majors from four state universities, 75% of whom were instrumental music education majors. Subjects listened to four versions of a selection of music and moved a CRDI when they detected variation in tempo and/or dynamics. After listening, subjects were asked to rate the degree of expressiveness of each selection. Results indicated that the performances with both tempo and dynamic changes had the greatest identification of change and was rated highest for level of expressiveness.

Geringer (1995) investigated how musician and non-musician listeners perceive and recognize loudness when listening to an excerpt of music performed with dynamic changes. Participants listened individually and responded continuously during ten diverse music examples using the CRDI to indicate perceived loudness levels. Musician subjects perceived smaller magnitudes of dynamic change than did their non-musician counterparts. Crescendos were perceived as having a greater magnitude of change than decrescendos. When compared to earlier research regarding pure tone and noise-band stimuli, music stimuli was perceived differently in context.

Haack (1975) investigated the effects of differing loudness levels on 101 undergraduate's

discernment of pitch, rhythm, duration, loudness, timbre, and tonal memory. Haack made comparisons between populations of music and nonmusic majors, male and female, and those with and without exposure to loud sounds. Results indicated that loudness significantly influenced the perception and discernment of rhythm duration, loudness, and timbre. Softer presentations enhance timbre perception.

Intent on investigating the effect of timbre on musicians' intonational activities during a listening and performance task, Ely (1992) assessed twenty-seven woodwinds (saxophone, clarinet, and flute). Participants' ability to play in tune and their ability to distinguish intonation problems were found to have a low correlation. Additionally, timbre had a significant effect on subjects' ability to detect intonation problems, but not on their ability to play in tune. Even though there was no significant difference between instrument groups' abilities to detect intonation problems, a significant difference was found between groups' abilities to play in tune. When matching other instrument timbres, subjects played significantly more flat than sharp.

Burnsed and Sochinski (1995) investigated the effects of expressive variation in dynamics on the musical preferences of middle school students. Forty-five middle school students were asked to complete a music preference test that presented two versions of ten folk songs. One version presented the song with even dynamic variation while another version used expressive dynamics. Results indicated that a significant number of students preferred the variation with expressive dynamics.

Building on previous work, Burnsed (1998) used elementary students in a study on the effects of dynamics in their musical preference. Three hundred and fifteen students in grades one through five from two urban elementary schools were given a music preference test, which presented two versions of ten folk songs. One version had very expressive dynamics while the

other was consistently even in dynamics. Results indicated that students preferred seven expressive versions and that age did not have an effect on preference.

Continuing in his field of interest, Burnsed (2001) modified the two previous studies and found contradictory results. Differing from his previous studies, he presented musical excerpts to participants that dynamic variation reduced by one third. In addition, he applied smoother curvatures to the crescendos and decrescendos in order to make the excerpts more musically authentic. Participants were elementary students (n=288), middle school music students (n=78), and conductors (n=22). Results indicated perception and preference for subtle dynamic nuance in music might be affected by age and musical experience.

Using four-voice chorales, Killian (1985) aimed to determine preference for balance. Choral conductors and students (n=87) stated their balance preference and listened to excerpts of a SATB choir. Using a four-channel tape recorder, which allowed every voice to be manipulated individually, Killian instructed subjects to manipulate the balance of the chorale. Subjects heard two balanced tracks and two unbalanced tracks. In the unbalanced tracks, one voice was 9-13 dB louder than the other voices. Results indicated that subjects, both conductors and students, preferred significantly less bass. Subjects could also discriminate when a single voice was unbalanced.

A study by Skadsem (1997) examined individual singers' dynamic responses to conductor verbalization, dynamic markings, conductor gesture, and choir dynamic level. While listening to a choir through headphones, referring to the music, and watching conductor on videotape singers (n=144) sang along with nine renditions of a tune. The conductor gave instructions on dynamic level four different ways: verbal instructions, written instructions, changes in conducting gesture, and volume changes in the choir. Results found that dynamic responses to the conductor's verbal

instructions were significantly stronger than when he used the other three instructional conditions. Choir members singing softly responded to instruction better than those singing loudly did.

Nakamura (1987) examined relationships between the following: the dynamics of a piece that performers intend to convey, the intensity of tones produced by the performers, and the listeners' perception of the dynamics of performances. Results showed performers communicated the dynamics they intended. Most listeners recognized crescendo when the performers intended to produce a crescendo, and intensity gradually increased. Results also found rising pitch enhanced an impression of crescendo, and falling pitch enhanced decrescendo. Crescendo was easier than decrescendo to both play and recognize. Even though the markings did not correspond to a fixed-intensity level, the performers conveyed their intention of observed dynamics to listeners.

In one of the earliest studies, Gordon (1960) investigated the dynamic ranges of eight band recordings from a music festival in 1951. The recordings were played for an oscillograph that recorded "sound level units" (SLU) onto a piece of paper. The author averaged the SLU to come up with a range within which the band played. The author compared the SLU readings to comments made by judges at the festival.

### ***Wind Band Seating and Balance***

Several articles provide practical information about the wind band, including discussion of musical issues that ensembles face (Musser, 1966) and suggestions for seating and instrumentation (Garofalo & Whaley, 1976). Some studies also examined preference for wind band seating using recording technology (Murray, 2006).

Musser (1966) wrote an informative article about the challenges faced by wind ensemble directors. The article, written during the early years of wind ensemble, discusses style, intonation, quality of tone, shaping phrases, balance, and control of dynamics. During his discussion on dynamics, the author notes that bands have a tendency to play too loud.

In an article about wind ensembles, Garofalo and Whaley (1976) offered advice on seating and instrumentation. The article took great care in formulating a seating chart that would create blend and enhance the abilities of the musicians. The result is a chart where players are seated in flat rows. Musicians play into others and primary players sit close together.

Murray (2006) used recording technology to examine one hundred and twenty university music majors' preferences for wind ensemble sounds in four virtual seating formations. Each section of a university wind ensemble separately recorded a Bach chorale. Using the separate audio tracks, four seating formations were produced: blocked sections, families of instruments, random placement of instruments, and center. Murray determined participants' preferences for the formations by asking subjects which excerpt they preferred: A, B, or neither. If they preferred excerpt A or B, Murray asked them to indicate their degree of preference. He then asked the subjects which musical factor most contributed to their response (tempo, volume, balance/blend, pitch/intonation, or tone quality). Results indicated that subjects preferred random, families and blocked section formations over center seating formations. Balance and blend were the musical factors that most significantly contributed to participants' preference responses.

### ***Hearing and Noise-induced Hearing Loss***

Several articles discuss issues relating to physiology of the auditory mechanism and hearing disorders in a way that can be easily understood by musicians (Owens, 2008; Moulton,

2003; Moore, 2005). The well-written articles provide scientifically backed insights that paint a clear picture of the dangers musicians face everyday.

Owens (2008) presents a review of hearing loss for musicians that discusses basic information on NIHL, testing methods, hearing protection standards, protective strategies, terminology, and the anatomy and physiology of the hearing mechanism. The article contains an extensive appendix that contains terminology related to the issues.

Moore (2005) discusses how sound levels are measured in ways that musicians, who are unfamiliar with idiosyncrasies of the decibel (dB), can understand. Moore wrote the article in direct response to an article published by Henoah (2005) earlier in the year about the dangers of sound levels that musicians are exposed. The article states there are three important factors one must know in order to understand sound measurements. The first important fact is that the unit usually measured is called a Sound Intensity Level (SIL). This unit describes how much acoustic power is present compared to how much power is present at the threshold of hearing. The second factor is that the dynamic range that humans experience is extremely large; the difference between the threshold of hearing (0 dB) and the threshold of pain (120 dB) is about a factor of one trillion. Lastly, the ear responds differently depending on the frequency of the sound. Lower frequencies are much harder to hear than higher frequencies. Because SIL contain such large numbers, they are usually converted to decibels (dB). When attempting to understand decibels, two rules are important to know. First, an increase of 3 dB is basically a doubling of intensity. Second, when an increase of 10 dB occurs, the intensity increases by ten times.

Moulton (2003) discusses the science of loudness. The article describes loudness as, “a subjective sensation that humans have as part of our hearing-a sensation relating roughly to the size or proximity of a sound source.” The article states the human threshold of hearing is



expressed as 0 dB, the level at which humans cannot detect acoustic energy. The author notes that this circumstance rarely occurs. The threshold of discomfort occurs around 120 dB. This is the point where sound brings pain upon the listener and reminds him or her that they should not be exposed to sound that loud.

## CHAPTER 3

### METHODOLOGY

The purpose of this study was to examine the effect of counseling on hearing conservation. This study first measured undergraduate music majors' understanding of their risk of hearing damage during ensemble rehearsals. Then, individual's sound exposure levels were measured during concert band rehearsals. Through counseling, students were made aware of their risk using the individualized sound exposure data that was measured. The participants' understanding of their risk of hearing damage was again measured after the counseling session.

#### *Participants*

The researcher recruited participants ( $N = 71$ ) from the University of Alabama Wind Ensemble ( $n = 33$ ) and Symphonic Band ( $n = 38$ ). Participants were undergraduate music majors over the age of 18 years who played either a wind or percussion instrument. No special consideration was given to subjects' gender or ethnic background. The researcher asked all eligible participants from the class rosters of the University of Alabama via a letter of consent (see Appendix A). A randomizer found at <http://randomizer.org> placed the participants into one of four groups.

Group A ( $n = 19$ ) completed a pretest consisting of a survey (see Appendix B); had their individual noise level exposure recorded with a dosimeter, attended a scripted sound exposure counseling session to go over the dosimeter results (see Appendix C), and viewed a brief video comprised of a spelling test designed to simulate a hearing loss (see Appendix D) as treatment;

and participated in a posttest survey identical to the pretest survey. Group B ( $n = 16$ ) completed the pretest and posttest surveys only (i.e., no treatment). Group C ( $n = 17$ ) received the treatment and completed the posttest survey, (i.e., no pretest). Group D ( $n = 19$ ) only completed the posttest.

