

Hearing Conservation Programs for Drum and Bugle Corps: Implications for Educational Audiologists

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The purpose of this study was to evaluate the effectiveness of a comprehensive hearing conservation program for increasing noise awareness and willingness to wear hearing protection devices (HPDs) among drum and bugle corps members. A hearing conservation program was provided to drum and bugle corps percussionists including the use of otoacoustic emission screenings. A questionnaire was administered pre- and post-intervention to assess changes in knowledge and attitude towards hearing conservation and HPD use. Exposure to the conservation program led to a significantly positive change in percussionists' attitudes towards HPDs. Educational programming was also effective in establishing more realistic expectations and addressing misconceptions about noise exposure, damage, and treatment. Training was also effective in helping participants understand ways to reduce exposure. Simulations of hearing damage, use of otoacoustic emission (OAE) screening results and increasing awareness about hearing protection designed specifically for musicians were effective in increasing the likelihood of HPD use. Educational audiologists are uniquely positioned to develop positive relationships with band directors/instructors and students within their school district. In that role, they can provide a comprehensive hearing protection program through programs like Adopt-a-Band (Etymotic, n.d.) or by working with the program to create an individualized program.

Background and Introduction

Many people are exposed to noise on a daily basis, but none are more at risk than those whose occupations and lifestyles revolve around noise or loud music. Excessive, long-term exposure to loud sounds can lead to permanent hearing loss, and an estimated eleven million individuals suffer from some degree of noise-induced hearing loss (NIHL) (Bogoch, House, & Kudla, 2005; Crandell, Mills, & Gauthier, 2004). Recent reports suggest that NIHL is becoming a concern for people at increasingly earlier ages; 16-20% of adolescents/young adults (ages 12-19) have some kind of hearing loss. Researchers have speculated that there is a link between the increase in hearing loss and regular exposure to excessively loud music (Shargorodsky, Curhan, Curhan, & Eavey, 2010). Groups of adolescents and young adults with especially high noise exposure include drum and bugle corps (drum corps) and marching band members, who are regularly exposed to intense noise during the course of their rehearsals and performances.

Drum and bugle corps are made up of elite musicians and athletes who spend an entire summer (80+ days) practicing for as long as 14 hours a day in order to perform in different cities across the country (Drum Corps International, n.d.). Marching band students also participate in long days of rehearsals during band camps each summer and into competition season in the fall months. Additionally, some students also participate in indoor marching percussion ensembles during the winter months.

Upwards of 5,000 young people, ages 13 to 22 years, participate in Drum Corps International (DCI) member corps each year; many more individuals participate in marching bands around the country. Researching the habits and attitudes of drum and bugle corps members may provide insight into the knowledge that marching band members have about hearing conservation. Additionally, over half of the participants plan to become music educators (Drum Corps International, n.d.), and it is possible that attitudes and behaviors developed during their time with the group will likely be conveyed to future students.

For musicians, sound exposures can range from 72 dBA while playing an acoustic guitar to 115 dBA while playing a snare drum. Unlike steady-state noise in industrial settings, music intensity varies greatly over time, with sound levels that peak as high as 120 dB (National Institute for Occupational Safety and Health [NIOSH], 1998). In an analysis of noise exposure in drum and bugle corps members, Presley (2007) found that percussionists are exposed to average sound levels ranging from 94.4 to 103.1 dBA, and most exposures ranged from ten times to as great as 94 times the recommended dose of noise in the course of a 12 hour rehearsal. According to Presley (2007), hearing protection device (HPD) use was limited in this population.

While there is substantial literature regarding the dangers of noise exposure and the increasing incidence of noise induced hearing loss in the young adult population, less is known about

effective approaches for teaching children and young adults how to prevent hearing loss and how to detect signs and symptoms of hearing problems. Children have limited knowledge about hearing conservation in general, but are especially naïve in their knowledge of noise hazards, which may be the most common barrier to protective actions (Chen, Huang, & Wei, 2008). Professional musicians, however, appear to be aware of long-term hearing damage and directly report symptoms related to over-exposure (Curk & Cunningham, 2006) including tinnitus and hearing problems. As many as 27% of musicians report these problems (Laitinen, 2005; Presley, 2007) and these symptoms have also been linked to increased stress levels and sensitivity to noise (Laitinen, 2005). While some musicians indicate awareness of the dangers of noise exposure, others continue to believe that damage will not occur following significant exposures to loud sounds (Bogoch et al., 2005).

Hearing protection use in musicians is low. None of the participants wore HPDs in Presley's 2007, and only 13% reported daily use in Jin, Nelson, Schlauch, & Carney (2012) with more than half of the marching band members reporting that they never wore HPDs. In the latter study, HPD use was greater in percussionists when compared to the rest of the marching band. Curk and Cunningham (2006) determined that almost half of study participants reported that they did not wear HPDs when performing, but approximately two-thirds did wear them while practicing.

