Noise Exposure:
How It Affects Hearing in Music Majors
Compared to Non-Music Majors

by
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Abstract

There has been minimal research comparing the daily noise exposure of student music majors to student non-music majors. There has also been limited research on the hearing of these individuals and their audiometric findings. Therefore, the goal of this study was to examine and compare the noise exposure and hearing of music majors and non-music majors. In addition, the current study compared the attitudes and perspectives of the two student populations through a qualitative interview process.

The following questions were addressed:

1. How does the noise exposure of Student Music Majors differ from that of Student Non-Music Majors?
2. Is there a difference in hearing thresholds between the Hughson-Westlake procedure (5dB step size) and the modified procedure (2 dB step size)?
3. Do Student Music Majors exhibit different hearing thresholds than Student Non-Music Majors?
4. What are the attitudes and perceptions of Student Music Majors and Student Non-Music Majors about noise exposure and how it affects hearing?

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CHAPTER I
Introduction

Hearing Loss

Hearing is not something we have to consciously think about. We use it daily without even realizing it, and it is vital for most communication. However, many individuals experience hearing loss throughout their lifetimes and are unable to communicate without amplification such as hearing aids or cochlear implants. Hearing loss is caused by many different factors such as prolonged noise exposure, high sound levels, room reverberation, pathologies and syndromes, aging, and other factors.

Hearing loss impacts individuals' lives significantly in many ways. It impacts their social life, work environment, and relationships and is also associated with increased anxiety, stress, depression, and other health related issues (Carroll et al., 2017; Hong et al., 2013). "Hearing loss has a profound impact on an individual's quality of life, primarily through the social handicap resulting from communication interference and various adverse outcomes such as depression, fear, embarrassment, loss of self-esteem, friction in relationships, and stigma" (Hong et al., 2013). In school-aged children hearing loss also affects learning, speech perception, social skill development, and self-image (Levey et al., 2012; Shargorodsky et al., 2010).

Hearing loss impacts an individual's life in many ways not only in their communication abilities but their career as well. Therefore, hearing should be protected and taken into consideration in daily interactions and activities. For example, when a person is exposed to noise under various conditions such as industrial occupational work, concerts, and even playing musical instruments, individuals should be conscious of the impact those noises have on their hearing and how they can best protect their hearing.

Noise Exposure

Noise exposure is the second leading cause of hearing loss after presbycusis, or aging, and although hearing is an important component in many of our lives and occupations, for example music, it is often not protected or even considered when listeners are exposed to environments with intensely loud noises (Phillips et al., 2010; Pouryaghoub et al., 2017). Noise is something we all experience daily, and it has an impact on our hearing whether we realize it or not. It varies across mediums and in intensity, and high volumes of any type of noise (traffic, machinery, cheering, conversation, television, music) can negatively impact hearing and potentially lead to Noise-induced hearing loss (NIHL). Noise-induced hearing loss is hearing loss caused by overexposure to noise at high levels. Factors such as the duration and type of noise to which an individual is exposed influence the risk for NIHL. The longer an individual is exposed to loud noise, the higher the risk for NIHL (Pouyaghoub, 2017).

Although, occupational noise exposure has been recognized as a public health concern, many do not realize the noise levels of nonoccupational activities, such as concerts, fireworks, radios, ambulance sirens, motorcycles, and even children's toys, which can involve noise exposure detrimental to the hearing of people of all ages (Niskar et al., 2001; Levey et al., 2012). Niskar et al. (2001) stated that failure to recognize environmental noise and its effects on hearing as a public health concern is especially prevalent among children. Niskar et al. (2001) also found that children are exposed to hazardous levels of noise for prolonged periods of time and that children's hearing is vulnerable to these exposures.

Similarly, Shargorodsky et al. (2010) found in a cross-sectional analysis over time a 31% increase in the prevalence of hearing loss for individuals 12-19 years of age. Risk of Noise-induced hearing loss (NIHL) continues to increase for this age group as they increase their use of personal music players over prolonged periods of time (Levey, Fligor, & Kagimbi, 2012). It was discovered that teenagers as well as college students reported they do not enjoy their music at lower volumes and often do not realize how intense the music actually is (Levey et al., 2012). A survey by Zogby (2006) found that teenagers reported exhibiting more characteristics of hearing loss such as increasing the volume on the television, saying words such as, "huh" or "what" during normal conversation, and experiencing tinnitus than do adults. In addition, although adults have different experiences with noise compared to teenagers and college students, Carroll et al. (2017) found that notches characterized by NIHL were prevalent among 24.4%, or 39.4 million, adults in the U.S. 20-69 years of age. Furthermore, damage to hearing progresses over time so the earlier an individual is exposed to dangerous levels of sound, the more potential noise has to negatively impact individuals' hearing (Carroll et al., 2017). If awareness of the impact of noise at dangerous levels becomes more prevalent and precautionary measures such as use of hearing protection devices (HPDs) and hearing conservation programs are implemented at earlier stages in life, possible hearing loss may be prevented.

The world rarely considers hearing and how noise affects hearing. However, noise has a more profound effect on hearing than most people like to believe. In addition, hearing health should be a priority for not only individuals because it is important for communication but also for musicians as well. Musicians, like workers in industrial settings, are exposed to noise over prolonged periods of time, including not only concerts but small group ensembles, practice, and rehearsals. Previous studies have found that variables such as the type of instrument individuals' play, seating arrangement, and number of hours practicing and performing impact noise exposure levels (Phillips et al., 2010; Smith et al., 2017). Hearing is vital in their occupation and plays a big role in their performance. Yet, they are very hesitant to utilize technology created to help prevent hearing loss in fear of distorting their performance. Noise exposure regulations for musicians are difficult to implement due to the excessive noise to which musicians are exposed.

Noise Exposure Criteria

Dangerous levels of noise exposure are determined by the duration of the exposure and at what level the noise is presented (Levey et al., 2012). Twenty-five percent of Americans working in construction, mining, agriculture, manufacturing, transportation, and military industries often experience noise levels above 90 dBA within their work environments (Petrescu, 2008). Noise exposure levels are often regulated in order to prevent NIHL, especially in these occupational settings. NIOSH and OSHA developed criteria for noise exposure levels to ensure occupational noise does not negatively impact employees' hearing. NIOSH recommends a maximum noise exposure level of 85 dBA within an eight-hour time period (Carroll, 2017; Levey et al., 2012; Phillips et al. 2008; Smith, 2017; Smith et al., 2019). NIOSH is slightly more conservative than OSHA, which recommends the maximum level of noise exposure to be 90 dBA within an eight-hour time period (Levey et al., 2012; Smith et al., 2019). Sound levels above these thresholds exceed 100% daily noise doses, and for NIOSH, every 3 dB above the recommended amount of noise exposure is an additional 100% above the daily noise dose. Similarly, for every 5 dB above the recommended noise dosage for OSHA criteria, is an additional 100% above the recommended daily noise dose (Phillips et al., 2008). Therefore, according to NIOSH criteria, an individual exposed to noise at 88 dB for four hours is at the same risk as someone who is exposed to noise at 91 dB for two hours, 100 dB for fifteen minutes, and 103 dB for seven and a half minutes (Levey et al., 2012). NIOSH and OSHA noise exposure standards are also used in research to compare the noise exposure of different environments and individuals to see if the noise exposure is at dangerous levels that put participants at higher risks for NIHL.

NIOSH and OSHA regulations apply primarily to industrial settings. However, NIOSH also has recommendations for musicians and individuals in the music industry as well (National Institute for Occupational Safety and Health [NIOSH], 2015). NIOSH recommends that employers, schools and colleges, and music venue operators consider incorporating hearing conservation programs in workplaces in which noise levels exceed 85 dBA (NIOSH, 2015). NIOSH also recommends education and awareness of music induced hearing loss, conduction of sound level assessments regularly, and hearing protection that is most beneficial to employees and musicians (NIOSH, 2015). It is recommended by NIOSH that musicians wear HPDs, play at lower levels when possible, and get their hearing evaluated by an audiologist as well (NIOSH, 2015). In addition, employers in the music and entertainment business where live or recorded music is played are required to adhere to the Noise at Work Regulations to protect their employees (Pulsar Instruments, 2018). These regulations require hearing protection to be available when daily or weekly noise exposure levels exceed 80 dBA and hearing protection to be used when daily or weekly noise exposure levels exceed 85 dBA (Musicians' Union [MU], 2021). Noise at Work Regulations also set the maximum level of noise exposure at 87 dBA after reduction of noise exposure due to use of HPDs is accounted for (MU, 2021).

Noise at Work Regulations are vital to a musician's career by preserving individuals' hearing, however they are often not implemented effectively. Noise exposure can be very detrimental to an individual's hearing when it is not regulated. Therefore, it is important to consider noise exposure levels and how they can negatively impact hearing when immersed in these environments and occupations.