### ***Procedure***

The researcher collected data during a four-week period during which time the Wind Ensemble and Symphonic Band prepared a variety of works for upcoming concerts. During week one, Groups A and B completed a computerized survey available at the school during typical work hours. The survey asked participants to rate their exposure to various intensities of sounds during a typical university band rehearsal. The survey also asked questions about hearing health and steps taken by participants to protect hearing. Participants were asked not to converse with others about the survey. The survey was online (Appendix E) and administered in a small computer lab adjacent to the Music Education Office. Participants could take the survey on three Internet accessible computers designated for completing the survey.

During the second week of the study, the participants in Groups A and C wore noise level dosimeters for the entire length of two regularly scheduled 90-minute rehearsals of either the Symphonic Band or Wind Ensemble. The *Quest Technologies NoisePro DL Noise Dosimeter* collected sound intensity readings in dB once every 60-seconds. Then it calculated sound exposure in accordance to either the American Conference of Industrial Hygienists (ACGIH) or Occupational Safety and Health Administration (OSHA) standards for sound exposure. Each dosimeter was calibrated beforehand in accordance to manufacturer specifications set forth in Chapter 3 of the NoisePro Noise Dosimeter Owner's Manual by Health Consultants working for the Alabama Safe State Program. The researcher placed the microphone of the dosimeter on the

shirt or collar of the subject on the left side of the body, approximately four inches from the ear. The participant clipped the dosimeter to the waist, and moved the microphone cord to the back of the body in order to cause the least amount of interference. To prevent accidental input to the device and to avoid tampering of the data by the subject, a protective lid covered the dosimeter's controls and screen. The dosimeter began logging data as soon as the subject was fitted for the dosimeter, approximately five minutes from the start of rehearsal. At the end of rehearsal, the researcher removed the dosimeter from the subject and stopped data recording.

After the dosimeter collected the data, the researcher ran individual reports for each participant. During counseling sessions, with up to three participants, the researcher shared the dosimeter reading with subjects. Participants could not see the dosimeter readings of the other participants. The participants viewed a chart (Appendix F) showing the dynamic range experienced in the form of (Slow) Min Level and (Slow) Max Level. Additionally, the average sound level ( $L_{AVG}$ ), percentage of daily allowable noise exposure (Dose), and percentage of eight-hour equivalent noise exposure (Dose[8]) according to the standards set by both the American Conference of Industrial Hygienists (ACGIH) and Occupational Safety and Health Administration (OSHA) (Appendix G). Following individual noise measurements, participants viewed a brief 5-minute video designed to simulate taking a spelling test with a hearing loss.

One-week later, after students attended two regular rehearsals of their respective ensembles, all participants rated their perceived exposure to various intensities of sounds during rehearsal. Using the same survey given in the pretest, participants also answered questions about hearing health, and they revealed steps taken to protect their hearing. The researcher compared results of the pretest and posttest to examine any indication of change attributed to the counseling session, influence of pretest, or a combination of both.

### ***Data Analysis***

All data was entered into SPSS 18.0 for Macintosh OSX for analysis. A combination of chi-squared goodness-of-fit tests ( $\chi^2$ ) and one-way ANOVAs (ANOVA) determined whether there were any differences between survey results by groups and before and after treatment. A predetermined  $\alpha$  of .05 was selected for all analysis. Eta-squared ( $\eta^2$ ) values were calculated to determine the amount of variance in the dependent variables attributed to the independent variables.

## CHAPTER 4

### RESULTS

Administration of the study resulted in 71 (95.9%) eligible participants. Descriptive statistics analyzed the participants' responses. Information gathered about the sample indicates a statistically equivalent ( $\chi^2[1, n = 71] = .69, p = .41$ ) representation of Wind Ensemble ( $n = 32$ ) and Symphonic Band ( $n = 39$ ) members. Participants represented statistically different ( $\chi^2[2, n = 71] = 17.27, p < .001$ ) groups of woodwinds ( $n = 36$ ), brasses ( $n = 27$ ), and percussionists ( $n = 8$ ).

The first question of the survey asked if participants were worried about their hearing. Results indicated that participants' responses were statistically different ( $\chi^2[4, n = 71] = 47.83, p < .001$ ). The 71 participants' responded that they were *only a little worried* (40.8%), *worried to some extent* (38%), *not at all worried* (14.1%), *quite worried* (5.6%), and *extremely worried* (1.4%). The remaining sections of the survey inquired about perception of sound exposure, habits of music listening, knowledge of hearing risks, use of hearing protection, and hearing health.

#### ***Perception of Sound Exposure***

Section one of the survey determined participants' perception of sound exposure during band rehearsal. Within this section, there were four groupings of questions. The first questions asked about the loudest, softest, and average sound students assume they are exposed to during either a typical rehearsal of a concert band or individual practice. Participants' responses were

converted to decibels (dB). The second grouping of questions asked about students' assumptions of how frequently sound reaches a certain level during a typical concert band rehearsal. Participants' responses were coded *Never* (0), *Almost Never* (1), *Seldom* (2), *Sometimes* (3), and *Often* (4). A third grouping of questions asked if students thought typical concert band sound exposure could cause hearing loss. The section also asked about length of time the participant thought he or she could spend in ensemble settings before hearing damage occurs. The questions were analyzed three different ways using a one-way ANOVA according to the following conditions: instrumental grouping, presence of treatment, and research grouping (i.e., Group A, Group B, etc.)

### ***Woodwinds and Brass/Percussion Compared***

The first analysis sought a statistical difference of perception of sound exposure based on instrumental grouping; woodwind compared to brass and percussion. The following questions were analyzed between instrumental groupings. When asked what the loudest sound participants thought they were exposed to during a normal rehearsal of the concert ensemble, results of a one-way ANOVA,  $F(1, 70) = 1.99, p = .16, \eta^2 = .03$ , demonstrated no statistically significant differences between the groups. Because no statistically significant difference existed between the two groups, results were combined indicating that the loudest average sound intensity participants thought they were exposed to was 105.6 dB ( $SE = 1.9$ ).

The next question asked participants what they thought was the softest sound experienced during a normal rehearsal of the concert ensemble. Results of a one-way ANOVA,  $F(1, 70) = .55, p = .46, \eta^2 = .01$ , demonstrated no statistically significant difference between the groups. In general the average softest sound experienced during a normal rehearsal was perceived by the participants to be 18.0 dB, ( $SE = 2.3$ ).

When asked what the average sound level participants thought they were exposed to during a normal rehearsal of the concert ensemble, results of a one-way ANOVA,  $F(1, 70) = .89$ ,  $p = .35$ ,  $\eta^2 = .01$ , found no statistically significant differences between the groups. In general the average sound the participants reported was 74.9 dB ( $SE = 2.3$ ).

Results of a one-way ANOVA,  $F(1, 70) = 15.34$ ,  $p < .001$ ,  $\eta^2 = .18$ , demonstrated statistically significant differences between woodwinds and brass/percussion when asked what the loudest sound participants thought they were exposed to during individual practice. Group mean scores in dB were woodwinds ( $M = 75.6$  dB,  $SE = 2.8$ ) and brass/percussion ( $M = 91.4$  dB,  $SE = 2.6$ ). Interpretation of  $\eta^2$  indicated considerable effect due to the instrument grouping that accounted for 18% in the variance of the dependent value.

When asked what the softest sound participants thought they were exposed to during individual practice, results of a one-way ANOVA,  $F(1, 70) = .01$ ,  $p = .92$ ,  $\eta^2 = .00$ , exhibited no statistically significant differences between the groups. Since no statistically significant difference was found between the two groups, the overall mean in dB was 8.7, ( $SE = 1.2$ ).

The next question asked the participants what they thought was the average sound level they were exposed to during individual practice. Results of a one-way ANOVA,  $F(1, 70) = 1.89$ ,  $p = .17$ ,  $\eta^2 = .03$ , revealed no statistically significant differences between the groups. The overall mean for all participants was 61.4 dB, ( $SE = 2.1$ ).

When asked how often the sound of a typical band rehearsal reaches levels comparable to a normal conversation (60 dB), results of a one-way ANOVA,  $F(1, 70) = 1.35$ ,  $p = .25$ ,  $\eta^2 = .02$ , demonstrated no statistically significant differences between the groups. The overall mean estimate indicated that the participants thought it *sometimes* ( $M = 3.2$ ,  $SE = 0.1$ ) occurred in rehearsals.



The next question asked participants how often they thought the sound of a typical band rehearsal reaches levels comparable to a hair dryer (70 dB). Results of a one-way ANOVA,  $F(1, 70) = .17, p = .68, \eta^2 = .00$ , demonstrated no statistically significant differences between the groups. Because there was no statistically significant difference in the two groups, the overall mean indicated that it occurred *sometimes to often* ( $M = 3.4, SE = 0.1$ ) in rehearsals.

Results of a one-way ANOVA,  $F(1, 70) = .01, p = .91, \eta^2 = .00$ , demonstrated no statistically significant differences between the groups when participants were asked how often they thought the sound of a typical band rehearsal reaches levels comparable to a dishwasher (80 dB). The overall mean estimate indicated that it occurred *sometimes* ( $M = 3.2, SE = 0.1$ ) in rehearsals.

The next question asked participants how often they thought the sound of a typical band rehearsal reaches levels comparable to a blender (90 dB). Results of a one-way ANOVA,  $F(1, 70) = 1.28, p = .26, \eta^2 = .02$ , demonstrated no statistically significant differences between the groups. The overall mean estimate indicated that the participants thought it occurred *sometimes* ( $M = 3.2, SE = 0.1$ ) in rehearsals.

When participants were asked how often they thought the sound of a typical band rehearsal reaches levels comparable to a diesel truck (100 dB), results of a one-way ANOVA,  $F(1, 70) = .02, p = .88, \eta^2 = .00$ , exhibited no statistically significant differences between the groups. The overall mean estimate indicated that it occurred *seldom to sometimes* ( $M = 2.5, SE = 0.1$ ) in rehearsal.

Participants then answered how often they thought the sound of a typical band rehearsal reaches levels comparable to a chainsaw (110 dB). Results of a one-way ANOVA,  $F(1, 70) = .46, p = .50, \eta^2 = .01$ , demonstrated no statistically significant differences between the groups.

