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## Managing the Musician With Hearing Loss: Treatment Considerations

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## Disclosures

- Dr. Fligor owns Boston Audiology Consultants, Inc., a private clinical and technical consulting practice.
- Dr. Fligor is a consultant to Lantos Technologies, Inc., a privately-owned early-commercial medical device company. Dr. Fligor has ownership interest in Lantos Technologies, Inc.
- Dr. Fligor is chair of the WHO/ITU working group making recommendations for manufacture of personal audio systems (portable listening device, portable music player).
- Dr. Fligor receives an honorarium from AudiologyOnline for presenting.

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## Learning Outcomes

- Prioritize the clinical significance of a patient's tinnitus, hyperacusis, diplacusis, and hearing loss.
- Discuss how to build upon existing tinnitus management techniques to engage in tinnitus management with musicians.
- Describe how to adjust hearing aid program settings to make music-listening more acceptable through hearing aids.

## Topics

- Review of tinnitus diagnosis and management
- Tinnitus and hyperacusis management for musicians
- Hearing aid settings for music-listening
- Non-hearing aid assistive devices for musicians



## Summary of Content from “Fundamentals” 11/14/18

- Music as a source of auditory dysfunction (“injury”)
- Diagnostic process for evaluation musician’s hearing loss, tinnitus, hyperacusis, and diplacusis
- Hearing loss prevention via custom hearing protection devices
- Treat the patient, not the audiogram



## Most Frequently Reported Problems with “Bothersome” Tinnitus

- Getting to sleep
- Persistence of tinnitus (can’t escape)
- Understanding Speech (Possibly Because Of Concomitant Hearing Loss)
- Despair, Frustration, Depression
- Annoyance, Irritation, Inability To Relax
- Poor Concentration Or Confusion

## Tinnitus Diagnosis and Management, Review

- VERY high rate of co-morbidity with anxiety and depression
  - Are they already depressed and anxious? Low trigger for these behavioral health challenges?
- Not the perception of the tinnitus, but the reaction to it
- Inappropriate assignment of importance of the tinnitus, results in the limbic system (the “lizard brain”) expressing a fear reaction
- Activation of the sympathetic response of the autonomic nervous system
  - Conditioned reflex (inappropriate assignment of cause-effect)
  - State of fight-or-flight
  - Persistence of tinnitus results in persistence of fight-or-flight (remains in hyperanxious state)

## Presentation of Tinnitus

- Does tinnitus pitch matter?
  - Often multi-tonal, if tonal at all
  - May approximate frequency region of a noise-notch
- Does tinnitus “loudness” matter?
  - Most tinnitus is loudness matched to within 12 dB of threshold of hearing sensitivity (Snow, 2004)
  - Absolute sensation level not correlated with “tinnitus suffering” (change in sensation level within the individual *does* correlate)
- Minimum Masking Level
  - Matters, for the sake of modifying perception of tinnitus

## Presentation of Tinnitus

- Barring sinister medical sources, the problem is not the tinnitus itself, but the patient's reaction to the tinnitus!
- Tinnitus activates the sympathetic response of the autonomic nervous system ("fight/flight/freeze") and because the tinnitus is persistent, sufferer is locked into state of hypervigilance and anxiety/fear/dread

## Tinnitus Interventions, Review

- Informational counseling
- Stress reduction
- Sound enhancement (white noise generator; tinnitus maskers; combo devices- hearing aid with tinnitus masker)
- Tinnitus Retraining Therapy (Jastreboff)
- Behavioral Health
- Anti-anxiety medications
- Hearing loss prevention program to mitigate exacerbation of tinnitus and hearing loss




## Sound Enhancement (Mitigate Perception)

- Music, Brookstone fountain
- White, pink noise generator
- Manufacturer tinnitus apps
- Sleep Sound apps
- Signal generator apps
- Tinnitus Maskers
- Hearing Aids
- Combo masker-hearing aids



MOST IMPORTANT: “what’s your favorite sound?” (Nod to NHCA)  
Masking Sound must be pleasant, or at least not as annoying as tinnitus!!

