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# Hearing Assessment of Orchestra and Marching Band Music Students

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## INTRODUCTION

Musicians are a unique population in the world of audiology. Their exposure to noise exceeds the recommended daily dose approximately 50% of the time due to both occupational and recreational exposures (Tufts & Skoe, 2018). Additionally, their rehabilitative needs may differ from their non-musician peers. Musicians who have hearing loss may experience difficulties with timbre perception or with tuning instruments (Luders, et al, 2014). Because noise-induced hearing loss may be permanent, and can affect musicians' abilities to enjoy hobbies or perform at work, it is critical to identify signs and symptoms of hearing loss and to begin rehabilitation urgently. Thus, it is critical for audiologists to complete a thorough and highly sensitive hearing evaluation for these patients.

## PURPOSE

The purposes of this study were to:  
1) develop a more sensitive hearing assessment protocol for young musicians;  
2) determine the presence of significant tinnitus, hearing loss, and hyperacusis in ETSU musicians;  
3) determine the use of hearing protection devices in ETSU musicians

## METHODS

### Participants

Twelve ETSU musicians between 19 and 30 years of age (5 male and 7 female subjects)

All subjects had normal otoscopy and tympanometry results and denied congenital or childhood hearing loss.

## METHODS (continued)

### Procedures

- Case history: A thorough questionnaire was developed and administered to all subjects, including questions regarding demographics, musical preferences, hearing protection use, otologic health, and general health history. Additional questionnaires, including the Tinnitus Handicap Inventory (THI), Dizziness Handicap Inventory (DHI), Hearing Handicap Inventory for Adults (HHIA) and/or the Khalfa Hyperacusis Inventory, were administered on a case-by-case basis.
- Otoscopy: Thorough examination of the external ear and ear canal was completed for all subjects; abnormal otoscopy was an exclusionary criterion.
- Tympanometry: Completed for all subjects to assess peak tympanic pressure, ear canal volume, and static admittance; abnormal tympanometric results were exclusionary criteria.
- Acoustic Reflexes: Completed for all subjects at 500, 1000, 2000, and 4000 Hz to determine presence of acoustic reflex responses to elevated stimuli.
- Distortion Product Otoacoustic Emissions (DPOAEs): Completed for all subjects using two different protocols to assess outer hair cell function.
- Pure Tone Audiometry: Completed for all subjects using pure tones between 125 and 20,000 Hz. Extended high-frequency audiometry was utilized.
- Speech Audiometry: Completed for all subjects using speech reception threshold to assess patient reliability and Words-In-Noise (WIN) testing to assess the patient's ability to comprehend speech in the presence of background noise.

## RESULTS

### Hearing Assessment

The average audiograms (shown in Fig. 1) are within normal limits. However, individual subjects 4 and 9 (Fig. 2 and 3, respectively) fell outside of normal limits. Subject 4 also had absent DPOAEs and absent acoustic reflex thresholds. These abnormal results are all consistent with hearing loss. WIN testing indicated that four subjects, including Subject 4, had a mild or moderate speech in noise loss. Table 1 details each subject's WIN results.

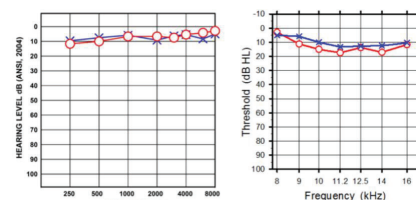


Figure 1: Average conventional and extended high frequency audiograms for all 12 subjects; all mean thresholds are within normal limits.

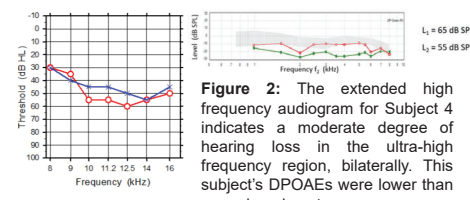


Figure 2: The extended high frequency audiogram for Subject 4 indicates a moderate degree of hearing loss in the ultra-high frequency region, bilaterally. This subject's DPOAEs were lower than normal or absent.