Because there was not a statistically significant difference in the two groups, the overall mean indicated that it *seldom* occurred ( $M = 2.1, SE = 0.2$ ) in rehearsals.

When participants were asked how often they thought the sound of a typical band rehearsal reaches levels comparable to a clap of thunder (120 dB), results of a one-way ANOVA,  $F(1, 70) = .88, p = .35, \eta^2 = .01$ , demonstrated no statistically significant differences between the groups. The overall mean estimate indicated that it *seldom* occurred ( $M = 1.9, SE = 0.1$ ) in rehearsals.

When asked how often the sound of a typical band rehearsal reaches levels comparable to a jackhammer (130 dB), results of a one-way ANOVA,  $F(1, 70) = .04, p = .84, \eta^2 = .00$ , demonstrated no statistically significant differences between the groups. Because no statistically significant difference between the two groups existed, the overall mean indicated that it *never* occurred ( $M = 1.1, SE = 0.1$ ) in rehearsals.

Lastly, participants answered how often they thought the sound of a typical band rehearsal reaches levels comparable to gunfire or a jet taking off (140 dB). Results of a one-way ANOVA,  $F(1, 70) = .37, p = .55, \eta^2 = .01$ , found no statistically significant differences between the groups. An overall mean estimate indicated that the participants thought it *never to almost never* occurred ( $M = 0.5, SE = 0.1$ ).

### ***Counseling Session Versus No Counseling Session Compared***

The second analysis examined if there was statistical difference of perception of sound exposure based on the participants' treatment condition, analyzing the previous questions from a different perspective. When asked what the loudest sound participants thought they were exposed to during a normal rehearsal of the concert ensemble, results of a one-way ANOVA,

$F(1, 70) = .90, p = .35, \eta^2 = .01$ , demonstrated no statistically significant differences between the groups with an overall mean of 105.6 dB, ( $SE = 1.9$ ).

Results of a one-way ANOVA,  $F(1, 70) = 4.61, p = .04, \eta^2 = .06$ , demonstrated statistically significant differences between the treatment groups when asked what the softest sound participants thought they were exposed to during a normal rehearsal of the concert ensemble. Mean scores for the no treatment ( $M = 13.1$  dB,  $SE = 2.4$ ) and treatment ( $M = 22.8$  dB,  $SE = 3.8$ ) groups differed by nearly 10 dB. Interpretation of  $\eta^2$  value indicates that the effect of the treatment was *medium* and accounted for 6% in the variance of the dependent value.

When asked what the average sound level participants thought they were exposed to during a normal rehearsal of the Symphonic Band or Wind Ensemble, results of a one-way ANOVA,  $F(1, 70) = .02, p = .88, \eta^2 = .00$ , demonstrated no statistically significant differences between the groups, the overall mean level reported was 74.9 dB, ( $SE = 2.3$ ).

The next question asked what the loudest sound participants thought they experienced during individual practice. Results of a one-way ANOVA,  $F(1, 70) = .01, p = .92, \eta^2 = .00$ , yielded no statistically significant differences between the groups so the overall mean level reported for the entire group of participants was 83.4 dB, ( $SE = 2.2$ ).

Participants answered what the softest sound they thought they encountered during individual practice. Results of a one-way ANOVA,  $F(1, 70) = 4.09, p = .047, \eta^2 = .06$ , demonstrated statistically significant differences between the groups. Group mean scores in dB were no treatment ( $M = 6.3$  dB,  $SE = 1.2$ ) and treatment ( $M = 11.1$  dB,  $SE = 2.0$ ). Interpretation of  $\eta^2$  value indicated a *medium* effect due to the treatment that accounted for 6% in the variance of the dependent value.

Participants were asked about the average sound level they thought they experienced during individual practice. Results of a one-way ANOVA,  $F(1, 70) = .47, p = .50, \eta^2 = .01$ , demonstrated no statistically significant differences between the groups, the overall mean level reported was 61.4 dB ( $SE = 2.1$ ).

When asked how often participants thought the sound of a typical band rehearsal reaches levels comparable to a normal conversation (60 dB), results of a one-way ANOVA,  $F(1, 70) = 1.48, p = .23, \eta^2 = .02$ , demonstrated no statistically significant differences between the groups, the overall mean indicated that sound reached the level of conversation *sometimes* ( $M = 3.2, SE = 0.1$ ) in rehearsals.

When participants were asked how often they thought the sound of a typical band rehearsal reaches levels comparable to a hair dryer (70 dB), results of a one-way ANOVA,  $F(1, 70) = .01, p = .93, \eta^2 = .00$ , demonstrated no statistically significant differences between the groups the overall mean reported number of times sound reached the level of a hair dryer was *sometimes to often* ( $M = 3.4, SE = 0.1$ ) in rehearsals.

Results of a one-way ANOVA,  $F(1, 70) = .47, p = .49, \eta^2 = .01$ , demonstrated no statistically significant differences between the groups when participants were asked how often they thought the sound of a typical band rehearsal reaches levels comparable to a dishwasher (80 dB). Generally participants indicated that sound levels reached this level *sometimes* ( $M = 3.2, SE = 0.1$ ) in a typical rehearsal.

The next question asked participants how often they thought the sound of a typical band rehearsal reaches levels comparable to a blender (90 dB). Results of a one-way ANOVA,  $F(1, 70) = 2.99, p = .09, \eta^2 = .04$ , demonstrated no statistically significant differences between the

groups. Generally, participants estimated the frequency of sound levels reaching the intensity of a blender as *sometimes* ( $M = 3.2, SE = 0.1$ ) in a typical rehearsal.

When participants were asked how often they thought the sound of a typical band rehearsal reaches levels comparable to a diesel truck (100dB), results of a one-way ANOVA,  $F(1, 70) = .76, p = .39, \eta^2 = .01$ , demonstrated no statistically significant differences between the groups. Generally, participants estimated the frequency of sounds levels reaching the intensity of a diesel truck as *seldom to sometimes* ( $M = 2.5, SE = 0.1$ ) in rehearsals.

When participants were asked how often they thought the sound of a typical band rehearsal reaches levels comparable to a chainsaw (110 dB), results of a one-way ANOVA,  $F(1, 70) = .46, p = .50, \eta^2 = .01$ , demonstrated no statistically significant differences between the groups. Generally, participants estimated the frequency of sounds levels reaching the intensity of a chainsaw as *seldom* ( $M = 2.1, SE = 0.2$ ) during a typical rehearsal.

When participants were asked how often they thought the sound of a typical band rehearsal reaches levels comparable to a clap of thunder (120 dB), results of a one-way ANOVA,  $F(1, 70) = .01, p = .93, \eta^2 = .00$ , demonstrated no statistically significant differences between the groups. Generally, participants estimated the frequency of sound levels comparable to a clap of thunder as *seldom* ( $M = 1.9, SE = 0.1$ ) happens during a typical rehearsal.

Results of a one-way ANOVA,  $F(1, 70) = .00, p = .99, \eta^2 = .00$ , demonstrated no statistically significant differences between the groups when asked how often the sound of a typical band rehearsal reaches levels comparable to a jackhammer (130 dB). The overall mean suggested that it occurred *almost never* ( $M = 1.1, SE = 0.1$ ) in rehearsals.

Finally, when participants were asked how often they thought the sound of a typical band rehearsal reaches levels comparable to gunfire or a jet taking off (140 dB), results of a one-way

ANOVA,  $F(1, 70) = .04, p = .84, \eta^2 = .00$ , demonstrated no statistically significant differences between the groups, the overall mean estimate suggested that it *never* ( $M = 0.5, SE = 0.1$ ) reached that level.

#### ***Four Experimental Groups Compared***

The third analysis investigated whether a statistical difference is present between the four original groupings when perceived sound exposure is measured. The four groupings are as follows: Group A, which completed pretest, treatment, and posttest; Group B, which completed pretest and posttest; Group C, which completed treatment and posttest; Group D, which completed the posttest only. When asked what the loudest sound participants thought they were exposed to during a normal rehearsal of the concert ensemble, results of a one-way ANOVA,  $F(3, 70) = 0.95, p = .42, \eta^2 = .04$ , demonstrated no statistically significant differences between the groups ( $M = 105.6 \text{ dB}, SE = 1.9$ ).

Results of a one-way ANOVA,  $F(3, 70) = 6.54, p = .001, \eta^2 = .23$ , demonstrated statistically significant differences between the groups when asked what the softest sound participants thought they were exposed to during a normal rehearsal of the concert ensemble. Group mean scores were Group A ( $M = 11.6 \text{ dB}, SE = 3.4$ ), Group B ( $M = 8.8 \text{ dB}, SE = 2.0$ ), Group C ( $M = 32.9 \text{ dB}, SE = 6.1$ ), and Group D ( $M = 19.0 \text{ dB}, SE = 4.0$ ). Interpretation of  $\eta^2$  value indicates that the effect of the treatment was *significant* and accounted for 23% in the variance of the dependent variable.

The next question asked what the average sound participants thought they encounter during a normal rehearsal of the concert ensemble. Results of a one-way ANOVA,  $F(3, 70) = .61, p = .61, \eta^2 = .03$ , demonstrated no statistically significant differences between the groups, ( $M = 74.9 \text{ dB}, SE = 2.3$ ).

After an analysis of the loudest sound, participants thought they experienced during individual practice, results of a one-way ANOVA,  $F(3, 70) = 0.35, p = .79, \eta^2 = .02$ , exhibited no statistically significant differences between the groups. The overall mean was 83.4 dB ( $SE = 2.2$ ).

Results of a one-way ANOVA,  $F(3, 70) = 1.83, p = .15, \eta^2 = .08$ , demonstrated no statistically significant differences between the groups when asked what the softest sound participants thought they were exposed to during individual practice, the overall mean estimate was 8.7 dB, ( $SE = 1.2$ ).

When asked what the average sound participants thought they were exposed to during individual practice, results of a one-way ANOVA,  $F(3, 70) = 1.32, p = .28, \eta^2 = .06$ , demonstrated no statistically significant differences between the groups; an overall mean estimate provided by the participants was 61.4 dB, ( $SE = 2.1$ ).