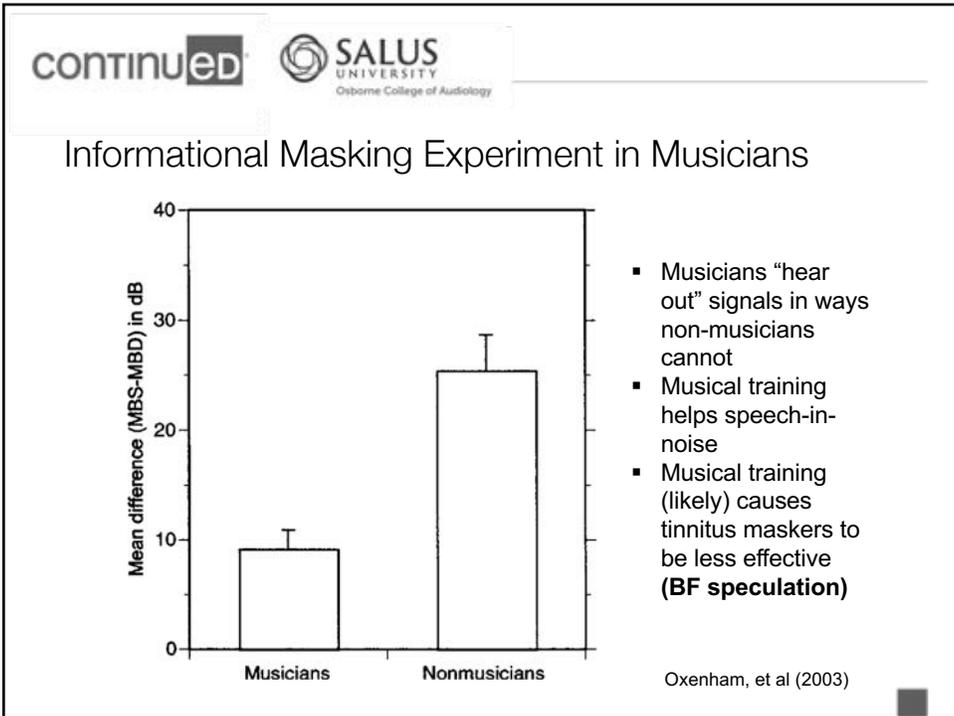
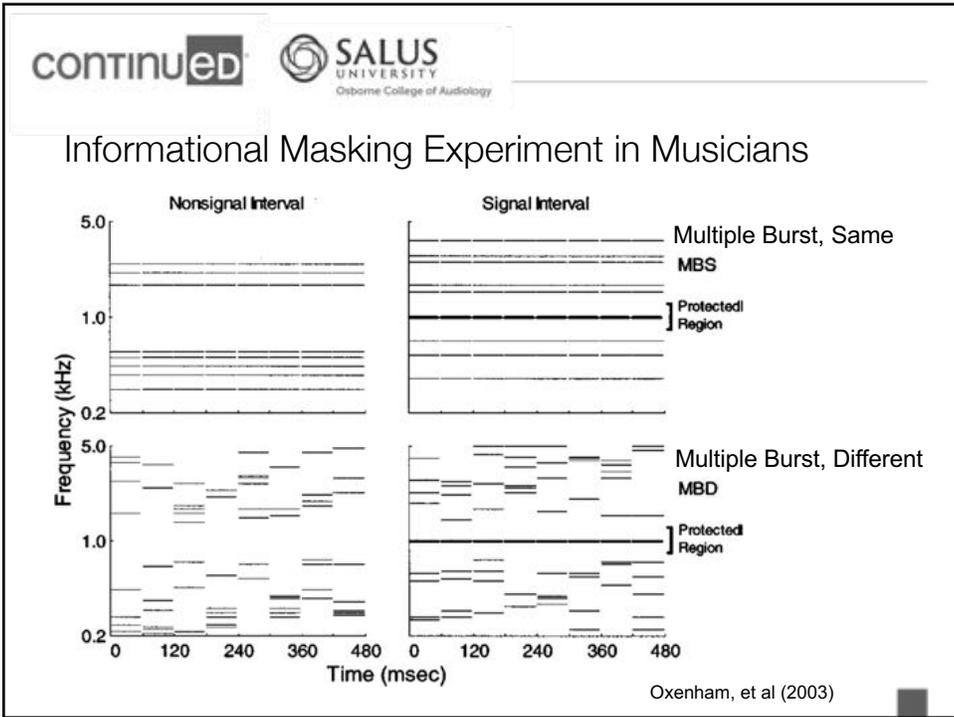



## Can we really mask tinnitus in musicians?

- Informational vs. Energetic masking

Energetic masking occurs when a sufficiently similar and intense masking stimuli prevents peripheral detection or neural encoding of a target stimuli

Informational masking occurs when variations in the masking stimuli, masker-target similarity or subject’s selective attention results in lower perceptual performance than can be explained by peripheral frequency selectivity alone.



## Can we really mask tinnitus in musicians?

- Tinnitus behaves more like an informational masker than an energetic masker: commanding attention away from physical sound (implications for use of tinnitus maskers)
- Musicians are specifically apt at listening through competing stimuli for a target signal. Musicians demonstrate reduced susceptibility to informational masking effects (Oxenham, et al 2003) (implications for counseling)

## Tinnitus Management: Habituation of Reaction

1. It's not their fault...
2. It's not the tinnitus, it's their reaction to it.
3. The tinnitus is neutral: it's like the amplifier turned up and you hear the hum of the circuit noise
4. Enhance environmental sound
5. ENSURE future exposures are less than 100% noise dose (prefer 50%)
6. Connect with a team of providers in complementary fields.

## Can't I Just Take a Pill? Assisting in Reaction to Tinnitus

- Anti-anxiety medications
  - Benzodiazepine; e.g., Clonazepam (Klonopin): Anti-anxiety (and anti-seizure)
- Anti-depression medications
  - Selective serotonin reuptake inhibitors (SSRI); e.g., Fluoxetine (Prozac; Sarafem): anti-depressant and anti-OCD; e.g. Sertraline (Zoloft): anti-anxiety (and anti-depressant/anti-OCD)
  - Careful use in children and teenagers (suicide risk)
- Close medical management by psychiatrist
- Beware “homeopathic” remedies... Quietus and other snake-oil and internet “cure-alls”

## Case Study: Tinnitus

55 year old hobby musician, scheduled to for fitting with musicians earplugs

- Urgent call to come in sooner
- Played a “loud show” Friday night
- Saturday, major family upheaval
- Didn't sleep Saturday, didn't sleep Sunday, didn't sleep Monday (saw him on Tuesday)




Date Completed: 1/20/10

## Case Study: Tinnitus

**Tinnitus Reaction Questionnaire (TRQ)**  
Name: \_\_\_\_\_

This questionnaire is designed to find out what sort of effects tinnitus has had on your lifestyle, general well-being, etc. Some of the effects below may apply to you, some may not. Please answer all questions by circling the number that best reflects how your tinnitus has affected you over the past week.