Musicians have expressed concern that their own performance could be adversely affected by HPDs, and were concerned about their ability to hear other players (Chesky et al., 2009). Other barriers include unpleasant sensation/discomfort, difficulty with insertion, problems with communication (loss of speech intelligibility), cosmetics, cost, and existing hearing loss that exacerbated the listening situation (Bogoch et al., 2005; Chesky et al., 2009; Laitinen, 2005). Therefore, Chesky et al. (2009) advised that HPDs be recommended only after attempts to reduce or eliminate noise exposure in other ways had been exhausted. In contrast, several other studies have supported education and provision of high-quality hearing protection (Jin et al., 2012; Palmer, 2009; Schmuziger et al., 2006).

Hearing conservation programs do exist for school-age children and include programs such as Dangerous Decibels and Wise Ears, among others, but are not generally required (Blessing, 2008; Griest, Folmer, & Martin, 2007). Interestingly, none of the above programs are directed towards the prevention of music induced hearing loss, especially for young musicians. At the time of this study, there were only a few new programs being introduced, including one targeting school-age musicians (Palmer, 2009) and another in college schools of music that was developed through the National Association of Schools of Music and the Health Promotion in Schools of Music project to focus on health of musicians (Chesky, 2011). Data on the efficacy of these programs were unavailable at the time of this study.

Throughout the literature, the general consensus is that more hearing conservation programming is needed, especially for musicians. To increase the effectiveness, several studies have suggested that experience with hearing symptoms, simulated or real,

is what is more critical for attitude and subsequent behavior change (Laitinen, 2005; Widen et al., 2009). In addition, incorporating hearing screenings, using dosimeters and "dose percentages", participating in interactive discussions, and including personal testimonies from musicians who suffer from hearing loss are beneficial (Curk & Cunningham, 2006; Palmer, 2009; Rawool & Colligon-Wayne, 2008; Widen et al., 2009). Presumably the more engaged the audience, the better they will be able to understand the significance of the risks they take and the consequences associated with their behavior, which will subsequently encourage HPD use as well as other protective measures (Rawool & Colligon-Wayne, 2008; Widen et al., 2009).

Limited research exists to evaluate the need for and effectiveness of hearing conservation programs for young adults involved in musical and athletic activities like drum and bugle corps. The purpose of the current study was to examine the effects of a hearing conservation program, including otoacoustic emissions screenings, on the attitudes of percussionists in drum and bugle corps. In doing so, we sought to answer the following research questions: (1) What are the currently held general and specific attitudes towards hearing conservation in drum corps percussionists?; (2) What levels of knowledge do they have regarding noise exposure, long-term exposure and hearing loss, and the use of HPDs as it relates to drum corps? We hypothesized that drum corps members have limited awareness of NIHL, hearing conservation, and the use of hearing protection, and that a hearing conservation program targeted at these percussionists would result in an increased knowledge about NIHL and a positive change in attitude about wearing HPDs. Additionally, we evaluated what areas of the hearing conservation program were particularly beneficial and what areas needed further research and development.

Methods

Participants

Participants were recruited from two Midwestern drum and bugle corps. Additional drum corps were invited to participate, but declined due to time and travel constraints. Seventy-four participants over the age of 18 enrolled in the study while 69 participants completed the entire study (93% return rate). Age of participants was limited to those over 18 years of age due to difficulty obtaining parental consent when the prospective participant was on tour. Participants consisted of marching members (those actually performing) and their instructors. Marching members ranged from 18 to 22 years of age ($m = 20.2$ years), while instructors' ages ranged from 22 to 31 years. Most (81%) of the marching members were male. Marching members represented a variety of percussion instruments: snare drums ($n=15$), quad/tenor drums ($n=10$), bass drums ($n=10$), cymbals ($n=6$), and front ensemble/pit percussionists who played a variety of instruments including tympani, marimba, bells, xylophone, and electronic keyboard ($n=28$). Additional demographic information was obtained regarding the participants' hearing health background and history of HPD use (Table 1).

Construction of Questionnaire

The pre-and post- questionnaires used in this study were adapted from two separate published surveys. Widen

Table 1. Summary of Participants' Experience with Hearing Healthcare

Question	% of Participants
Has had previous hearing test	62
Has worn hearing protection devices (HPDs) before	97
Has used foam earplugs	75
Has used non-foam earplugs	39
Has used earmuffs	19
Has used high fidelity earplugs (ETY-plugs™)	28
Has used custom Musicians Earplugs™	25

and colleagues (2009) developed the *Hearing, Use of Hearing Protection and Attitudes Towards Noise Among Young American Adults Questionnaire* for young adults, and Chen and colleagues (2008) designed the *Elementary School Children's Knowledge and Intended Behavior Towards Hearing Conservation Questionnaire* for use with elementary school children. Additional investigator-developed questions were added to address attitudes and knowledge specific to drum and bugle corps musicians.

The questions were presented in random order and this order differed between the pre-and post- intervention surveys to reduce bias in completing the forms. The post-intervention survey included three additional questions to assess the effect of the hearing conservation program on HPD use. (Survey provided in Appendix A).