When participants were asked how often they thought the sound of a typical band rehearsal reaches levels comparable to a normal conversation (60 dB), results of a one-way ANOVA,  $F(3, 70) = 2.13, p = .10, \eta^2 = .09$ , demonstrated no statistically significant differences between the groups; the overall mean indicated that the participants thought it *sometimes* occurred during a typical rehearsal ( $M = 3.2$  dB,  $SE = 0.1$ ).

The next question asked how often participants thought the sound of a typical band rehearsal reaches levels comparable to a hair dryer (70 dB). Results of a one-way ANOVA,  $F(3, 70) = .03, p = .99, \eta^2 = .00$ , demonstrated no statistically significant differences between the groups. The overall mean indicated that the participants thought it occurred *sometimes to often* during a typical rehearsal ( $M = 3.4, SE = 0.1$ ).

Results of a one-way ANOVA,  $F(3, 70) = .24, p = .87, \eta^2 = .01$ , demonstrated no statistically significant differences between the groups when participants were asked how often they thought the sound of a typical band rehearsal reaches levels comparable to a dishwasher (80 dB). The overall mean indicated that the participants thought it occurred *sometimes to often* during a typical rehearsal ( $M = 3.2, SE = 0.1$ ).

When participants were asked how often they thought the sound of a typical band rehearsal reaches levels comparable to a blender (90 dB), results of a one-way ANOVA,  $F(3, 70) = .67, p = .58, \eta^2 = .03$ , demonstrated no statistically significant differences between the groups. Because there was no statistically significant difference between the four groups, the overall mean indicated that the participants thought it *sometimes* occurred during a typical rehearsal ( $M = 3.2, SE = 0.1$ ).

When participants were asked how often they thought the sound of a typical band rehearsal reaches levels comparable to a diesel truck (100 dB), results of a one-way ANOVA,  $F(3, 70) = .15, p = .93, \eta^2 = .01$ , demonstrated no statistically significant differences between the groups. The overall mean indicated that the participants thought it *seldom to sometimes* occurred during a typical rehearsal ( $M = 2.5, SE = 0.1$ ).

The next question asked how often participants thought the sound of a typical band rehearsal reaches levels comparable to a chainsaw (110 dB). Results of a one-way ANOVA,  $F(3, 70) = .71, p = .55, \eta^2 = .03$ , demonstrated no statistically significant differences between the groups. A mean estimate indicated that the participants thought it *seldom* occurred during a typical rehearsal ( $M = 2.1 (SE = 0.2)$ ).

Results of a one-way ANOVA,  $F(3, 70) = .11, p = .96, \eta^2 = .00$ , demonstrated no statistically significant differences between the groups when participants were asked how often



they thought the sound of a typical band rehearsal reaches levels comparable to a clap of thunder (120 dB). The overall mean estimate indicated that the participants thought it *seldom* occurred during a typical rehearsal ( $M = 1.9, SE = 0.1$ ).

When participants were asked how often they thought the sound of a typical band rehearsal reaches levels comparable to a jackhammer (130 dB), results of a one-way ANOVA,  $F(3, 70) = .67, p = .58, \eta^2 = .03$ , demonstrated no statistically significant differences between the groups. The overall mean estimate indicated that the participants thought it *almost never* occurred ( $M = 1.1, SE = 0.1$ ) during a typical rehearsal.

The final question of the section asked participants how often they thought the sound of a typical band rehearsal reaches levels comparable to a jackhammer (130 dB). Results of a one-way ANOVA,  $F(3, 70) = 0.48, p = .70, \eta^2 = .02$ , demonstrated no statistically significant differences between the groups. The overall mean estimate indicated that the participants thought it *never* to *almost never* occurred ( $M = 0.5, SE = 0.1$ ) during a typical rehearsal.

### ***Hearing Damage Due to Perceived Sound Exposure***

Another grouping of questions related to perceived sound exposure asked if participants believed they were exposed to sound levels that could damage their hearing during a typical ensemble rehearsal. Analyzing differences between woodwinds and brass/percussion,  $F(1, 70) = .48, p = .49, \eta^2 = .01$ , between treatment and non treatment groups  $F(1, 70) = 2.87, p = .10, \eta^2 = .04$ , and between experimental groups  $F(3, 70) = 1.53, p = .22, \eta^2 = .06$ , demonstrated no statistically significant differences which indicated that all participants on average *agreed* with the statement ( $M = 3.3, SE = 0.1$ ).

An additional question asked participants how long they think they can spend in a typical band rehearsal environment before hearing loss occurs considering the average level of sound

they experience. Responses were coded less than fifteen minutes (1), fifteen minutes (2), thirty minutes (3), one hour (4), one and half hours (5), two hours (6), three hours (7), four hours (8), six hours (9), eight hours (10), and more than eight hours (11). No statistically significant differences were found in analyses of participants responses by instrument group,  $F(1, 70) = .32$ ,  $p = .58$ ,  $\eta^2 = .00$ , treatment group,  $F(1, 70) = 2.76$ ,  $p = .10$ ,  $\eta^2 = .04$ , and experimental group  $F(3, 70) = 1.25$ ,  $p = .30$ ,  $\eta^2 = .05$ . In general the overall mean indicated that the participants believed they could withstand roughly *3-4 hours* in a band rehearsal before any hearing damage occurred ( $M = 7.7$ ,  $SE = 0.3$ ).

### ***Knowledge of Noise Induced Hearing Loss***

Section two dealt with participants' music listening habits and their knowledge of the causes of noise induced hearing loss. The questions in this section sought to determine participants' awareness of state and federal laws concerning musicians' limits of sound exposure.

Participants were asked if they used earphones when listening to music; results were statistically different ( $\chi^2[4, n = 71] = 86.25$ ,  $p < .001$ ). Amount of headphone use was as follows: 62.0% *often*, 22.5% *sometimes*, 5.6% *never*, 5.6% *always*, and 4.2% *seldom*. When asked if they consciously listened to music at a certain volume to conserve hearing, participants' responses were statistically equivalent ( $\chi^2[4, n = 71] = 9.49$ ,  $p = .05$ ). Participants' responses were *never* (33.8%), *sometimes* (19.7%), *seldom* (18.3%), *always* (15.5%), and *often* (12.7%).

Participants were asked about their awareness of a possible cure for hearing loss. Participants' responses were significantly different ( $\chi^2[2, n = 71] = 31.21$ ,  $p < .001$ ). Most participants responded that there was *no cure for hearing loss* (57.7%). Other participants were neutral (38%) or thought there was a cure (4.2%).

Additional questions asked about factors potentially leading to hearing loss including loudness of music, a person's proximity to the music source, and the length of exposure to music. When participants were asked about all three factors, a significant difference was present, 83.1% of participants thought that the loudness of music would damage hearing. 11.3% were neutral, and 5.6% disagreed ( $\chi^2[2, n = 71] = 79.47, p < .001$ ). When asked about damage due to close proximity to the source of music, 74.6% of participants agreed damage was possible while 21.1% were neutral and 4.2% disagreed ( $\chi^2[2, n = 71] = 57.58, p < .001$ ). Of the 71 participants, 68 (95.8%) agreed that the risk of damage to hearing depends on how long music exposure occurs. 2.8% were neutral and 1.4% disagreed ( $\chi^2[2, n = 71] = 124.59, p < .001$ ).

Another question asked participants if being forced to shout to be heard is an indication that an environment is too loud and thus damaging to one's hearing. Results indicated that participants' responses were statistically different ( $\chi^2[3, n = 71] = 31.93, p < .001$ ). The 71 participants' responses were *agree* (52.1%), *neutral* (23.9%), *strongly agree* (16.9%), *disagree* (7%), and *strongly disagree* (0%).

### ***State and Federal Laws***

The last grouping of questions in section two asked about participants' knowledge of state and federal laws designed to protect the hearing of musicians. At this time, there are no such laws. When asked if state laws to protect musicians' hearing existed, 40.8% disagreed, 38% were neutral, 15.5% strongly disagreed, 4.2% agreed, and 1.4% strongly agreed ( $\chi^2[4, n = 71] = 48.79, p < .001$ ). When asked about federal laws, 38% were neutral, 36.6% disagreed, 15.5% strongly disagreed, 8.5% agreed, and 1.4% strongly agreed ( $\chi^2[4, n = 71] = 39.07, p < .001$ ).

### ***Hearing Protection***

The third section examined the use of hearing protection. Information gathered about the sample indicates a statistically equivalent ( $\chi^2[1, n = 71] = .69, p = .41$ ) representation of hearing protection *users* ( $n = 32$ ) and *nonusers* ( $n = 39$ ). The most popular form of hearing protection was *fingers in the ears* with 32.4% of participants performing this action ( $\chi^2[1, n = 71] = 8.80, p = .003$ ). Other forms of protection were not as popular even though they are more effective at preventing hearing loss. Hearing protections used by participants are as follows: *disposable foam earplugs* (29.6%), *wads of paper or cotton* (11.3%), *pre-molded earplugs* (9.9%), *custom molded earplugs* (4.2%), and *other* (5.6%).

Hearing protection use was statistically different in a variety of rehearsal environments: individual ( $\chi^2[3, n = 64] = 154.25, p < .001$ ), marching band ( $\chi^2[4, n = 40] = 33.00, p < .001$ ), concert band ( $\chi^2[2, n = 61] = 104.69, p < .001$ ), jazz band ( $\chi^2[1, n = 17] = 13.24, p < .001$ ), orchestra ( $\chi^2[1, n = 26] = 40.09, p < .001$ ), and chamber ensemble ( $\chi^2[1, n = 44] = 40.09, p < .001$ ). Of the 64 participants who responded, 92.2% never use hearing protection while rehearsing individually. Other responses were *seldom* (4.7%), *sometimes* (1.6%), and *always* (1.6%). When rehearsing in marching band, 55% of the 40 responding participants never wore hearing protection. Others wore hearing protection *seldom* (17.5%), *sometimes* (12.5%), *often* (12.5%), and *always* (2.5%). During concert band rehearsal, 95.1% of participants never use hearing protection. 3.3% and 1.6% use hearing protection *seldom* or *always*, respectively. In jazz band, 94.1% of the 17 participants never use hearing protection, while 5.9% of the participants seldom use protection. Of the 26 participants who responded to questions about hearing protection in orchestra, 92.3% never use and 7.7% seldom use protection. In chamber ensemble, 97.7% of participants never use protection during rehearsals. Only one participant (2.3%) uses

protection. No participants use hearing protection in the rehearsals of pep band or vocal ensemble.

