

The Twenty-fourth Annual Interactive Audio Conference

PROJECT BAR-B-Q 2019



Group Report:
#KidsHearingMatters: Designing a Safer In-Ear
Listening Experience (for Kids of All Ages)

Participants: *A.K.A. "Deaf Metal Strikes Back"*

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Problem Statement

2019 World Health Organization (WHO) projections say that by 2050, there will be over 900 million people with disabling hearing loss. Risk factors include rubella and meningitis, but preventable risk factors are on the rise. WHO estimates that over one billion people worldwide are at risk of hearing loss due to unsafe listening practices. There has been a significant increase in the number of people exposed to loud sound through the use of personal entertainment audio systems, which puts this group at high risk of damaging their hearing. (See reference section.)

The group reviewed the WHO report, the ITU benchmarks, previous recommendations at Project BBQ, and other forums. We noted that despite controls implemented today that rely on volume reduction and exposure time (typically targeted at children), the number of hearing loss cases has not decreased.

We decided to focus our investigation on the root causes of sound-triggered hearing loss, particularly two recent changes in the way people listen to recorded music: in-ear listening devices and transient-rich digital audio.

While dosimetry (pressure level and exposure time) is the standard metric used to quantify causes of sound-triggered hearing loss, more recent studies suggest that extreme transients could be a significant cause of hearing damage as well. Existing exposure guidelines were developed before it was feasible to measure transients precisely, and the analog delivery systems of the day naturally dulled transients. Furthermore, in-ear devices boost levels (see graph) and couple more directly to the eardrum.

A brief statement regarding the group's solutions to those problems

The group urges that new studies be done on the effect of transients and in-ear devices on hearing loss, with the goal of establishing precise and comprehensive exposure standards. Once these standards are established, we recommend that manufacturers implement hardware and DSP to deliver strict and non-defeatable safety features for headphones.

However, standards and data won't be enough to get people, particularly children, to adopt safe listening practices. (Witness failed campaigns against smoking, excessive drinking, and other damaging behaviors.) What we *have* seen work is endorsements by celebrities and social influencers, and some of our members will endeavor to facilitate that.

Expanded problem statement

Scenarios that may aggravate hearing damage:

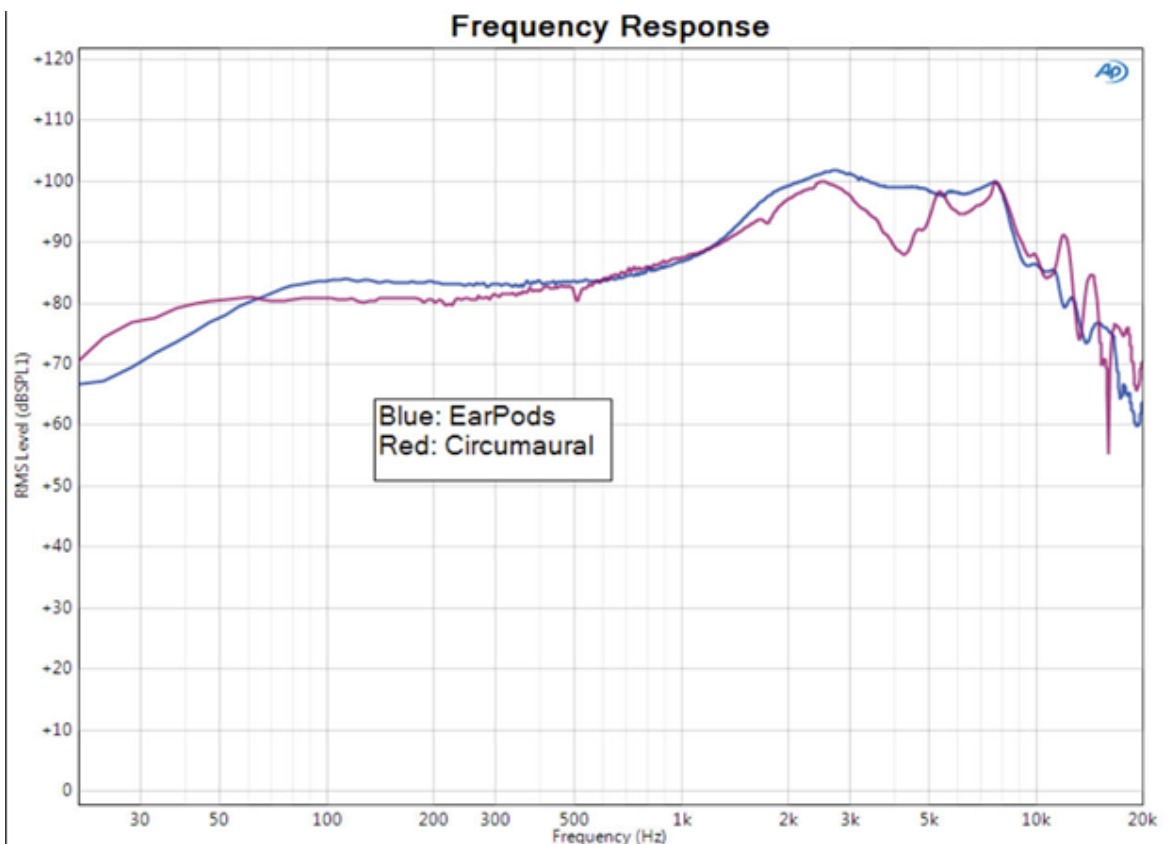
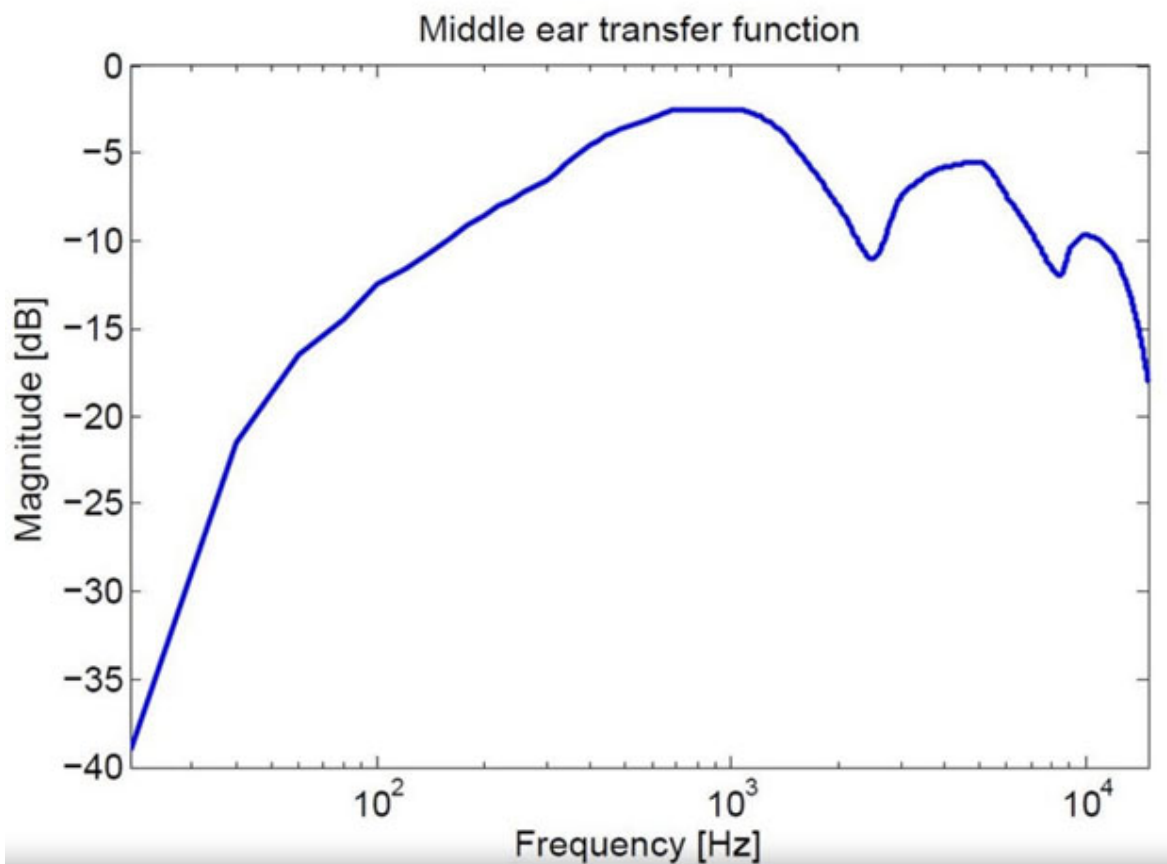
- Headphones, particularly earbuds that seal the ear canal
- The explosion of user-generated content means that recordings may not be pre-limited.
- A combination of technologies such as active noise canceling (ANC), ambient monitoring/awareness, and personalization can deliver higher dynamic range, resulting in significantly increased transient amplitude.
- Insufficient ambient noise reduction can provoke listeners to increase volume to dangerous levels.
- Weak bass in small speakers provokes listeners to raise overall levels.
- Limiters can be defeated.