Hearing Protection Devices

Many individuals do not understand the risks of prolonged periods of noise exposure at high sound levels that could potentially be dangerous to their hearing ability. Musicians especially do not understand the risk, even though hearing is a vital part of their occupation (Pouryaghoub et al., 2017). McIlvaine et al. (2012) discovered that hearing conservation programs are strongly needed for the musician population given the dangerous sound levels to which musicians are exposed. This is consistent with the findings by Miller et al. (2007) that also demonstrated the need for hearing protection devices (HPDs) and conservation programs to protect musicians from hearing loss.

Technology is available for musicians to help decrease the negative effects of noise on their hearing such as hearing protective devices and noise conservation programs, but many protective programs and devices have been ineffective and unpopular among the student musician population. Pudrith (2017) found that students are reluctant to wear HPDs because they believe the devices disrupt the quality of music being produced. Of the student musicians who participated in the Miller et al. (2007) study, 59% reported exposure to loud noise outside of band, indicating that education on hearing conservation is either ineffective or students are unaware of the dangerous sound levels to which they are exposed. Zeigler and Taylor (2001) found that HPDs are not utilized among the student musician population. Zeigler and Taylor (2001) conducted a survey that focused on attitudes about tinnitus, which is ringing in the ear, and evaluated how the survey impacted individuals' future behaviors. The researchers initially found that 157 students reported they were more willing to participate in better hearing conservation practices, while 22 students were not willing to, even after gaining the knowledge that excessive amounts of exposure to intense sounds can lead to hearing loss and tinnitus (Zeigler & Taylor, 2001). Zeigler and Taylor (2001) also conducted a follow-up survey in which they found that a large majority of students in each group did not change their hearing conservation practices during rehearsal, performance, or when exposed to loud noise outside of rehearsals and performances after completing the preliminary survey.

Inner and Outer Hair Cell Function

In the absence of hearing protection devices (HPDs), noise exposure at dangerous levels for prolonged periods of time can lead to impaired transmission of both low and high frequency sounds to the brain (Hong et al., 2013). Hong et al. (2013) reported that as noise exposure levels and duration of exposure to these noise levels increases, damage to the sensory organ of the ear also increases. The sensory organ of the ear, the cochlea, processes different frequencies of sound. Within the cochlea are outer and inner hair cells. The outer hair cells (OHC) are responsible for amplifying soft sounds and tuning the sounds we encounter. Outer hair cells also allow us to perceive the pitch of different sounds (Phillips et al., 2008). Inner hair cells (IHC) facilitate the chemical exchange necessary to send electrical signals to the brain, enabling us to understand and interpret sounds. Therefore, when the outer or inner hair cells are damaged, hearing ability is impacted. This can especially be detrimental to musicians because if their OHC are damaged, their pitch perception will not be as accurate which could affect how they play music.

Significance of Hearing Thresholds

Hearing loss possibly due to noise exposure can be shown on an audiogram by looking at hearing thresholds. It is important to look at hearing thresholds because they have clinical significance when diagnosing hearing loss. Hearing thresholds represent the softest levels at which an individual can hear specific frequencies measured in Hertz (Hz) presented at different levels of intensity measured in decibels (dB). Frequency is how high or low the pitch of a sound is, and intensity is the volume of the sounds presented. Typically, an individual will hear frequencies ranging from 250-8000 Hz within the 15 to 25 decibel range. A hearing threshold on an audiogram that is outside of the normal range indicates hearing loss that can vary in severity depending on what decibel level the tone is heard at a given frequency. Hearing loss is shown by a shift in thresholds on an audiogram to higher levels of intensity at the different frequencies.

Types of threshold shifts include permanent threshold shifts (PTS) and temporary threshold shifts (TTS). Permanent thresholds shifts are shifts in thresholds in which hearing ability is damaged, hearing does not revert back to normal over time, and is irreversible (Hong et al. 2013). Temporary threshold shifts on the other hand, are reversible, and hearing does revert back to normal over time. Research on temporary threshold shifts (TTS) of musicians shows a temporary threshold shift as a short-term change in hearing as a result of exposure to noise (Petrescu, 2008; Washnik et al., 2016). Shifts in thresholds are often a result of hazardous levels of noise exposure such as concerts, explosions, and firearms that can result in a noise-induced threshold shift (NITS) (Hong et al., 2013; Niskar et al., 2001; Phillips et al., 2008). Noise-induced threshold shifts are shifts in hearing thresholds that indicate changes in hearing ability. Studies show that thresholds of student musicians were different than those of students who were not musicians (Washnick et al., 2016). Researchers have found significant shifts in the thresholds in the 4000-6000 Hz range for musicians as compared to other populations (Washnik et al., 2016). Gopal et al. (2013) conducted a study in which an experimental group of 14 male students majoring in music and a control group of 11 male students not majoring in music participated in a full hearing evaluation and wore a Quest Q-400 personal noise dosimeter to record noise exposure levels over the course of a fifty-minute class period. Gopal et al. (2013) found that the experimental group was exposed to significantly more noise during a fifty-minute class period than the control group. The noise exposure of the college student musicians' fifty-minute class period ranged from 95 dBA to 105.8 dBA with a mean of approximately 99.5 dBA while the noise levels of the student non-musicians' classrooms ranged from 46.4 dBA to 67.4 dBA with a mean of approximately 49.9 dBA (Gopal et al., 2013). When comparing participants' hearing thresholds, Gopal et al. (2013) found that college student musicians typically exhibited notches at 6000 Hz and their hearing thresholds were poorer after exposure to noise. A notch exhibited on an audiogram at 6000 Hz means that an individual hears the 6000 Hz frequency tone at an increased amplitude or volume. However, when compared to the hearing thresholds of college students who were not musicians, Gopal et al. (2013) found that hearing thresholds of the student musicians they studied were better than the outcomes recorded by Phillips et al. (2010) who also found musicians' thresholds to be better than the general population except for thresholds at 6000 Hz. Washnik et al. (2016) also found hearing thresholds of musicians to be different than non-musicians. In contrast, Jin et al. (2013) found no significant difference in the thresholds of classical musicians and non-musicians.

Characteristics of Noise-Induced Hearing Loss

Noise-induced hearing loss is characterized by NITS on an audiogram through notches at 4000 and 6000 Hz, which are relatively high frequencies (Hong et al., 2013; Niskar et al., 2001; Phillips et al., 2010). These notches will eventually be seen across all frequencies as the damage to noise-induced hearing loss begins, affecting low frequencies as well (Hong et al., 2013; Niskar et al., 2001; Phillips et al., 2010). A notch is defined as a 10 or more dB increase in thresholds compared to normal hearing thresholds at different frequencies (Phillips et al., 2008; Jin et al., 2013; Pouryaghoub et al., 2017). Noise-induced hearing loss is a sensorineural hearing loss that is usually bilateral but can be unilateral depending on the location of noise exposure (Hong et al., 2013; Phillips et al., 2010). In addition, many studies have found noise-induced hearing loss (NIHL) to be more prevalent in the left ear than the right (Phillips et al., 2010). Individuals with NIHL experience muffled high frequency sounds such as those of whistles and buzzers, and often have trouble discriminating consonant speech sounds especially in noisy environments (Hong et al., 2013). However, NIHL is often hard to detect because individuals may not realize they have a hearing loss until it affects their communication abilities (Hong et al., 2013). Typical frequencies of speech are between 500 and 2000 Hz, but damage to hair cells due to noise exposure starts with the hair cells that help with perception of high frequencies that are above the frequencies associated with speech (Hong et al., 2013). Therefore, NIHL does not directly impact hearing necessary to hear speech until it advances in severity making it hard to identify in its early stages. In addition, NIHL is not associated with damage to the outer or middle ear but in the inner ear, and inner ear damage often lacks overt symptoms such as pain, bleeding, or easily noticeable deformity (Hong et al., 2013). NIHL is also often indistinguishable from many other causes of hearing loss such as presbycusis as it increases in severity as well (Hong et al., 2013).

Studies have found that student musicians are at a higher risk of Noise-induced hearing loss than the general student population (Phillips et al., 2010; Phillips et al., 2008). In a study by Smith et al. (2019), which included an examination of college student musicians and the exposure of noise they experienced, researchers found that factors such as the type of instrument played, type of activity, location within the ensemble, and room environment all contributed to musicians' noise dosage, which impacted their risk of NIHL. To assess different factors that contribute to the noise exposure of student musicians, Smith et al. (2019) recorded noise levels at different locations during rehearsals of four different orchestras, measured the noise dosage of a student playing within different environments, and measure the daily noise exposure levels of student musicians over two consecutive days. Washnik et al. (2016) also evaluated the noise exposure of student musicians and compared their findings to the noise exposure criteria of industrial workers. Washnik et al. (2016) had 123 marching band students and 2 college students who were placed within the audience of the football stadium wear Etymotic ER-200D personal noise dosimeters that measured their noise exposure levels within two rehearsal sessions and two football games. Researchers found that approximately half of their participants exceeded a 100% daily noise dose in a typical day, which led them to the conclusion that student musicians are exposed to noise in their daily routines, including ensemble rehearsal and individual practice, at hazardous levels that could result in NIHL (Washnik et al., 2016).