	Not at all	A little of the time	Some of the time	A good deal of the time	Almost all of the time
1. My tinnitus has made me unhappy.	0	1	2	3	4
2. My tinnitus has made me feel tense.	0	1	2	3	4
3. My tinnitus has made me feel irritable.	0	1	2	3	4
4. My tinnitus has made me feel angry.	0	1	2	3	4
5. My tinnitus has led me to cry.	0	1	2	3	4
6. My tinnitus has led me to avoid quiet situations.	0	1	2	3	4
7. My tinnitus has made me feel less interested in going out.	0	1	2	3	4
8. My tinnitus has made me feel depressed.	0	1	2	3	4
9. My tinnitus has made me feel annoyed.	0	1	2	3	4
10. My tinnitus has made me feel confused.	0	1	2	3	4
11. My tinnitus has "driven me crazy."	0	1	2	3	4
12. My tinnitus has interfered with my enjoyment of life.	0	1	2	3	4
13. My tinnitus has made it hard for me to concentrate.	0	1	2	3	4
14. My tinnitus has made it hard for me to relax.	0	1	2	3	4
15. My tinnitus has made me feel distressed.	0	1	2	3	4
16. My tinnitus has made me feel helpless.	0	1	2	3	4
17. My tinnitus has made me feel frustrated with things.	0	1	2	3	4
18. My tinnitus has interfered with my ability to work.	0	1	2	3	4
19. My tinnitus has led me to despair.	0	1	2	3	4
20. My tinnitus has led me to avoid noisy situations.	0	1	2	3	4
21. My tinnitus has led me to avoid social situations.	0	1	2	3	4
22. My tinnitus has made me feel hopeless about the future.	0	1	2	3	4
23. My tinnitus has interfered with my sleep.	0	1	2	3	4
24. My tinnitus has led me to think about suicide.	0	1	2	3	4
25. My tinnitus has made me feel panicky.	0	1	2	3	4
26. My tinnitus has made me feel tormented.	0	1	2	3	4
<b>Total</b>	0	1	2	3	4

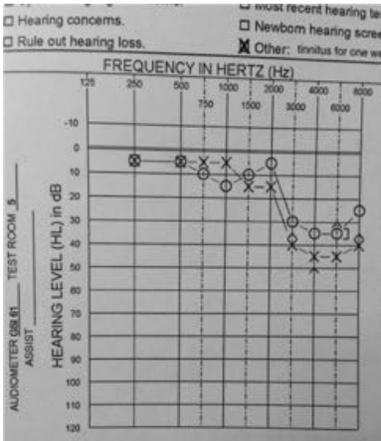
Total = 94  
Wilson et al. 1991




Date: \_\_\_\_\_

## Case Study: Tinnitus

Hearing concerns.       Newborn hearing screen  
 Rule out hearing loss.       Other: tinnitus for one week



	AIR CONDUCTION		BONE CONDUCTION		SOUND FIELD (NOT EAR SPECIFIC)	NC RESPONSE
	UNMASKED	MASKED	UNMASKED	MASKED		
RIGHT	0	△	<	△		↓
LEFT	X	□	>	□		↓
BCS			^		S	↓

**Results**

1 Left-Right, very high score on tinnitus reaction questionnaire, gait/roll, weekly ggg.

SRT (dB HL)	SAT (dB HL)	SPEECH AUDIOMETRY		SPEECH AUDIOMETRY MATERIALS
		WORD RECOGNITION %	THRESHOLD (dB HL)	
R	100	60		SPEECH RECEPTION THRESHOLD (SRT)
L	100	60		SPEECH RECEPTION THRESHOLD (SRT)

TEST METHODS FOR AUDIOGRAM:  Conventional,  Conditioned,  Play,  Visual,  Reinforcement,  Observation,  Behavioral,  Audiology

ACUSTIC IMPEDANCE MEASURES

EARS	EQUV. CANAL VOL. (cc)	PEAK PRESSURE (daPa)	STATIC ADMITTANCE (mmho)	GRADIENT (daPa)
RIGHT	1.8	18	0.5	170
LEFT	1.7	0	0.4	205