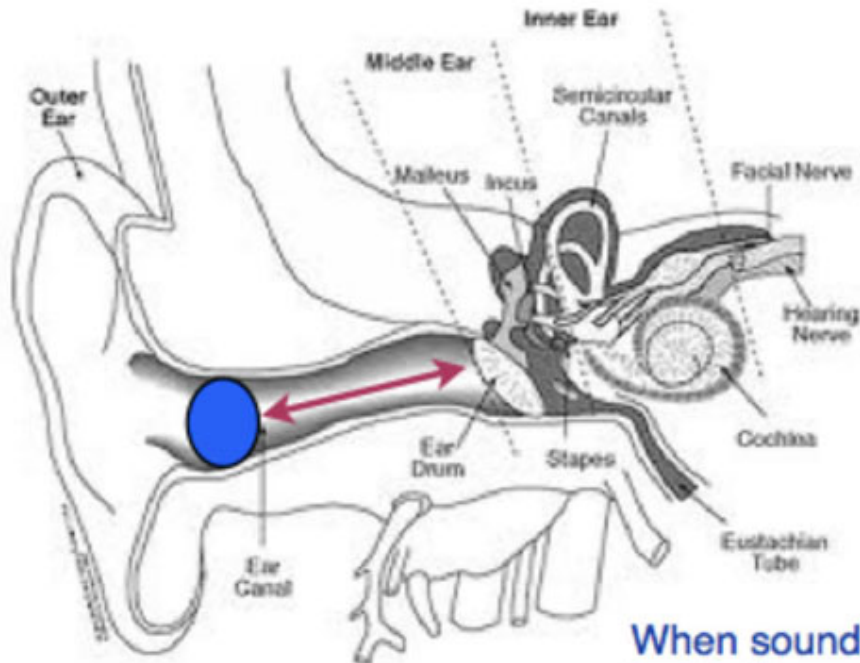
Items from the brainstorming lists that the group thought were worth reporting:

1. #KidsHearingMatters
2. Hearing protection through transient control
3. Avoid volume level as sole metric for safety
4. Analog tape as an example of former solutions — inherit limiting function
5. Include content monitoring
6. Previous initiatives failed to deliver results, likely due to ignoring the social influencer component
7. Next generation of audio solutions for the ear can be utilized to monitor, protect, dynamically control, and normalize the audio as perceived by the user.
8. Possible solutions: filtering focused on the transient effects, transient shaping
9. Value-add use of headphones at live events
10. Biosensor-equipped headphones for health monitoring
11. Gaps in current studies
 - a. Outdated audio technology, e.g., headphones considered to be analog passive receivers
 - b. Limited focus on movies and music; gaming and user-generated content were not considered.
 - c. Limited styles: In-ear designs (now roughly two-thirds of headphones shipped) were not considered.
 - d. Occlusion effect on sound level and pressure
5. Public awareness campaign
 - a. Celebrity influence and social media
 - b. Certification — establish a new brand or exploit existing ones like HearSafe
 - Active Transient Management (ATM — “where the money is”)
 - b. Business incentives
 - Brand endorsements
3. Standards bodies:
 - a. Recommend ISO 226-2003 be revised so that equal-loudness contour adds measurement of transient response of audio source material in the occluded ear canal.