Hearing protection use was also statistically different in concert band ( $\chi^2[1, n = 61] = 57.07, p < .001$ ) and orchestra ( $\chi^2[1, n = 25] = 21.16, p < .001$ ) performance environments. Of the 61 participants who responded to questions about the use of hearing protection in concert band performance, only one participant (1.6%) indicated use every time. All other participants (98.4%) never used protection. In orchestra, 96% of the participants never use protection during performance. One participant (4%) indicated seldom use during performance. Hearing protection was not used in performances of the marching band, jazz band, pep band, chamber ensemble, vocal ensemble, or the individual.

When participants were asked if they would like to learn more about ways to protect their hearing, most (83.1%) responded that they would ( $\chi^2[1, n = 71] = 31.11, p < .001$ ).

### ***Self-Reported Hearing Health***

Section four examined the hearing health of the participants. The first part examined the occurrence of tinnitus in the participants. Results indicated that there was no statistical difference in the occurrence of tinnitus ( $\chi^2[1, n = 71] = 1.70, p = .19$ ) among participants. Thirty of the subjects (42.2%) reported having experienced tinnitus. Forty-one (57.8%) have not. Of those who have experienced tinnitus, only 25.8% knew what caused the tinnitus ( $\chi^2[1, n = 31] = 7.26, p = .007$ ). Most of the participants' tinnitus was temporary (93.5%), while two (6.5%) have permanent tinnitus ( $\chi^2[1, n = 31] = 23.52, p < .001$ ).

The next question asked subjects if they experience temporary tinnitus after participating in various musical environments. Result indicated that participants' responses were statistically different for all environments: individual ( $\chi^2[5, n = 61] = 50.59, p < .001$ ), marching band ( $\chi^2[4,$

$n = 44] = 13.05, p = .011$ ), concert band ( $\chi^2[4, n = 60] = 93.83, p < .001$ ), jazz band ( $\chi^2[2, n = 14] = 17.29, p < .001$ ), pep band ( $\chi^2[3, n = 17] = 15.71, p = .001$ ), orchestra ( $\chi^2[2, n = 22] = 23.55, p < .001$ ), chamber ensemble ( $\chi^2[2, n = 42] = 43.43, p < .001$ ), and vocal ensemble ( $\chi^2[1, n = 12] = 8.33, p = .004$ ). Of the 61 participants that responded, 75.4% never experience tinnitus after individual practice. 19.7% responded they seldom experience tinnitus, while 4.9% of participants experience tinnitus sometimes. After marching band, 44 participants experience tinnitus *never* (36.4%), *seldom* (25%), *sometimes* (22.7%), *often* (9.1%), and *always* (6.8%). After concert band, 57.7% of the 60 ensemble members participating responded they never experience tinnitus. However, the other concert band members *seldom* (20%), *sometimes* (6.7%), *often* (3.3%), and *always* (1.7%) experience tinnitus. After jazz band, the 14 ensemble members experience tinnitus *never* (85.7%), *seldom* (7.1%), and *sometimes* (7.1%). Participants in pep band ( $n=17$ ) experienced tinnitus *never* (64.7%), *seldom* (5.9%), *sometimes* (23.5%), and *often* (5.9%). After orchestra, 22 participants responded that they *never* (81.8%), *seldom* (13.6%), and *sometimes* (4.8%) experience tinnitus. Of the 42 participants who played in chamber ensembles, 81% do not experience tinnitus. Other chamber ensemble members responded *seldom* (14.3%) and *sometimes* (4.8%). Only one vocal ensemble participant (8.3%) responded that they sometimes experience tinnitus. 91.7% of the 12 participants never experience tinnitus.

Examination of hyperacusis, the abnormal sensitivity to everyday sound levels or noise, was the second part of the section. Results indicated that there was a statistical difference in the occurrence of hyperacusis among participants ( $\chi^2[1, n = 71] = 33.82, p < .001$ ). 15.5% of participants experienced some type of hyperacusis. In these participants, hyperacusis occurred in different ears or a combination: only in the right ear (9.1%), only in the left ear (27.3%), and in both ears (63.6%) ( $\chi^2[2, n = 11] = 5.09, p = .08$ ).

Distortion, a condition where sound is perceived as being impure, cracked, or distorted when sound reaches a certain volume, was rarely experienced by participants ( $\chi^2[1, n = 71] = 49.03, p < .001$ ). Of the 8.5% of students who experienced distortion, 83.3% experienced it in both ears ( $\chi^2[1, n = 6] = 2.67, p = .10$ ). Other's distortion occurred in the left ear (16.7%).

The last medical condition examined was diplacusis, where the same sound presented to both ears is heard differently in each ear. Result indicated that most of the participants (97.2%) never experienced diplacusis ( $\chi^2[1, n = 71] = 63.23, p < .001$ ).

The last part of the hearing health section determined the last time participants submitted themselves to a hearing screening. Participants' answers differed significantly ( $\chi^2[5, n = 71] = 65.14, p < .001$ ). The majority of participants were unsure of the last time they had their hearing checked (50.7%). Other participants indicated that their hearing was checked this year (2.8%), 1-3 years ago (18.3%), 4-5 years ago (7%), 6-10 years ago (12.7%), and over 10 years ago (8.5%). There was a significant difference in results when asked if they remembered having a hearing loss at checkup ( $\chi^2[2, n = 71] = 24.54, p < .001$ ). Most participants were unsure (46.5%) or did not have hearing loss (47.9%), while 5.6% did have a hearing loss when their hearing was checked.

## **CHAPTER 5**

### **DISCUSSION**

The present study examined whether counseling, which presented musicians with their individualized OSHA and ACGIH noise exposure data collected during ensemble rehearsals, effected musicians perceptions of sound exposure and their awareness of risk of hearing damage.

Chapter One discussed the need for effective ways to alter music majors' understanding of the potentially hazardous sound exposure they experience during individual and ensemble music rehearsals. The purpose of the present investigation was specified and research questions were presented.

Chapter Two examined a variety of research literature related to the sound exposure music students experience. Specifically, the chapter reviewed ten different areas of study, including Musicians' Risk, Instrument-specific Risk of Hearing Loss, Music Teachers' Risk of Hearing Loss, Music Students' Risk of Hearing Loss, Professional Musicians' Risk of Hearing Loss, Attitudes and Perceptions of Hearing Protection Devices, Environmental Risk Factors of Hearing Loss, Expressiveness in Music, Wind Band Seating and Balance, and Science of Hearing and Noise-induced Hearing Loss.

Chapter Three presented the methodology for the study, as well as the procedures for the administration of the survey and counseling sessions. In addition, the chapter set forth the way in which individual sound levels that were used in the counseling sessions were measured.



Finally, Chapter Four revealed the procedures employed for analyzing the data obtained for the surveys. A combination of chi-squared ( $\chi^2$ ) and one-way ANOVAs, were performed to determine significant relationships among variables.

Results of this investigation found that the music majors at a large southern university understood the conditions that cause hearing damage. However, participants were less likely to identify everyday audio hazards found in concert ensembles and individual environments. Additionally, participants rarely took steps to prevent hearing loss, even though many experience symptoms related to the condition.

The first question of the survey yielded the most telling data collected during the course of this study. The question asked if participants were worried about their hearing. The results found that of the 71 responses, 54.9% of the participants in total are not worried or only a little worried about their hearing. Only 5.6% and 1.4% of participants, respectively, were quite worried or extremely worried about their hearing. While the participants were all majoring in music, their youthful age and maturity may account for their troubling lack of concern for their hearing. The results are similar to an earlier study by Chung, Des Roches, Meunier, and Eavey (2005), which found that only 8% of adolescents and young people participating in the study thought that hearing loss was a “very big problem.”

Grouping participants according to instrument and presence of a treatment showed dissimilar results toward participants’ understanding of sound exposure in several instances. When asked what the loudest sound participants thought they were exposed to during individual practice, brass and percussionists demonstrated significant difference compared to their woodwind counterparts. Statistical tests found that instrument grouping accounted for 18% of variance in responses. Clearly, brasses and percussionists in the sample thought that they were

exposed to significantly louder levels of sound when practicing alone. This may explain why those musicians are often found practicing in larger rooms or outdoors. Other research reflects the differences in instrument groupings assumptions. Chesky and Hensch (2000) found that some of highest occurrence of hearing loss was in musicians who play drum set and primary brass instruments. Hoffman, Cunningham, and Lorenz (2006) found 39% percent of percussionists indicated a hearing loss, compared to 9% of the reference population.

Treatment and research group affected indication of the softest level of sound exposure. When participants were asked the softest sound they were exposed to during a normal rehearsal of the concert ensemble and individual practice, there was a difference of response according to the presence of treatment. Treatment accounted for 6% of the difference of the group, a medium effect. This may be because those who received treatment were told that at no point during a rehearsal is there absolute silence. The lowest sound level measured during rehearsal was 60 dB, the threshold of the dosimeter. Participants grouped randomly and according to whether or not they had a treatment and pretest showed differing results when asked to indicate the softest level of sound they thought they had experienced in concert ensembles. The grouping accounted for 23% of the difference in responses.

Overall, the treatment had little influence on participants' abilities to accurately rate the level of sound exposure they experience in both rehearsal and individual practice. No statistical differences existed in participants' ability to rate the average level of sound or highest level of sound exposure they experienced. Average level and highest level of sound exposure are perhaps the most telling sign if an environment presents risk to hearing and would need to be addressed for the treatment to be considered effective. Further confounding the matter, when asked if during a typical ensemble rehearsal participants are exposed to sound that can be damaging to

their hearing, 62% of participants indicated that they agree. Another 26.8% were neutral. Only 11.2% of participants disagreed with the statement.