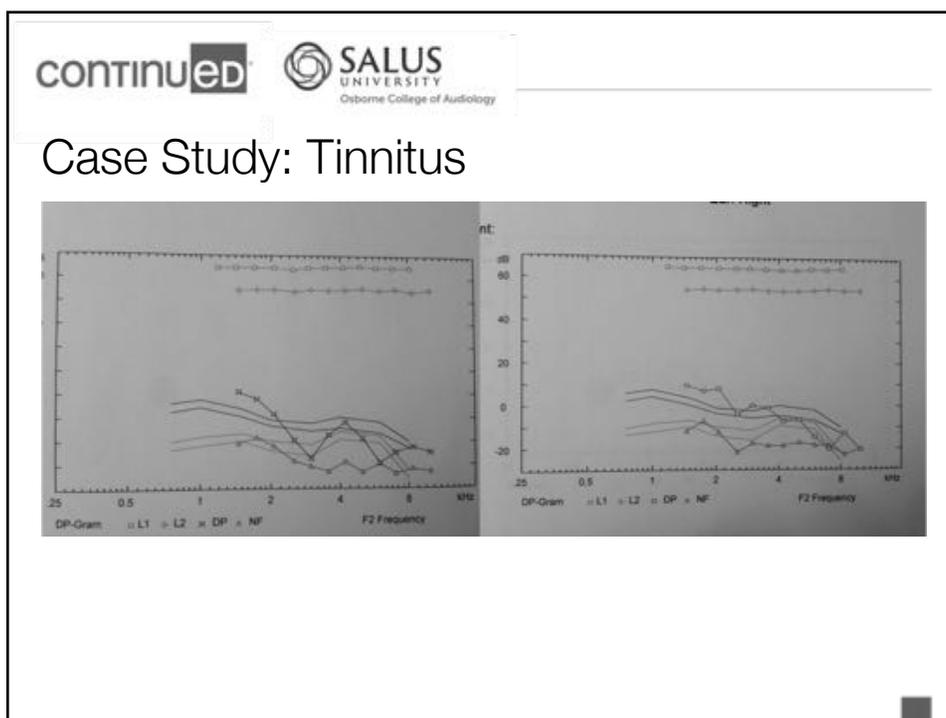
ACUSTIC REFLEX THRESHOLDS (dB HL)

PROBE EAR	STIM EAR (MODE)	500 Hz	1000 Hz	2000 Hz
RIGHT				
LEFT				

RELIABILITY:  Good,  Fair,  Poor

INTERPRETATION OF TYMPANOMETRY:  Normal middle ear measures,  Abnormal middle ear pressure,  Middle ear compliance & with normal pressure,  Noncompliant middle ear.

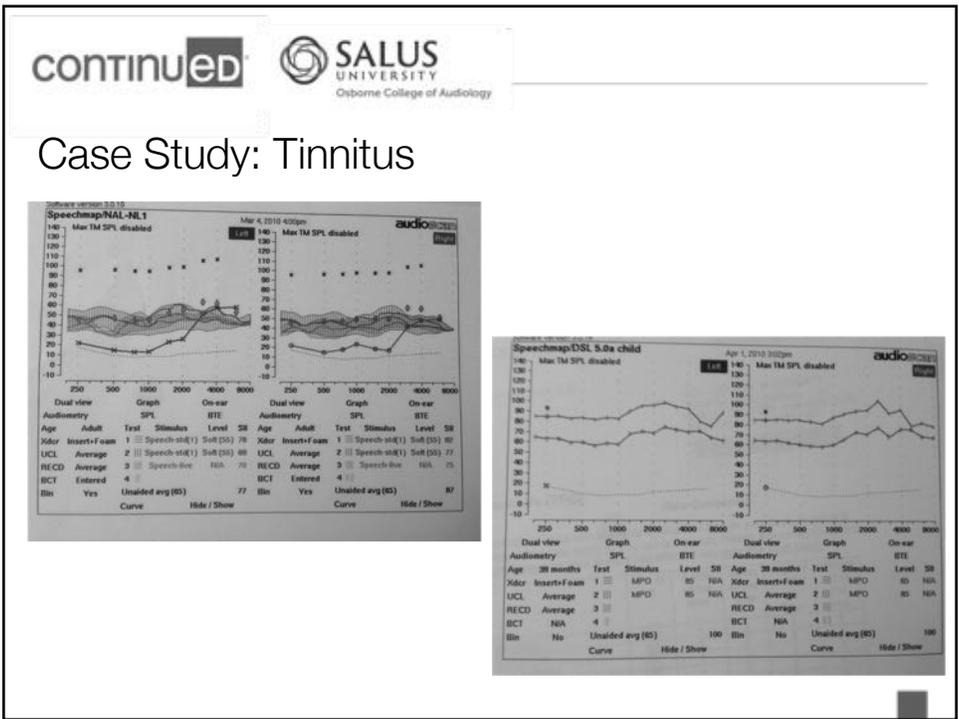
OTHER TEST FINDINGS: Loudness discomfort levels normal 1% @ 8k Hz bilaterally.






## Case Study: Tinnitus

- 55 year old hobby musician, scheduled to for fitting with musicians earplugs
- Intake, TRQ = 94: referred immediately for medical management
  - Sleep, “I can’t live like this for long”
- PCP Rx Prozac (low dose)
- Fitted for musicians earplugs (ER-25s) – performance
- Fitted with combo hearing aid-tinnitus masker devices – non-performance
- PCP referred to a social worker for CBT
- Saw me 1x/wk for 8 weeks for informational counseling on tinnitus



## Case Study: Tinnitus

Osborne College of Audiology

- 55 year old hobby musician
  - HF SNHL
  - Combo tinnitus maskers-hearing aids
  - Prozac, CBT
  - 8 weeks of informational counseling
  - 90-point reduction in TRQ score

**Tinnitus Reaction Questionnaire (TRQ)**

Name: \_\_\_\_\_ Date Completed: *1/2010*

This questionnaire is designed to find out what sort of effects tinnitus has had on your lifestyle, general well-being, etc. Some of the effects below may apply to you, some may not. Please answer **all** questions by circling the number that **best reflects** how your tinnitus has affected you **over the past week**.

