Bring Music To Life:

Programming Music with Genesis AI

Keeley Layfield, Au.D. Education and Training Audiologist

Starkey

Hear better. Live better.

Webinar FAQs

Bring Music to Life: Programming Music with Genesis AI

Keeley Layfield, Au.D.

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- Click Q & A, type your question, and Send

Resources Tab:

- Download the course handout
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- After the webinar, go to your Pending Courses and pass the multiple-choice exam

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- Call 866-782-9924
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Learning Outcomes

1

Describe the different frequency responses associated with common musical instruments

2

Discuss how additive compression is being used by Starkey in our music processing

3

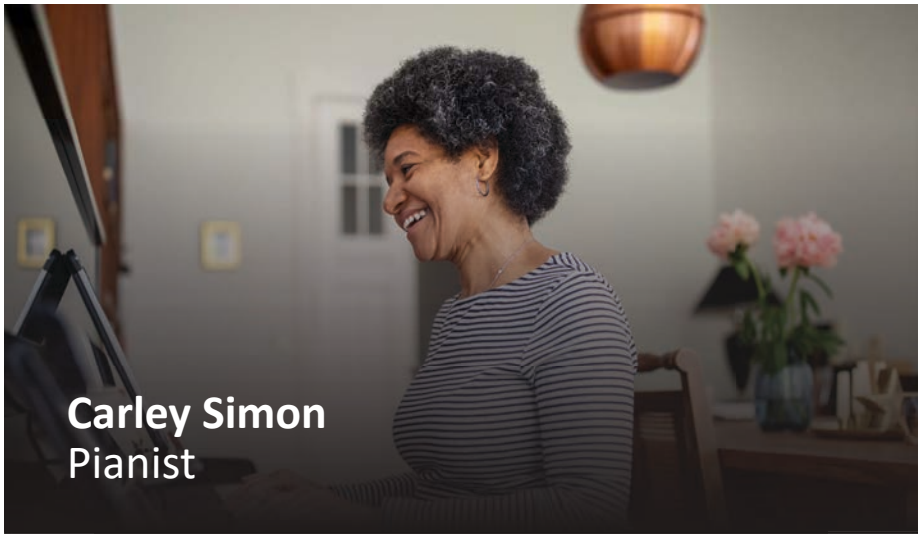
Discuss how streaming can be controlled via the My Starkey app

Two Case Studies

A. Will examine programming of the hearing aids for their perspective music listening habits

B. Will examine troubleshooting specific patient complaints

C. Will discuss different office configurations for music programming

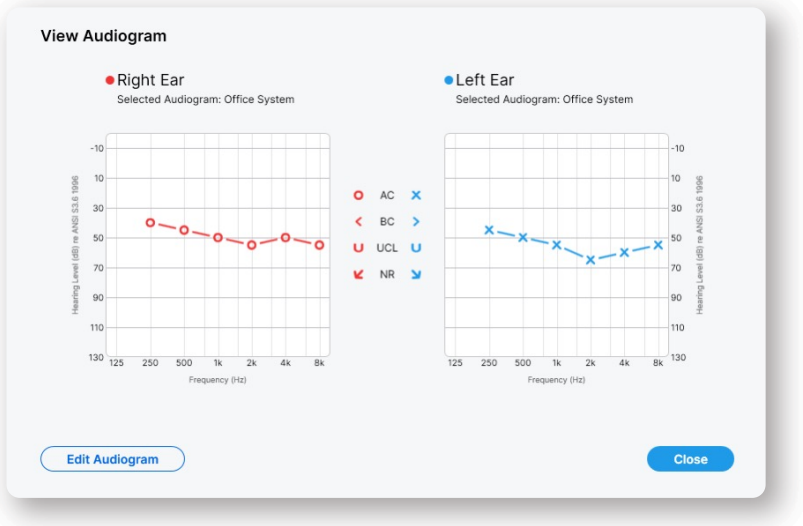


Carley Simon

54 Pianist

Teaches piano for a living

Enjoys going to the local jazz bar to listen to live music

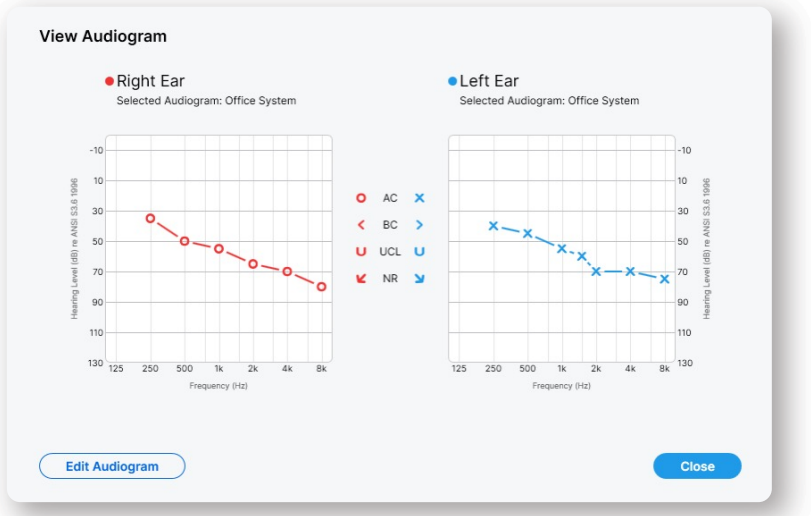


Devin Shelton

38 Vocalist

Performs in a local choir

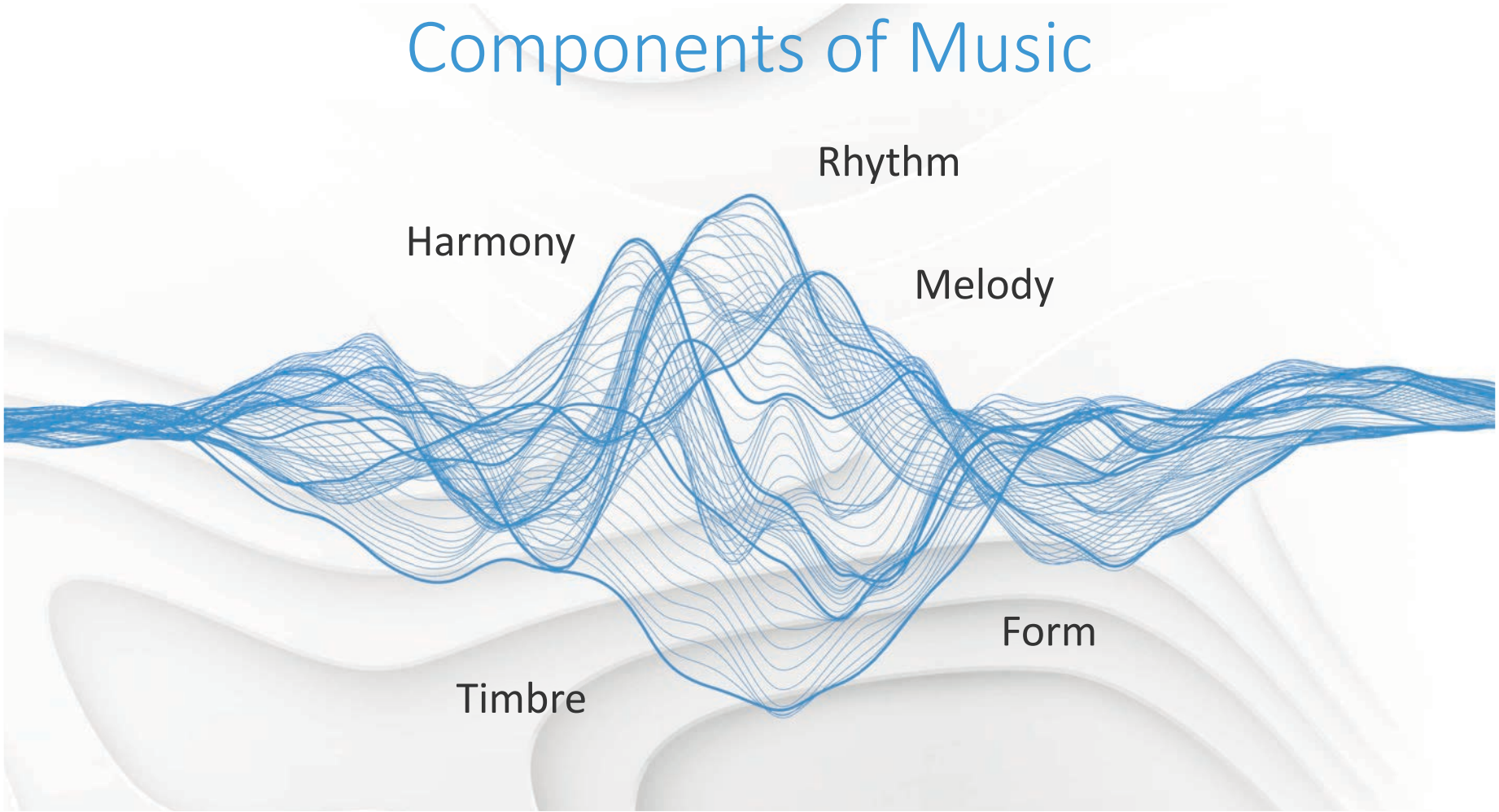
Sings for fun at local events



“Music is the universal language of mankind”

-Henry Wadsworth Longfellow

Components of Music



Components of Music

All of these layered together build music!

Music Terminology

Tone
a steady periodic sound

Interval
the distance of two single tones

Octave
when the interval between the frequencies of two tones is 1:2

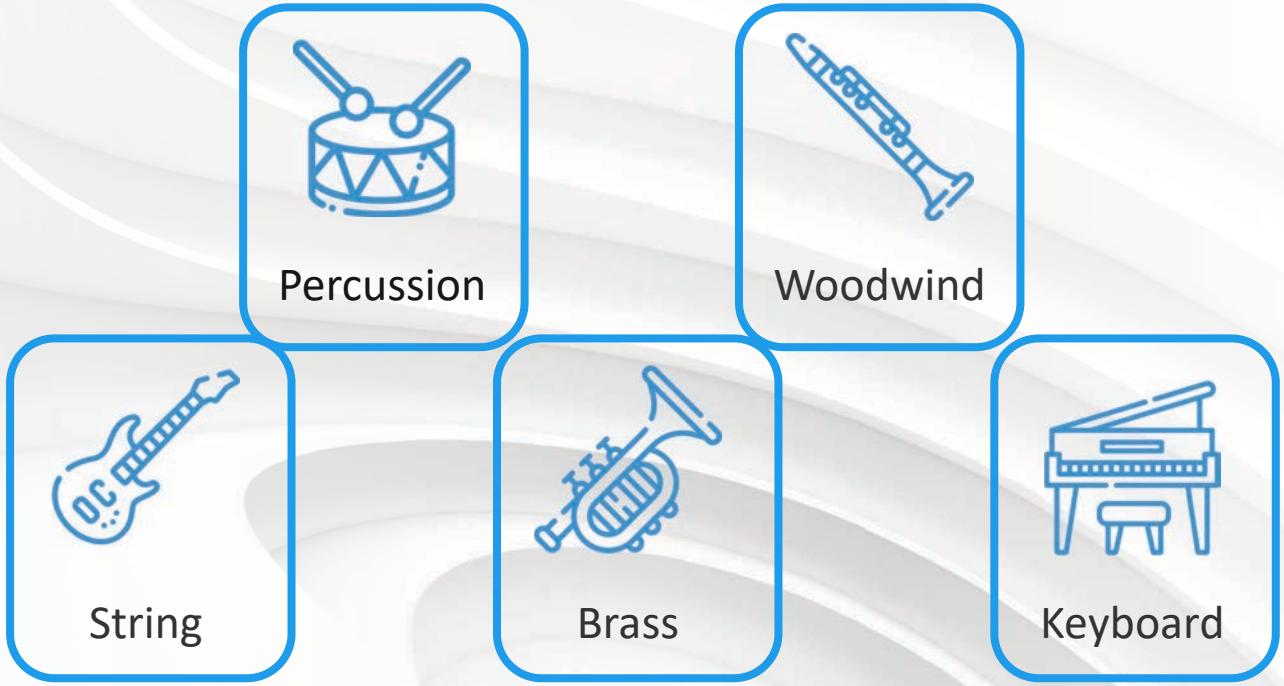
Music Terminology

Bass
sounds that are lower in frequency

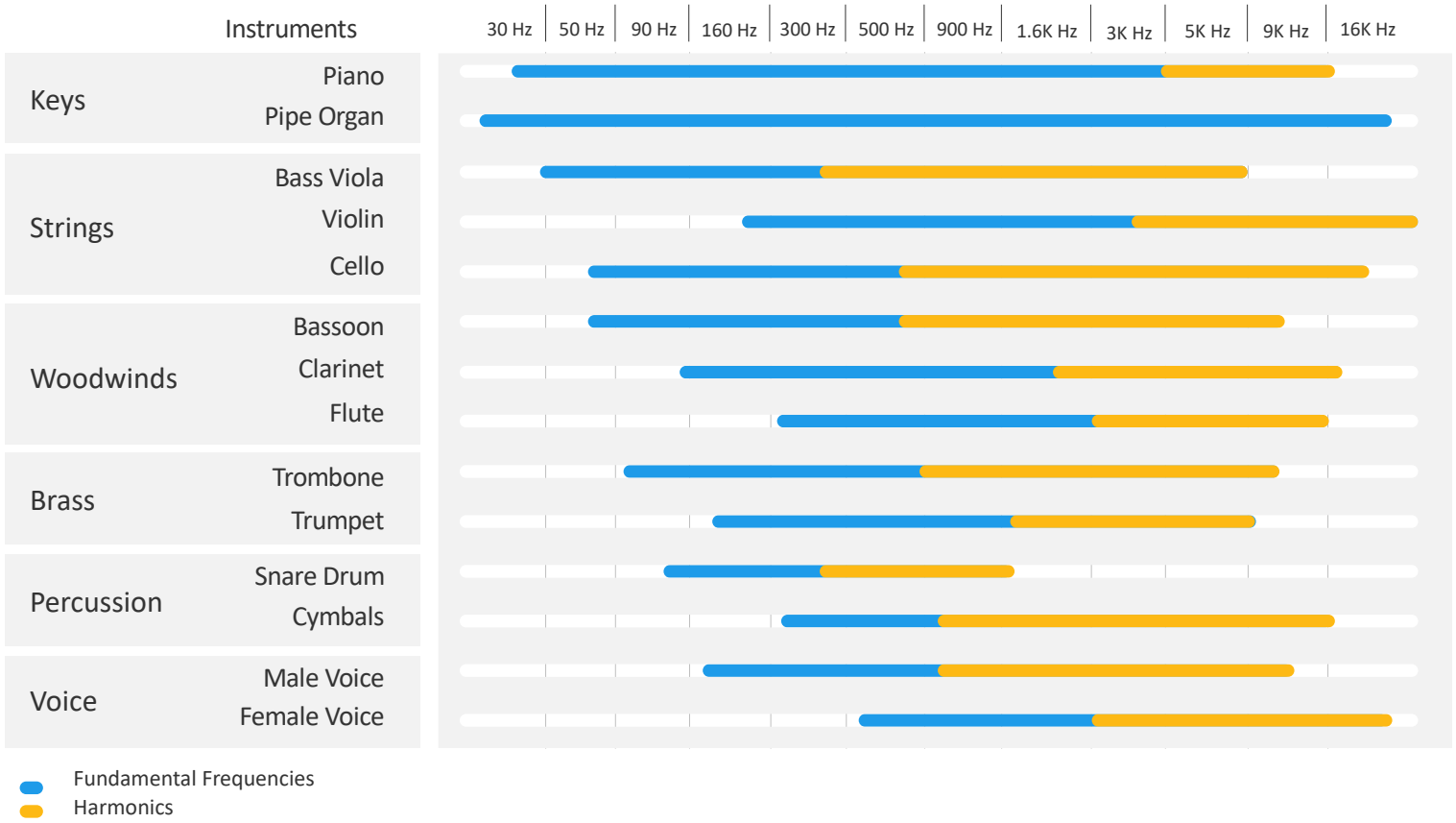
Tenor
range of notes between the alto and bass