Like Washnik et al. (2016), the research by Phillips et al. (2010) also showed that musicians were exposed to noise at levels similar to those to which industrial workers were exposed. The noise levels for industrial workers are regulated by the National Institute for Occupational Safety and Health (NIOSH) and the Occupational Safety and Health Administration (OSHA), which have developed criteria for the level of sound that is detrimental to an individual's hearing. In a similar study, Gopal et al. (2013) found that college student musicians exceeded NIOSH criteria, while students who were not musicians did not. Washnick et al. (2021) also found that the noise exposure levels of musicians during rehearsal exceeded the NIOSH criteria.

College student musicians are at a higher risk for NIHL due to prolonged practice, rehearsals, and performances. Smith et al. (2017) discovered not only that student musicians experienced a higher noise dosage during longer periods of exposure and during rehearsal versus practice, but that the noise dosage also varied across instruments.

Research Questions

There has been little research comparing the daily noise exposure of Student Music Majors to Student Non-Music Majors. There has also been limited research on the hearing of these individuals and their audiogram findings. Therefore, the goal of this study was to examine and compare the hearing thresholds, daily noise exposure, and the attitudes and perspectives of noise exposure and how noise impacts hearing of Student

Music Majors and Student Non-Music Majors. Students received a hearing evaluation and participated in an interview that included questions that helped the Primary Investigator understand the behaviors and attitudes of the two student populations. The Primary Investigator, Hanna Kolwyck, under Faculty Advisor, Dr. Rebecca Fischer, also evaluated how noise exposure affected students' hearing. Music majors were expected to be exposed to more noise daily than non-music majors, and their attitudes and perceptions of noise exposure were also expected to be different.

The following questions were addressed:

1. How does the noise exposure of Student Music Majors differ from that of Student Non-Music Majors? It is expected that Student Music Majors are exposed to different types of noise daily than Student Non-Music Majors.
2. Is there a difference in hearing thresholds between the Hughson-Westlake procedure (5dB step size) and the modified procedure (2 dB step size)? Very few studies have included hearing evaluations when comparing the noise exposure of musicians and non-musicians. In addition, very few studies have used a modified procedure to obtain thresholds and observe small but significant differences between thresholds.
3. Do Student Music Majors exhibit different hearing thresholds than Student Non-Music Majors? It is expected that the hearing of student musicians is different than that of non-music students because they are expected to be exposed to different noise compared to the Student Non-Music Major population.

4. What are the attitudes and perceptions of Student Music Majors and Student Non-Music Majors about noise exposure and how it affects hearing? This study contributes research to the field of audiology because there has been little research on the attitudes and perspectives of Student Music Majors and Student Non-Music Majors about the use of hearing protective devices, hearing conservation programs, and overall noise exposure, and how students think noise exposure and hearing protection affect their hearing.

CHAPTER II
Methodology and Procedure

Methodology

Approval from the IRB was obtained on January 25, 2022, to conduct this study and all participants were given a consent form to sign prior to their participation. A copy of the IRB Approval Notice and the approved IRB Consent Form can be found in Appendix A.

Participants

Sixteen Student Music Majors (SMM) and twenty-one Student Non-Music Majors (SNMM) were recruited for this study. Participants were recruited through word of mouth. Student Non-Music Majors were recruited through speaking to students directly within a classroom setting. Student Music Majors were informed about the study through multiple sessions of free hearing screenings offered to all SMM by the Middle Tennessee State University (MTSU) Speech Language Pathology and Audiology Program. Participants were students currently attending Middle Tennessee State University in Murfreesboro, Tennessee. Student Music Majors were recruited from the MTSU School of Music, and SNMM were recruited from the MTSU Speech Language Pathology and Audiology Program. One recruited participant was excluded because of a history of hearing loss prior to participation in the study.

Procedure

Case History and Noise Exposure Questionnaire

Participants came to the MTSU Speech Language and Hearing Clinic where they were screened according to a completed Case History Form (see Appendix B) in order to ensure participants' hearing had not been compromised prior to the study. Attached to the Case History Form was a Noise Exposure Questionnaire (see Appendix C) containing questions about the types of noise in which students were exposed; their use of Hearing Protection Devices (HPDs); and what risk level, for hearing loss, they thought SMM were compared to SNMM. The purpose of the questionnaire was to compare the different types of noises to which each group is exposed. Included in the questionnaire were additional questions for Student Music Majors inquiring about the type of instrument the student played, which instruments the student was typically seated near when performing, and the amount of time per week the student spent practicing, performing, and listening to live music. The average number of hours Student Music Majors spent practicing, performing, and listening to live music was also calculated.

Hearing Thresholds

Once the participant's Case History Form and Noise Exposure Questionnaire were reviewed, hearing thresholds were obtained using a GSI 61 Audiometer following normal otoscopy and tympanometry measures. Hearing evaluations were conducted in which air-conduction thresholds were obtained using the standard Hughson-Westlake 5 dB step size procedure, followed by a Modified Hughson-Westlake procedure in which a

2-dB step size was used. The reason for the 2dB Step Size Procedure was to observe whether small but significant hearing differences between the two groups might be revealed. A copy of the Audiogram Data Form may be found in Appendix D. An ANOVA analysis was conducted to see if there were any statistically significant differences between the 2 dB and the 5 dB Step Size Procedures and between the thresholds of the two groups, SMM and SNMM.

Personal Listening Experiences and Perspectives Interview

A select number of students also participated in an extended interview with myself, the Primary Investigator, or Lia Richardson, the Research Assistant after participants' hearing was evaluated. During the interview, participants were asked questions about their listening experiences and perspectives of noise and how it impacted hearing. The interviewers also asked participants about their experiences with HPDs, and their education about the impact of noise on hearing. Appendix E contains an outline of questions directed to participants. Each interview was audio recorded and transcribed by the Primary Investigator and the Research Assistant. Twenty-two interviews were conducted, however only twenty interviews were transcribed, ten interviews from each group. Transcribed interviews were reviewed by the Primary Investigator, Research Assistant, and Faculty Advisor. From these reviews, an outline was created (see Appendix F) to examine the common phenomena and student perspectives that emerged from the interviews. Phenomena included Personal Experiences with Noise, Education/Learning/Additional Information, Experiences with HPDs, and Risk for

Hearing Loss. Frequently voiced perspectives regarding each phenomenon were noted and included in the outline.

Agreement between the Primary Investigator and Research Assistant was conducted by randomly selecting four interviews: two interviews from conversations with Student Music Majors and two interviews from conversations with Student Non-Music Majors. The occurrence of perspectives related to the identified phenomena were then recorded on the outline. Agreement was 100% for the identification of phenomena within the selected interviews. The remaining interviews were also analyzed, and occurrence of phenomena were recorded.

CHAPTER III
Results

Results

Noise Exposure Questionnaire Data

Noise Exposure Questionnaires were analyzed by calculating the percentage of participants within each group exposed to each type of noise listed on the questionnaire. Percentages were compared between Student Music Majors and Student Non-Music Majors. There were few significant differences found between the two groups except for the following categories: classroom noise, household noise, and concerts. Out of the SNMM, 100% of participants reported exposure to classroom noise compared to 81.3% of SMM. In addition, 71.4% of SNMM reported exposure to household noise, while only 37.5% of SMM reported exposure to household noise. Participants' exposure to concerts varied greatly in that only 33.3% of SNMM reported exposure to concert noise while 93.8% of SMM were exposed to concert noise. The researcher also found that 81% of SNMM listened to music via earphones, 95.2% listened to music via the car radio, and 9.5% listened to music through other means, while 83.3% of SMM listened to music via earphones, 87.5% listened via the car radio, and 37.5% listened via other means. Other percentages calculated include 14.3% of SNMM and 12.5% of SMM reported exposure to noise due to sports events; 76.2% of SNMM and 68.8% of SMM reported exposure to restaurant noise; 66.7% of SNMM and 62.5% of SMM reported exposure to noise within social events; and 9.5% of SNMM and 12.5% of SMM reported exposure to other noises. A table representing the percentage of students who reported different types of noise exposure in each group can be found in Appendix G.

The number of participants in each group that wore hearing protection devices (HPDs) frequently, sometimes, never, or always was also calculated. See Appendix H for a pie chart representing the reported use of HPDs for each group of students. Seventeen out of twenty-one SNMM reported they never wore HPDs, while four students reported they wore them sometimes. Two out of sixteen SMM reported they never wore HPDs, one reported they always wore HPDs, six reported they used HPDs sometimes, and seven reported frequent use of HPDs.

Means and standard deviations of the number of hours SMM spent practicing, performing, and listening to live music per week were calculated. The average number of hours SMM spent practicing was 8.34 hours with a standard deviation of 6.45. The average number of hours spent performing was 2.22 hours with a standard deviation of 1.51 and the average number of hours SMM spent listening to live music was 3.03 hours with a standard deviation of 2.11 (see Appendix I). Compared to performing and listening to live music, SMM spent more hours practicing, and there was a greater range of hours each SMM spent practicing.