Questions on both pre- and post-intervention surveys were constructed to obtain both negative and positive type responses. A five-point Likert Scale was used with response choices coded as (5) Totally agree, (4) Partly agree, (3) Neutral, (2) Partly Disagree, and (1) Totally Disagree. (See Table 2 for Focus Questions)

Hearing Conservation Programming

The hearing conservation program was multi-faceted. Each participant received an Otoacoustic Emission (OAE) screening, which is explained in the following section. The OAE results were used as part of the hearing conservation program to allow for discussion with corps members about NIHL, the potential to identify outer hair cell damage before it can be seen on a hearing evaluation, and to support the need to wear hearing protection. The remainder of the program consisted of an interactive power point presentation and the use of a dosimeter.

Otoacoustic emissions screening.

Otoacoustic emissions (OAEs) are generated by the outer hair cells in the cochlea in

response to an acoustic stimulus. Specifically, distortion product OAEs are generated when the outer hair cells are stimulated by two pure-tones simultaneously; the response generated by the outer hair cells is a combined tone at frequencies arithmetically related to the stimulating pure tones ($2f_1-f_2$) (Dhar & Hall, 2012). OAEs are sensitive to cochlear damage related to noise and ototoxicity and are, thus, used frequently for monitoring cochlear status in hearing conservation programs (Muller, Dietrich, & Janssen, 2010; Pride & Cunningham, 2005). For the purposes of this study, OAE screenings were conducted using the Ero-Scan™ Pro (Maico, n.d.), which is resistant to ambient noise up to 70dB. Testing was completed pre-intervention for most participants. The OAE protocol was set up to test

using distortion product otoacoustic emissions (DPOAEs) at seven frequencies: 2000, 3000, 4000, 5000, 6000, 8000, and 10,000 Hz. The stimuli were presented using an intensity level (L) of 65 dB SPL for L1 and 55 dB SPL for L2, which corresponds to f_1 , and f_2 in the arithmetic equation mentioned above. This is the most common stimulus paradigm used in clinical DPAOE measurements (Dhar

Table 2. Sample of Prompts Used in Hearing Conservation Survey, Subdivided by Perspective

A4: The sound level in my drum corps is comfortable to me.
A5: Noise and loud sounds are natural parts of our society.
A7: I need to hear everything in my environment, regardless of how loud.
B5: Drum corps and marching percussion groups should have some rules or regulations about the use of hearing protection devices in order to prevent hearing loss.
B8: I am prepared to give up activities where the sound level is too loud.
B9: I am prepared to do something to protect my hearing.
C4: Hearing will not be harmed by listening to an iPod or playing music at intense sound levels for extensive amounts of time.
C7: If I can't tell I have a hearing problem, then I probably don't have any hearing loss.
C10: I know when it is no longer safe to listen to loud sounds and use hearing protection.
D11: Using hearing protection will make it hard to hear instruction from instructors on the field and in the (press) box.
D12: If I wear hearing protection, I will play harder.
D13: If I wear hearing protection, I will experience pain and tension from playing too hard.
D14: If I wear hearing protection, there is no way to overcome this way of playing louder and causing injury.
D15: I will have difficulty hearing others around me as clearly.
D16: I will have difficulty hearing the other instruments in the corps if I wear hearing protection.
D17: I think hearing conservation and hearing protection devices should be a concern in drum corps.
Post Intervention 1: Knowing about my options for earplugs designed for musicians, I am more likely to wear earplugs.
Post Intervention 2: After learning the results of my tympanometry and OAE screening, I am more likely to wear hearing protection regularly.
Post Intervention 3: After hearing simulations of hearing loss and tinnitus, I am more likely to wear hearing protection regularly.

& Hall, 2012). A “refer” result was obtained when one or more frequency’s emissions did not exceed a 6 dB signal-to-noise ratio (SNR). When participants referred on the OAE screening, the Ero-Scan™ Pro automatically conducted a tympanometry screening using a 226 Hz probe tone to evaluate the presence of middle ear or ear canal pathologies that might confound OAE results. For the tympanometry screening, a “refer” was assessed if peak pressure was significantly negative (< -150 daPa) or significantly positive (> +50). A referral was also assigned when peak compliance was less than 0.1mL or greater than 1.5 mL. These tympanometry referral guidelines were the default settings in the Ero-Scan™ Pro device.

Approximately 30% of participants passed the OAE screening in both ears; 30.4% passed in the right ear only, and 10.1% passed in the left ear only. Twenty-nine percent failed both ears. Of 147 ears tested, 75 (51%) ears referred. Further analysis of OAE results indicated that 35 ears referred at only one frequency, 20 ears referred at two frequencies, four ears referred at three frequencies, nine ears referred at four different frequencies, and seven referred at five frequencies. No ears referred at more than five frequencies.