Alto
the second highest part in a 4-part voice; higher than the tenor

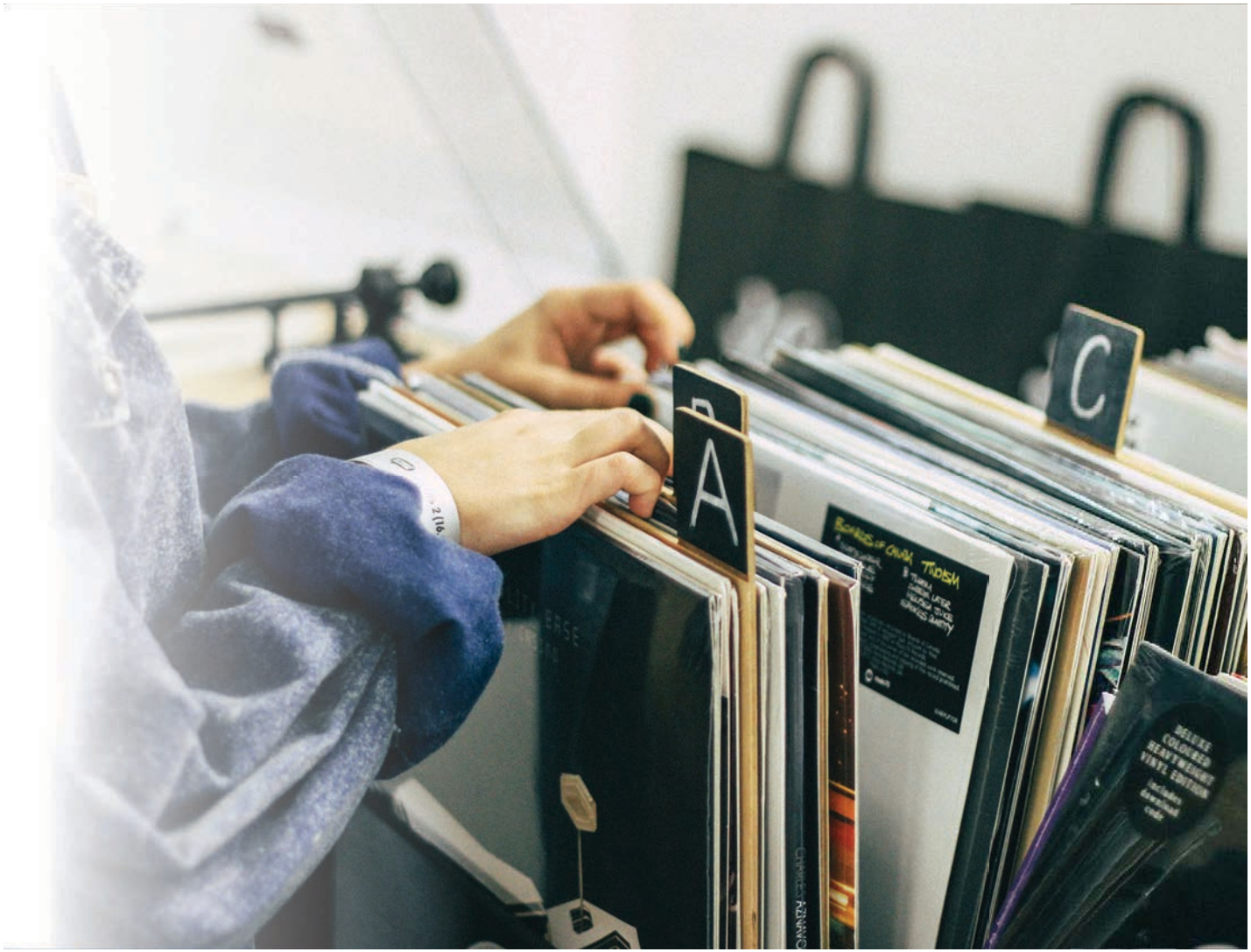
Types of Music Instruments



Music Frequency Chart

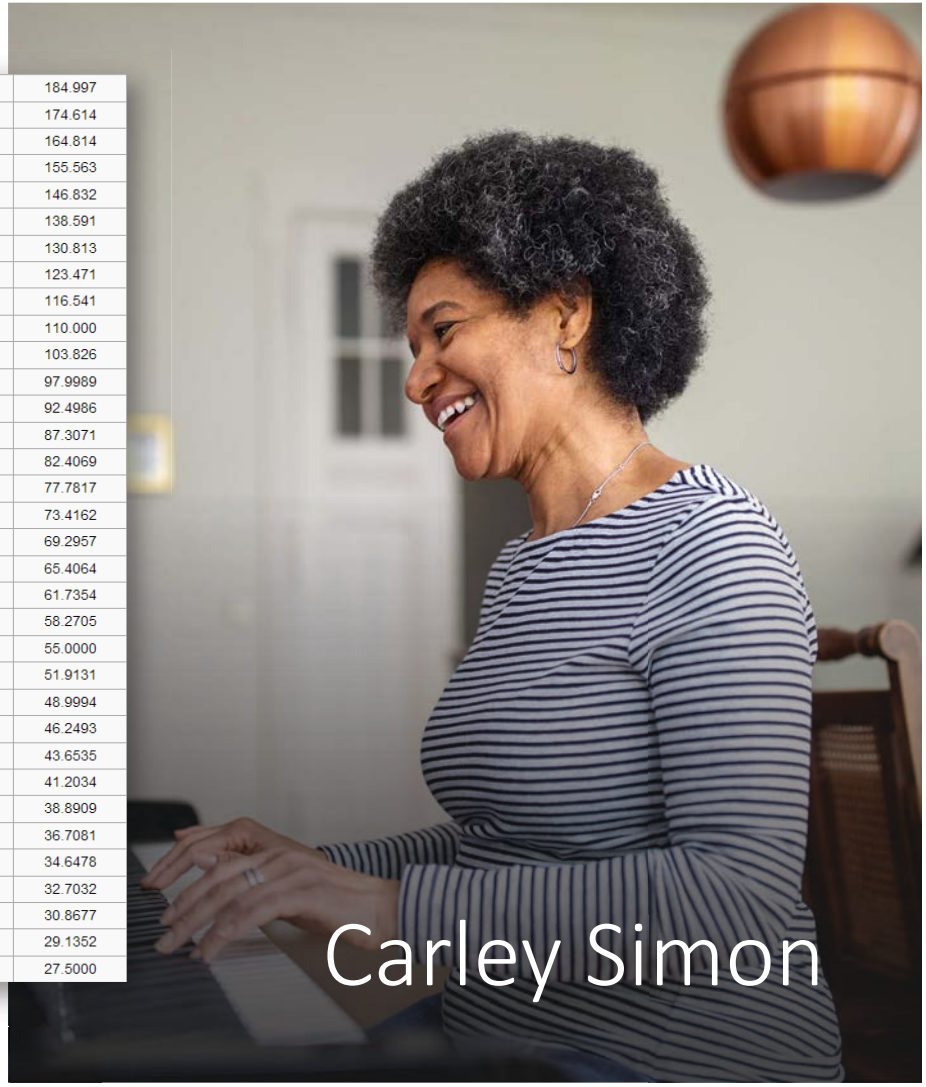


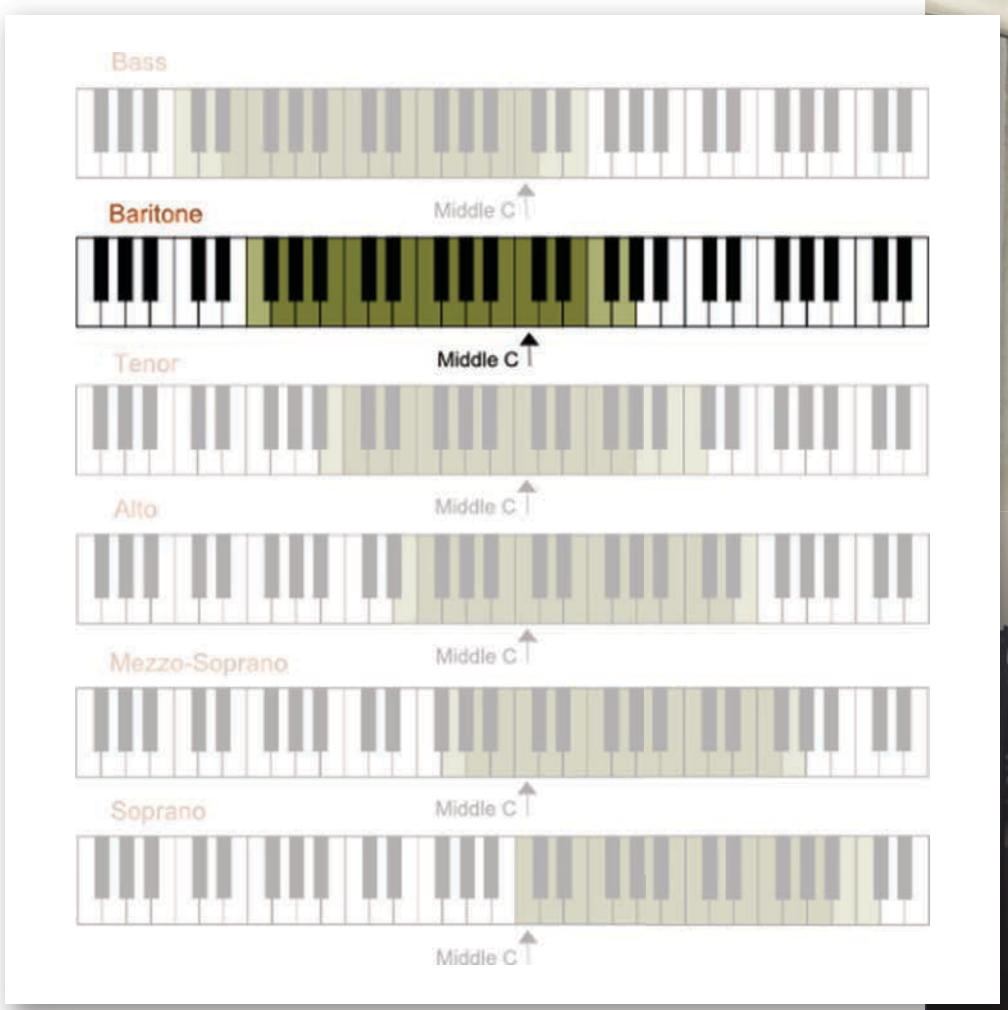
Musical Genres

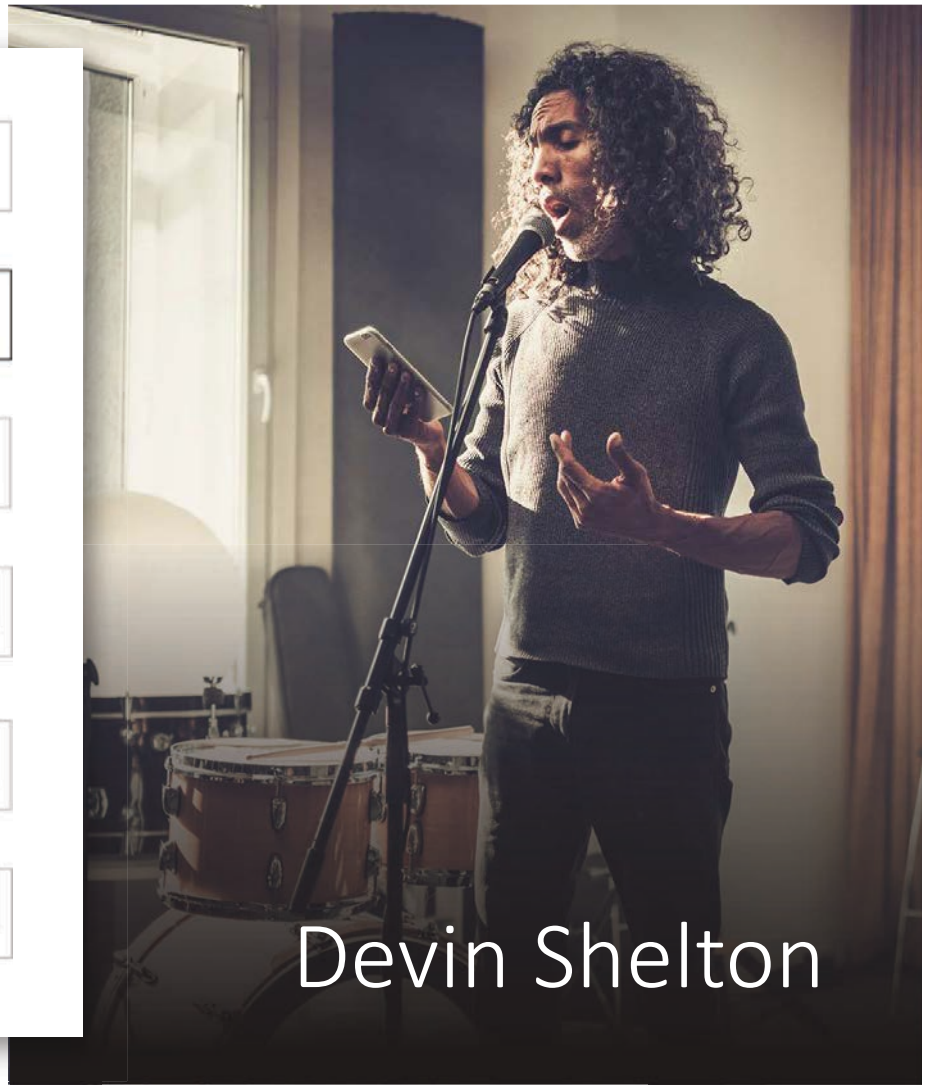


65	c♯‴/d♭‴	C♯6/D♭6	1108.73
64	c‴ 3-line octave	C6 Soprano C (High C)	1046.50
63	b″	B5	987.767
62	a♯″/b♭″	A♯5/B♭5	932.328
61	a″	A5	880.000
60	g♯″/a♭″	G♯5/A♭5	830.609
59	g″	G5	783.991
58	f♯″/g♭″	F♯5/G♭5	739.989
57	f″	F5	698.456
56	e″	E5	659.255
55	d♯″/e♭″	D♯5/E♭5	622.254
54	d″	D5	587.330
53	c♯″/d♭″	C♯5/D♭5	554.365
52	c″ 2-line octave	C5 Tenor C	523.251
51	b′	B4	493.883
50	a♯′/b♭′	A♯4/B♭4	466.164
49	a′	A4 A440	440.000
48	g♯′/a♭′	G♯4/A♭4	415.305
47	g′	G4	391.995
46	f♯′/g♭′	F♯4/G♭4	369.994
45	f′	F4	349.228
44	e′	E4	329.628
43	d♯′/e♭′	D♯4/E♭4	311.127
42	d′	D4	293.665
41	c♯′/d♭′	C♯4/D♭4	277.183
40	c′ 1-line octave	C4 Middle C	261.626
39	b	B3	246.942
38	a♯/b♭	A♯3/B♭3	233.082
37	a	A3	220.000
36	g♯/a♭	G♯3/A♭3	207.652
35	g	G3	195.998

34	f♯/g♭	F♯3/G♭3	184.997
33	f	F3	174.614
32	e	E3	164.814
31	d♯/e♭	D♯3/E♭3	155.563
30	d	D3	146.832
29	c♯/d♭	C♯3/D♭3	138.591
28	c small octave	C3 Low C	130.813
27	B	B2	123.471
26	A♯/B♭	A♯2/B♭2	116.541
25	A	A2	110.000
24	G♯/A♭	G♯2/A♭2	103.826
23	G	G2	97.9989
22	F♯/G♭	F♯2/G♭2	92.4986
21	F	F2	87.3071
20	E	E2	82.4069
19	D♯/E♭	D♯2/E♭2	77.7817
18	D	D2	73.4162
17	C♯/D♭	C♯2/D♭2	69.2957
16	C great octave	C2 Deep C	65.4064
15	B,	B1	61.7354
14	A♯,/B♭,	A♯1/B♭1	58.2705
13	A,	A1	55.0000
12	G♯,/A♭,	G♯1/A♭1	51.9131
11	G,	G1	48.9994
10	F♯,/G♭,	F♯1/G♭1	46.2493
9	F,	F1	43.6535
8	E,	E1	41.2034
7	D♯,/E♭,	D♯1/E♭1	38.8909
6	D,	D1	36.7081
5	C♯,/D♭,	C♯1/D♭1	34.6478
4	C, contra-octave	C1 Pedal C	32.7032
3	B,,	B0	30.8677
2	A♯,,/B♭,,	A♯0/B♭0	29.1352
1	A,, sub-contra-octave	A0 Double Pedal A	27.5000




Bass
Baritone
Middle C
Middle C
Tenor
Middle C
Alto
Middle C
Mezzo-Soprano
Middle C
Soprano
Middle C
Middle C


Devin Shelton

Professional Musicians

Hearing loss is very common amongst professional musicians

There is a **higher occurrence of hearing loss in rock musicians** versus classical musicians

---

Classical musicians tend to have more asymmetric hearing loss configurations than their rock musician counterparts

MUSIC CHARACTERISTICS THAT DIFFER BY GENRE:

Frequency ranges

Intensity of the instruments

AVERAGE EXPOSURE

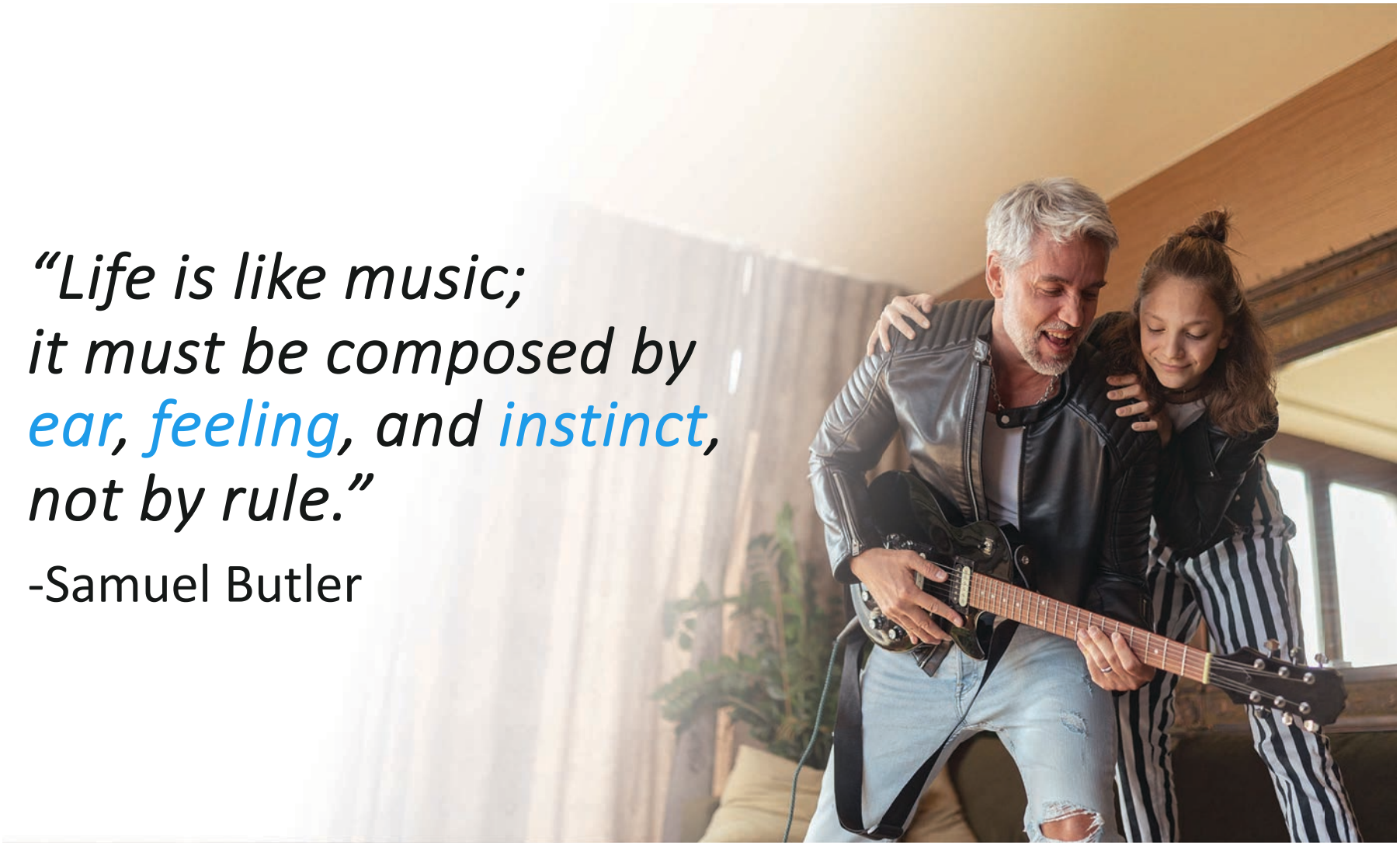
103 dB for rock

94 dB in classical

Di Stadio A, Dipietro L, Ricci G, et al. Hearing Loss, Tinnitus, Hyperacusis, and Diplacusis in Professional Musicians: A Systematic Review. *International Journal of Environmental Research and Public Health*. 2018; 15(10):2120. https://doi.org/10.3390/ijerph15102120

“Life is like music;
it must be composed by
ear, feeling, and instinct,
not by rule.”