In general, participants were aware that there is no cure for hearing loss, with 57.7% of the participants responding correctly. However, 38% of the population was unsure.

Astonishingly, 4.2% of the surveyed musicians thought that there was a cure for hearing loss.

The participants of the present study are more misinformed than the percussionists examined by Curk and Cunningham (2006), who found that 89% of the participants studied were aware that music induced hearing loss was irreversible.

Most participants held healthy views related to potential audio threats. 83.1% of participants thought that loud music would damage hearing. When asked if being close to the source of music could damage hearing, 74.6% of participants agreed. 95.8% agreed that the risk of damage to hearing depends on how long music exposure occurs. Participants understand what would constitute a potential audio hazard. However, participants lack sufficient skills in the identification of hazards.

Tinnitus, a symptom of noise induced hearing loss, was reported in 42.2% of the participants in the study. While only 6.5% of the reporting population's tinnitus was permanent, tinnitus is a serious problem for musicians at the major southern university of the study. Other studies have found the same results in other populations. Zeigler (1997) investigated the prevalence of tinnitus in college music majors compared to nonmajors and found that music majors were more likely to report tinnitus. Like the present study, most music majors indicated that it was temporary. Six percent reported permanent ear noise.

Tinnitus was found to occur in participants after several ensembles, presenting a great risk of auditory damage. Marching band was the greatest offender. Of the 44 members of the

marching band who participated in the study, only 36.4% indicated that they never experience hearing loss. Nearly 16% of participants frequently suffer tinnitus, a clear indication that some members of the marching band participate in music making which is degrading the health of their hearing. While one might expect marching band to be loud, and therefore hazardous due to its large size and abundance of overzealous brass and percussion players, concert band was found to be damaging to some participants as well. Nearly 10% of the participants indicated that they often or always suffer tinnitus after rehearsal of their concert band.

Participants also reported other types of hearing ailments including hyperacusis, distortion, and diplacusis. 15.5% of participants reported hyperacusis or abnormal sensitivity to everyday sound levels. Hyperacusis is typically caused by overexposure to excessively high sound levels. Distortion, a condition where sound is perceived as being impure, cracked, or distorted when sound reaches a certain volume, was experienced by 8.5% of participants. 2.8% of participants experienced diplacusis, a medical condition where the sound presented to both ears is heard differently in each ear.

While the auditory health of the participants includes problematic conditions, participants place little value in hearing screenings. Most participants were unsure of the last time they had their hearing checked (50.7%). 28.2% of participants indicated that it had been four or more years since their last hearing screening. Only 2.8% of the participants had their hearing checked within the last year. Alarmingly, of those who had remembered the last time they had a hearing check, 5.6% participants indicated that the hearing screening identified a hearing loss. Tinnitus, a type of hearing loss, was self-reported in 42.2% of the participants in the study. Clearly, students do not recognize a connection between their own self reported conditions and a need for medical help.

Musicians rely on their hearing to perform. Therefore, maintaining proper care of hearing is essential for a successful musical career. Participants' attitudes towards hearing protection were not unlike results found in previous studies related to preventive measures. In a study investigating the oral hygiene practices of dentists, only 56.3% dentists flossed at least once a day, a practice that prevents gum disease, halitosis, and dental cavities (Merchant, Pitiphat, Douglass, Crohin and Joshipura, 2002). Like dentists and their flossing habits, participants neglected to protect hearing even though they were aware of the damage their neglect causes.

One way musicians can protect their hearing is by using hearing protective devices (HPD) such as earplugs. Participants' most popular form of hearing protection is inserting their fingers into their ears (32.4%), a practice which is ineffective at best. Another popular form of ineffective hearing protection was using wads of paper or cotton placed in the ears (11.3%). Effective, but less than ideal forms of hearing protection for musicians were also used. 29.6% of participants used disposable foam earplugs. While the foam earplugs do provide adequate protection from dangerous sound levels, users often experience sound as distorted with an uneven reduction of higher frequencies. 9.9% and 4.2% of participants used quality hearing protection that included pre-molded earplugs and custom molded earplugs respectively. Other unidentified forms of hearing protection were used by 5.6% of participants. Results were similar to those in the Laitinen and Paulsen (2008) study that found that musicians were aware of the dangers of loud music, but rarely use hearing protection.

While participants used many forms of hearing protection, the frequency of use is highly variable. Most, 92.2% of participants, never use hearing protection while rehearsing individually. Musicians who play brass and percussion instruments identified their practice environments much louder than their woodwind counterparts, a statistic that is not reflected in hearing

protective device use. Hearing protection use was highest in marching band rehearsal. While 55% of the responding participants never wore hearing protection, 15% cited frequent use. In concert band rehearsal, 95.1% of participants never use hearing protection. In jazz band (94.1%), orchestra (92.3%), and chamber ensemble (97.7%) rehearsal hearing protection is not frequently used. When hearing protection is used in these ensembles, it is infrequently. No participants use hearing protection in the rehearsals of pep band or vocal ensemble. Participants used hearing protection even less in performances. Only 1.6% of the participants used hearing protection every concert band performance. 4% of the participants in orchestra used hearing protection during performance, though seldom. In performances of the marching band, jazz band, pep band, chamber ensemble, vocal ensemble, or the individual hearing protection is not used. While hearing protection was used by only a few individuals, 83.1% of participants indicated that they would like to learn about ways to protect their hearing. A previous study (Goodman, 2001) found that older and more experienced musicians choose to wear musicians' earplugs. Again, youth could be a factor in participants' use of hearing protection.

This study examined the attitudes and perceptions of 71 individuals involved in the university band program at The University of Alabama. Nearly all members in the top two concert bands participated in the study. This large sample size accounted for nearly a quarter of the total music school population. Because of this large population, results of the survey hold a large degree of validity.. Any amount of hearing damage to students should be a considered significant, especially when 42.2% of the participants already suffer a form of hearing loss. Students are unaware of the risks they are exposed to on a daily basis. Those who are aware retain a carefree attitude. Clearly, efforts need to be taken by the school and faculty to ensure that all students are aware of potential auditory hazards. Neglecting to educate musicians, whose

careers rely on the ability to hear correctly, is irresponsible. Making music should not be a hazardous activity that causes hearing damage.

Several steps can be easily taken to help make students aware of the daily risks they face as musicians. Throughout the school, and especially in areas where instrumentalists rehearse, signs should be placed reminding students of the potential hazards of exposure to high levels of sound for long lengths of time. Additionally, professors and directors should be aware of the risks that musicians face, especially those in higher education environments. In turn, those educators should make preventative measures to ensure safety of students. Professors should be responsible for monitoring sound levels and limiting time spent in dangerous environments.

Students also need to further develop their awareness of the risk of hearing damage due to music making within their environment. Every year, freshmen music majors take an introductory course in music study. This course introduces fields of study that are available to the music student, teach students how to use the library, and prepares students for their years ahead as a music major. Perhaps this course could teach students how to best conserve and protect their hearing. Students could learn what causes noise induced hearing loss, how to identify potential audio hazards, and the steps to prevent hearing loss. Yearly seminars addressing noise induced hearing loss should be available for the rest of the music school.

Students could also be required to have their hearing tested at university hearing centers. Through yearly monitoring, students would be aware of the state of their hearing and could make efforts to prevent further hearing loss. Studies have shown that participants hold healthier attitudes towards noise and hearing loss prevention after hearing testing (Williams, Purdy, Murray, Dillon, LePage, Chanllinor, & Storey, 2004).

University professors should also require students to purchase quality hearing protection. Currently, most professors require students to purchase metronomes, tuners, professional model instruments, and a basic library of literature. Students would be more likely to use protection if required to purchase hearing protection designed for musicians. Also higher quality protection has better sonic capabilities. The school should also provide basic hearing protection to students not required to purchase the higher quality protection. On marching band fields and in the ensemble rehearsal rooms, buckets of disposable foam hearing protection should be available for use in a similar way hand sanitizer is provided to prevent communicable disease.

As the auditory world becomes louder, musicians are at an even greater risk; even mild impairments in hearing have disastrous effects on musicians. Since there are no state and federal laws to help protect musicians, educators have an even greater responsibility to guard the health of their students. Further research needs to examine noise-induced hearing loss not just in its prevalence but its prevention. Effective strategies to promote healthy attitudes in musicians related to noise induced hearing loss need to be developed. In addition to finding reasons why hearing protection is not used, strategies to help musicians understand the need for hearing protection in hazardous environments requires development.



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**APPENDIX A**  
**LETTER OF CONSENT**

Dear Student,

You are being asked to be in a research study. The name of this study is “The Effect of Counseling on Hearing Conservation Using Individualized Sound Exposure Data on Undergraduate Music Majors Perceptions of Sound Exposure During Concert Band Rehearsals.” Brendan Vincent is the primary investigator of this study. He is a graduate student in Music Education at the University Of Alabama College of Education.

The purpose of this study is three-fold. First, the study is trying to find information about undergraduate students’ perceptions and attitudes towards hearing loss as it relates to being a musician. Second, the study is attempting to find information on some of the everyday hearing loss risks that undergraduate students encounter. Lastly, the researcher hopes to use the information he acquires to alter the perceptions and attitudes of the subjects in a way that better protects them against possible hearing damage.

The results may reveal a need for hearing loss education to be added to the program of study for musicians. The study may also reveal a way to help musicians understand the dangers of their work environment.

You have been asked to be in this study because you were selected at random from the class roster of either the University of Alabama Wind Ensemble or Symphonic Band. This is a moderate sized study. Only 80 undergraduate members of the University of Alabama Band Program will be part of the study.

If you agree to be in this study, you will complete a survey during regular school hours. Some students may be asked to complete the survey twice. A select group of subjects will be asked to wear noise-logging equipment during two rehearsals of their major ensemble. The equipment will not interfere with typical music making. Those who wear the monitors will also be asked to attend a private session where they will receive information about noise data collected during their rehearsal.