Of the 75 ears that referred on OAEs, only eight ears referred on tympanometry results as well. Three participants had significant negative pressure; five ears had peak compliance that exceeded the maximum level suggesting hypermobile eardrum movement. Additionally, one ear yielded a small ear canal volume, which may be attributed to cerumen impaction or a blocked probe. Tympanometry results were unavailable for one ear.

Educational portion and noise dosimetry. The educational portion of the hearing conservation program consisted of a 45 minute interactive Microsoft PowerPoint presentation (Appendix B). The presentation targeted four main areas: general introduction to the ear and hearing, noise exposure and long term effects, and safe listening techniques including hearing protection device use and noise dosimetry. Noise dosimeters were also employed during rehearsal on a cymbal player for one group and a snare player for another group in order to further support the need for hearing conservation in a “see it to believe it” approach. The dosimeter is a small device used to measure sound levels over a period of time and is particularly useful in environments when duration and intensity varies. It is used to determine the “dose” of noise during the exposure period. These results, including dose percentages, were shared with the group following rehearsal and were consistent with results obtained by in the Presley study (2007).

Procedures

The study was explained to participants and consent forms, along with the pre-survey, were disseminated among all participating members over the age of 18. Consent forms and pre-surveys were collected at the time of the OAE screening or prior to the educational portion (if the screening was unable to be completed before the presentation). Due to the nomadic nature of the drum corps, most of the forms were completed on the bus as the group traveled to the next housing/rehearsal site. OAE screenings were completed in a quiet hallway during the participant’s breakfast, lunch, dinner, and snack breaks. The educational presentation occurred during a meal break in order to avoid rehearsal conflicts.

Following the presentation, each participant was given a pair of EtyPlugs® which are high-fidelity hearing protection that are designed to provide equal reduction in sound levels across all frequencies without adversely affecting speech or music clarity (Etymotic Research, n.d.), and one volunteer participant was provided with a dosimeter to wear for the duration of a rehearsal day. Following the presentation, the participants were given one week to return the survey. No rehearsal time was disrupted during the study, recognizing the elite status of these performers and their need to maintain a consistent rehearsal schedule.

Data Analysis

For inclusion in data analysis, complete data on both pre- and post-intervention survey questions were required. Data were analyzed using the Chi-Square “Goodness of Fit” Test (Lowry, 2011). The Chi-Square analysis was conducted to determine statistical significance between pre- and post- survey responses.

Results

Due to the large pool of data collected in this study, only significant results and those that directly corresponded with the research questions will be presented here.

General results of the questionnaire suggested a significant positive change in attitude toward HPDs from pre- to post-intervention ($N = 68, p = .021$). No individuals declared a “negative” attitude toward hearing protection in pre- or post-results; seven percent were “somewhat negative” pre-intervention while only four percent maintained a somewhat negative attitude post-intervention (Table 3).

Beyond basic attitude change, this study targeted three areas of participant knowledge: (1) noise exposure; (2) NIHL, damage, and treatment; HPDs. Several findings were statistically significant from pre- to post- intervention. These findings are highlighted in the following sections.

Noise Exposure

Prior to intervention, most participants (97%) considered noise and loud sounds to be a natural part of our society. That perspective was changed significantly post-intervention, $\chi^2(1, N = 67) = 6.32, p = .01$; however, the percentage of participants who believed that noise was a natural part of society remained high (91%). Most individuals (69%) also expressed an initial opinion that they need to hear everything in their environment, regardless of how loud. Post-intervention, only 46% maintained that negative belief following intervention, which was a significant change, $\chi^2(1, N = 68) = 14.24, p < .001$.

More than two-thirds (71%) of participants felt that adjusting

Table 3. General Attitudes towards Hearing Conservation and Hearing Protection

General Attitude	Pre-intervention n (%)	Post-Intervention n (%)
Positive	34 (50%)	41 (60%)
Somewhat Positive	15 (22%)	17 (25%)
Neutral	14 (21%)	7 (10%)
Somewhat Negative	5 (7%)	3 (4%)
Negative	0 (0%)	0 (0%)

the volume of the iPod louder could not make the noise go away when the environmental noise is too high. A significantly greater number of participants (91%) agreed with the statement following intervention, $\chi^2(1, N = 69) = 12.83, p < .001$. Seventy-eight percent of participants responded positively to the statement: If we have to stay in a noisy environment, moving to quieter places would decrease the harmful effects of noise prior to intervention. As a result of the intervention, that percentage significantly increased to 90%, $\chi^2(1, N = 68) = 5.3, p = 0.02$.

Noise Induced Damage and Treatment

Prior to educational intervention, over half of the participants (56%) were unaware that medication and surgery cannot cure hearing loss. This was the most significant improvement post intervention, $\chi^2(1, N = 66) = 18.84, p < .001$, with 83% acknowledging after the training session that medication and surgery is not a resort if hearing is not protected. Twenty-two percent were not aware prior to intervention that they could have hearing loss without noticing, which decreased to 10% following intervention, $\chi^2(1, N = 68) = 4.81, p = 0.03$.