-Samuel Butler



Music in Sound Processing

Enhanced Speech Perception in Noise and Cortical Auditory Evoked Potentials in Professional Musicians

Participants Ages 22-59

Hearing Thresholds < 20dB 250-2000 Hz

Hearing Thresholds < 45dB 3000-8000 Hz

Testing included:

Audiometric evaluations between 250-8000 Hz

Tympanograms

Ipsi and Contra Reflexes

DPOAEs

Pitch Discrimination

Gaps-in-Noise

Sinusoidal amplitude modulation

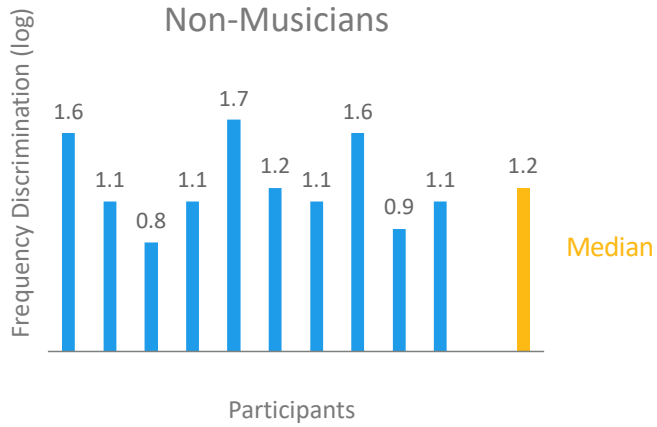
LiSN-S

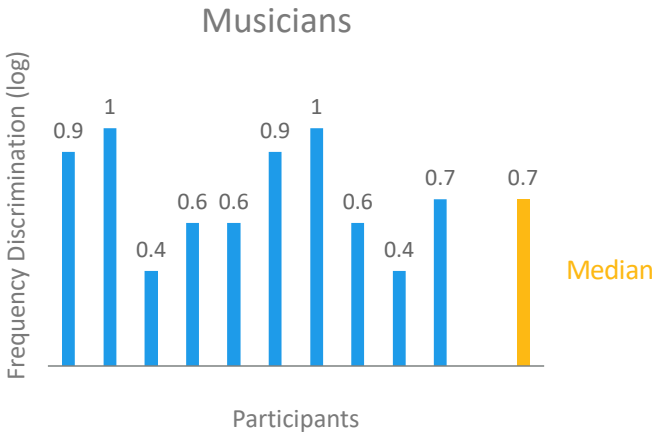
Music in Sound Processing

The smallest differences in frequency between two stimuli to still be distinguished as separate pitches

Duration of 200 ms with an onset/offset ramp of 10 ms

Responses collected on the Apex 3 software





K. Meha-Bettison, M. Sharma, R.K. Ibrahim, P.R.M. Vasuki. "*Enhanced speech perception in noise and cortical auditory evoked potentials in professional musicians*"
Int J Audiol, 57 (2018), pp. 40-52

Music in Sound Processing

Four LiSN-S Testing Conditions:

A. Different voices at ±90 *(high-cue SRT)*
B. The same voice at ±90
C. Different voices at 0
D. The same voice at 0 *(low-cue SRT)*

K. Meha-Bettison, M. Sharma, R.K. Ibrahim, P.R.M. Vasuki. "*Enhanced speech perception in noise and cortical auditory evoked potentials in professional musicians*"
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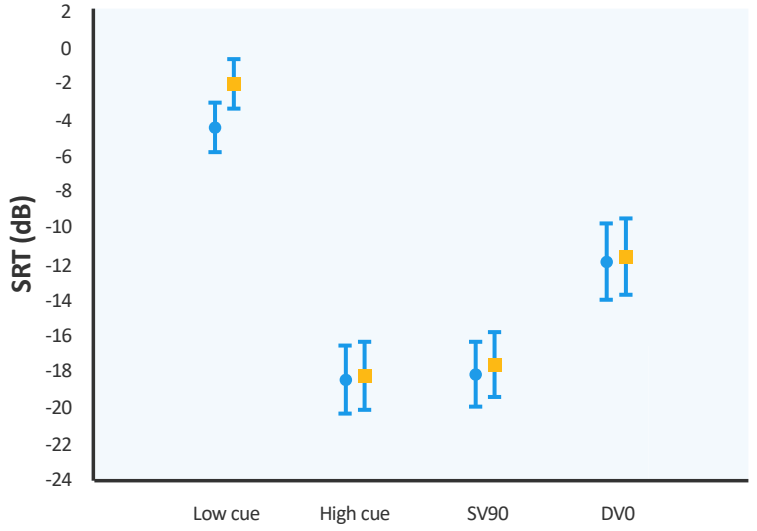
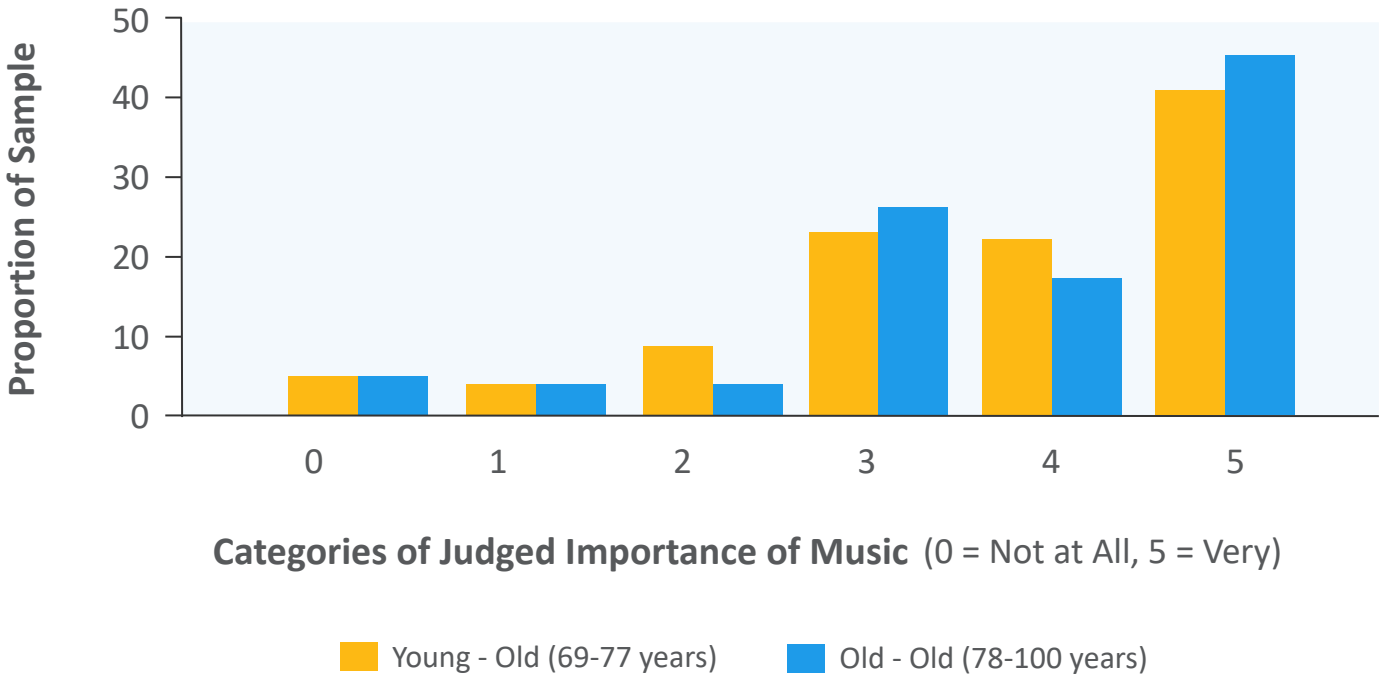
Enhanced Speech Perception in Noise and CAEPs in Musicians

Vertical bars denote 0.95 confidence intervals



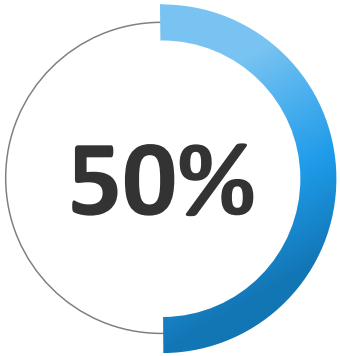
Age: 45.85
3-6kHz average: 14.04

Music is Important

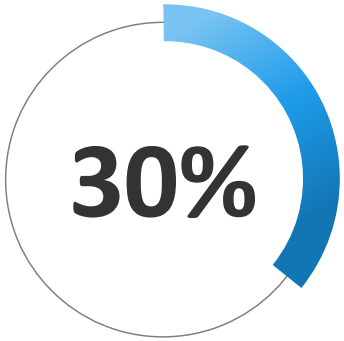


Cohen, Annabel, et al. "The Importance of Music to Seniors." *Psychomusicology: A Journal of Research in Music Cognition*, vol. 18, no. 1-2, 2002, pp. 89–102., https://doi.org/10.1037/h0094049.

Impact of Hearing Loss



Listened to music daily



Reported hearing loss impacts the enjoyment of music

Too Loud / Soft

Melody Recognition

Understanding Lyrics

Volume Changes

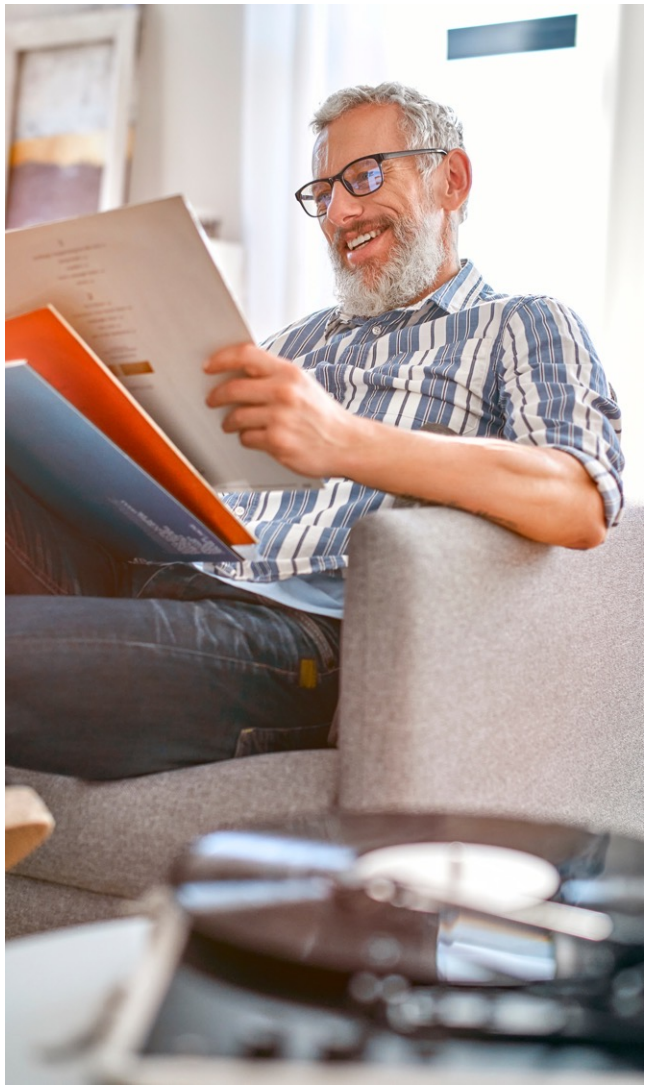
Leek, Marjorie R., et al. “Enjoyment of Music by Elderly Hearing-Impaired Listeners.” *Journal of the American Academy of Audiology*, vol. 19, no. 06, 2008, pp. 519–526., https://doi.org/10.3766/jaaa.19.6.7.

Impact of Hearing Loss

The more severe the hearing loss,
the worse the music appreciation scores

There are few differences between mild and moderate hearing loss in terms of music appreciation

The more severe the hearing loss,
the greater the preference for lower pitched instruments



Looi, Valerie, et al. “Music Appreciation of Adult Hearing Aid Users and the Impact of Different Levels of Hearing Loss.” *Ear & Hearing*, vol. 40, no. 3, 2019, pp. 529–544., https://doi.org/10.1097/aud.0000000000000632.

We know…

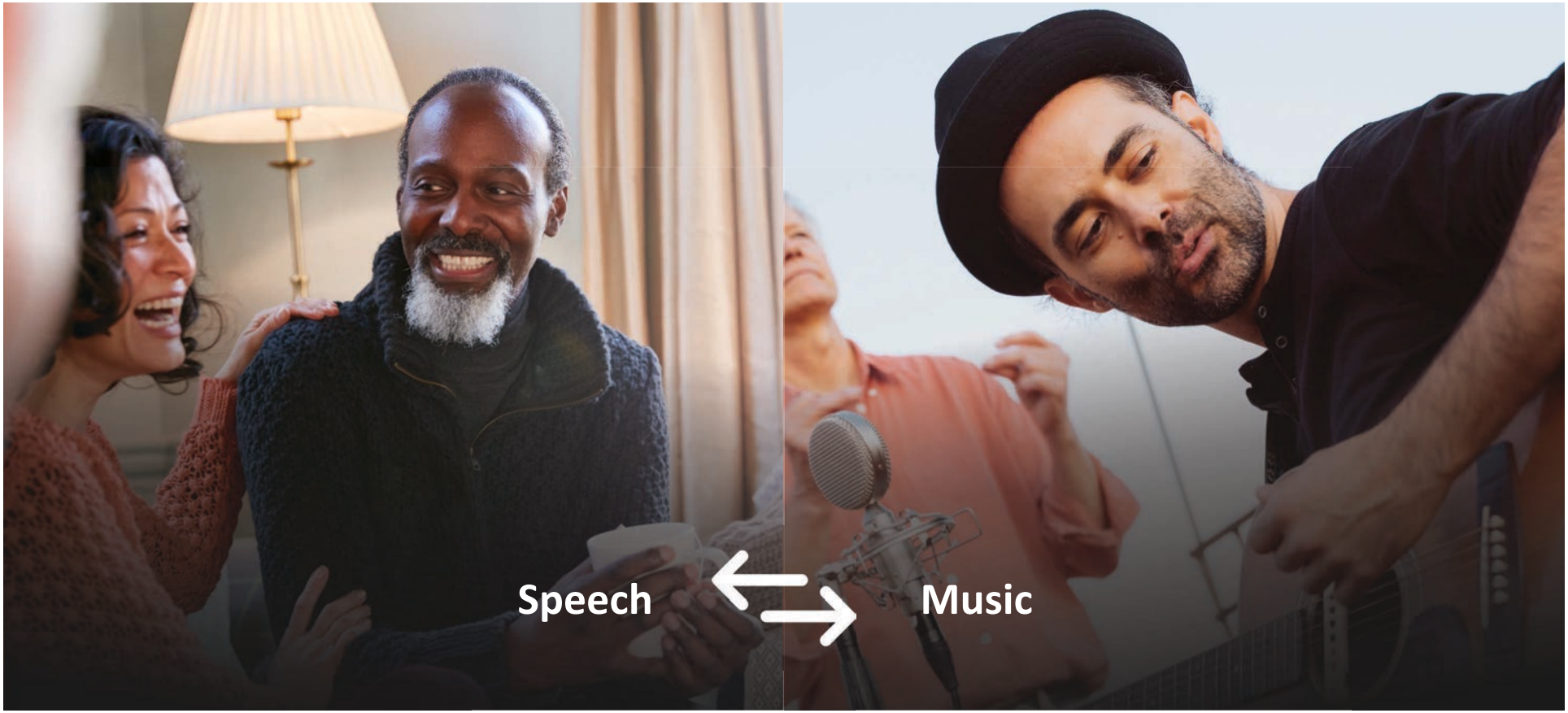
Music is important to many people

Hearing loss impacts enjoyment of music

Music and speech signals are different

Traditional fittings haven’t been satisfactory

Signal of Interest



Speech vs. Music

Speech

65 dB SPL on average with peaks and valleys about ± 12-15 dB

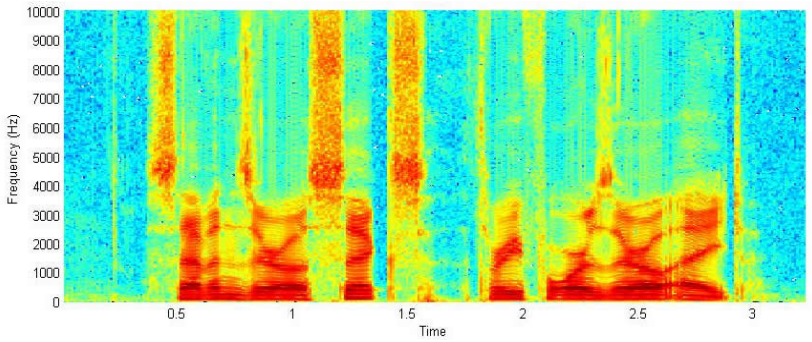
Often not greater than 90 dB

Music

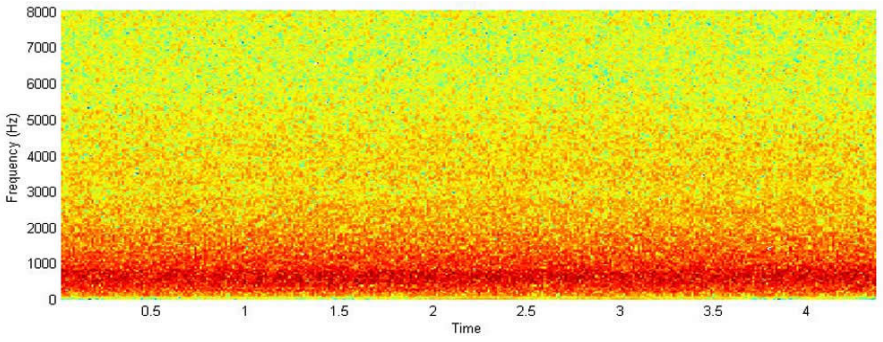
Can range from 20-30 dB SPL up to 120 dB SPL