Comparison of the 2 dB and 5 dB Step Size Procedures

To examine the differences between the Hughson-Westlake Procedure (5 dB Step Size) and the Modified Procedure (2 dB Step Size), an Analysis of Variance (ANOVA) was performed. Thresholds were divided into low-frequency thresholds (average thresholds at 500, 1000, and 2000 Hz across all subjects) and high-frequency thresholds (average thresholds at 4000. 6000, and 8000 Hz across all subjects) for each procedure. A graph and table comparing the thresholds for the 2 dB and 5 dB Step Size Procedures for low and high frequencies is shown in Appendix J.

Results showed that thresholds for the 2 dB Step Size Procedure were better than thresholds obtained using the 5 dB Step Size Procedure for both low- and high-frequency values. While the differences were small, the ANOVA, which examined thresholds for the two procedures, revealed that threshold differences were significant. T-tests showed that threshold differences were significant for low-frequency and high-frequency thresholds.

Comparison of Thresholds for Student Music Majors and Student Non-Music Majors

A graph and table of average thresholds for the 2 dB and 5 dB Step Size Procedures for SMM and SNMM are shown in Appendix K and Table 1. Data for the average low-frequency thresholds and the average high-frequency thresholds are depicted for both groups. Thresholds for SMM and SNMM were poorer when determined by the Hughson-Westlake Procedure as compared to the Modified Procedure. Thresholds for the high-frequency averages were better than the low-frequency averages. An analysis of variance revealed that there were no significant differences between thresholds for SMM and SNMM.

The average threshold of SMM for the low frequencies using the 5 dB Step Size Procedure was 10.10 and 7.98 for the 2 dB Step Size Procedure. The SNMM average thresholds were 9.25 for the 5 dB Step Size Procedure and 8.02 for the 2 dB Step Size Procedure for the low frequencies. Average thresholds for the high frequencies for SMM include 1.98 for the 5 dB Step Size procedure and –0.23 for the 2 dB Step Size Procedure. The average thresholds for the high frequencies for SNMM were 2.18 for the 5 dB Step Size Procedure and 0.34 for the 2 dB Step Size Procedure.

Personal Listening Experiences and Perspectives Data

Personal Experience with Noise

Qualitative interviews were analyzed regarding four phenomena identified across twenty transcribed interviews, which included Personal Experiences with Noise, Education/Additional Information/Learning, Experiences with hearing protection devices (HPDs), and Risk for Hearing Loss. The Primary Investigator found that SNMM typically had experiences with noise that resulted in reduced hearing afterwards, and a few reported tinnitus, loudness, and ear pain. Student Music Majors reported listening experiences in which they experienced more loudness and tinnitus along with reduced hearing ability compared to the SNMM. A few SMM also reported ear pain.

Education/Additional Information/Learning

Most SNMM and SMM reported that they learned about hearing loss due to noise through the personal experiences of others. Many reported they knew individuals who had reduced hearing due to careers in the military and a few reported they knew individuals who had hearing loss due to their careers in music. A majority of SMM reported that they have not received any education on hearing loss due to noise during class, compared to SNMM who have learned about hearing loss due to noise within their classes in the speech language pathology and audiology program. However, most participants reported that they thought the information they had received about hearing loss due to noise, whether it was in class or through the experiences of others, was valid.

When participants were asked about what additional information they would like about hearing loss due to noise, some participants wanted to know more about different frequency and decibel levels and how those levels impact hearing. Very few participants wanted more education on how to protect their hearing, when to wear HPDs, and how to best use HPDs. However, SMM showed more interest in learning more about the use of HPDs than SNMM, who showed almost no interest in learning about how to use HPDs.

Experience with HPDs

When participants were asked about their use of HPDs, most participants wore them in specific situations, such as when they shot guns at a shooting range. However, most participants reported little use of HPDs. Most SNMM reported they never wore HPDs, but some SMM reported they wore HPDs in practice and rehearsals sometimes. A few SMM who wore HPDs during practice and rehearsals only wore them in one ear, and some reported they would take them out before they were done practicing or rehearsing. Some SMM reported they wore HPDs during performances, but most SMM who reported they wore HPDs also reported that HPDs made it hard to hear themselves and others playing. Similarly, SNMM reported HPDs make it hard to hear others and what is happening in the environment around them as well. A few participants in each group reported that another disadvantage of HPDs was physical and social discomfort.

Participants from both groups also reported that HPDs take away from the listening experience by not allowing participants to fully hear the noises to which they are exposed. In contrast, when interviewers asked what participants thought were the advantages of HPDs, a majority of them reported that they protect hearing, and a few reported they prevent the negative effects of loud noises on hearing such as reduced hearing ability, tinnitus, and ear pain.

Risk of Hearing Loss due to Noise

When participants were asked what they thought was their current risk for hearing loss due to noise, SNMM reported they were not at a high risk due to the minimal amount of noise they are exposed to daily. Most SNMM participants reported they thought they were most likely to be at a more moderate risk of hearing loss due to noise, while SMM reported they felt they were at a high risk of hearing loss due to noise because of their constant exposure to noise daily. In addition, interviewers asked participants what they thought was their future risk of hearing loss due to noise by asking them where they thought the condition of their hearing would be after ten years. Most SMM reported that they thought their hearing would probably be a little worse. Similarly, some SNMM reported they thought their hearing would be a little worse, and some reported their hearing would be the same.

CHAPTER IV
Discussion and Conclusion

Discussion

This study compared the hearing thresholds, noise exposure, and attitudes and perspectives of noise exposure and how it affects hearing of Student Music Majors and Student Non-Music Majors. Participants completed a Noise Exposure Questionnaire including questions about the types of noise to which they are exposed, their use of HPDs, and the risk level of SMM compared to SNMM for hearing loss due to noise. Participants' air-conduction thresholds were then obtained using the standard 5 dB Step Size Procedure and a modified 2 dB Step Size Procedure. Select participants participated in an extensive interview including questions about their attitudes and perspectives of noise and how it impacts hearing.

Noise Exposure Questionnaire

In order to answer the first research question—are there differences in the noise exposure of Student Music Majors and Student Non-Music Majors— researchers compared the different types of noise exposure between the groups based on participants' answers on the Noise Exposure Questionnaire. The types of noises in which each group was exposed were similar between the two groups with the exception of concerts, classroom noise, and household noise. Noise exposure due to concerts was expected to be different among participants because SMM were expected to often perform in concerts and therefore be exposed to more noise due to concerts, while SNMM may only attend a few concerts within a year.

In addition, classroom noise exposure may vary between participants because of the type of classroom to which each group is exposed. A classroom for a SMM may be very different from a SNMM in that SMM classrooms are probably not set up like a traditional classroom setting. Although SMM may be exposed to more noise within a typical class, SMM may not have considered the noises within their classroom, typical classroom noise because it is very different from a traditional classroom. Gopal et al. (2013) found that sound levels measured within a typical classroom for a non-music major students differed greatly when compared to a jazz ensemble instructional classroom for students majoring in music. The noise exposure measured during jazz ensemble instruction exceeded NIOSH recommendations for daily noise exposure levels, while the sound levels measured within a traditional classroom did not (Gopal et al., 2013).

The differences between household noise across groups was unexpected because all participants are students, and therefore most likely have similar lifestyles. This could be because students considered household noise as noise within their parents' households instead of their own in which they may not be as exposed as often. However, the reason household noise exposure was more common for SNMM than SMM cannot be determined.

Hearing Thresholds

The ANOVA indicated a significant difference between hearing thresholds when comparing the two methods (Hughson-Westlake Procedure-5 dB step size; and the

Modified Procedure-2 dB step size). Average thresholds also indicated that the thresholds obtained using the 2 dB Step Size Procedure were better than thresholds obtained using the 5 dB Step Size Procedure across participants. There was also a significant difference for low- and high-frequencies values between the procedures as well. High-frequency averages were better than low-frequency averages.

The current study is different from previous studies that have found student musicians to have poorer thresholds in the 4000-6000 Hz range (Phillips et al., 2008; Phillips et al., 2010; Washnik et al., 2016). The Gopal et al. (2013) study also found that college students majoring in music exhibited notches at 6000 Hz on an audiogram. There has also been research conducted that shows professional musicians exhibited notches characterized by noise-induced hearing loss (NIHL) at 4000 and 6000 Hz (Pouryaghoub, 2017). None of the participants in this study exhibited notches at any of the frequencies tested. Student Music Majors in this study surprisingly exhibited better thresholds in the higher frequencies than in the lower frequencies. This could be because SMM are in the beginning stages of their musical careers and have not yet been exposed to enough noise to have a negative impact on their hearing at the lower frequencies.

Personal Listening Experiences and Perspectives Interview

The current study found that SMM and SNMM reported instances of negative experiences with noise such as reduced hearing ability, tinnitus, and ear pain. More SMM reported experiences of tinnitus than SNMM. Similarly, Gopal et al. (2013) found more students majoring in music reported experiences with tinnitus as well, compared to students not majoring in music. Gopal et al. (2013) found that 64% of students majoring in music experienced issues with tinnitus. Zeigler and Taylor (2001) found that 146 students out of 248 reported they had tinnitus. The current findings are consistent with these findings, that almost all SMM reported experiences with tinnitus. Almost all participants experienced reduced hearing ability after exposure to loud noise as well.