Hearing Protection Use

Prior to the educational program, nearly half (48%) of the participants did not feel hearing protection was necessary when at a rock concert, dance, or sporting event. That number significantly decreased to 35% following intervention, $\chi^2(1, N = 69) = 4.2, p = 0.04$. A common complaint seen as a barrier to HPD use was the difficulty hearing instructions on the field and in the press box during rehearsals. Three-quarters of participants (76%) agreed, prior to intervention, that HPD use causes difficulty hearing instruction from instructors on the field and in the press box during rehearsals, but that number significantly decreased to 64% post intervention, $\chi^2(1, N = 67) = 4.62, p = 0.03$.

When provided with further questions regarding these common complaints identified by Chesky and colleagues (2009), all responses improved post-intervention, while only one question demonstrated significant improvement post-intervention. For questions and results, see Table 4. One of the most common complaints was that individuals wearing hearing protection will play harder and as a result experience pain and tension leading to overuse injuries. Pre-intervention, 16% held that concern, while 9% remained concerned post-intervention (see Table 4). When asked whether hearing conservation and HPDs should be a concern in drum corps, 69% agreed while that number increased only slightly post-intervention (70%).

General Attitudes Based on Outcomes of Training

Three additional questions in the post-intervention survey assessed the effectiveness of the training on HPD use. Participants expressed that they were more likely to wear HPDs as a result of being educated about the options regarding hearing protection designed for musicians (87%), learning the results of their individual OAE screening (90%),

and experiencing simulations of tinnitus and hearing loss (86%).

Discussion

Noise Exposure

The survey results indicated that many young musicians have received limited education regarding the dangers of noise exposure. The educational program, in general, appeared to positively impact attitudes towards noise and helped to build a basic knowledge base regarding the dangers of noise exposure. The program also helped convey the importance of using techniques to reduce excessive noise exposure. The next step may be to help music students advocate for the use of treated acoustic environments where possible. This may be more difficult for drum corps and marching band percussionists who are often restricted to untreated acoustic environments, such as gymnasiums and hallways, when unable to practice/perform outside. Educational audiologists can serve as valuable resource to help students and teachers address concerns about noise exposure, especially in less than ideal environments.

Noise Induced Damage and Treatment

Participants in this study had rudimentary knowledge of symptoms of noise induced hearing loss (NIHL) and prior to intervention, did not seem to understand the repercussions of this damage. Intervention resulted in an increased knowledge base; yet, it was not as effective as originally anticipated as only two main questions regarding noise induced hearing damage and treatment showed significant improvement from pre- to post-intervention.

Table 4. Hearing Protection Use

Question and Number of Overall Responses (N)	Pre-Intervention Positive Response n (%)	Post-Intervention Positive Response n (%)	Chi-Square Statistic χ^2 p value
D11: Using hearing protection will make it hard to hear instruction from instructors on the field and in the (press) box. (N = 67)	16 (24%)	24 (36%)	4.62 <i>p</i> = .03*
D12: If I wear hearing protection, I will play harder. (N = 66)	41 (62%)	44 (67%)	0.4 <i>p</i> = .53
D13: If I wear hearing protection, I will experience pain and tension from playing too hard. (N = 66)	54 (82%)	60 (91%)	3.08 <i>p</i> = .08
D14: If I wear hearing protection, there is no way to overcome this way of playing louder and causing injury. (N = 67)	56 (84%)	61 (91%)	2.2 <i>p</i> = 0.14
D15: I will have difficulty hearing others around me as clearly. (N = 66)	20 (30%)	24 (36%)	0.88 <i>p</i> = .35
D16: I will have difficulty hearing the other instruments in the corps if I wear hearing protection. (N = 64)	18 (28%)	24 (38%)	2.34 <i>p</i> = .13
D17: I think hearing conservation and hearing protection devices should be a concern in drum corps. (N = 67)	46 (69%)	47 (70%)	0.02 <i>p</i> = .89

n = number of positive responses; *p* values significance: Tier 1 (*) *p* < 0.05, Tier 2 (**) *p* < 0.01, and Tier 3 (***) *p* < 0.001.

Educational audiologists can introduce healthy listening habits when musicians are in their formative years of learning their instrument and developing their performance qualities. Young musicians need to be made aware of the implications of excessive exposure to loud noise and music. Also, as evidenced by the results of this study, it is imperative that they understand that treatment options are limited and less than ideal because medical treatments are not available to reverse the effects of noise induced hearing loss and hearing aids are not able to restore normal auditory perceptions, especially not fine musical nuances that these performers rely on.

Audiologists can also help place particular emphasis on acting early and consistently to protect hearing. In that way, young musicians may be more willing to address their hearing and safe listening as part of the learning process (Palmer, 2009).