Can hit a player's ear between 85-100 dB SPL

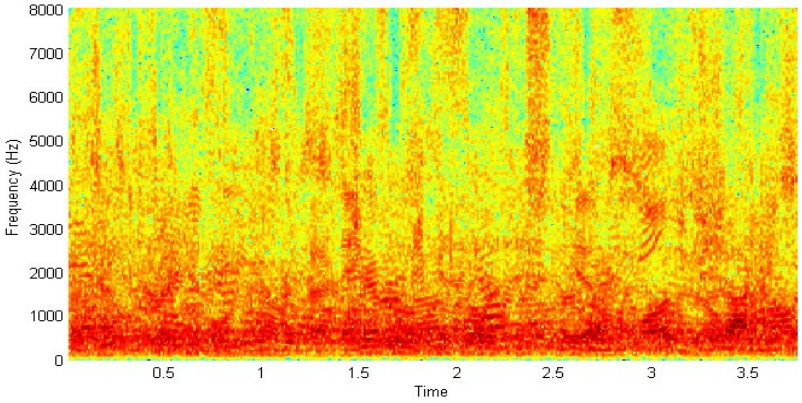
Speech



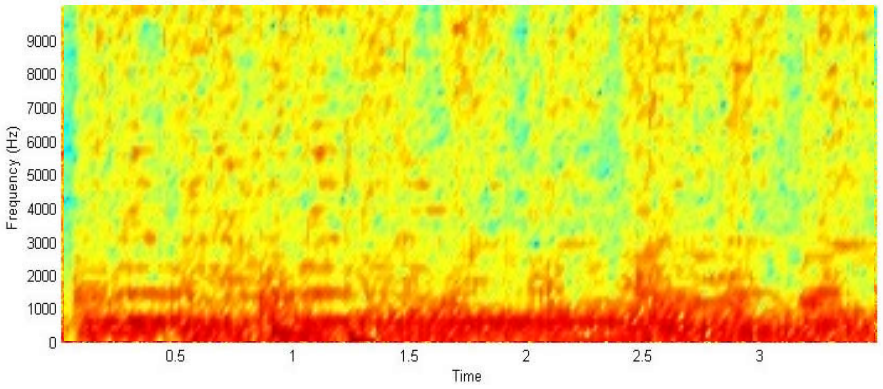
Noise

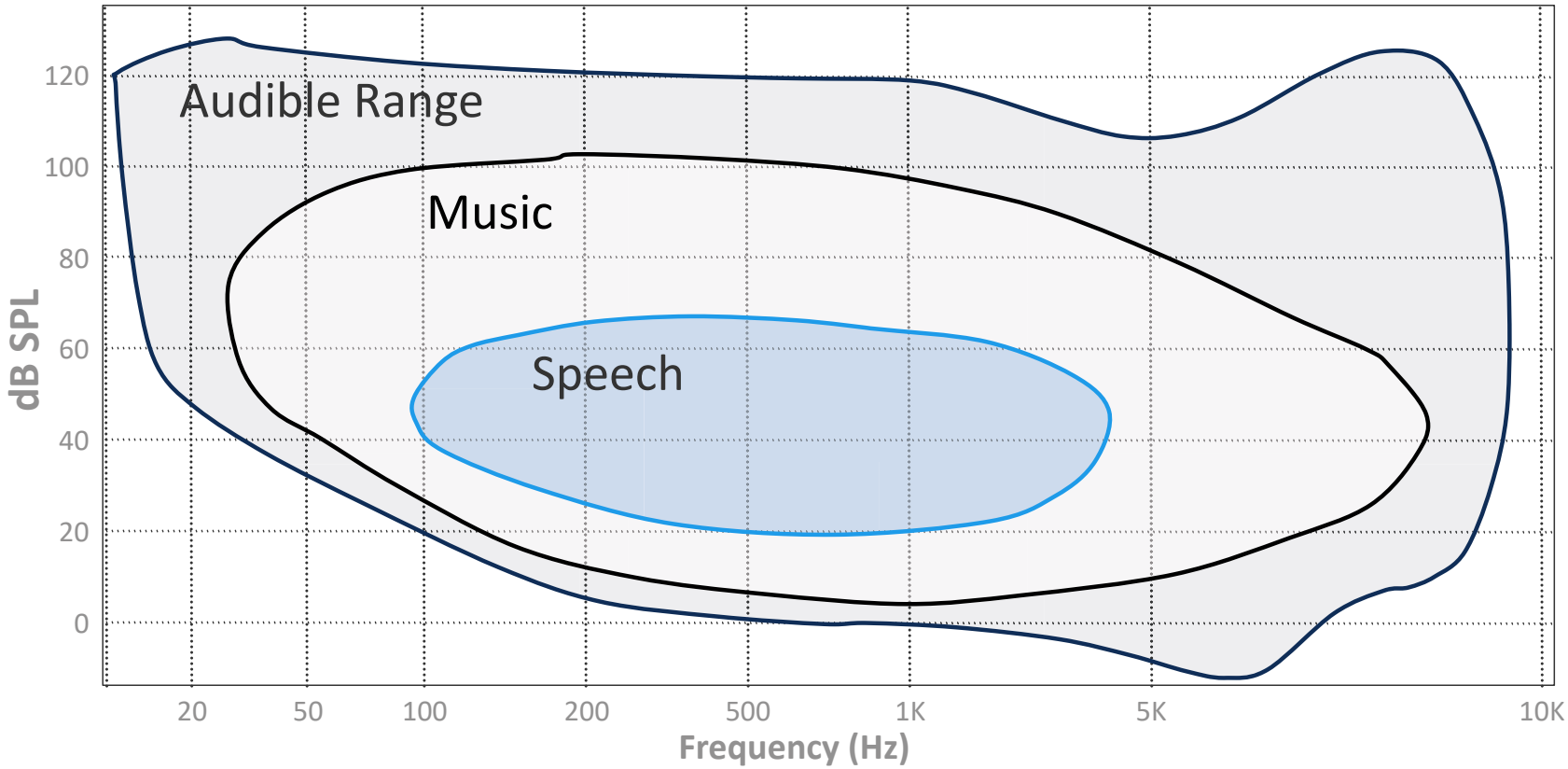


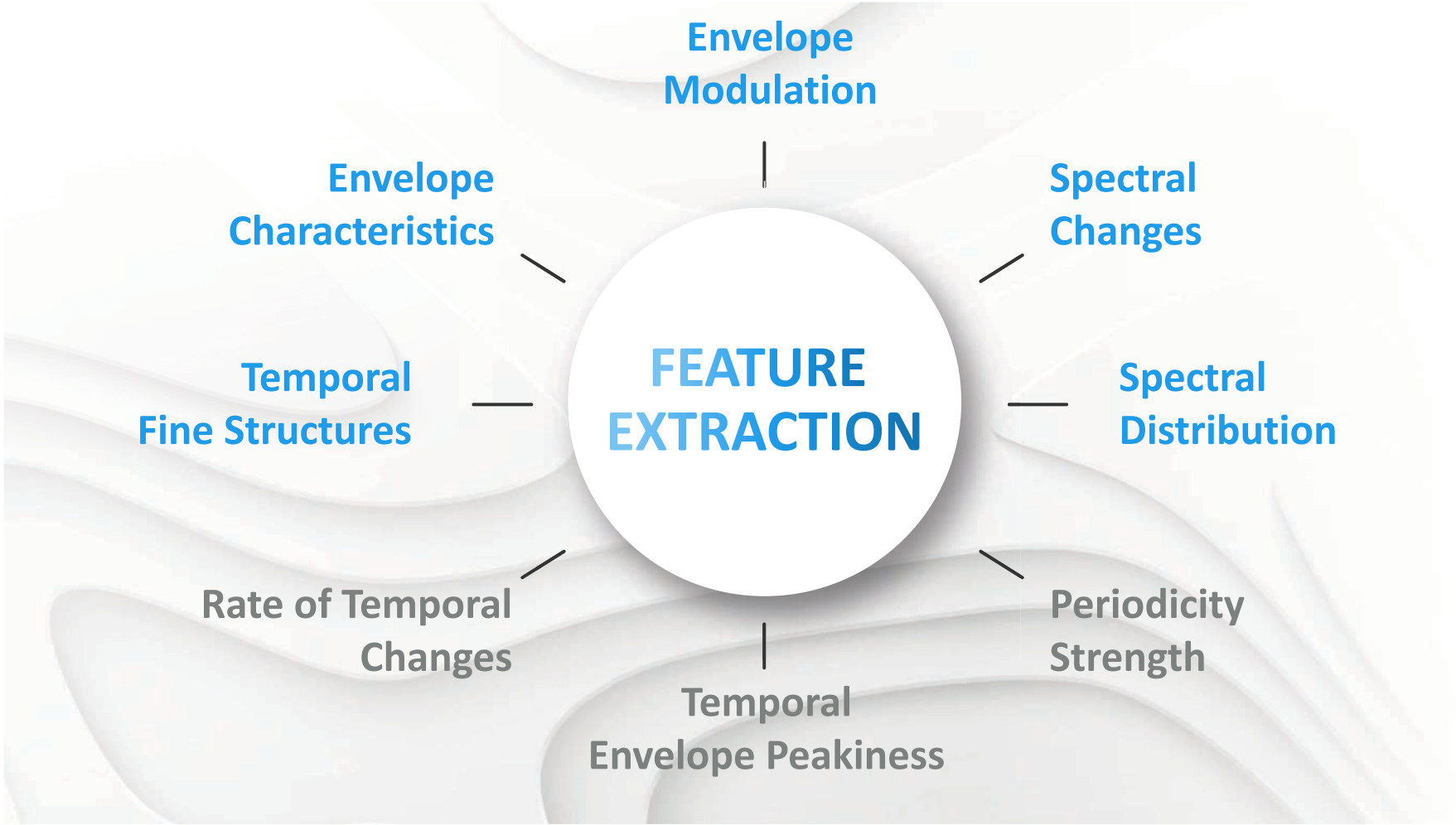
Speech in Noise



Music




Audible Range
Music
Speech
dB SPL
120
100
80
60
40
20
0
20
50
100
200
500
1K
5K
10K
Frequency (Hz)


Envelope Modulation
Envelope Characteristics
Spectral Changes
Temporal Fine Structures
FEATURE EXTRACTION
Spectral Distribution
Rate of Temporal Changes
Periodicity Strength
Temporal Envelope Peakiness

Classification Accuracy

Unique Music Compression

10 kHz bandwidth

Compression variables optimized for music

Loud music processed without distortion

Linear gain at high inputs to restore loudness

Additive Compression

Additive Compression

Speech Programs

Dedicated knee points and compression ratios for speech

Fast and slow compression running in conjunction*

Adaptive features based off speech characteristics

Music Program

Dedicated knee points and compression ratios for music

Fast compressor disabled*

Adaptive features based off music characteristics

Both Speech & Music

Expansion has been removed from compression architecture

Broader Hz response

e-STAT 2.0 Proprietary Fitting Formula

Designed to complement the Genesis AI compression architecture

~4-6 dB more gain for soft sounds*

Improved vent modeling

More gain at higher frequencies** (> 3kHz)

*Varies with the audiogram and acoustic stimuli
**Varies with audiogram and with frequency

Dedicated Music Program

Music Proprietary Fitting Formula

Designed to complement the Genesis AI compression architecture

Unique music-centric fitting prescription

Shaped gain according to hearing loss for quiet music

Flat, linear insertion gain for loud music

*Varies with the audiogram and acoustic stimuli
**Varies with audiogram and with frequency

Dedicated Music Program

A Program environment that can be selected

A package of functionality including:

A fitting rationale optimized for music

Compression optimized for music

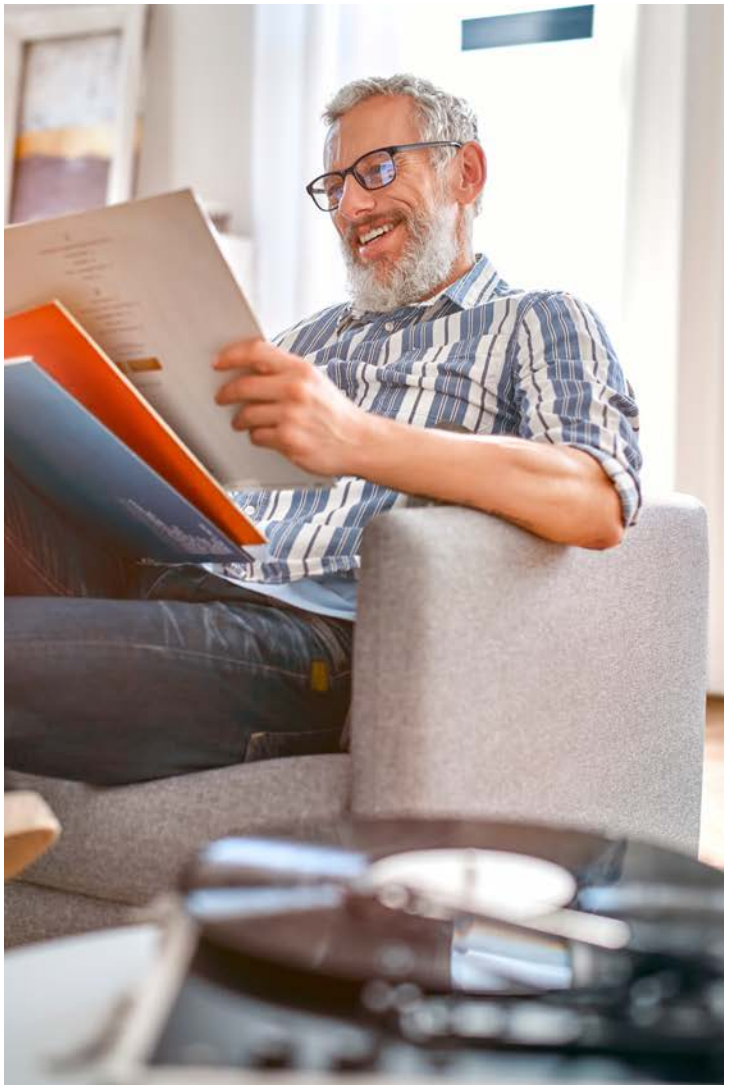
Controls in Pro Fit optimized for music adjustment

Music Program Fitting Rationale Goals

Focused on music audibility, desired loudness, and sound quality

Make soft music audible while achieving transparency

Restoring desired loudness at high input levels

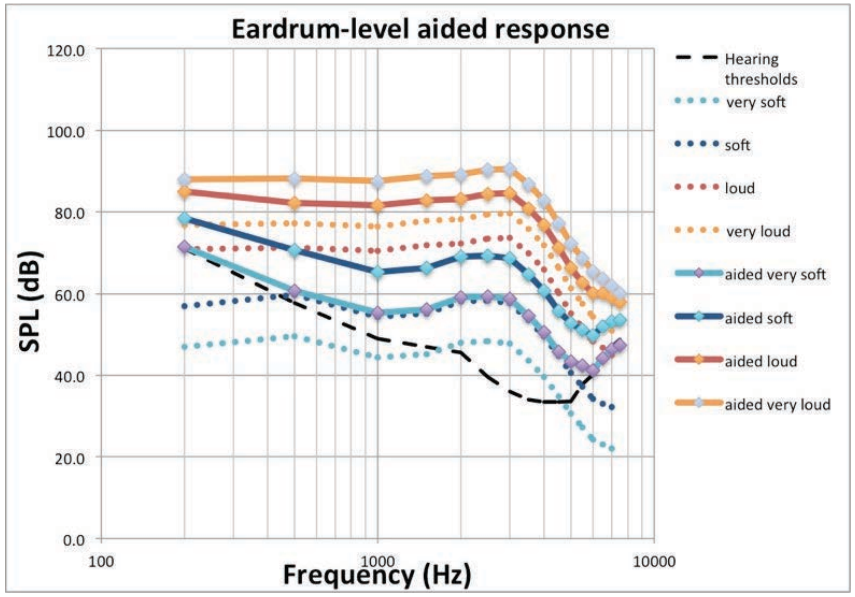


Prescriptive Fitting for Music

Goals:

Restore overall loudness of *loud* music with flat gain

Restore audibility of *soft* music with shaped, compressive gain



Prescriptive Fitting for Music

Goals:

Restore overall loudness of *loud* music with flat gain

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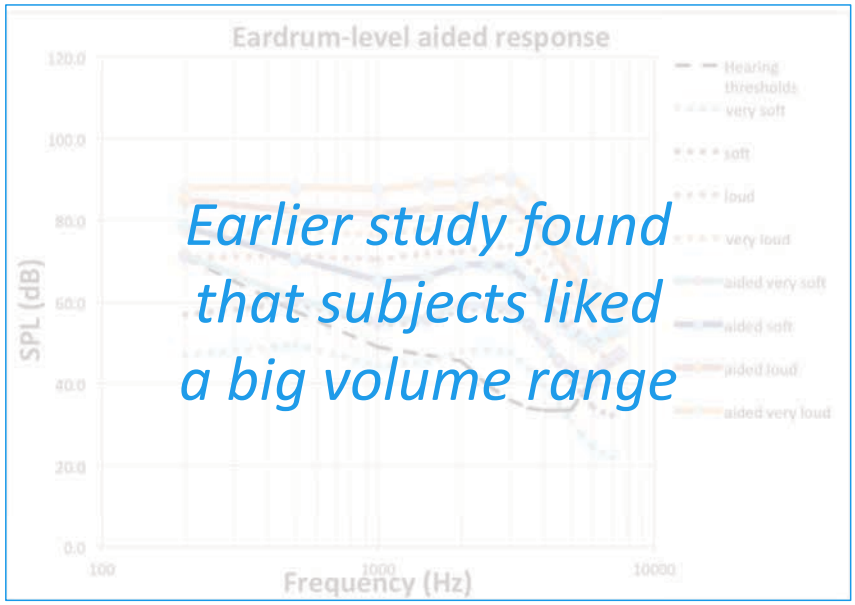


Prescriptive Fitting for Music

Goals:

Restore overall loudness of *loud* music with flat gain

Restore audibility of *soft* music with shaped, compressive gain

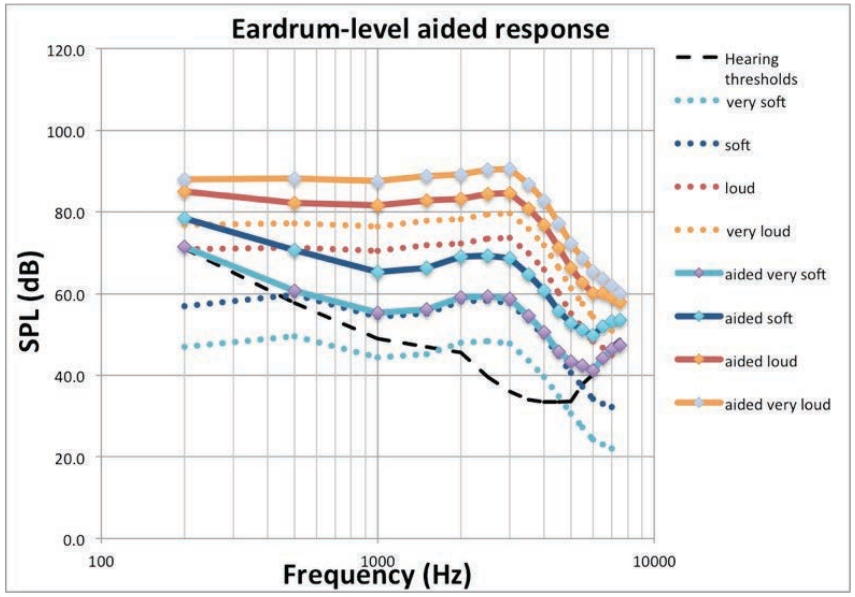
Prescriptive Fitting for Music

Evidence-based prescription optimized for music

Restores audibility for soft music

Restores desired loudness for loud music

Unique compression TKs and CRs



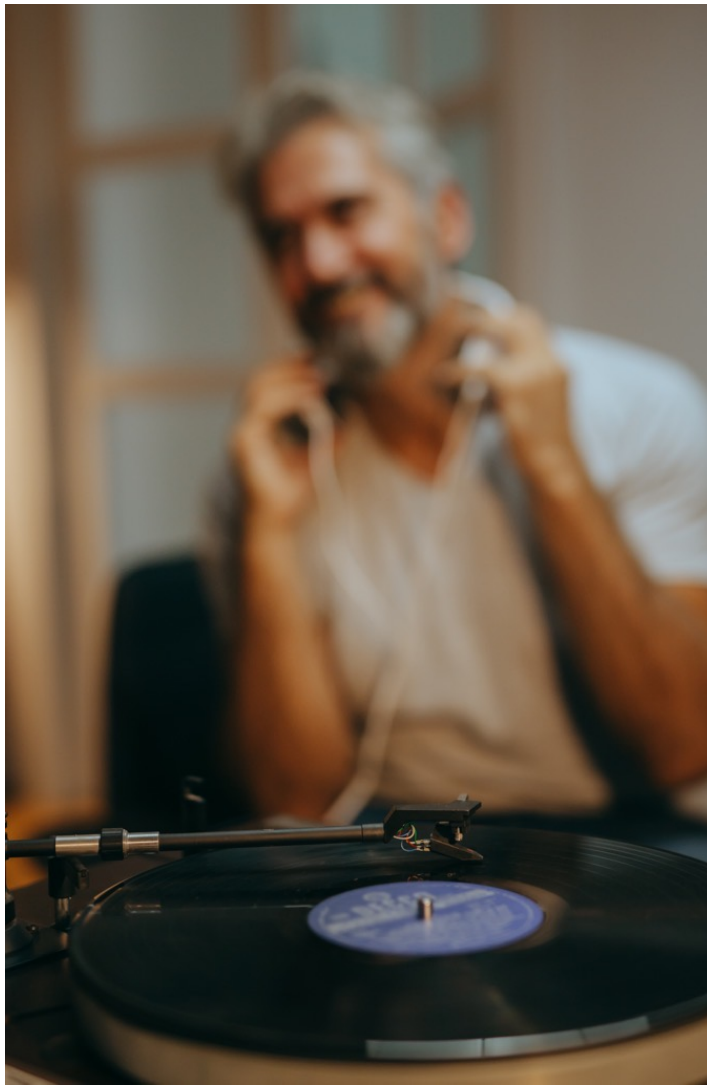
Music Program

Fitting and evaluation of Music Program is subjective

Individual variability of desired sound is likely much higher than for speech

No objective measures exist for evaluating a hearing device fitting for music

Adjustments will need to be made based on patient feedback regarding music sound quality

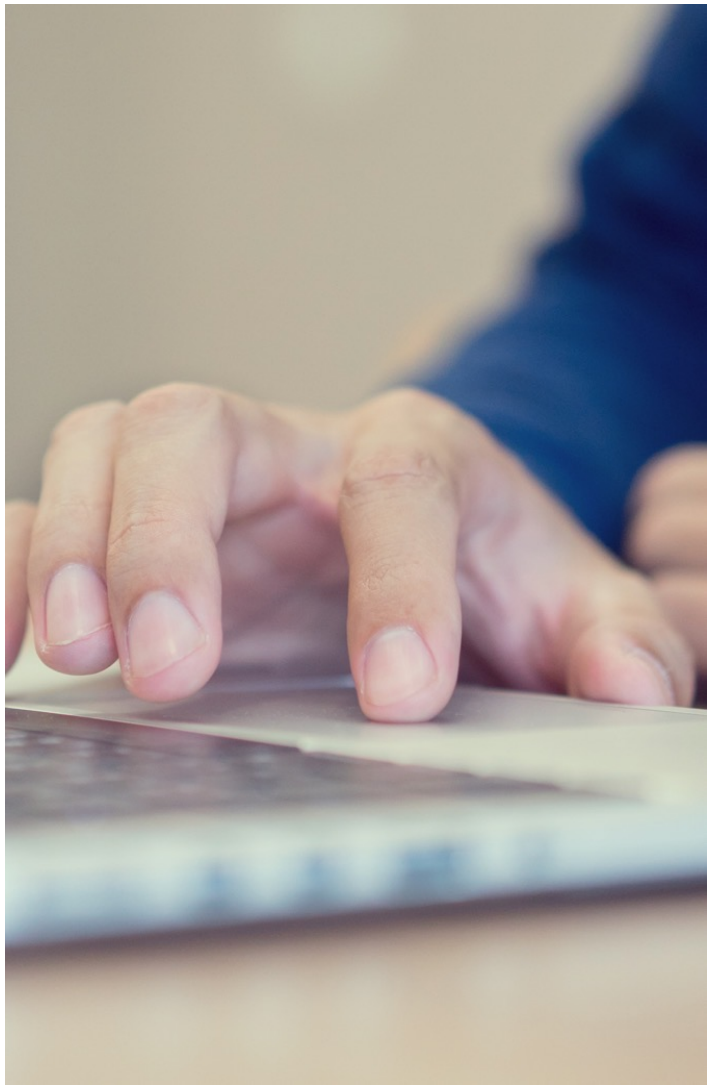


Music Program Controls

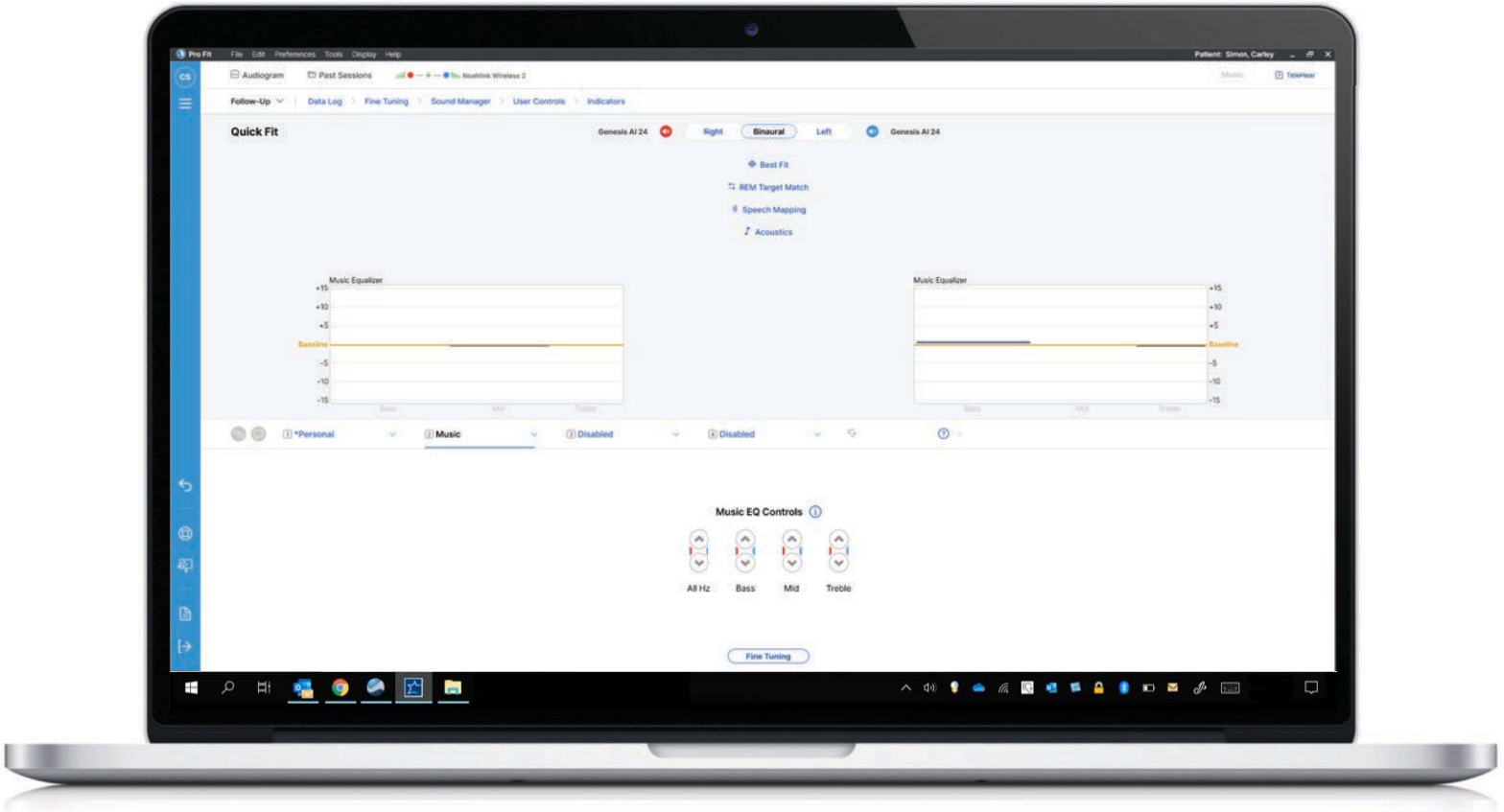
Dedicated Music Program can be programmed in multiple Program banks of the hearing device

Music-Centric controls

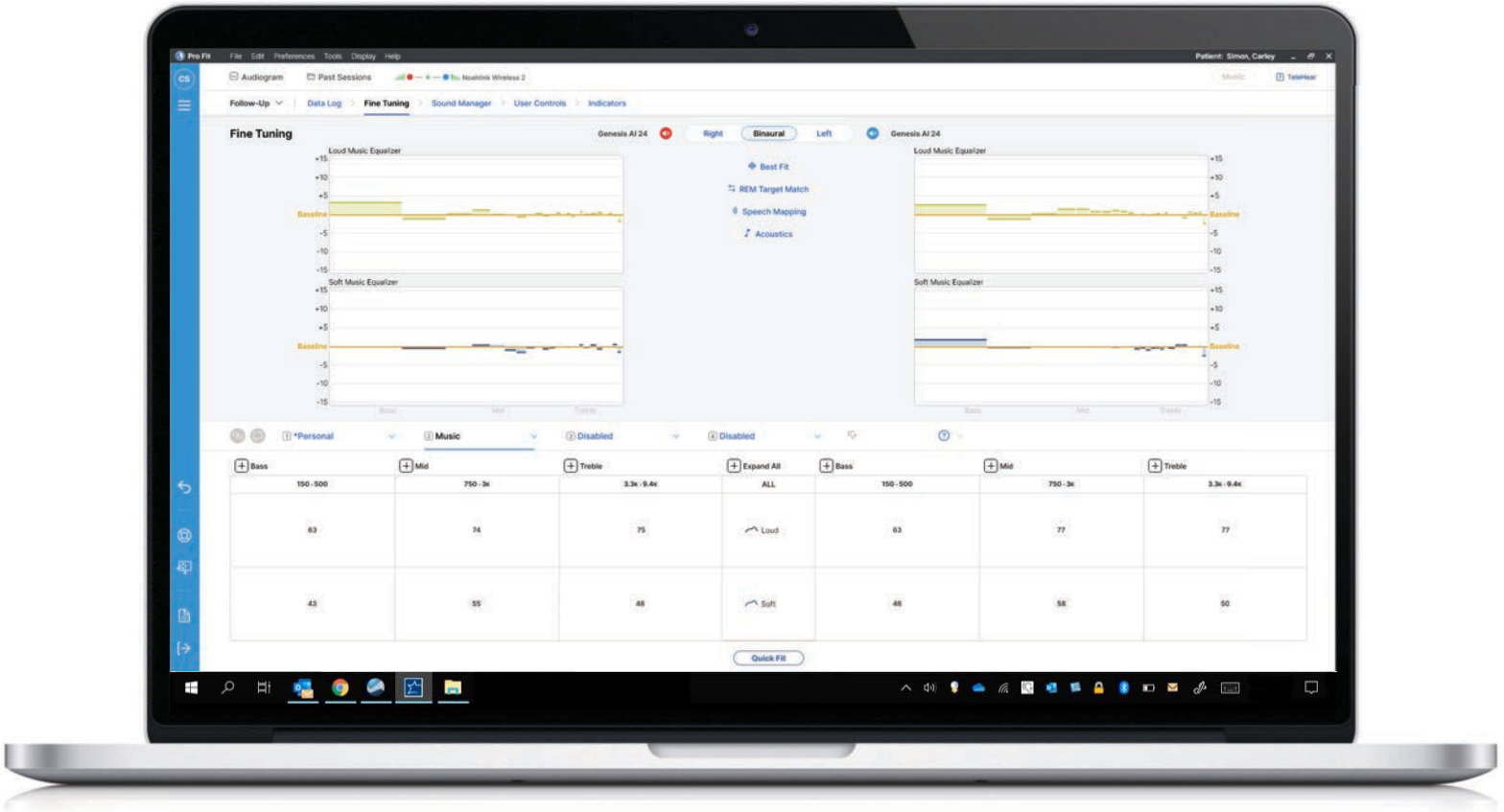
To facilitate communication between patient and professional for addressing subjective music listening reports



Dedicated Music Program



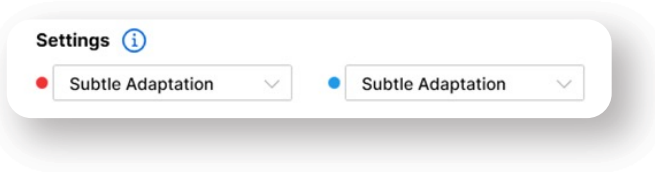
Dedicated Music Program



Unique Adjustments for Music

Omni Mic

No Noise Reduction



Feedback Sensitivity Reduced

Two Case Studies

Carley Simon
Pianist
Fit with Genesis AI RIC RT 24

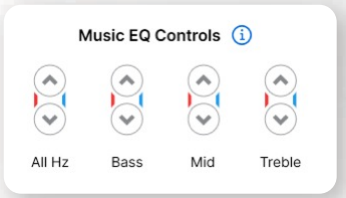
Devin Shelton
Vocalist
Fit with Genesis AI mRIC 16