However, participants reported little use of hearing protection devices (HPDs), if any at all, and found them physically uncomfortable, socially uncomfortable, and limiting because HPDs make it hard for students to hear themselves and others in their environments. Contrary to the findings of Pouryaghoub et al. (2017) that many musicians do not understand their risk of NIHL, in the current study all except one participant indicated they thought SMM were at a higher risk for hearing loss due to noise. However, although SMM are aware they are at an increased risk for NIHL, few use HPDs effectively. This finding supports the results of Zeigler and Taylor (2001) that even after students indicate they will be willing to participate in better hearing conservation practices, few implement better practices.

In the current study, a few SMM reported wearing HPDs in practice and rehearsal but often ended up taking them out before they finished practicing or rehearsing. The inconsistent usage of HPDs could possibly be because of the negative impact HPDs have on students' musical performance. The SMM who reported wearing HPDs during performances indicated HPDs made it hard to hear themselves and those around them play. This supports the findings of Pudrith (2017) that students were reluctant to wear HPDs because of how the devices disrupted the quality of music being produced. Zeigler and Taylor (2001) also found that the student population they studied did not use HPDs. SMM also reported little education about HPDs and how to use them effectively. While SNMM were expected to have learned about hearing loss due to noise in their classes due to their field of study, a very small amount of SMM reported talking about the impact of noise on hearing in class. Most participants reported learning about the impact of noise on hearing through the experiences of others. The current study found that when participants were asked about what additional information, they would like about hearing loss due to noise, SMM indicated they would like information on how and when to use HPDs.

Conclusion

In the future, more effective education about hearing loss due to noise exposure is needed and should be available to students, especially for SMM because it could potentially have a negative impact on their future careers. Researchers propose education about hearing loss due to noise be conducted by students who are educated on the most current research about hearing loss due to noise. In addition, more hearing conservation programs and practices are needed for Student Music Majors.

The current study found that SNMM and SMM are very similar with a few differences due to participants' differing selected fields of study and different practices regarding attending and performing in concerts. The results of this study found significant differences in the two procedures used to obtain thresholds. Although the differences may not be clinically significant, the Modified Procedure showed small differences, which were not seen using the Standard Hughson-Westlake Procedure for research purposes.

In addition, the current study revealed to the researcher that students often do not wear HPDs. It also gave the researcher insight on students' personal experiences with noise and why students do not wear HPDs. Not only did the current study provide the researcher with information about students' education about hearing loss due to noise, but it also revealed the need for implementation of better education and hearing-conservation practices in the future. Future research should include measurements of the daily noise-exposure of Student Music Majors and Student Non-Music Majors and comparison between the two groups of students. Future research could also include a longitudinal study on student who participated in the current study to observe changes in their hearing thresholds over time.

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Appendices

Appendix A.1
IRB Approval Notice

IRB
INSTITUTIONAL REVIEW BOARD
Office of Research Compliance,
010A Sam Ingram Building,
2269 Middle Tennessee Blvd
Murfreesboro, TN 37129
FWA: 00005331/IRB Regn. 0003571

MIDDLE TENNESSEE STATE UNIVERSITY

IRBN001 - EXPEDITED PROTOCOL APPROVAL NOTICE

Tuesday, January 25, 2022

Protocol Title ***Noise Exposure: Its Effects on Music Majors Versus Non-Music Majors***
Protocol ID **22-2059 47i**

Principal Investigator **Hanna Kolwyck** (Student) *Faculty Advisor:* Rebecca Fischer
Co-Investigators Lia Richardson (lml5q)
Investigator Email(s) *hbk2d@mtmail.mtsu.edu; Rebecca.fischer@mtsu.edu*
Department Health and Human Performance
Funding NONE

Dear Investigator(s),

The above identified research proposal has been reviewed by the MTSU IRB through the **EXPEDITED** mechanism under 45 CFR 46.110 and 21 CFR 56.110 within the category *(4) Collection of data through noninvasive procedures*. A summary of the IRB action is tabulated below:

IRB Action	**APPROVED for ONE YEAR**
Date of Expiration	**11/30/2022** — *Date of Approval:* 1/25/22 — *Recent Amendment:* NONE
Sample Size	THIRTY (30)
Participant Pool	*Target Population:* Primary Classification: **General Adults (18 or older)** Specific Classification: **Student Musicians and/or non-Music Majors**
Type of Interaction	☐ Non-interventional or Data Analysis ☐ Virtual/Remote/Online interaction ☒ **In person or physical interaction – Mandatory COVID-19 Management**
Exceptions	1. In-person interaction is permitted. 2. Contact information is allowed
Restrictions	**1. Mandatory SIGNED Informed Consent.** **2. Other than the exceptions above, identifiable data/artifacts, such as, audio/video data, photographs, handwriting samples, personal address, driving records, social security number, and etc., MUST NOT be collected. Recorded identifiable information must be deidentified as described in the protocol.** **3. Mandatory Final report (refer last page).** **4. The protocol details must not be included in the compensation receipt.** **5. CDC guidelines and MTSU safe practice must be followed**
Approved Templates	*IRB Templates:* IRB Flyer and In-person Informed Consent *Non-MTSU Templates:* Verbal Recruitent Script(s)
Research Inducement	$10
Comments	NONE

IRBN001 (Stu) Version 2.0 Rev 08/07/2020

Post-approval Requirements

The PI and FA must read and abide by the post-approval conditions (Refer "*Quick Links*" in the bottom):

- ***Reporting Adverse Events:*** The PI must report research-related adversities suffered by the participants, deviations from the protocol, misconduct, and etc., within 48 hours from when they were discovered.
- ***Final Report:*** The FA is responsible for submitting a final report to close-out this protocol before **11/30/2022 (Refer to the Continuing Review section below)**; REMINDERS WILL NOT BE SENT. **Failure to close-out or request for a continuing review may result in penalties** including cancellation of the data collected using this protocol and/or withholding student diploma.
- ***Protocol Amendments***: An IRB approval must be obtained for all types of amendments, such as: addition/removal of subject population or investigating team; sample size increases; changes to the research sites (appropriate permission letter(s) may be needed); alternation to funding; and etc. The proposed amendments must be requested by the FA in an addendum request form. The proposed changes must be consistent with the approval category and they must comply with expedited review requirements
- ***Research Participant Compensation:*** Compensation for research participation must be awarded as proposed in Chapter 6 of the Expedited protocol. The documentation of the monetary compensation must Appendix J and MUST NOT include protocol details when reporting to the MTSU Business Office.
- ***COVID-19:*** Regardless whether this study poses a threat to the participants or not, refer to the COVID-19 Management section for important information for the FA.

Continuing Review (The PI has requested early termination)

Although this protocol can be continued for up to THREE years, The PI has opted to end the study by **11/30/2022** **The PI must close-out this protocol by submitting a final report before 11/30/2022 Failure to close-out may result in penalties that include cancellation of the data collected using this protocol and delays in graduation of the student PI.**

Post-approval Protocol Amendments:

The current MTSU IRB policies allow the investigators to implement minor and significant amendments that would fit within this approval category. ***Only TWO procedural amendments will be entertained per year*** *(changes like addition/removal of research personnel are not restricted by this rule).*

Date	Amendment(s)	IRB Comments
NONE	NONE.	NONE

Other Post-approval Actions:

The following actions are done subsequent to the approval of this protocol on request by the PI/FA or on recommendation by the IRB or by both.

Date	IRB Action(s)	IRB Comments
NONE	NONE	NONE

COVID-19 Management:

The PI must follow social distancing guidelines and other practices to avoid viral exposure to the participants and other workers when physical contact with the subjects is made during the study.

- The study must be stopped if a participant or an investigator should test positive for COVID-19 within 14 days of the research interaction. This must be reported to the IRB as an "adverse event."
- The MTSU's "Return-to-work" questionnaire found in Pipeline must be filled by the investigators on the day of the research interaction prior to physical contact.
- PPE must be worn if the participant would be within 6 feet from the each other or with an investigator.
- Physical surfaces that will come in contact with the participants must be sanitized between use
- **FA's Responsibility:** The FA is given the administrative authority to make emergency changes to protect the wellbeing of the participants and student researchers during the COVID-19 pandemic. However, the FA must notify the IRB after such changes have been made. The IRB will audit the changes at a later date and the FA will be instructed to carryout remedial measures if needed.

Data Management & Storage:

All research-related records (signed consent forms, investigator training and etc.) must be retained by the PI or the faculty advisor (if the PI is a student) at the secure location mentioned in the protocol application. The data must be stored for at least three (3) years after the study is closed. Additional Tennessee State data retention requirement may apply (*refer "Quick Links" for MTSU policy 129 below*). The data may be destroyed in a manner that maintains confidentiality and anonymity of the research subjects.

The MTSU IRB reserves the right to modify/update the approval criteria or change/cancel the terms listed in this letter without prior notice. Be advised that IRB also reserves the right to inspect or audit your records if needed.