Hearing Protection Use

The results revealed an increase in participants who agreed that earplugs are necessary in loud environments, but while study participants and percussionists seem to know they need to wear hearing protection, data on hearing protection wearing patterns in these groups is not commonly documented. In Chesky and colleagues' research (2009), drummers' reaction to the wearing of hearing protection devices was identified as a great concern. For that reason, part of the intervention was aimed at discussing some of the concerns related to these beliefs. All responses improved post-intervention, while only one question demonstrated significant improvement post-intervention. Intervention appears to have positively affected participants' beliefs regarding those concerns, although not significantly (see Table 4).

Addressing these specific misconceptions and concerns regarding HPD use within the educational programming appears to help change opinions and attitudes and instill healthy hearing habits. Further, instructors may benefit from coaching/specialized training in how to provide feedback to a musician about changes in performance with hearing protection in place. Again, educational audiologists can work with groups and individuals to find creative solutions to the barriers listed above..

General Attitudes Based on Outcomes of Training

An overwhelming majority of participants indicated that real-life experiences and exposure to hearing related symptoms (tinnitus and simulated hearing loss), along with earplugs designed for musicians and participating in hearing screenings increased the likelihood of HPD use. However, we are unsure as to what the follow-through rate is in this population. It would be helpful to determine whether the three conditions mentioned above truly lead to increased HPD use.

In general, because this topic is quite broad in scope for musicians, it seems possible that briefer, more focused educational pieces could be presented over the course of a season rather than all at once. These shorter educational sessions can be delivered in a prescribed order so that developing a knowledge base and a safe listening attitude can be developed over time. This study also identified the need to further emphasize the long-term effects of excessive noise exposure and the importance of regular hearing screenings to monitor hearing status and address auditory symptoms, such as tinnitus, diplacusis, and pain as early as possible. Educational audiologists can work with the music

teacher/director to develop and schedule a series of presentations and hearing screenings over the course of the semester.

Finally, a majority of participants (70%) agreed that hearing conservation and HPDs should be a concern in drum corps, further supporting the need for developing and promoting the use of a systematic hearing conservation program for marching bands and drum corps. In recent years, the Drum Corps Medical Project (DCMP) was formed. It is a group of allied healthcare professionals who works together to support marching arts organizations with the goals of promoting health and wellness and preventing injury and illness for participants. With support from the audiology consultant on the DCMP and assistance from independent audiologists and educational audiologists in areas where these groups practice and perform, hearing conservation programs can be implemented in drum corps and as part of high school marching band programs to address the concerns identified in this study. It is within the scope of an educational audiologist to provide these types of programs to the music programs within the districts they serve.

Limitations

Several limitations must be considered when interpreting the findings of this study. A sample of convenience was used with a relatively small number of participants. Random selection of participants was not possible, which may affect the ability to generalize the findings. Further, the opportunities to recruit participants were limited by geography and the drum corps' tour schedules. Some instructors'/educators' beliefs may have been shared with participants that were not controlled for and were not expressed when these researchers were present.

The DPOAE screening was administered during subjects' break times, and therefore, each subject's time and duration of exposure to loud music prior to the screening was not controlled for, but was rather used as an informational measure to demonstrate the potential for noise/music induced damage.

The survey and presentation were created by the researchers to target the main areas that are typically part of a hearing conservation program and felt to be important features specific to the drum corps population. Because this was the first time the survey and presentation were used, the validity and reliability of the survey and appropriateness of presentation need to be evaluated and if necessary, revised to incorporate a health promotion theoretical framework.

HPDs were donated to the corps members as part of their participation (see Procedures) and as part of the hearing conservation presentation. Some participants had experience with these earplugs, while others did not which might affect initial responses to the questionnaires. They were distributed immediately following the presentation, and their use was neither encouraged nor discouraged. Therefore, use of HPDs or lack thereof following the presentation may have affected responses to the post-questionnaire.

Implications for Further Research

As a result of this study, several additional research questions have been developed in order to create a more efficient and accessible program that educational and clinical audiologists can administer with musicians in schools and private groups. These questions include: (1) What are the factors contributing to use and

non-use of HPDs?, (2) What are the wearing patterns for these musicians and what keeps them from wearing HPDs all the time or at all?, (3) Are there specific barriers or problems that are the reasons behind non-use (e.g. difficulty hearing those around them playing or speaking, difficulty localizing sound, problems with discomfort, and problems with overplaying to overcome the attenuation, potentially resulting in overuse injuries)?, (4) What are the effects of HPD use on listening and playing in an ensemble, and what are some methods for overcoming any negative effects?, (5) Do instructors' attitudes and awareness adversely affect use of HPDs in students?, (6) How do we help instructors facilitate the adjustment period as these musicians become acclimated to wearing HPDs?

Uniform use of HPDs is desired to prevent noise induced hearing loss and damage in these populations. Etymotic Research, Inc. reports that EtyPlugs™ and custom musicians' plugs using filters also made by Etymotic Research, Inc. (ER-9, ER-15, ER-25) were designed to provide a flat response without rolling off high frequencies necessary for hearing and playing music (Etymotic, n.d.). These are also designed to reduce distortion and allow for more focused playing, but it is important that musicians understand what and how they are hearing through repetition. This comes from education, and instructors and students are equally charged with that responsibility. Working together with instructors and students may lead to safer playing, but might also lead to improved sound quality and performance techniques.