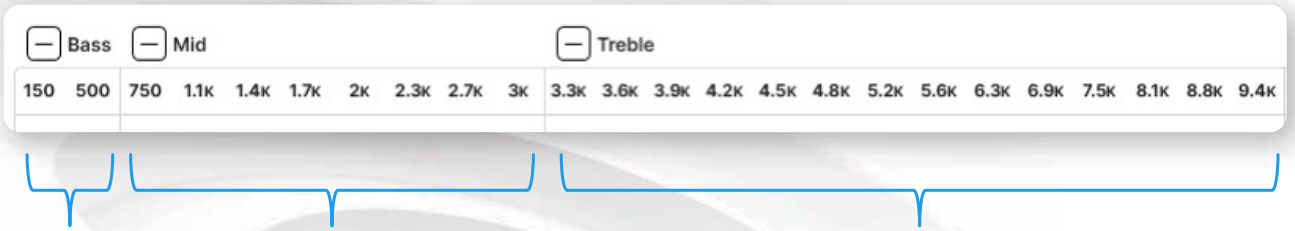
Music Programming Basics

Quick Fit
Adjusts larger frequency bands

Fine Tuning
Targeted and specific frequency adjustments

All adjustments are in 2 dB steps



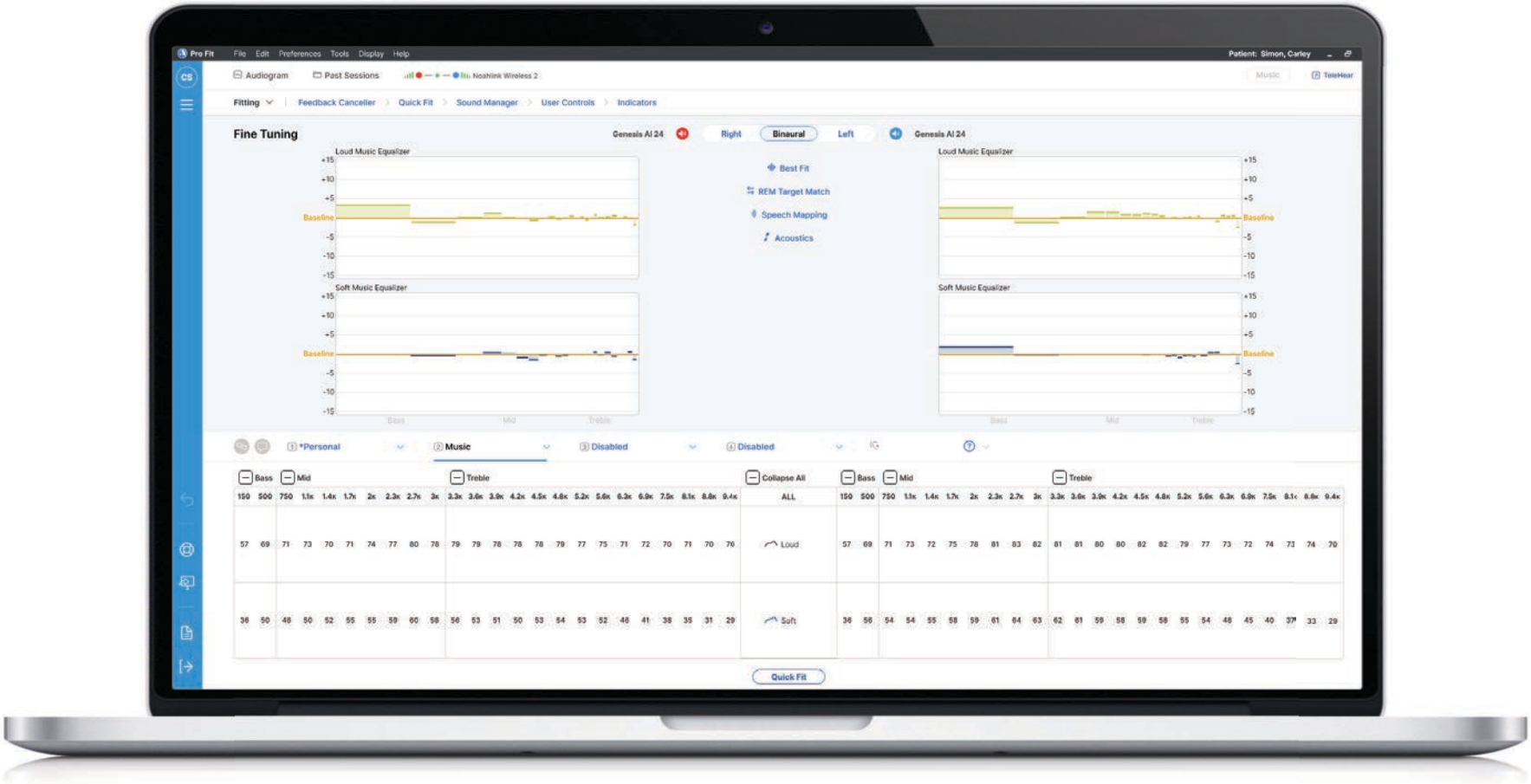


Bass
150-500 Hz

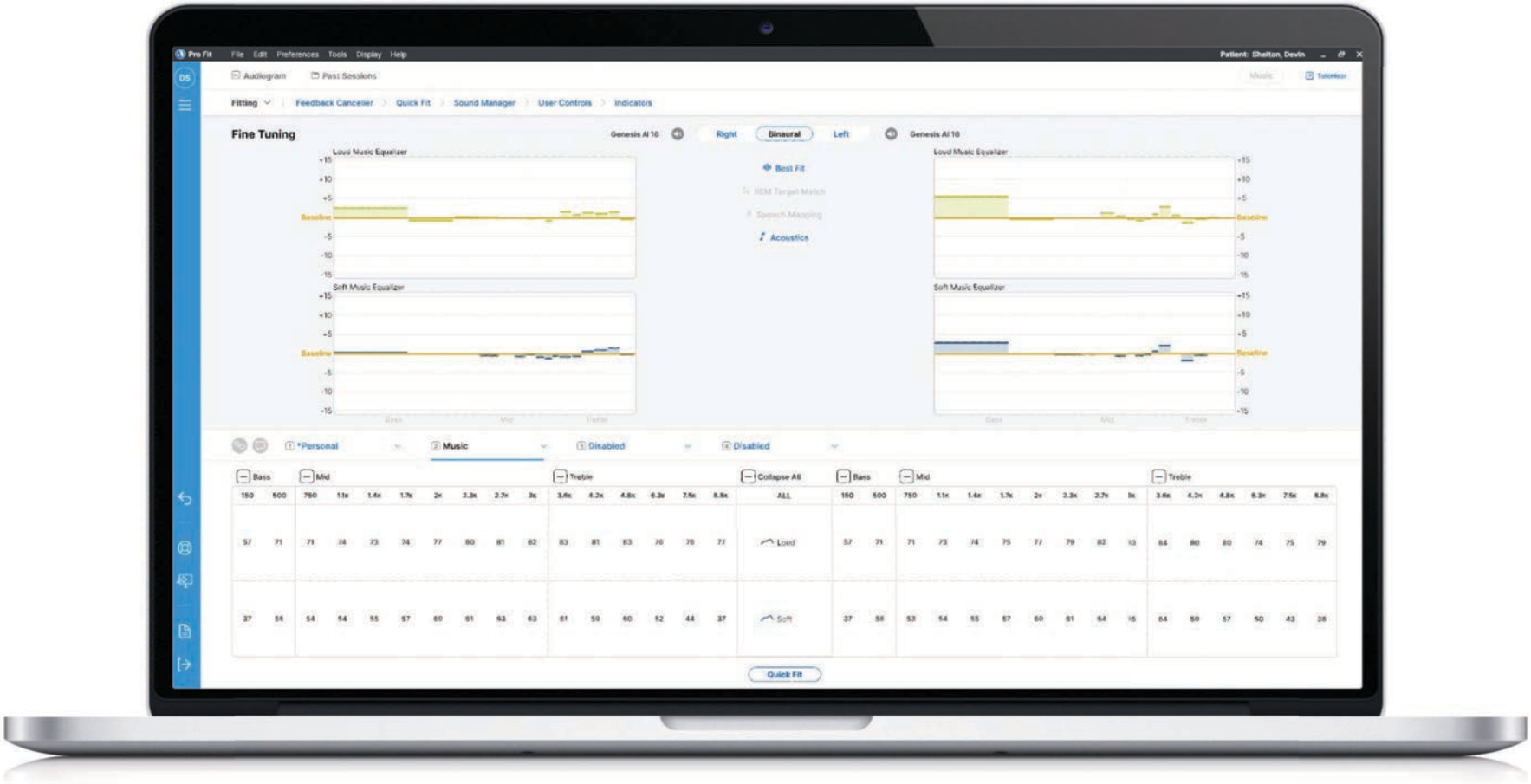
Mid
750-3000 Hz

Treble
3300-9400 Hz

Carley


Pro Fit
File Edit Preferences Tools Display Help
Patient: Simon, Carley
Audiogram
Past Sessions
Fitting
Feedback Canceller
Quick Fit
Sound Manager
User Controls
Indicators
Fine Tuning
Genesis AI 24
Right
Binaural
Left
Genesis AI 24
Loud Music Equalizer
Soft Music Equalizer
Best Fit
REM Target Match
Speech Mapping
Acoustics
Baseline
Bass
Mid
Treble
*Personal
Music
Disabled
Disabled
Collapse All
ALL
Loud
Soft
Quick Fit

Devin


Pro Fit
File Edit Preferences Tools Display Help
Patient: Shelton, Devin
Audiogram
Past Sessions
Fitting
Feedback Canceler
Quick Fit
Sound Manager
User Controls
Indicators
Fine Tuning
Genesis AI 10
Right
Binaural
Left
Genesis AI 10
Loud Music Equalizer
Soft Music Equalizer
Best Fit
Acoustics
*Personal
Music
Disabled
Disabled
Bass
Mid
Treble
Collapse All
Loud
Soft
Quick Fit

Carley

Reporting

The upper keys on the piano are coming in a little tinny or crispy

Mid keys seem a little flat

Adjustment options

Drop upper key frequencies

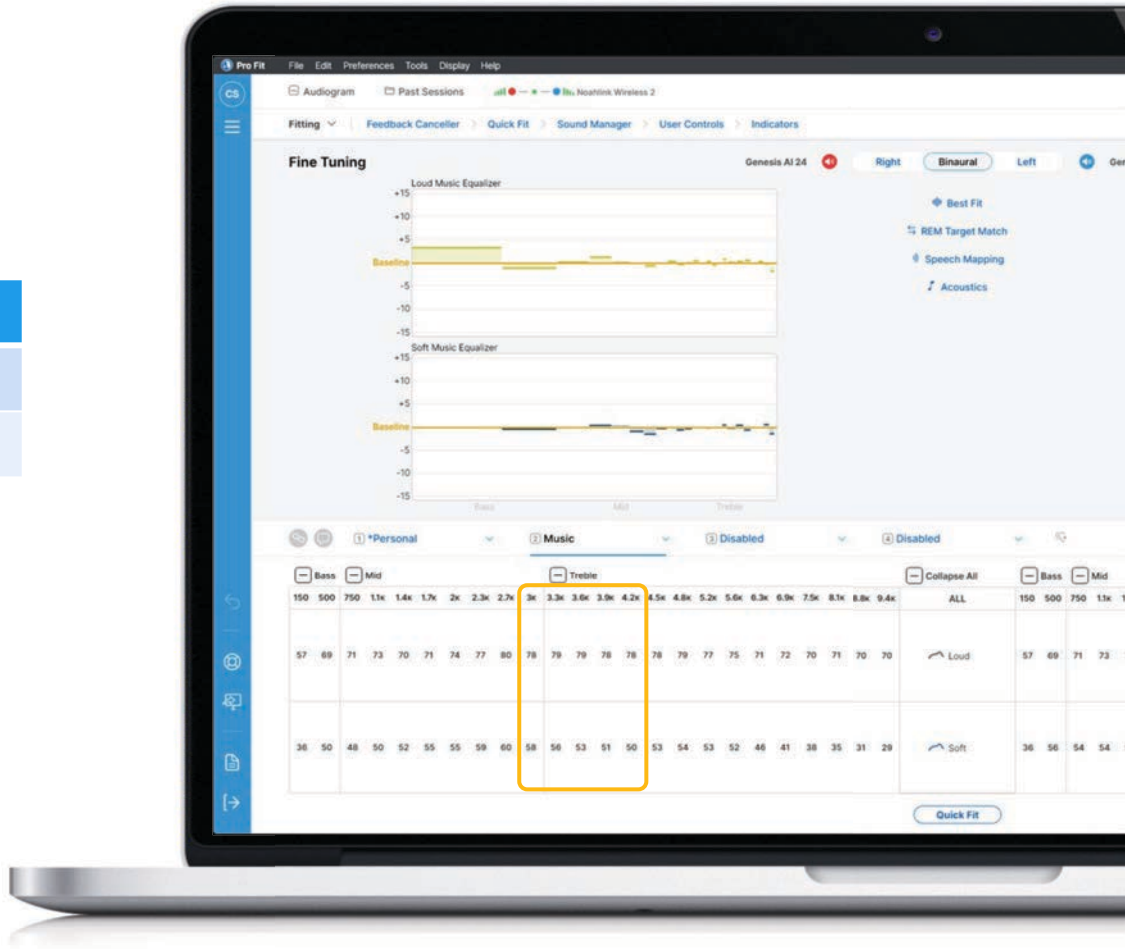
Raise mid and high frequencies

Try to bring some balance between the frequencies overall

Carley

Original

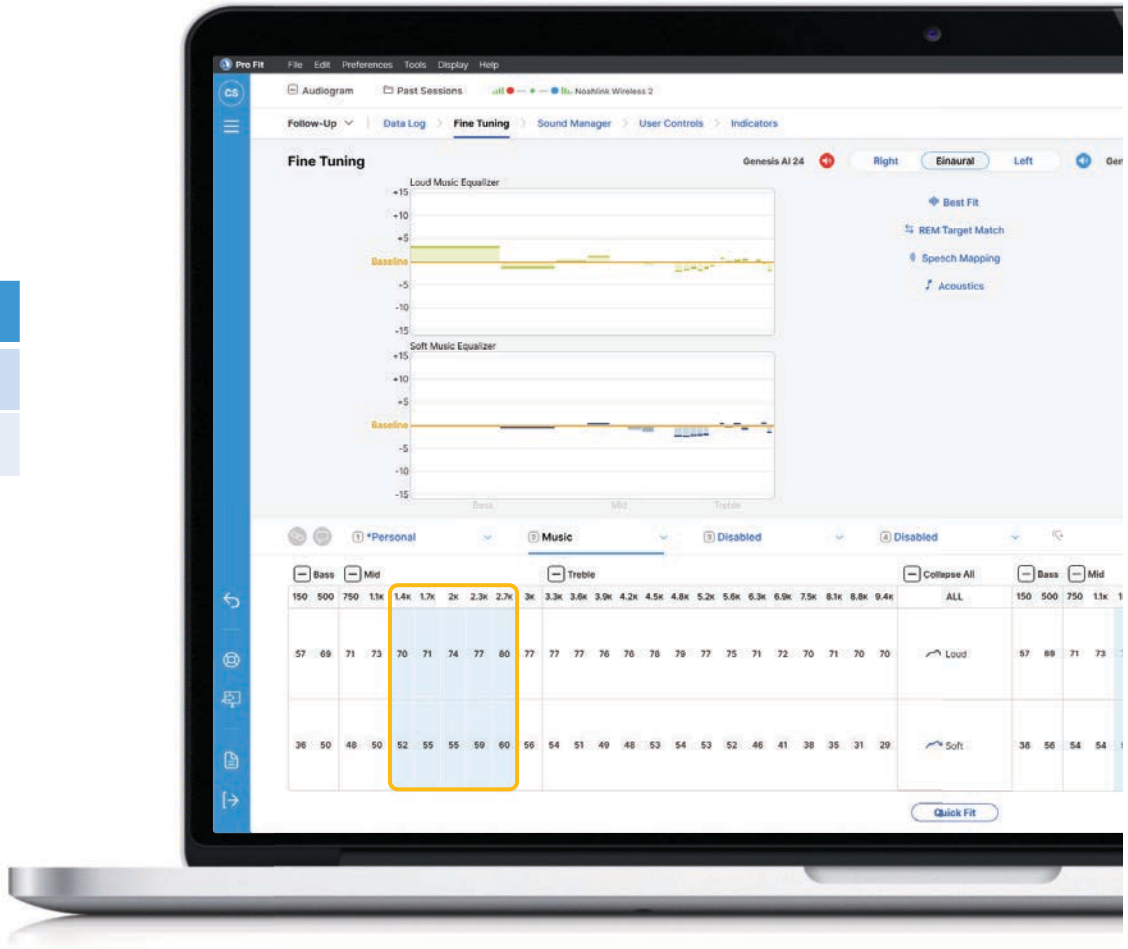
	3k	3.3k	3.6k	3.8k	4.2k
Loud	78	79	79	78	78
Soft	58	56	53	51	50