Sincerely,

Institutional Review Board
Middle Tennessee State University

Quick Links:

- Post-approval Responsibilities: http://www.mtsu.edu/irb/FAQ/PostApprovalResponsibilities.php
- Expedited Procedures: https://mtsu.edu/irb/ExpeditedProcedures.php
- MTSU Policy 129: Records retention & Disposal: https://www.mtsu.edu/policies/general/129.php

Appendix A.2
Informed Consent

Institutional Review Board Office of Compliance Middle Tennessee State University

IRBF016 – Participant Informed Consent

B. Consent Segment 1 - IN PERSON INTERACTION

(Researchers' Copy)

Primary Investigator(s)	Hanna Kolwyck (**Student**)
Contact information	Email: hbk2d@mtmail.mtsu.edu Phone: 731-334-3866
Department & Institution	Health and Human Performance at Middle Tennessee State University
Faculty Advisor	Dr. Rebecca Fischer ***Department*** Health and Human Performance
Study Title	Noise Exposure: How it Affects Hearing in Music Majors Versus Non-Music Majors
IRB ID	**22-2059 47i Approval: 11/05/2021 Expiration: 11/30/2022**

PARTICIPANT SECTION

(To be filled by the participant and returned to the researcher)	**Participants give consent**
I have read this informed consent document	☐No ☐Yes
The research procedures to be conducted have been explained to me verbally	☐No ☐Yes
I understand all of the interventions and all my questions have been answered	☐No ☐Yes
I am aware of the potential risks of the study	☐No ☐Yes
I understand that I will be audio recorded and analyzed	☐No ☐Yes
I agree to allow my information to be retained by the investigator for use of COVID-19 contact tracing. I understand that this information will not be used for any other purposes and it will be destroyed after this purpose is served.	☐No ☐Yes
I give permission to share my identifiable information to MTSU Business Office for accounting and taxation purposes if I decide to receive the $10 compensation	☐No ☐Yes

By entering my name and signing below, I affirm that I freely and voluntarily choose to participate in this study. I understand I can withdraw from this study at any time without facing any consequences.

Name and Signature of the Participant Date Participant's Age

RESEARCHER SECTION

(To be filled by an investigator and the FA if applicable)

Informed Consent obtained by:

Faculty Verification (if administered by a student)

Name Signature Date

Name Signature Date

Appendix B
Case History Form

ID#_________

CASE HISTORY RESEARCH PARTICIPANT HEARING EVALUATION

Major ____________________ Date _____________________

1. Please tell us about your hearing concerns.

2. My hearing is __________________.

A. Better in the right ear. B. Better in the left ear. C. About the same in both ears.

3. Do you have difficulty hearing _______________?

A. in noisy places	□ Yes □ No	D. the television	□ Yes □ No
B. in quiet places	□ Yes □ No	E. over the telephone	□ Yes □ No
C. in restaurants	□ Yes □ No	F. the direction of sounds	□ Yes □ No

4. Do you have a history of ___________________?

A. ear infections	□ Yes □ No	G. ear pain	□ Yes □ No
B. allergies	□ Yes □ No	H. headaches	□ Yes □ No
C. fluctuation in hearing	□ Yes □ No	I. ear surgery	□ Yes □ No
D. dizziness	□ Yes □ No	J. noise exposure	□ Yes □ No
E. fullness in ears	□ Yes □ No	K. ringing or roaring	□ Yes □ No
F. hearing loss in family	□ Yes □ No		

5. Have you had ________________?

A. meningitis	□ Yes □ No	G. diabetes	□ Yes □ No
B. measles	□ Yes □ No	H. kidney disease	□ Yes □ No
C. scarlet fever	□ Yes □ No	I. seizures	□ Yes □ No
D. tuberculosis	□ Yes □ No	J. multiple sclerosis	□ Yes □ No
E. syphilis	□ Yes □ No	K. concussion	□ Yes □ No

F. head fracture	□ Yes □ No	L. chemotherapy	□ Yes □ No

6. Are you currently taking any medication? □ Yes □ No

If yes, please list.

____

7. Have you previously worn hearing aids? □ Yes □ No

8. Please use the space below to give us additional information you feel would be helpful to the person testing your hearing.

Appendix C
Noise Exposure Questionnaire

ID#_________

9. Have you ever had a hearing evaluation? What were the results?

10. Describe the noises you are exposed to within a typical month.

For example (check all that apply):

1. Listening to music via □ earphones □ car radio □ other _______________
2. Classroom noise. Elaborate _______________________
3. Noises within your household. Elaborate _______________________
4. Concerts.
5. Sports events.
6. Restaurants.
7. Social events.
8. Other _______________________

Circle the three noises you are exposed to for the longest duration.

11. I wear Hearing Protection Devices (HPDs):

□ Never □ Sometimes □ Frequently □ Always

12. I think music majors are at (a) ---__________ for hearing loss compared to non-music majors:

□ Lower risk □ Equal risk □ Higher risk

Additional Questions for Music Majors Only:

1. What instrument do you play?

2. What instruments are you typically seated near when performing?

3. On average, how many hours per week do you spend

Practicing____________

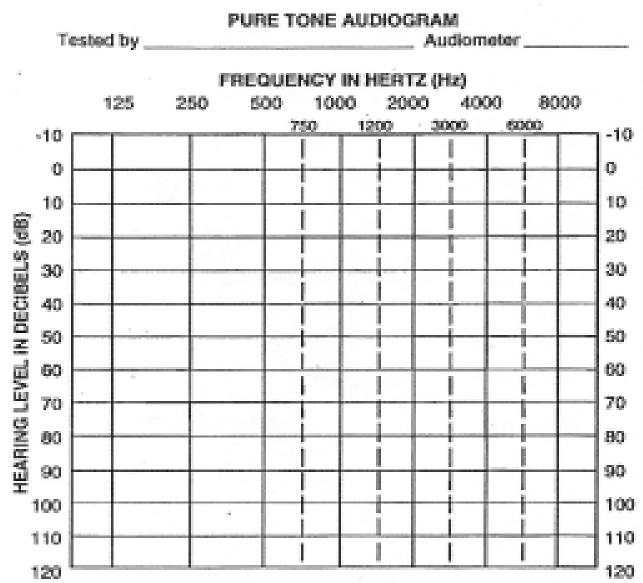
Performing____________

Listening to live music____________

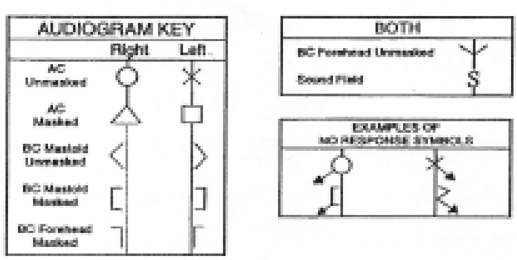
Appendix D
Audiogram Data Form

Speech-Language and Hearing Clinic
AUDIOLOGICAL EVALUATION

ID#__________



	500 Hz	1000 Hz	2000 Hz	4000 Hz	6000 Hz	8000 Hz
R						
L						



PURE TONE SUMMARY

Average Loss Within Speech Range		
Ear	AC 3-Frequency	BC 3-Frequency
Right		
Left		

*Fletcher's Average (2 frequency)

TYMPANOMETRY

	Type	Compliance	M.E.P.	Vol.	A.R.
R					
L					

Appendix E
Personal Listening Experiences and Perspectives Interview

1. QUESTION: Tell me about a personal experience you have had listening in a noisy environment.

   PROMPT: What happened after the experience?

   PROMPT: What about an experience during your college years?

2. QUESTION: How have you learned about hearing loss due to noise?

   QUESTION: In your opinion, how valid is the information you have received about hearing loss due to noise?

   QUESTION: What additional information would you like?

3. QUESTION: Describe your experience with ear plugs or Hearing Protection Devices.

   QUESTION: What do you see as the advantages and disadvantages of Hearing Protection Devices?

   PROMPT: (If yes) Why have you decided to wear HPDs?

   PROMPT: (If yes) When do you wear HPDs?

   PROMPT (If no) Why have you decided to not wear HPDs?

4. QUESTION: What do you feel is ***your*** risk for developing hearing loss as a result of exposure to noise?

   PROMPT: (If yes) Why do you feel you are at risk for hearing loss?

   PROMPT: (If no) Why do you feel you are not at risk for hearing loss?

5. QUESTION: Describe where you think the condition of your hearing will be in 10 years.

   PROMPT: What would you be willing to do to keep your hearing in the same condition as it is today?

Appendix F
Interview Phenomena Outline

Themes from Interviews

Qualitative Analysis ID#_________

1. **Personal Experience with Noise**

    Tinnitus

    Reduced hearing

    Pain

    Loud

2. **Education/Additional Information/Learning**

    Education during class

    No learning during class

    Through the experiences of others

Validity

    Is valid

What additional information would you like?