Other reference material:

1. *Hearing Loss Due to Recreational Exposure to Loud Sounds:*
https://www.who.int/pbd/deafness/Hearing_loss_due_to_recreational_exposure_to_loud_sounds.pdf
2. *Deafness and Hearing Loss:*
<https://www.who.int/news-room/fact-sheets/detail/deafness-and-hearing-loss>
3. *New WHO-ITU Standard Aims to Prevent Hearing Loss Among 1.1 Billion Young People:*
<https://www.who.int/news-room/detail/12-02-2019-new-who-itu-standard-aims-to-prevent-hearing-loss-among-1.1-billion-young-people>
4. *Toolkit for Safe Listening Devices and Systems:*
<https://apps.who.int/iris/bitstream/handle/10665/280086/9789241515283-eng.pdf>
5. *Guidelines for Safe Listening Devices/Systems:*
https://www.itu.int/rec/dologin_pub.asp?lang=e&id=T-REC-H.870-201808-I!!PDF-E&type=items
6. *Music-Induced Hearing Disorders:*
<http://www.aes.org/events/reports/47thConference.pdf>
7. *Assessing Sensorineural Hearing Loss Using Various Transient-Evoked Otoacoustic Emission Stimulus Conditions:*
<https://www.ncbi.nlm.nih.gov/m/pubmed/28437273/>
8. *Various Aspects of Auditory Fatigue Caused by Listening to Loud Music:*
<https://www.intechopen.com/books/advances-in-clinical-audiology/various-aspects-of-auditory-fatigue-caused-by-listening-to-loud-music>
9. *The Loudness of Transient Sounds as a Function of Some Physical Parameters:*
<https://www.sciencedirect.com/science/article/pii/S0022460X74802543>
10. *External Ear | Cochlea:*
<http://www.cochlea.eu/en/ear/external-ear>
11. *Equal-Loudness Contour:*
https://en.m.wikipedia.org/wiki/Equal-loudness_contour
12. *Modeling of External Ear Acoustics for Insert Headphone Usage:*
<https://pdfs.semanticscholar.org/1365/3b2a860ae0bef25938eb3894b680d21b5c95.pdf>
13. *Data Sheet: AECM206 Headphone Test Fixture:*
<https://www.ap.com/download/aecm206-headphone-test-fixture-data-sheet/?wpdmdl=7560>
14. *Data Sheet: AECM304 Occluded Ear Simulator:*
<https://www.ap.com/download/aecm304-ear-simulator-data-sheet/?wpdmdl=7026>
15. *Next Generation Headphone Testing:*
<https://www.gras.dk/files/MiscFiles/News/GRAS%20Alma%202017%20Microphones%20and%20couplers%20PWA%20170102.pdf>
16. *Musician Wins Landmark Ruling Over Ruined Hearing:*
<https://www.bbc.com/news/amp/entertainment-arts-43571144>
17. *The Truth About Hearing Loss & 18 Ways to Avoid It:*
<https://drummagazine.com/hearing-loss/>
18. *Headphone Listening Habits and Hearing Thresholds in Swedish Adolescents (2017):*
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5501022>
19. *Why AirPods—and Earbuds Like Them—Are Especially Bad for Your Hearing (2019):*
<https://onezero.medium.com/why-airpods-and-earbuds-like-them-are-especially-bad-for-your-hearing-20f32b6e02e2>
20. *Cultural and Demographic Factors Influencing Noise Exposure Estimates from Use of Portable Listening Devices in an Urban Environment:* https://www.researchgate.net/publication/261256174_Cultural_and_Demographic_Factors_Influencing_Noise_Exposure_Estimates_From_Use_of_Portable_Listening_Devices_in_an_Urban_Environment
21. *Protecting Tomorrow's Ears (Project Bar-B-Q 2015):*
<https://www.projectbarbq.com/reports/bbq15/bbq15r7.htm>





When sound is trapped inside the ear canal, the sound trapped becomes amplified.