Over the next four weeks, you may spend up to an hour outside of the usual ensemble time. This includes time taking surveys and/or attending a brief educational session. There is no cost to be in this study. There will be no risk or danger to you if you are in this study. Although we cannot promise certain results, it is possible that you will learn more about your hearing health as a musician.

We will not tell anyone you are in this study. You do not have to answer any questions or give us any information that you do not wish to share. We will protect your information by giving you and each person in this study an identification number. Your names will not appear on any study document besides this consent form. There is no way to link consent forms and names with data. The data from the study will be kept in locked file drawers in locked offices. No one will have access to it except the investigators. We may publish articles on this study, but no individuals will be identified.

You do not have to be in this study. You can also start the study and decide to stop at any time. You will not be penalized in any way if you choose to not participate or start the study without completion.

If you have questions about the study now, please ask them. If you have questions or concerns later, you can reach Brendan Vincent at (859) 771-5977 or by email at



## APPENDIX B

### SURVEY

=====  
Participant Information  
=====

1. What is your Identification Number?

\_\_\_\_\_

2. Which university ensemble(s) do you currently participate in? (Check all that apply)

- Million Dollar Band
- Pep Band
- Wind Ensemble
- Symphonic Band
- Concert Band
- University Singers
- University Chorus
- Opera Theatre
- Huxford Orchestra
- Jazz Ensemble
- Studio Ensemble (e.g. Trombone Choir)
- Chamber Ensemble (e.g. Woodwind Quintet)

3. Which band are you presently a member of at the University of Alabama ?

- Wind Ensemble
- Symphonic Band
- Concert Band

4. Which of the following instruments are you playing in this ensemble? (Check all that apply)

- Piccolo
- Flute
- Oboe
- English horn
- Bassoon
- Contrabassoon
- Clarinet in E-flat
- Clarinets in B-flat
- Alto Clarinet
- Bass Clarinet
- Contra-alto Clarinet
- Contrabass Clarinet
- Soprano Saxophone
- Alto Saxophone
- Tenor Saxophone
- Baritone Saxophone
- Trumpet/Cornet
- Horn
- Trombone
- Bass Trombone
- Baritone/Euphonium
- Tuba
- Percussion
- Piano



5. What year did you begin playing any music instrument under the guidance of any of the following: music teacher, studio teacher, lesson instructor, band director, piano teacher, community musician, church musician, etc.?

\_\_\_\_\_

6. For how many years have you performed, rehearsed, and played in large concert ensembles such as orchestras, concert bands, marching bands, jazz bands, chamber ensemble, etc.?

\_\_\_\_\_

7. Are you worried about your hearing?

- Not at all worried
- Only a little worried
- Worried to some extent
- Quite worried
- Extremely worried

=====  
Perception (Part I)  
=====

8. During a normal rehearsal of my concert ensemble, the loudest sound I am exposed to is comparable to ...

- Absolute Silence
- Person Breathing While at Rest
- Rustling Leaves
- Quiet Rural Area
- Hum of a Refrigerator
- Moderate Rainfall
- Normal Conversation
- Hair Dryer
- Dishwasher
- Blender
- Diesel Truck
- Chainsaw
- Clap of Thunder
- Jackhammer
- Gunfire or a Jet Taking Off

9. During a normal rehearsal of my concert ensemble, the softest sound I am exposed to is comparable to...

- Absolute Silence
- Person Breathing While at Rest
- Rustling Leaves
- Quiet Rural Area
- Hum of a Refrigerator
- Moderate Rainfall
- Normal Conversation
- Hair Dryer
- Dishwasher
- Blender
- Diesel Truck
- Chainsaw
- Clap of Thunder
- Jackhammer
- Gunfire or a Jet Taking Off

10. During a normal rehearsal of my concert ensemble, the average level of sound I am exposed to is comparable to...

- Absolute Silence
- Person Breathing While at Rest
- Rustling Leaves
- Quiet Rural Area
- Hum of a Refrigerator
- Moderate Rainfall
- Normal Conversation
- Hair Dryer
- Dishwasher
- Blender
- Diesel Truck
- Chainsaw
- Clap of Thunder
- Jackhammer
- Gunfire or a Jet Taking Off

11. During individual practice, the loudest sound I am exposed to is comparable to...

- Absolute Silence
- Person Breathing While at Rest
- Rustling Leaves
- Quiet Rural Area
- Hum of a Refrigerator
- Moderate Rainfall
- Normal Conversation
- Hair Dryer
- Dishwasher
- Blender
- Diesel Truck
- Chainsaw
- Clap of Thunder
- Jackhammer
- Gunfire or a Jet Taking Off

12. During individual practice, the softest sound I am exposed to is comparable to...

- Absolute Silence
- Person Breathing While at Rest
- Rustling Leaves
- Quiet Rural Area
- Hum of a Refrigerator
- Moderate Rainfall
- Normal Conversation
- Hair Dryer
- Dishwasher
- Blender
- Diesel Truck
- Chainsaw
- Clap of Thunder
- Jackhammer
- Gunfire or a Jet Taking Off

13. During individual practice, the average level of sound I am exposed to is comparable to...

- Absolute Silence
- Person Breathing While at Rest
- Rustling Leaves
- Quiet Rural Area
- Hum of a Refrigerator
- Moderate Rainfall
- Normal Conversation
- Hair Dryer
- Dishwasher
- Blender
- Diesel Truck
- Chainsaw
- Clap of Thunder
- Jackhammer
- Gunfire or a Jet Taking Off

14. Do you find the following settings in which you play your instrument noisy?

	Not Applicable	Not at all	Only a little	To some extent	Quite	Extremely
Individual	_____	_____	_____	_____	_____	_____
Marching Band	_____	_____	_____	_____	_____	_____
Concert Band	_____	_____	_____	_____	_____	_____
Jazz Band	_____	_____	_____	_____	_____	_____
Pep Band	_____	_____	_____	_____	_____	_____
Orchestra	_____	_____	_____	_____	_____	_____
Chamber Ens.	_____	_____	_____	_____	_____	_____
Vocal Ensemble	_____	_____	_____	_____	_____	_____

15. During a typical ensemble rehearsal I am exposed to sound that can be damaging to my hearing.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

16. With consideration to the average level of sound I am exposed to during my concert ensemble, the longest I can spend in that environment before hearing loss occurs is...

- less than 15 minutes
- 15 minutes
- 30 minutes
- 1 hour
- 1.5 hours
- 2 hours
- 3 hours
- 4 hours
- 6 hours
- 8 hours
- more than 8 hours

=====  
 Perception (Part II)  
 =====

17. In your typical concert band rehearsal how often does sound reach levels comparable to normal conversation?

- Never
- Almost Never
- Seldom
- Sometimes
- Often

18. In your typical concert band rehearsal how often does sound reach levels comparable to a hair dryer?  
 Never  
 Almost Never  
 Seldom  
 Sometimes  
 Often

19. In your typical concert band rehearsal how often does sound reach levels comparable to a dishwasher?  
 Never  
 Almost Never  
 Seldom  
 Sometimes  
 Often

20. In your typical concert band rehearsal how often does sound reach levels comparable to a blender?  
 Never  
 Almost Never  
 Seldom  
 Sometimes  
 Often

21. In your typical concert band rehearsal how often does sound reach levels comparable to a diesel truck?  
 Never  
 Almost Never  
 Seldom  
 Sometimes  
 Often

22. In your typical concert band rehearsal how often does sound reach levels comparable to a chainsaw?  
 Never  
 Almost Never  
 Seldom  
 Sometimes  
 Often

23. In your typical concert band rehearsal how often does sound reach levels comparable to a clap of thunder?  
 Never  
 Almost Never  
 Seldom  
 Sometimes  
 Often

24. In your typical concert band rehearsal how often does sound reach levels comparable to a jackhammer?  
 Never  
 Almost Never  
 Seldom  
 Sometimes  
 Often

25. In your typical concert band rehearsal how often does sound reach levels comparable to gunfire or a jet taking off?  
 Never  
 Almost Never  
 Seldom  
 Sometimes  
 Often

=====  
Attitudes  
=====

26. Do you use earphones when listening to music?  
 Never  
 Seldom  
 Sometimes  
 Often  
 Always
27. Do you consciously listen to music at a certain volume to conserve your hearing?  
 Never  
 Seldom  
 Sometimes  
 Often  
 Always
28. There is a cure for hearing loss.  
 Strongly disagree  
 Disagree  
 Neutral  
 Agree  
 Strongly agree
29. The risk of damage to your hearing depends on the loudness of music.  
 Strongly disagree  
 Disagree  
 Neutral  
 Agree  
 Strongly agree
30. The risk of damage to your hearing depends on proximity to the source of the music.  
 Strongly disagree  
 Disagree  
 Neutral  
 Agree  
 Strongly agree
31. The risk of damage to your hearing depends on how long you are exposed to the music.  
 Strongly disagree  
 Disagree  
 Neutral  
 Agree  
 Strongly agree
32. If it is necessary to shout to hear oneself over a noise, I may be experiencing hearing damage.  
 Strongly disagree  
 Disagree  
 Neutral  
 Agree  
 Strongly agree
33. There are state laws that are designed to protect the hearing of musicians.  
 Strongly disagree  
 Disagree  
 Neutral  
 Agree  
 Strongly agree

34. There are federal laws that are designed to protect the hearing of musicians.

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

=====  
 Hearing Protection  
 =====

35. What type(s) of hearing protection do you use? (Check all that apply)

- Disposable foam earplugs
- Pre-molded, reusable earplugs
- Custom-molded earplugs
- Wads of paper or cotton
- Canal caps
- Acoustic earmuffs (a.k.a. ear defenders)
- Fingers in ears
- Other
- I do not use hearing protection

36. I use hearing protection during the following rehearsals...

	Not Applicable	Never	Seldom	Sometimes	Often	Always
Individual	_____	_____	_____	_____	_____	_____
Marching Band	_____	_____	_____	_____	_____	_____
Concert Band	_____	_____	_____	_____	_____	_____
Jazz Band	_____	_____	_____	_____	_____	_____
Pep Band	_____	_____	_____	_____	_____	_____
Orchestra	_____	_____	_____	_____	_____	_____
Chamber Ens.	_____	_____	_____	_____	_____	_____
Vocal Ensemble	_____	_____	_____	_____	_____	_____

37. I use hearing protection during the following performances...

	Not Applicable	Never	Seldom	Sometimes	Often	Always
Individual	_____	_____	_____	_____	_____	_____
Marching Band	_____	_____	_____	_____	_____	_____
Concert Band	_____	_____	_____	_____	_____	_____
Jazz Band	_____	_____	_____	_____	_____	_____
Pep Band	_____	_____	_____	_____	_____	_____
Orchestra	_____	_____	_____	_____	_____	_____
Chamber Ens.	_____	_____	_____	_____	_____	_____
Vocal Ensemble	_____	_____	_____	_____	_____	_____

38. Would you be interested in learning about ways to protect your hearing?

- Yes
- No

=====  
 Hearing Health  
 =====

39. Tinnitus is an occasional sensation of ringing, roaring, or bussing sound in the ears or head even though no such sound is present that lasts for at least five minutes. Do you experience tinnitus?