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9. My tinnitus has made me feel annoyed.	0	1	2	3	4
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25. My tinnitus has made me feel panicky.	0	1	2	3	4
26. My tinnitus has made me feel tormented.	0	1	2	3	4
<b>Total</b>					

*Σ = 4*      Wilson et al. 19

## Hearing aid settings for musicians

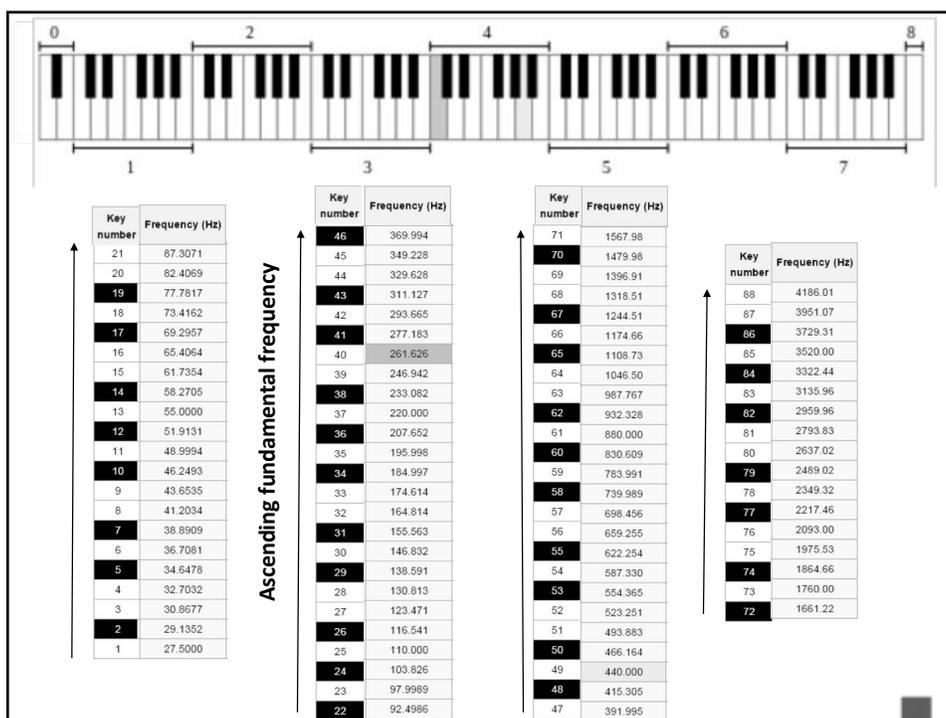
### Music $\neq$ Speech

1. Maximum input (and dynamic range)
2. Crest Factor (Peak – RMS)
3. Spectral structure
4. Time domain envelope
5. “Intent”

## Hearing aid settings for musicians

### Music $\neq$ Speech

1. Maximum input (and dynamic range)
  - Speech = 80 dB (30-40 dB)
  - Music = >100 dB (60-100 dB)
2. Crest Factor (Peak – RMS)
  - Speech = 12 dB Music = 18 dB
3. Spectral structure
  - Fundamental frequency: voice = 82 – 1046 Hz
  - Fundamental frequency:
  - piano = 27.5 – 4186 Hz; violin = 196 – 2637 Hz
  - Speech = Formants; < 8k Hz; Music = Harmonics; >10k Hz



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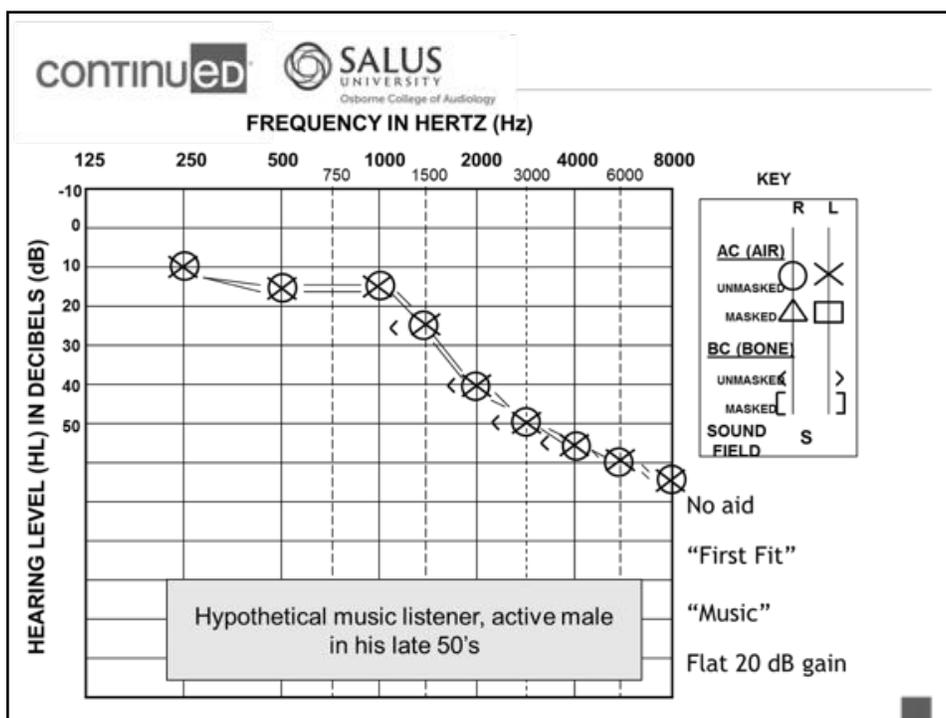
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## Hearing aid settings for musicians