Conclusion

Hearing is one of the musician's most important assets, but it may easily be taken for granted. For drum corps and marching band participants and instructors, hearing conservation and use of hearing protection is a relatively new topic, and those that have used HPDs in the past may not have been aware of a variety of options for hearing protection. Furthermore, many have not experienced an educational program designed specifically for them and are unaware of the dangers of over-exposure to sound.

Overall, the findings of this study support the hypothesis that a comprehensive hearing conservation program would promote positive change in drum corps members' attitudes and improve drum corps percussionists' knowledge about the importance of hearing conservation and the use of high-fidelity hearing protection. The same may be possible for marching band students and participants in indoor, competitive percussion ensembles.

Long-term effort is required to achieve the "buy in" to the need for awareness surrounding hearing conservation and HPD use. As drum corps members are considered the "elite" of marching musicians, high school marching bands, in turn, look to these groups as role models and the same goes for middle school musicians to high school musicians. This "trickle down" effect may help promote earlier adoption of hearing protection and safe listening, especially if hearing conservation programs designed specifically for these musicians are available to all groups around the country, starting as early as elementary school and extending into middle and high school programs.

It is essential that these programs are specifically targeted for drum corps and marching bands. Currently, commercially available hearing conservation programs such as Dangerous

Decibels (Dangerous Decibels, n.d.), ASHA's Public Service Program: "Listen to Your Buds" (ASHA, n.d.), and the American Academy of Audiology's "Turn it to the Left" program (AAA, n.d.) are not targeted for students in concert bands, marching bands, and drum corps who have unique needs related to musicianship and athleticism. Adopt-a-Band supported by Etymotic (n.d.) is perhaps one of the only programs that targets this specific population.

Educational audiologists have ready access to school programs, and they may be the most effective way to spread the word and make sure that every adolescent and young adult is made aware of the risk and the need for intervention. Educational audiologists can work as advocates through the Adopt-a-Band program and can help facilitate the ordering and distribution of hearing protection and also ensure that students understand the importance of hearing conservation practices by using the Adopt-a-Band educational material, by developing their own materials, or adapting others or using a combination of different methods. (contact the author for copies of the program used in this study). In addition, educational audiologists can initiate a relationship with the directors/instructors so that they can provide ongoing support to the programs and establish a positive relationship with the instructors and students to promote healthy hearing, ensuring that these musicians will be able to continue their musical aspirations throughout their lifetime.

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Appendix A. General assessment of knowledge towards noise exposure and hearing conservation, including hearing protection devices.

Pre/Post Survey

Initials: _____ Age: _____

Drum and Bugle Corps Name: _____

Please check one: _____ Member _____ Instructor

Years in marching percussion (indoor and outdoor), down to the quarter year: _____

Have you ever had your hearing tested? Yes No

If yes, what were the results?

Have you ever worn hearing protection? Yes No

If yes, what type have you worn? (Circle all that apply):

foam ear plugs reuseable non-foam earplug earmuffs
non-custom filtered musicians earplugs custom musicians earplugs

In general, what is your attitude towards the use of hearing protection:
Positive Somewhat positive Neutral Somewhat Negative Negative

Please read and answer the following survey items completely. Please avoid interacting with others around you so that the opinions or information expressed are yours alone.

Perspectives on Noise Exposure and the potential impact:

	Totally agree (5)	Partly Agree (4)	Neutral (3)	Partly disagree (2)	Totally disagree (1)
Our ears can get used to loud music and noise. Our ears will then be protected and it makes no difference how long we stay in noisy environments					
If the environmental noise is too high, adjusting the volume of iPod louder could make the noise go away					
Drum corps is a noisy environment/activity					
The sound level in my drum corps is comfortable to me.					
Noise and loud sounds are natural parts of our society					
The sound level at dances, rock concerts and sporting events is not a problem					
I need to hear everything in my environment, regardless of how loud					
I don't like it when it is quiet around me					

Perspectives on Hearing Protection:

	Totally agree (5)	Partly Agree (4)	Neutral (3)	Partly disagree (2)	Totally disagree (1)
Hearing could be protected by using earplugs or wearing earmuffs					
Putting cotton or tissue paper in ears is an effective method for protecting hearing from loud noise.					
If a sudden loud sound is heard, blocking ears with fingers would decrease the possible harmful effect from the loud sounds					
There is no way to protect my hearing when listening to my iPod.					
Drum corps and marching percussion groups should have some rules or regulations about the use of hearing protection devices in order to prevent hearing loss.					
Hearing protection affects my appearance and does not always work.					
I think it is unnecessary to use earplugs when I am at rock concert, dance, or sporting event.					
I am prepared to give up activities where the sound level is too loud.					
I am prepared to do something to protect my hearing.					