- Yes
- No

40. Do you know what caused the tinnitus?  
 Yes  
 No  
 I have not experienced tinnitus

41. Is your tinnitus always present?  
 Yes  
 No  
 I have not experienced tinnitus

42. Have you had temporary tinnitus after the following settings where you play your instrument...

	Not Applicable	Never	Seldom	Sometimes	Often	Always
Individual	_____	_____	_____	_____	_____	_____
Marching Band	_____	_____	_____	_____	_____	_____
Concert Band	_____	_____	_____	_____	_____	_____
Jazz Band	_____	_____	_____	_____	_____	_____
Pep Band	_____	_____	_____	_____	_____	_____
Orchestra	_____	_____	_____	_____	_____	_____
Chamber Ens.	_____	_____	_____	_____	_____	_____
Vocal Ensemble	_____	_____	_____	_____	_____	_____

43. Hyperacusis is an abnormal sensitivity to everyday sound levels or noises. Often there is also sensitivity to high pitch sounds. Do you experience hyperacusis?  
 Yes  
 No

44. In which ear do you experience hyperacusis?  
 Right  
 Left  
 Both  
 I have not experienced hyperacusis

45. Distortion is a condition when sound reaches a certain level, it is perceived as being impure, cracked, and/or distorted. Do you experience distortion?  
 Yes  
 No

46. In which ear do you experience distortion?  
 Right  
 Left  
 Both  
 I have not experienced distortion

47. Diplacusis is when the pitch of a sound presented to both ears is heard different in the two ears. Do you experience diplacusis?  
 Yes  
 No

48. When was your hearing last checked?  
 This Year  
 1-3 Years  
 4-5 Years  
 6-10 Years  
 Over 10 Years  
 Don't Know

49. When your hearing was checked, did you have hearing loss?  
 Yes  
 No  
 Don't Know

=====  
Thank You!  
=====

Thank you for taking our survey. Your response is very important to us.



## APPENDIX C

### SCRIPT

*Participants enter office and takes their seat. The participants are handed a pencil and a clipboard that includes an individualized data report and a response sheet to take a spelling test.*

*Researcher speaks:*

Last week during your ensemble rehearsal, you wore a dosimeter that collected information about the noise to which you were exposed. During the next few minutes, we will discuss the measurements the dosimeter collected and the implications they have for you as a musician.

Recent studies have shown an increased incidence of hearing loss among musicians. At work and home, we are often subject to levels of noise that threaten our hearing. Power tools, factory noises, fireworks, and loud music, are all sources of noise that can potentially cause irreversible inner ear damage. At first, the hearing loss may only be temporary, with hearing returning to normal after several hours or days. But, if exposure occurs repeatedly, the ears will eventually lose their ability to bounce back. This will result in permanent hearing damage.

When you notice a difference between loud sounds and quiet ones, your ears are perceiving changes in sound pressure level. Intensity (or volume) is measured in decibels (dB). Zero (0) dB is the softest sound that can be heard. Normal conversation is around

60 dB. A whisper is around 30 dB. Machinery such as chainsaws and jackhammers can average between 110 and 120 dB. The sound from gunfire is approximately 140 dB. Hearing loss becomes a factor for sounds greater than 85 dB. One way to prevent hearing damage is by paying attention to noise levels and realizing when the sound is too loud.

During the rehearsal where you wore the dosimeter, you experienced a dynamic range between (Slow) Min Level and (Slow) Max Level. According to standards set forth by Occupational Safety and Health Administration (OSHA), the average sound level measured over the time of the rehearsal was  $L_{AVG}$ . You experienced Dose of the maximum allowable noise exposure for the day during the rehearsal alone. If the exposure lasted for eight hours, which is a typical industrial workday, your exposure would have been Dose[8] of maximum allowable noise exposure. When using the suggestions of the American Conference of Industrial Hygienists (ACGIH), a newer and more up-to-date standard, the average sound level measured over the time of the rehearsal was  $L_{AVG}$ . You experienced Dose of the maximum allowable noise exposure for the day and Dose[8] of the maximum allowable noise exposure over the course of an 8-hour day.

While these standards are in place to protect industrial workers, they do not apply to musicians, students, or teachers. It is up to individual musicians to protect their own hearing. Now you will view a short video that will allow you to experience what hearing loss is like. This film is a simulation of taking a spelling test with a hearing loss. The test is given three times. Each time the degree of hearing loss becomes less severe. Turn to the page marked “Spelling Test” on your clipboard. As the video plays, write the answers to the words in the provided spaces.

*The video plays, and the participant completes the spelling test.*

Thank you for participating in my study. You may keep the individualized sound report and the spelling test response sheet for your future reference. If you have any questions about hearing loss and musicians you can find more information at H.E.A.R. | Hearing Education and Awareness for Rockers found on the Internet at [www.hearnet.com](http://www.hearnet.com). Please do not share any of the information that you learned today with your colleagues and peers until after the entire study has been completed.

*Participants return the empty clipboards and pencils and exit the room.*

**APPENDIX D**  
**SPELLING TEST SIMULATING HEARING LOSS**



*Figure 1* Screenshot of spelling test simulating hearing loss.

# Spelling Test

**A**

**B**

**C**

1. _____	1. _____	1. _____
2. _____	2. _____	2. _____
3. _____	3. _____	3. _____
4. _____	4. _____	4. _____
5. _____	5. _____	5. _____
6. _____	6. _____	6. _____
7. _____	7. _____	7. _____
8. _____	8. _____	8. _____
9. _____	9. _____	9. _____
10. _____	10. _____	10. _____

*Figure 2* Response form of spelling test simulating hearing loss.

**APPENDIX E**  
**ONLINE SURVEY**

Survey can be found and completed at:

<http://www.surveymzmo.com/s/205338/musicians-hearing>

**APPENDIX F**

**ENSEMBLE SOUND EXPOSURE RESULTS CHART**

## ENSEMBLE SOUND EXPOSURE RESULTS

Participant #: \_\_\_\_\_ Ensemble: \_\_\_\_\_

Dynamic Range Experienced: \_\_\_\_\_ dB - \_\_\_\_\_ dB

### *Occupational Safety and Health Administration (OSHA)*

Average Sound Level: \_\_\_\_\_ dB

Daily Allowable Noise Exposure: \_\_\_\_\_ %

8-Hour Equivalent Noise Exposure: \_\_\_\_\_ %

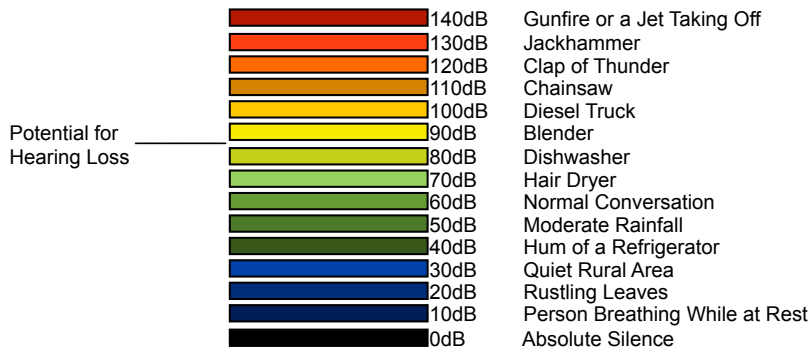
### *American Conference of Industrial Hygienists (ACGIH)*

Average Sound Level: \_\_\_\_\_ dB

Daily Allowable Noise Exposure: \_\_\_\_\_ %

8-Hour Equivalent Noise Exposure: \_\_\_\_\_ %

### Decibel (dB) Comparison Chart



Thank you for participating in my study. If you have any questions about hearing loss and musicians you can find more information at H.E.A.R. | Hearing Education and Awareness for Rockers found on the Internet at [www.hear.net](http://www.hear.net). Please do not share any of the information that you learned today with your colleagues and peers until after the entire study has been completed.

*Figure 4* Chart viewed by participants' at counseling session.



## APPENDIX G

### ACGIH AND OSHA STANDARDS FOR HEARING PROTECTION

Hearing protection standards, like those set forth by the American Conference of Industrial Hygienists (ACGIH) and the Occupational Health and Safety Administration (OSHA), exist to protect us from the upper limits of noise exposure. These standards work by setting restrictions on exposure level and duration of exposure. The ACGIH standard retains a maximum daily exposure limit of 85 dB(A) over an 8-hour period. For every 3 dB increase in exposure level the duration of allowable exposure is reduced by one-half. The OSHA standard, an industrial measure designed to protect workers in high noise environments, uses a 90 dB threshold and a 5 dB exchange rate. The table below compares the ACGIH and OSHA standards:

Table 1

*Sound Exposure Duration: ACGIH and OSHA Standards*

Duration of Exposure (hrs)	Sound Pressure Level, in dB(A)	
	ACGIH	OSHA
8	85	90
6	-	92
4	88	95
3	-	97
2	91	100
1.5	-	102
1	94	105
0.5	97	110
0.25	100	115
0.125	103	-