### Music $\neq$ Speech

4. Time domain envelope
  - Rise-time of signal: violin bow vs. piano key strike vs. drums
  - As opposed to voice-onset time
5. "Intent"
  - Communication of emotion, not content

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## Hearing aid selection

- Peak input limiting: 94 dB SPL vs. 104-112 dB SPL
- Ability to turn off processing (non-linear signal processing, noise reduction, feedback management, frequency compression)
- Omni-directional microphones (not directional)
- "Fake it" into thinking single channel?
- Option of patient to perform self-tuning

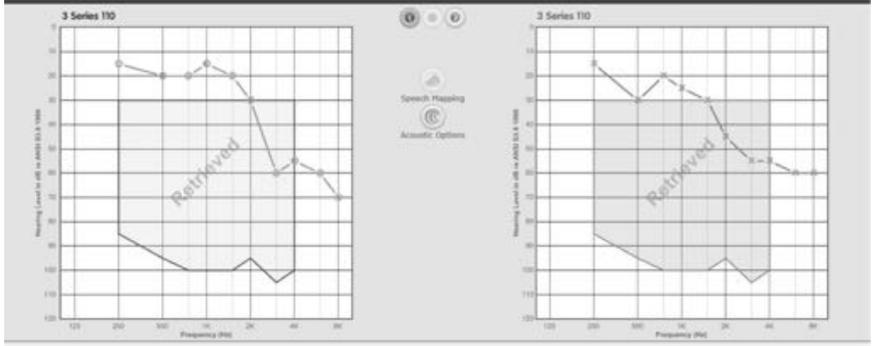
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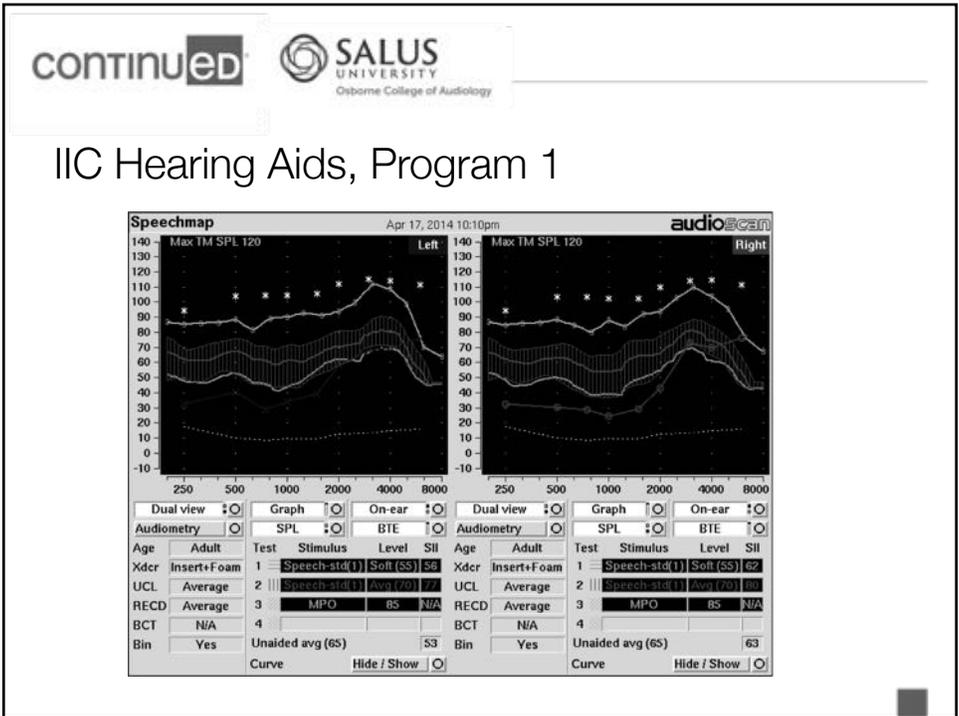
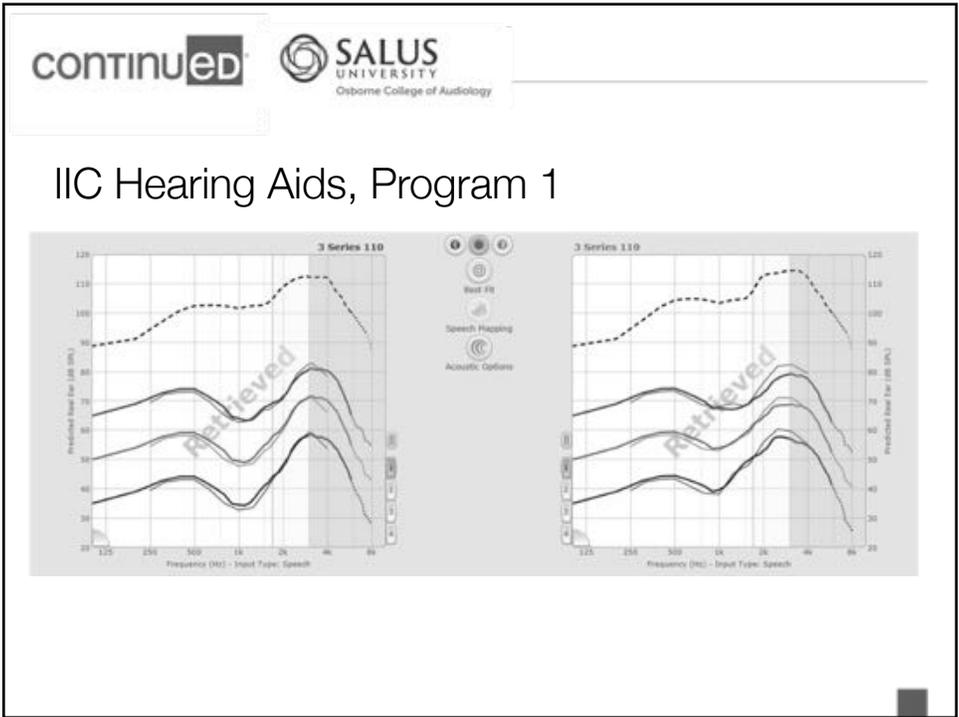
## Case Study: 55 Year Old Attorney, Music Fan