    Ways to protect hearing

    When to wear

    How to best use

3. Experience with HPDs

Advantages of HPDs

Protecting hearing

Preventing negative effects

Specific Situations where HPDs worn

Disadvantages of HPDs

Want full experience of listening

Social discomfort

Physical discomfort

Cannot hear others

Cost of HPDs

Use of HPDs- YES or NO

No-never

Yes- one ear during practice or rehearsal

No-during performance

Yes-during performance

Wear earplugs as listener

Do not wear earplugs

Has personal HPDs

4. Risk for Hearing Loss

Current risk

High risk

Moderate risk

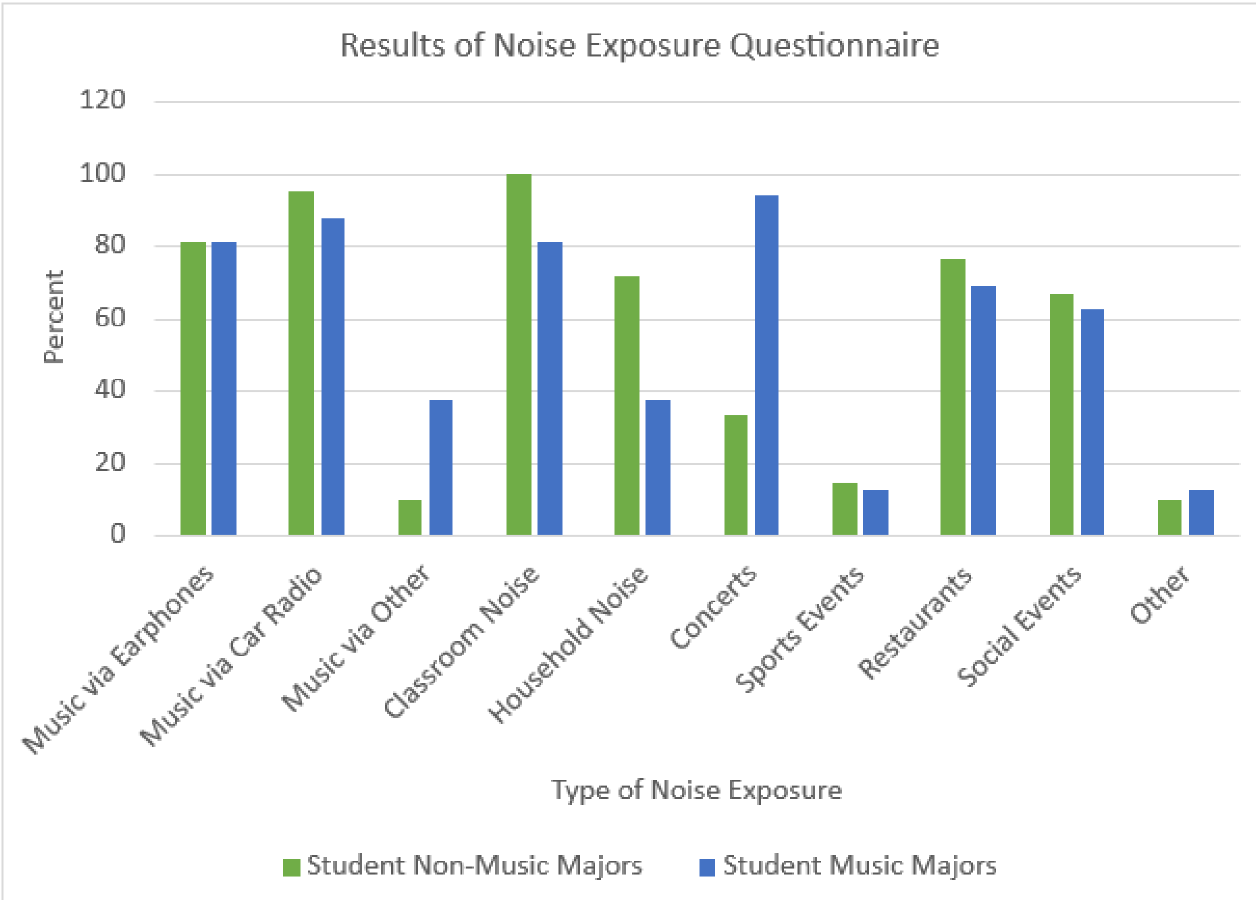
No risk-OK

Future risk-Hearing in ten years

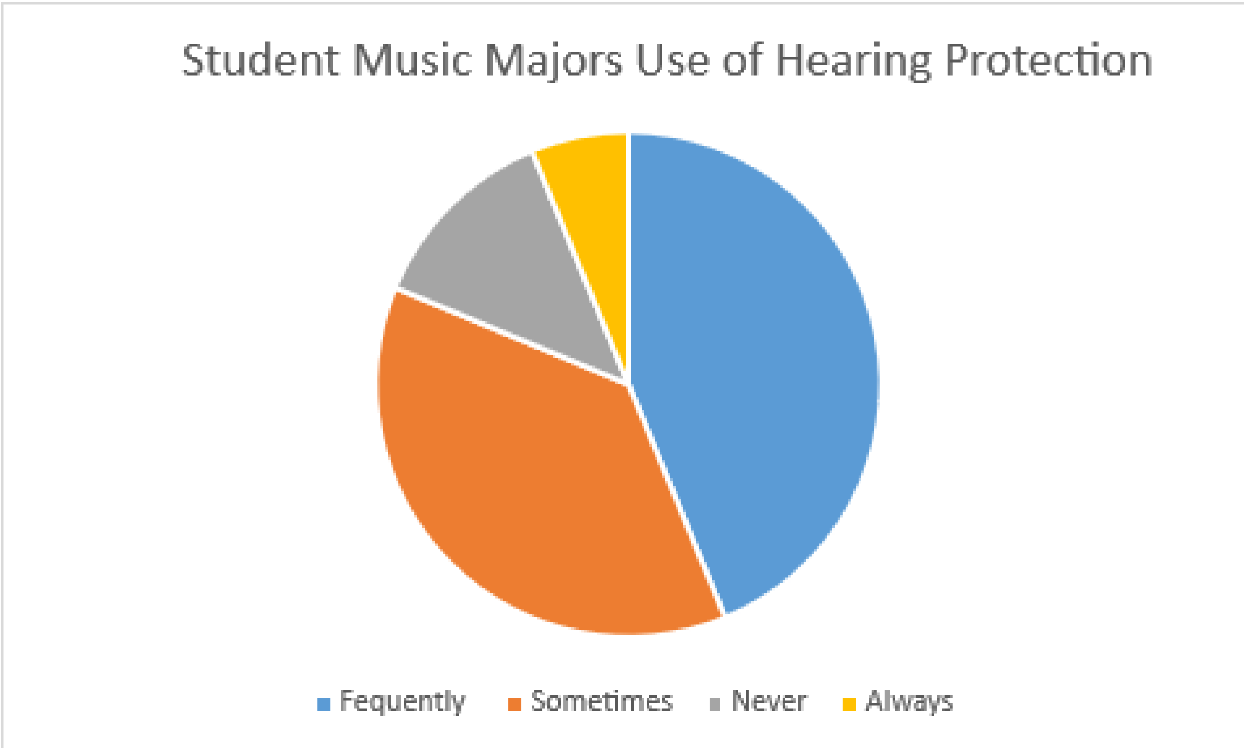
The same

A little worse

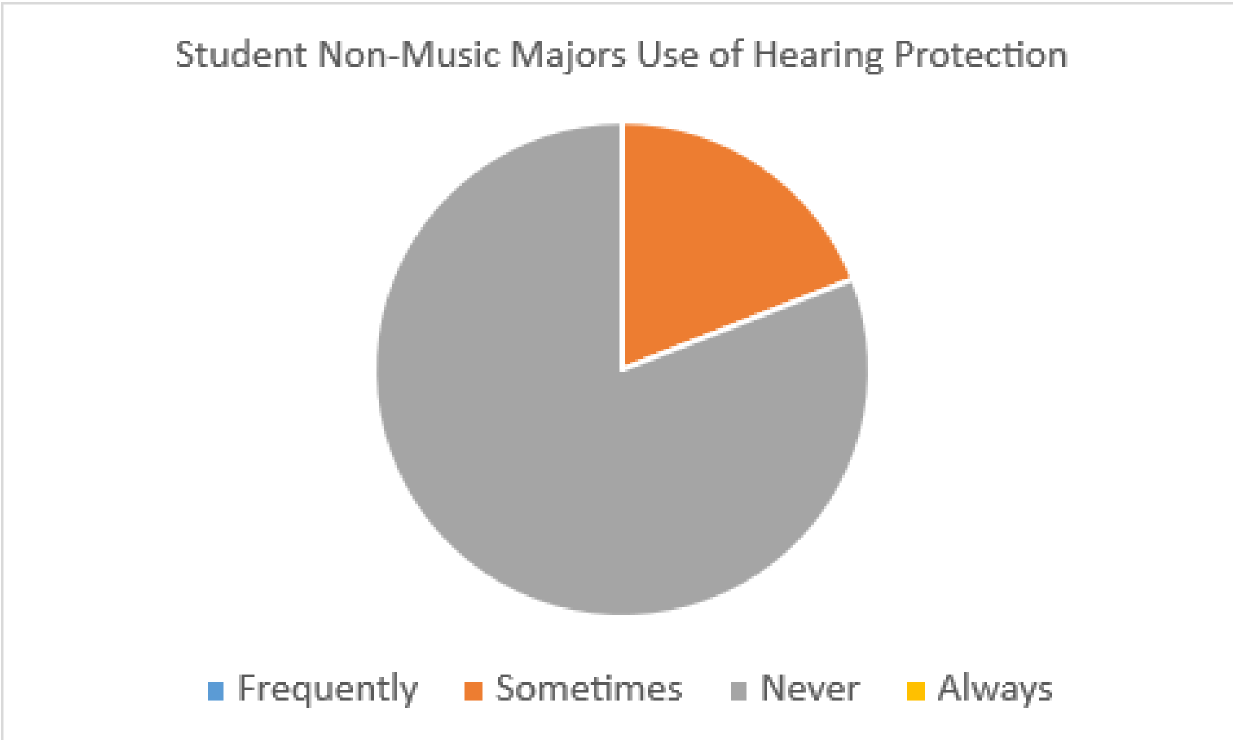
Appendix G
Results of Noise Exposure Questionnaire