Perspective on long term effects of noise exposure and hearing loss:

	Totally agree (5)	Partly Agree (4)	Neutral (3)	Partly disagree (2)	Totally disagree (1)
Medication and surgery are able to cure hearing loss and bring it back to normal levels.					
Temporary hearing loss, which is caused by intense sounds, could be cured by taking some rest.					
Once hearing loss becomes permanent, hearing will not go back to normal even with a lot of rest.					
Hearing will not be harmed by listening to an iPod or playing music at intense sound levels for extensive amounts of time.					
Intense sound would elevate our hearing sensitivity temporarily.					
It is hard for one to know that his or her hearing sensitivity will decrease gradually due to long-term exposure to loud sounds.					

If I can't tell I have a hearing problem, then I probably don't have any hearing loss.					
If we stay in a noisy environment daily, the deterioration of our hearing would not be that much if we do not go to other places which have loud sounds.					
If we have to stay in a noisy environment, moving to quieter places would decrease the harmful effect of noise.					
I know when it is no longer safe to listen to loud sounds and use hearing protection.					
High impact noise could harm our hearing even if it occurs only once.					

Personal assessment of hearing and use of hearing protection

	Always (5)	Often (4)	Sometimes (3)	Rarely (2)	Never (1)
I experience ringing or buzzing in my ears: Right after playing for long periods (5+ hrs)					
I experience ringing or buzzing in my ears: Right after playing for short periods of time (0-4 hours)					
I experience ringing or buzzing in my ears: It eventually goes away/resolves.					
I experience pain, pressure, or a feeling of fullness in my ears. Right after playing for long periods (5+ hrs)					
I experience pain, pressure, or a feeling of fullness in my ears. Right after playing for short periods of time (0-4 hours)					
I experience pain, pressure, or a feeling of fullness in my ears. It eventually goes away/resolves.					
I experience a feeling of reduced sound in my ears where sounds are softer and voices appear muffled. Right after playing for short periods of time (0-4 hours)					
I experience a feeling of reduced sound in my ears where sounds are softer and voices appear muffled. Right after playing for long periods (5+ hrs)					
I experience a feeling of reduced sound in my ears where sounds are softer and voices appear muffled. It eventually goes away/resolves					
I have trouble understanding voices or sometimes miss words, particularly in background noise and it seems to have gotten worse over time. (Permanent change, does not seem to recover.)					

	Totally agree (5)	Partly Agree (4)	Neutral (3)	Partly disagree (2)	Totally disagree (1)
Using hearing protection will make it hard to hear instruction from instructors on the field and in the (press) box.					
If I wear hearing protection, I will play harder.					
If I wear hearing protection, I will experience pain and tension from playing too hard.					
If I wear hearing protection, there is no way to overcome this way of playing louder and causing injury.					
I will have difficulty hearing others around me as clearly.					
I will have difficulty hearing the other instruments in the corps if I wear hearing protection.					
I think hearing conservation and hearing protection devices should be a concern in drum corps.					

Appendix B. Presentation as part of the research project: An Assessment of Attitudes towards Hearing Protection Devices among members and instructors involved in Drum and Bugle Corps.

Outline

- I. Introduction
- II. Overview of Anatomy (using photos and graphic pictures).
 - a. Outer ear
 - b. Middle ear
 - c. Inner ear
 - i. Cochlea
 - ii. Outer Hair Cells
 - d. Hearing with the brain
- III. Noise Exposure
 - a. What is it?
 - b. Familiar Sounds/ Loud Sounds in our Environment (Graphs and Figures)
 - c. How do we measure it?
 - d. Standards: National institute for Occupational Safety and Health (NIOSH)
 - i. Recommended standards for sound-level exposure in various work environments.
 - ii. Dose percentage and formulas to consider safe amount of exposure.
 - e. Doug Presley Research (2007): An Analysis of Sound Level Exposure in Drum& Bugle Corps
 - i. Group participation: What type of sound level for each instrument.
 - ii. Group participation: How long can each instrumentalist play before exceeding the recommended daily dosage?
 - iii. Group participation: What is each instruments' dose percentage for 4 and 8 hours?
- IV. Long term effects of noise exposure.
 - a. Myths about noise and damage.
 - b. Hearing loss/damage
 - i. How does hearing damage occur?/What causes it?
 - ii. Signs and symptoms of hearing damage
 - iii. Simulations of hearing loss
- V. Instrumentation and Measurement of damage/hearing loss.
 - a. Otoacoustic Emissions/Tympanometry
 - b. Audiometric Screening/full diagnostic testing
- VI. Prevention of Hearing Loss/Hearing Conservation
 - a. Ways to keep yourself protected
 - i. Regular hearing screenings/full evaluations
 - ii. Distance
 - iii. Duration
 - iv. Use of dosimeters
 - b. Hearing Protection Devices
 - i. Pros and Cons of each type of protection
 - ii. How to use them correctly.