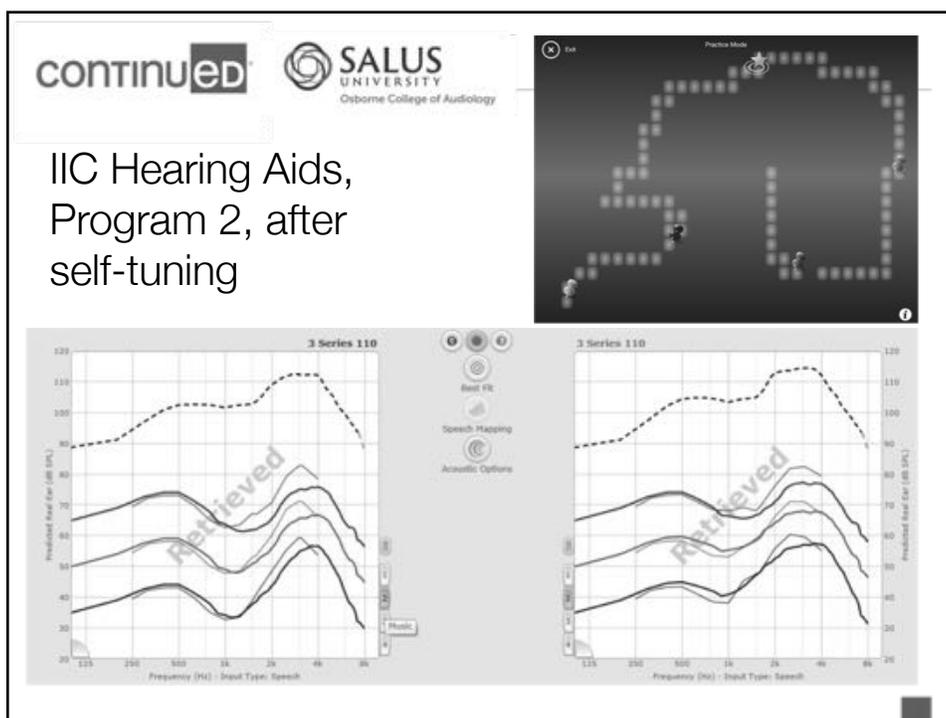
- Huge music fan (esp live music)
- Progressive SNHL of known genetic origin
- Fitted with electronic earplugs 3 years ago
- Fitting with IIC hearing aids March 2014; known peak input limit was ~107 dB SPL