Carley

Original

	1.4k	1.7k	2k	2.3k	2.7k
Loud	73	75	78	81	83
Soft	56	59	59	63	63



Devin

Reporting

Struggles to hear other singers around him

Feels like overall robustness of music is lower than he would like

Adjustment options

Increase low frequencies

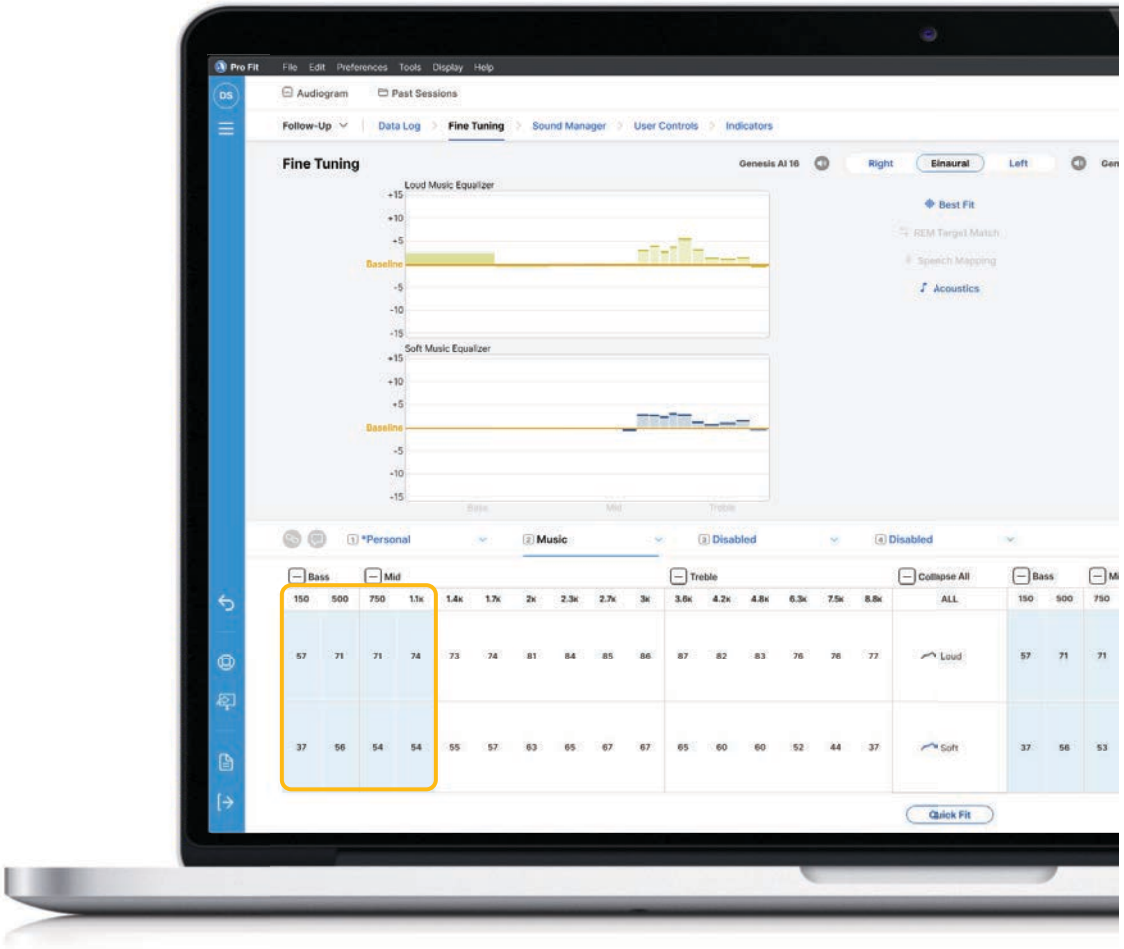
Increase baritone frequencies

Increase all frequencies

Devin

Original

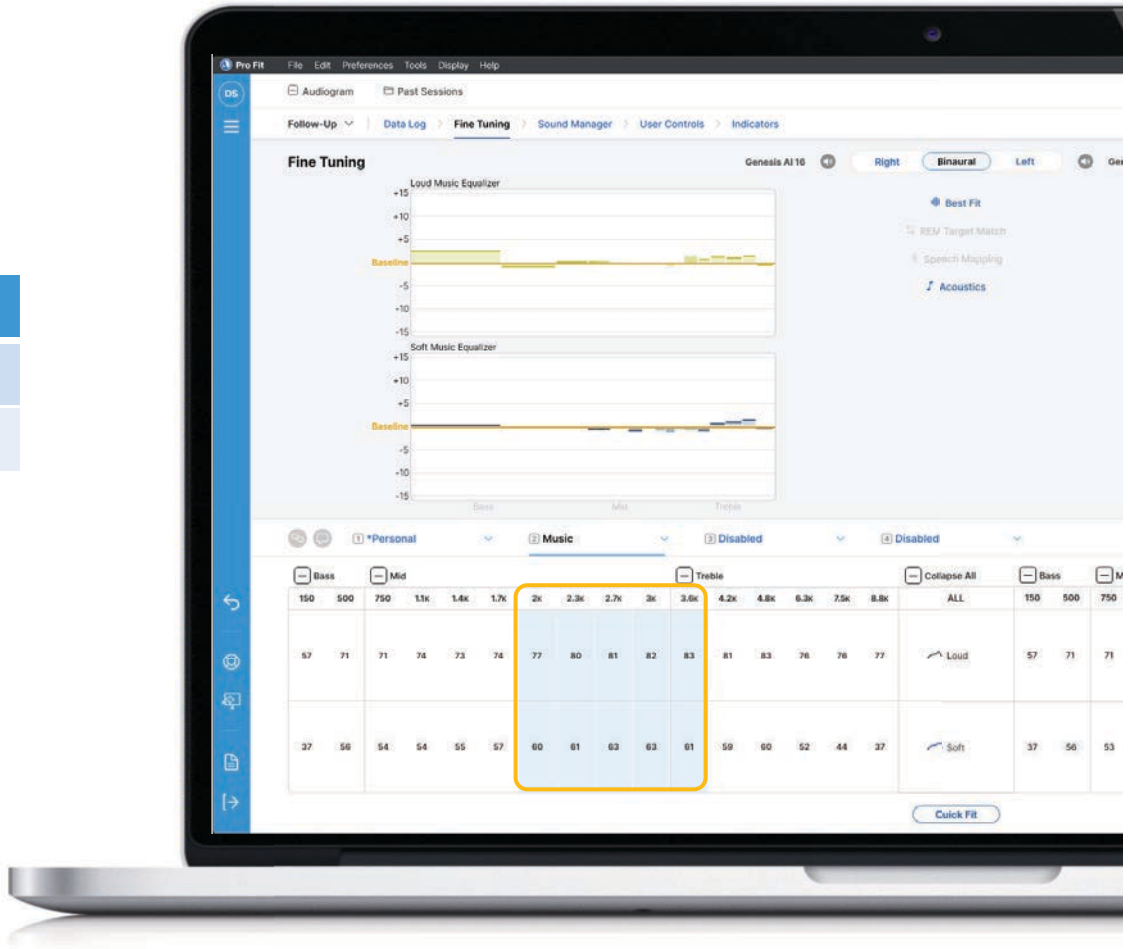
	150	500	750	1.1 K
Loud	57	71	71	74
Soft	37	56	54	54



Devin

Original

	2k	2.3k	2.7k	3k	3.6k
Loud	77	80	81	82	83
Soft	60	61	63	63	61



Overall Fitting Considerations

Dedicated Music Program is for acoustic music and not speech

No two patients will perceive music the same way

Individualization of programming is key for musicians and music lovers

Streaming Quality

IMPROVED

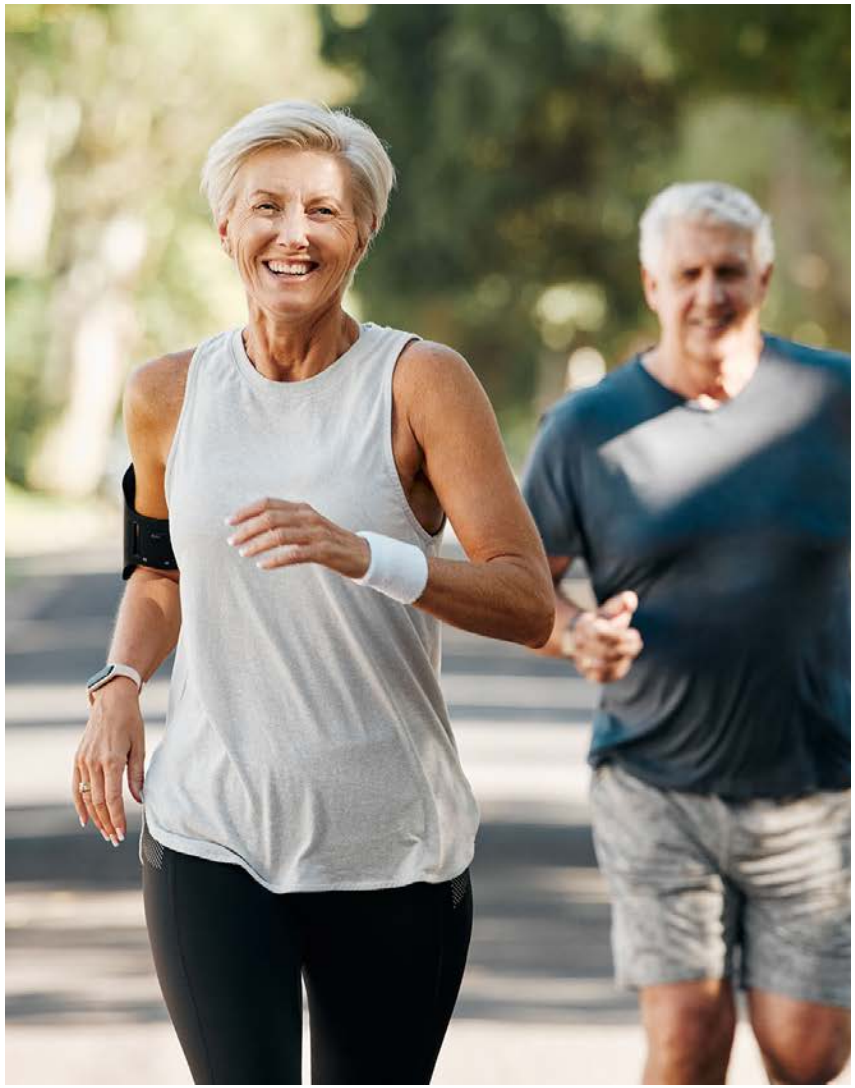
Streaming Sound Quality

Genesis AI also boasts improved streaming capabilities

Streaming can be initiated in any program

Allows customization of the streaming frequency response for phones and individual accessories through Pro Fit or the My Starkey App

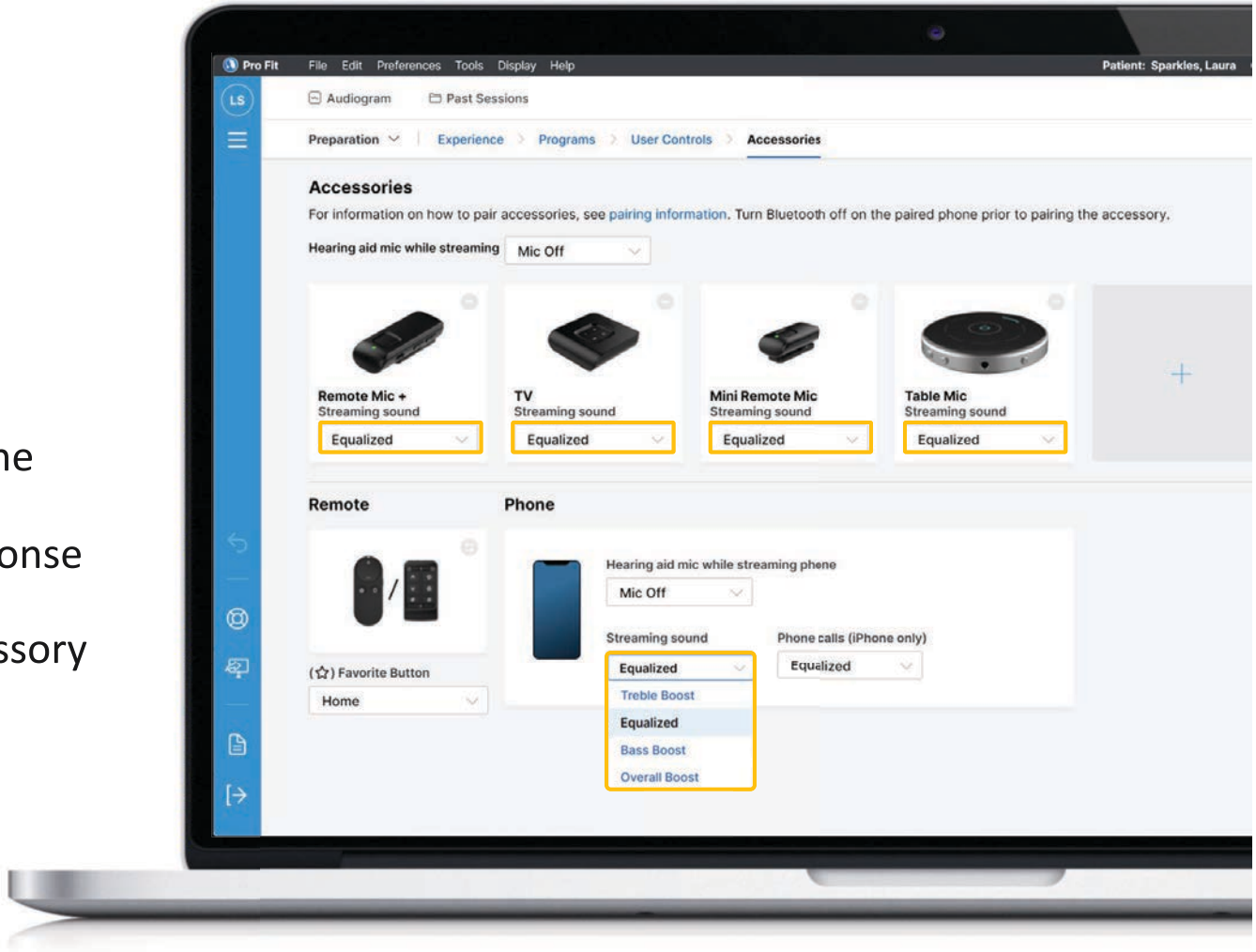
Automatic recovery of accessory streams



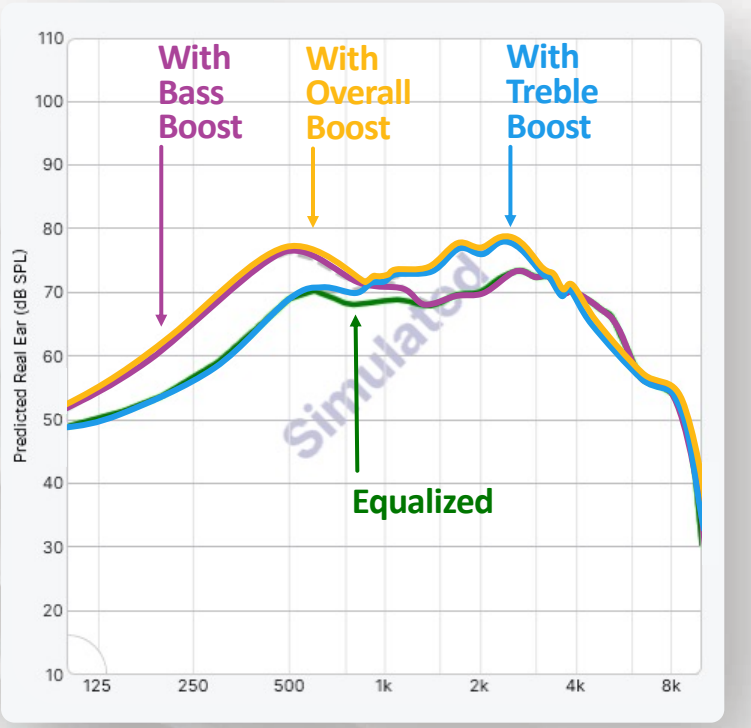
IMPROVED

Streaming Behavior

Streaming sound allows the patient to customize the streaming frequency response for iPhones and each individual streaming accessory



Streaming Sound Options

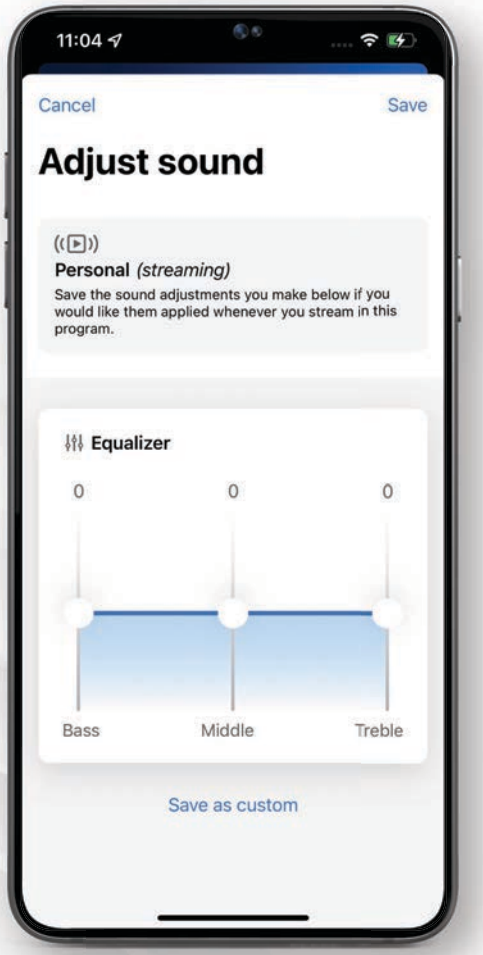


Best Fit - Flat 50 dB Audiogram

ENHANCED

Improved Streaming Sound Quality

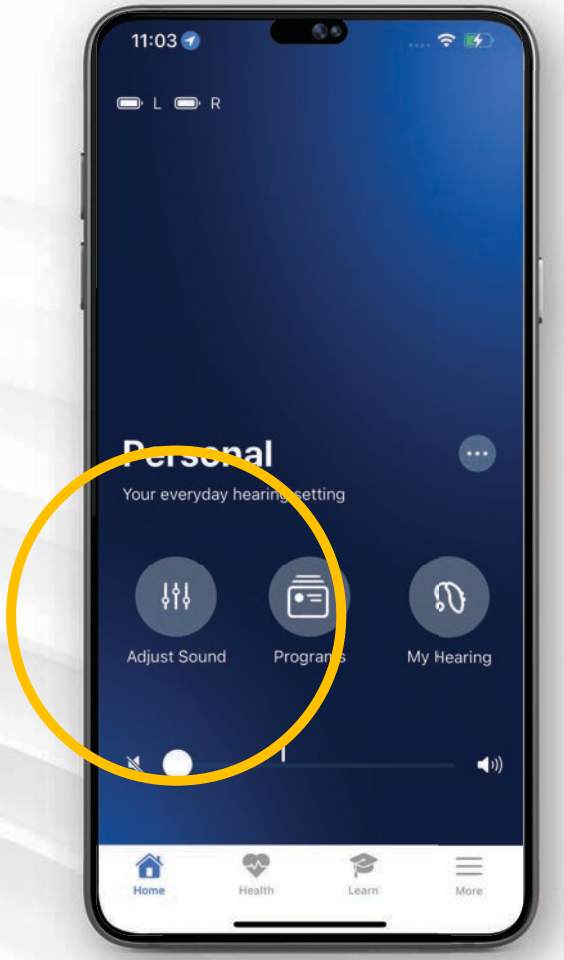
New equalizer to adjust streaming sound quality in the My Starkey app