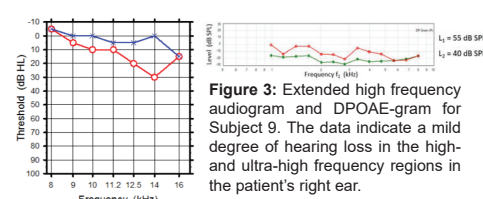


Figure 3: Extended high frequency audiogram and DPOAE-gram for Subject 9. The data indicate a mild degree of hearing loss in the high- and ultra-high frequency regions in the patient's right ear.

Subject	WIN AD	WIN AS
Subject 1	10.8	14.8
Subject 2	10.8	10
Subject 3	14.8	11.6
Subject 4	16.4	15.6
Subject 5	6	3.6
Subject 6	5.2	6
Subject 7	5.2	6.8
Subject 8	4.4	5.2
Subject 9	5.2	6.8
Subject 10	9.2	7.6
Subject 11	4.4	7.6
Subject 12	2.8	4.4

Table 1: WIN scores indicate mild or moderate speech-in-noise loss in each subject. Abnormal results are colored red. Please note: AD indicates a subject's right ear and AS indicates a subject's left ear.

## RESULTS (continued)

### Tinnitus and Hyperacusis

Six out of 12 subjects reported bothersome tinnitus. Three out of 12 subjects reported hyperacusis. All of the subjects who reported hyperacusis also reported tinnitus. The subjects were also screened for anxiety and depression, as current research indicates a link between mental health and these conditions. See Table 2 for more details.

	Anxiety/ Depression	Tinnitus	Hyperacusis	Dizziness
Subject 1	✓	✓		✓
Subject 2	✓	✓		
Subject 3	✓	✓	✓	✓
Subject 4				
Subject 5				✓
Subject 6				
Subject 7				
Subject 8				
Subject 9	✓	✓	✓	
Subject 10	✓	✓	✓	✓
Subject 11				
Subject 12		✓		

Table 2: Subject responses regarding tinnitus, hyperacusis, dizziness, anxiety and/or depression.

### Hearing Protection Device (HPD) Use

The rate of HPD use was poor among subjects. Fig. 4 details subjects' use of HPD in different environments and Fig. 5 details why some subjects reject hearing protection.

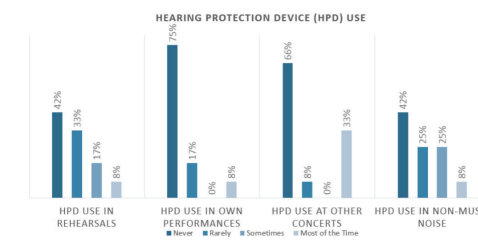


Figure 4: The majority of subjects denied using hearing protection consistently across the majority of situations, even when recommended.

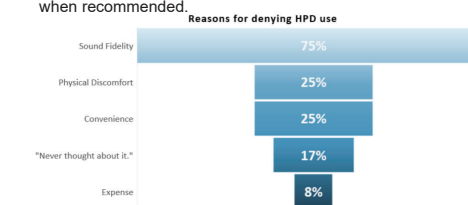


Figure 5: The majority of subjects cited concerns regarding sound fidelity when using hearing protection devices as the reason why they avoid using them.

## SUMMARY & CONCLUSIONS

- Two subjects had absent acoustic reflexes, which could increase susceptibility to noise-induced hearing loss.
- Two subjects had elevated extended high-frequency audiometry thresholds.
- One subject had abnormal DPOAEs.
- Four subjects had mild or moderate impairment of speech understanding in noise according to WIN testing.
- WIN testing was the most sensitive to potential damage to the auditory system. Additionally, WIN testing was the most valuable for researchers' use during counseling, as it illustrates situations when hearing loss may be problematic, even if audiometric testing is otherwise within normal limits.
- Tinnitus and hyperacusis were noted in 50% and 25% of the subjects, respectively. The patients who reported hyperacusis indicated that this condition is more bothersome than tinnitus. A correlation between tinnitus or hyperacusis and subjects identified with anxiety or depression was positive, which is consistent with well-established tinnitus research.
- Adoption rate of HPD within our subject pool was poor, primarily due to their concerns that HPDs would distort signals, indicating a greater need for education and counseling among young musicians.

## REFERENCES

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