**CONTINUED** 

## Case Study: 55 Year Old Attorney, Music Fan







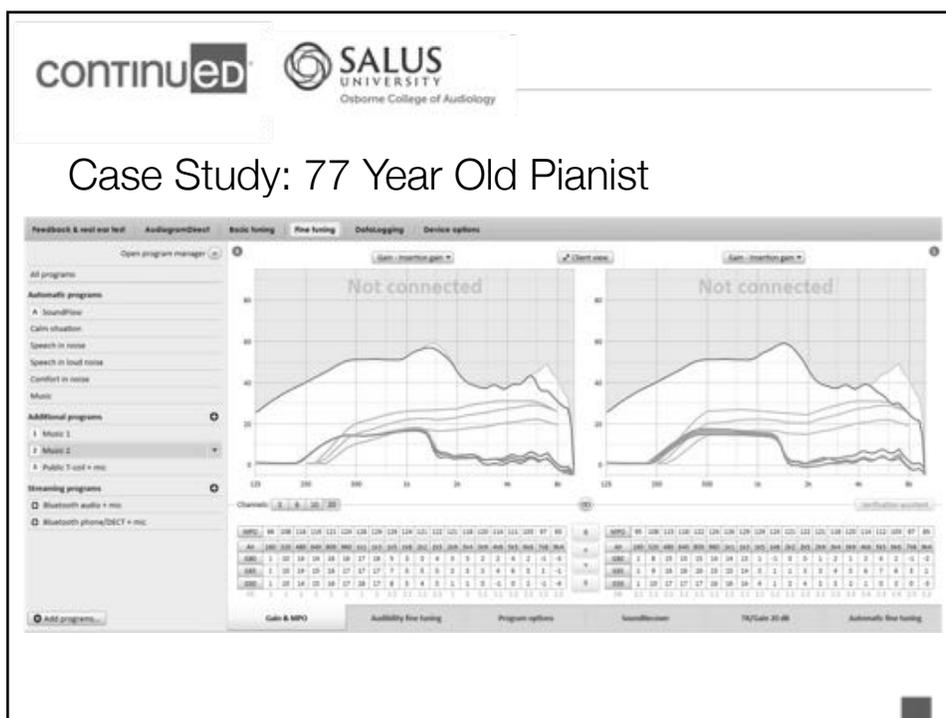



Case Study: 55 Year Old Attorney,  
Music Fan

- “Loves” his music program!
- Initial fitting not totally satisfactory with all other programs
- At 1st follow-up, “tweaked” P1 to reduce frequency compression, changed out another speech-in-noise program for comfort-in-noise
- At 2nd follow-up visit, reported extreme satisfaction with speech intelligibility (in quiet and noise) and with music listening!







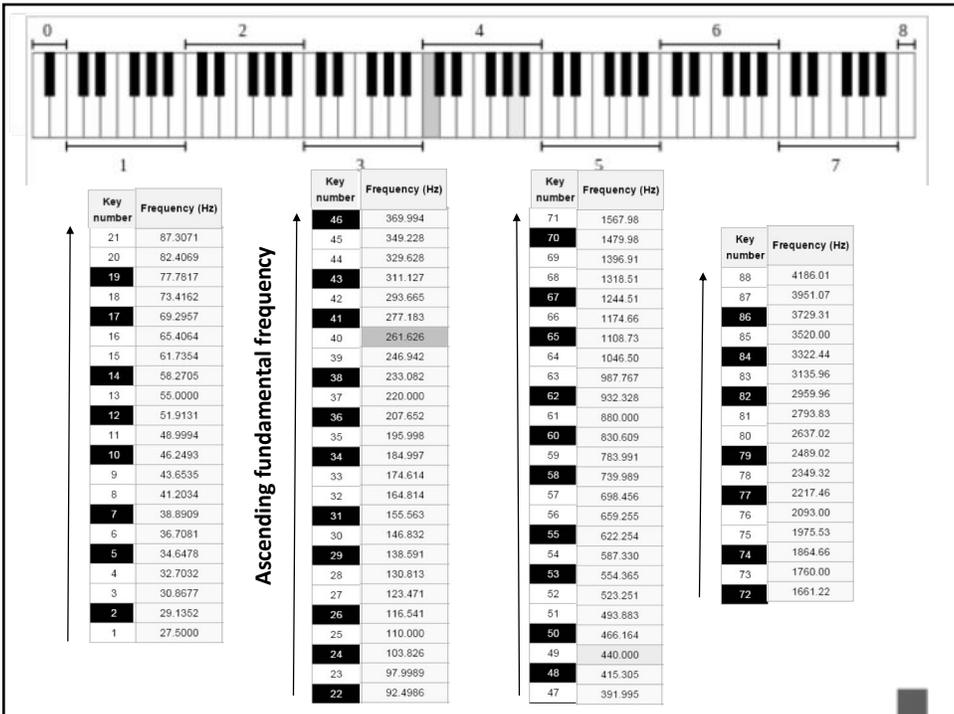
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## Case Study: 77 Year Old Pianist

- Not happy with either music program, takes aids out during piano use and listening to home stereo system
- Really likes using t-coil setting for symphony attendance (induction-looped hall)
- Speech intelligibility markedly better than with previous, right-only basic-technology hearing aid
- Doesn't use remote microphone very often at all
- Spectral structure and time domain envelope problems?
  - Explored new options... in-ear monitor rigged to be a "master" hearing aid

### Alternatives to Hearing Aids for Musicians

- Hearing aid frequency response: low-frequency roll-off ~150 – 200 Hz (?); high-frequency roll-off 6k – 10k Hz (?)
- Processing (noise-reduction, feedback management, dynamic range compression, frequency compression) – can all of these be truly turned off?
- Multiple channels vs. single channel?
- Level-dependent electronic earplugs
- In-ear monitors outfitted as a “master” hearing aid



## Alternatives to Hearing Aids for Musicians

- Level-dependent electronic earplugs; Bean QSA



- In-ear monitors outfitted as a “master” hearing aid:  
Sensaphonics 3D Active Ambient Music Enhancement

- 142 dB SPL peak input limit
- Personal analog mixer to EQ, amplify, and limit output



## Summary: Hearing Aids for Musicians

- Hearing aid technology has focused on improving speech intelligibility
  - Non-linear signal processing/wide-dynamic range compression, multiple channels, noise reduction, feedback management, directional microphones
- Chasin and others have recommended linear hearing aids (compression ratio 1:1), single-channel, low-frequency emphasis, very high peak input limiting
- Successful fitting for music perception challenged by patient's individual hearing loss and other auditory challenges (tinnitus, hyperacusis, diplacusis)

## Summary: Hearing Aids for Musicians

- Musicians and audio engineers like to tinker with sound and technology that manipulates sound: hearing aids are of the same ilk
- Fit devices for music program with omni-directional microphone setting, linear flat-frequency response as a first-fitting with musician “tweaking” from there; turn off feedback management and noise reduction
- Provide access to intelligible speech, and know when to “give up” on hearing aids for music, consider alternative options