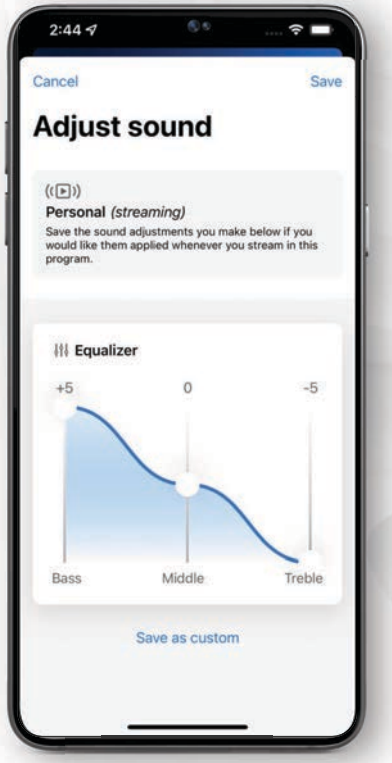
Streaming

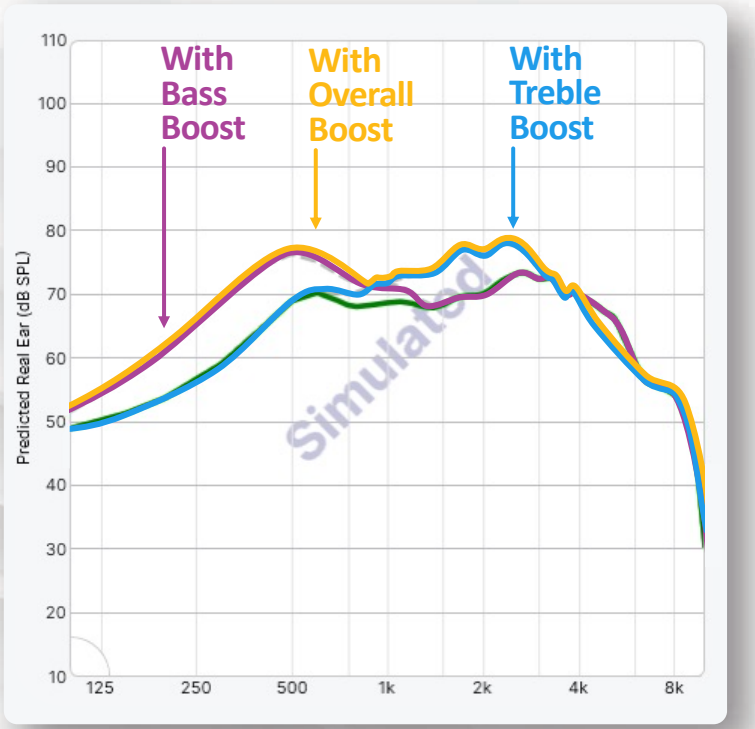
Improved streaming experience

When streaming, Edge Mode+ button is replaced with “Adjust Sound”



Streaming


2:44
Cancel
Save
Adjust sound
Personal (streaming)
Save the sound adjustments you make below if you would like them applied whenever you stream in this program.
Equalizer
+5
0
-5
Bass
Middle
Treble
Save as custom

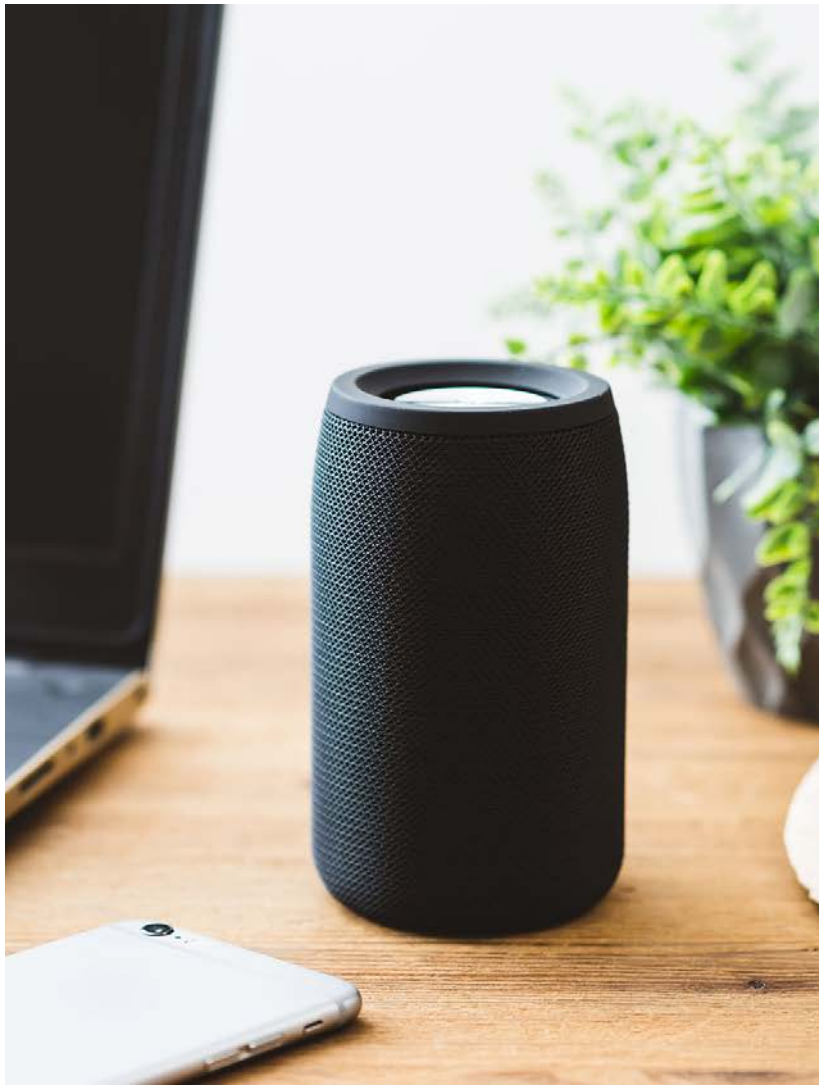

With Bass Boost
With Overall Boost
With Treble Boost
Predicted Real Ear (dB SPL)
110
100
90
80
70
60
50
40
30
20
10
125
250
500
1k
2k
4k
8k
Simulated

Office Optimization

Optimizing the Office

External speakers for playing sound sources

CD player or the ability to play MP3 sound sources so you can play patients' specific music of choice

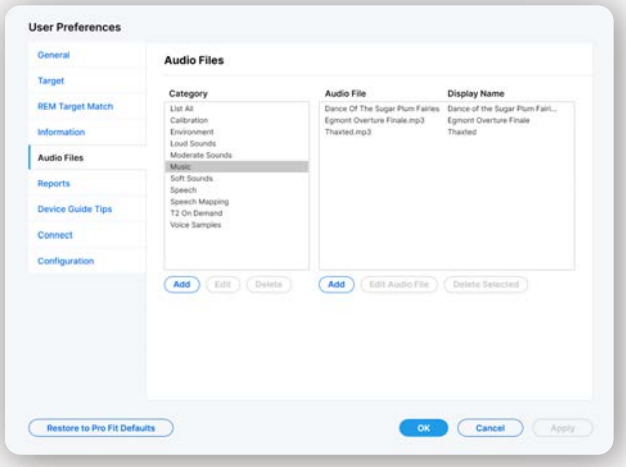


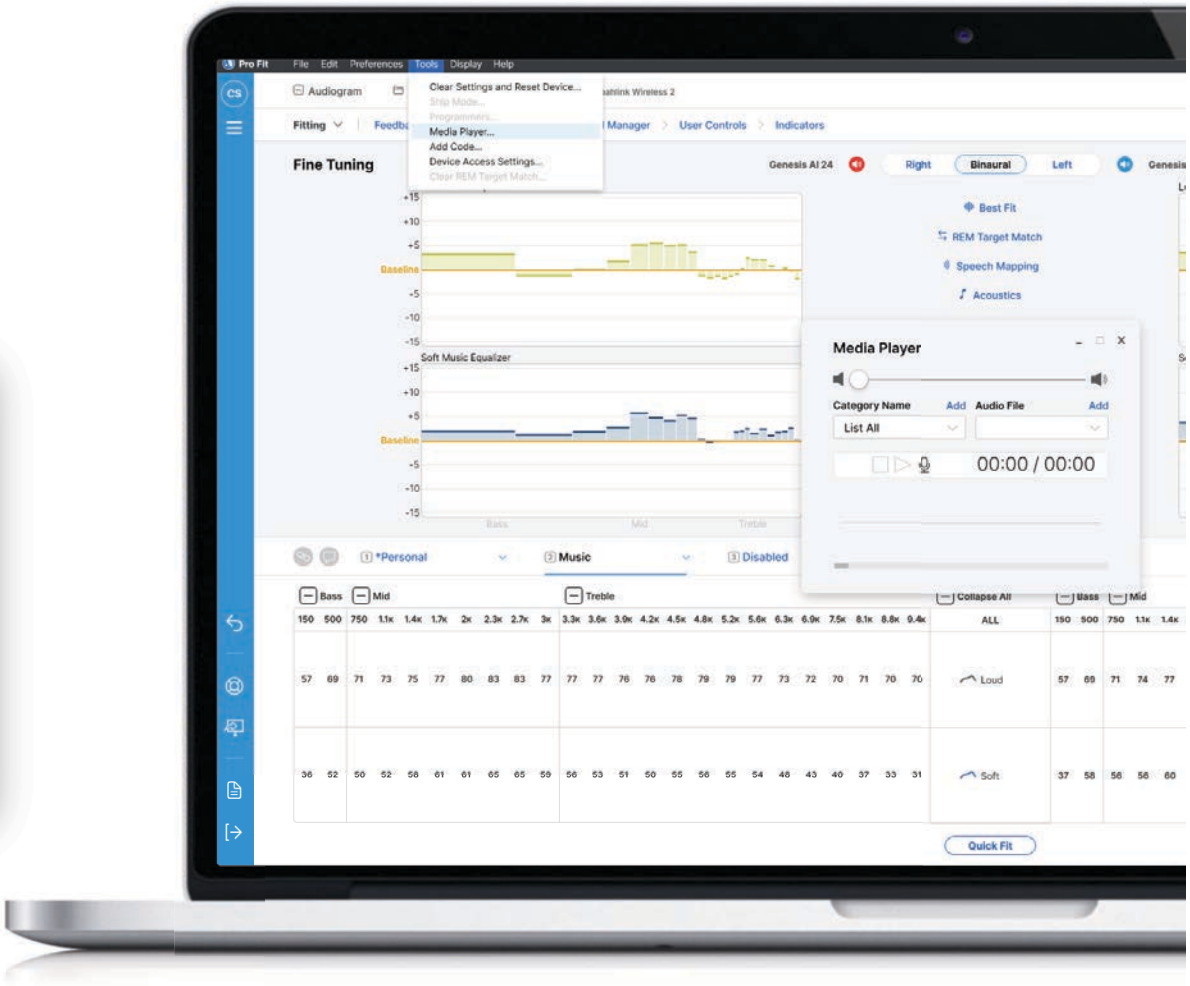
Optimizing the Office

Digital music streaming services

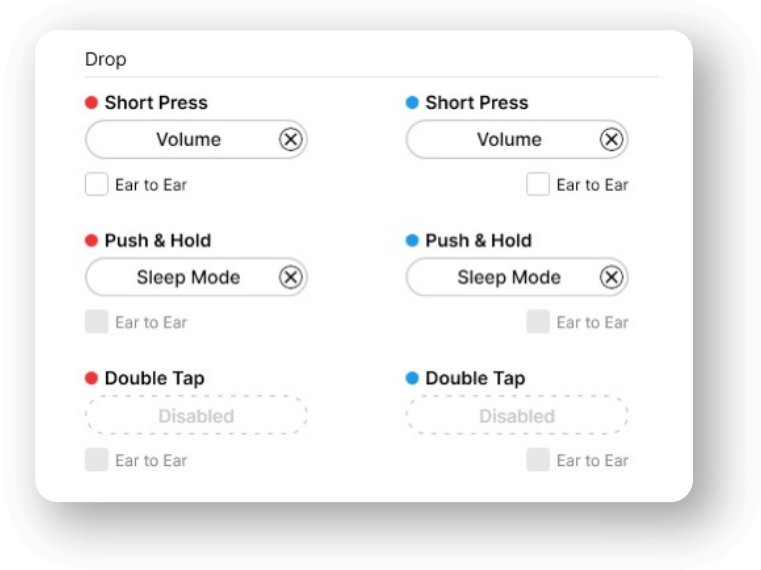
Optimizing the Office

Media player in software





Bring instrument into office for programming



Clinical Considerations for Different Instruments

Many string instruments like the violin are played by holding the instrument up to the shoulder on one side

Fitting devices where you can disable the ear-to-ear VC allows patient to adjust the volume independently to keep things balanced

Clinical Considerations for Different Instruments

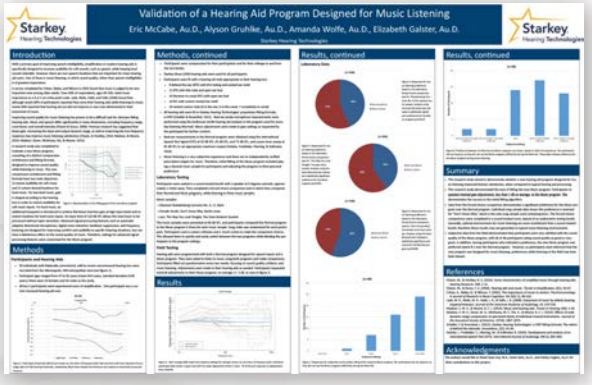
Many string instruments like the violin are played by holding the instrument up to the shoulder on one side

Individual ear VC within My Starkey can achieve the same thing

Resources

QuickTips

White Papers



Support Materials

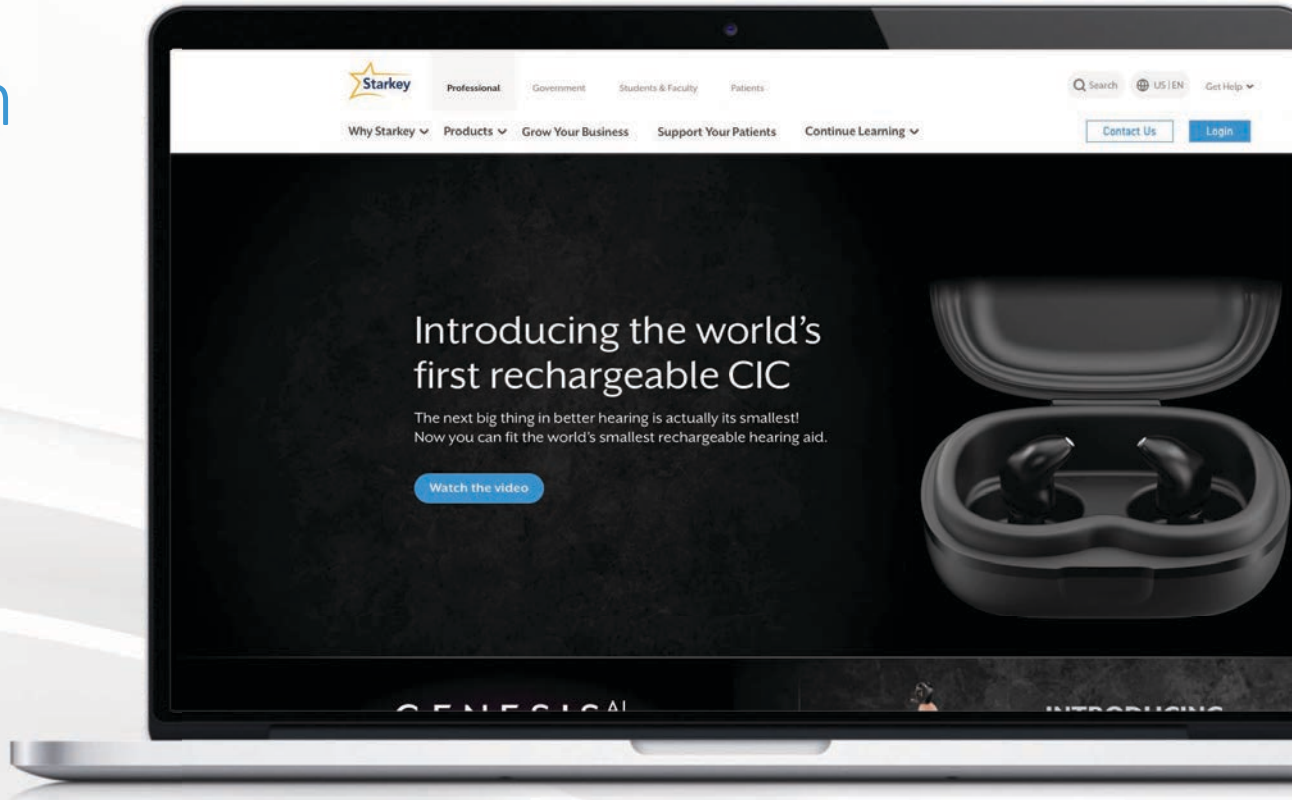
Starkeypro.com

White Papers

Quick Tips

Videos

Training Opportunities



Thank You

Hear better. Live better.