Appendix H.1
Use of HPDs Pie Chart



Appendix H.2
Use of HPDs Pie Chart



Appendix I
Average Number of Hours Student Music Majors Spent Practicing, Performing, and Listening to Live Music

Average Number of Hours Student Musicians Spent Practicing, Performing, and Listening to Live Music

Activities	Descriptive Statistics	
	μ	σ
Practice	8.34	6.45
Performance	2.22	1.51
Listening to Live Music	3.03	2.11

Note. This graph shows the average number of hours Student Music Majors who participated in this study normally spend practicing, performing, and listening to live music.

Appendix J.1
Comparison of Thresholds for the Hughson-Westlake Procedure and the Modified Procedure Graph

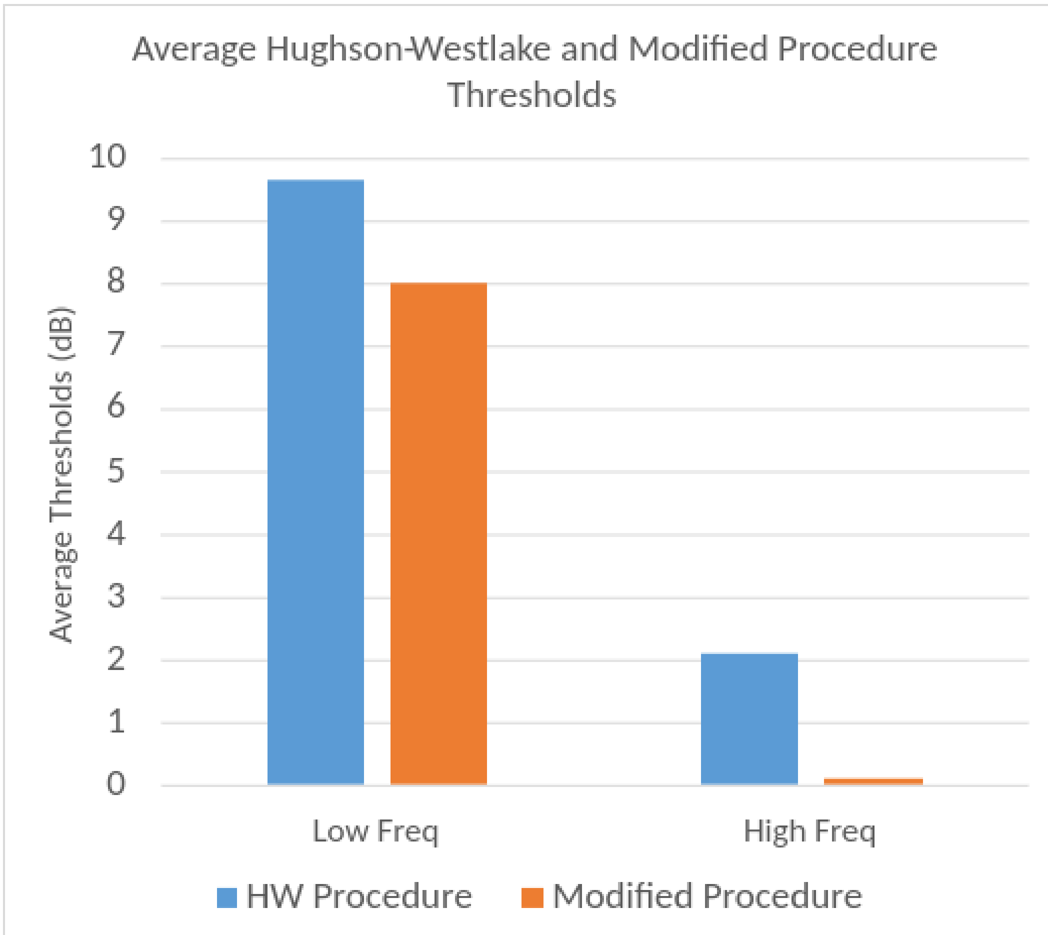


Table 1

Comparison of Thresholds for the Hughson-Westlake (HW) Procedure and the Modified Procedure (MP)

Procedure	Descriptive Statistics	
	μ	σ
HW Low Freq.	9.62	3.80
MP Low Freq.	8.00	3.70
HW High Freq.	2.09	4.01
MP High Freq.	0.09	3.98

Note. This table shows the average low frequency (500, 1000, and 2000 Hz) thresholds and high frequency (4000, 6000, and 8000 Hz) thresholds for each procedure (the Hughson-Westlake Procedure- 2 dB step size; and the Modified Procedure- 2 dB step size). The average thresholds for the 2 dB Step Size Procedure are better than the thresholds for the 5 dB Step Size Procedure. High frequency thresholds are also better for both procedures.

Appendix K
Average Thresholds for Student Music Majors and Student Non-Music Major

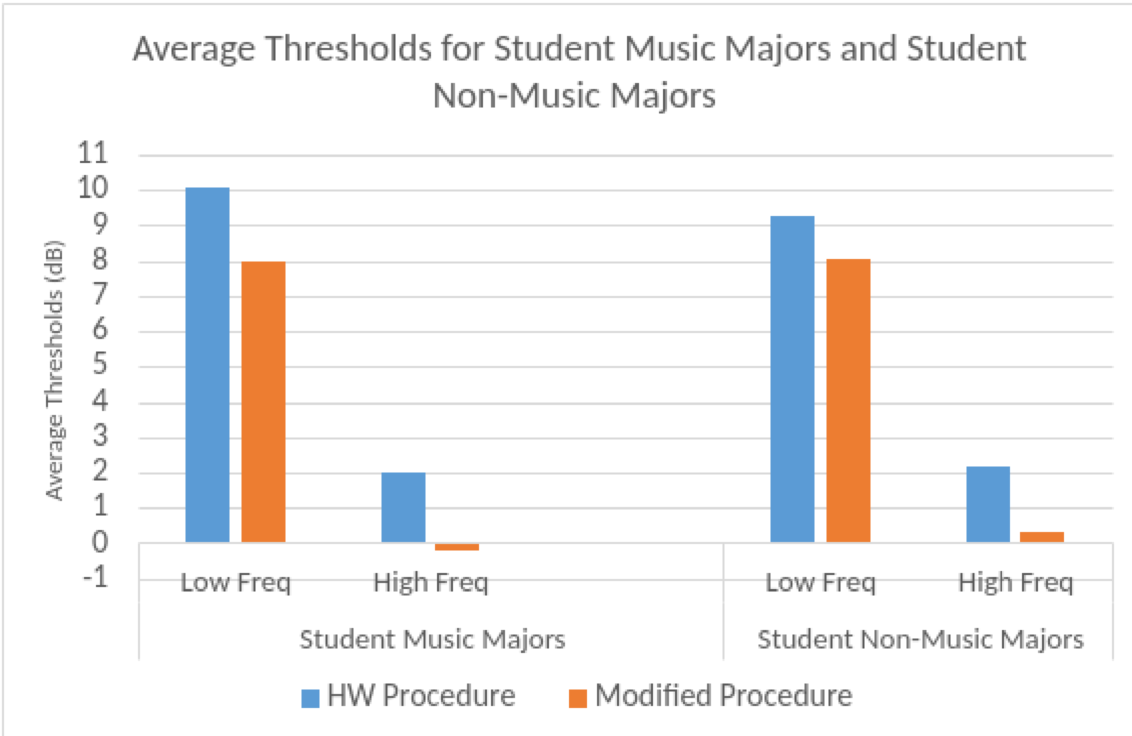


Table 2

Comparison of Thresholds Between Student Music Majors and Student Non-Music Majors

Procedure	Student Non-Music Majors		Student Music Majors	
	μ	σ	μ	σ
	Hughson-Westlake Procedure			
Low Freq	9.25	3.99	10.10	3.60
High Freq	2.18	4.55	1.98	3.30
	Modified Procedure			
Low Freq	8.02	4.15	7.98	3.16
High Freq	0.34	4.66	-0.23	2.99

Note. This table shows the average low frequency (500, 1000, and 2000 Hz) thresholds and high frequency (4000, 6000, and 8000 Hz) thresholds of Student Non-Music Majors and Student Music Majors using the two different methods (the Hughson-Westlake Procedure- 2 dB step size; and the Modified Procedure- 2 dB step size). High frequency averages were poorer than low frequency averages across groups.