

Tips for Tinnitus

Programming Genesis AI for Tinnitus Patients

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Hear better. Live better.

Tips for Tinnitus

Programming Genesis AI
for Tinnitus Patients

Webinar FAQs

How to Ask a Question

Click Q & A, type your question,
click Send

Where to get the Handout

A PDF handout for this presentation
may be accessed through your
Pending Courses on Audiology
Online or by clicking on the link in
Chat within the classroom

Tips for Tinnitus

Programming Genesis AI
for Tinnitus Patients

Webinar FAQs

How to Earn CEUs

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Assistance or Tech Support

- Call Audiology Online at 800-753-2160
- customerexperience@continued.com
- Use the Q & A window

Learner Outcomes

1

Identify possible risk factors of tinnitus

2

Discuss the three masking options for tinnitus within Pro Fit

3

Describe the tinnitus options within My Starkey

What's in a Word

Latin root:

tinnire — to ring

TINNITE
tin-it-us-us

Emphasis on syllable 2 follows the
grandma rule of keeping the
word's original meaning (iatron
the inflammation of ringing)

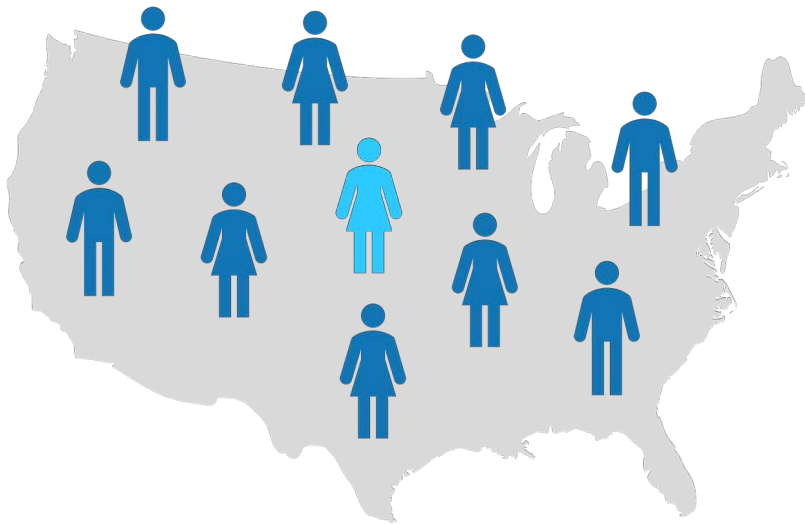
tin·ni·tus

["TIN-it-us", "tin-NITE-us"]

a symptom characterized by
the perception of sound in the
absence of an external stimulus.



Tinnitus



One of the **most common health conditions** in the United States

American Academy of Otolaryngology found that **one in ten Americans** experience some form of tinnitus.

The NIDCD estimates that approximately **two million Americans** experience debilitating tinnitus.

American Tinnitus Association

Classifying Tinnitus

Traditionally classified by whether it could be heard by the clinician



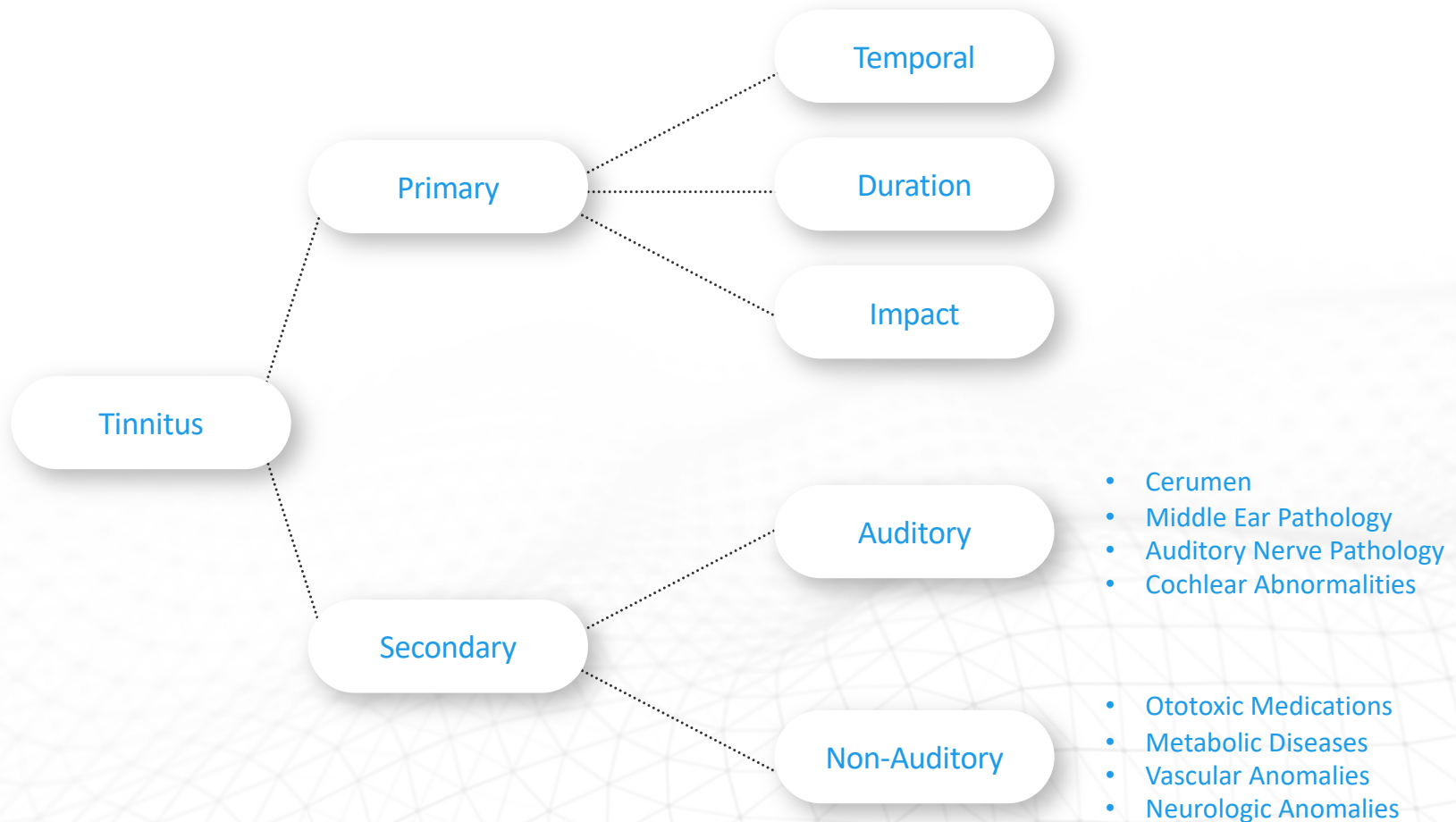
Objective

- Audible to another person
- Internal acoustic source
(Ex. muscle spasms or vascular tumor)
- Detected via human ear, stethoscope, or microphone
- Represents less than 1% of cases



Subjective

- Only heard by the patient
- May be idiopathic or caused by various disorders involving the head/neck or other systems
- 99% of all cases



Primary Tinnitus

TEMPORAL CHARACTERISTICS

Spontaneous

Temporary

Occasional

Intermittent

Constant

DURATION

Recent

Persistent

IMPACT

Non-Bothersome

Bothersome

Phantom Auditory Perceptions



**Auditory
Hallucinations**



**Musical Ear
Syndrome**



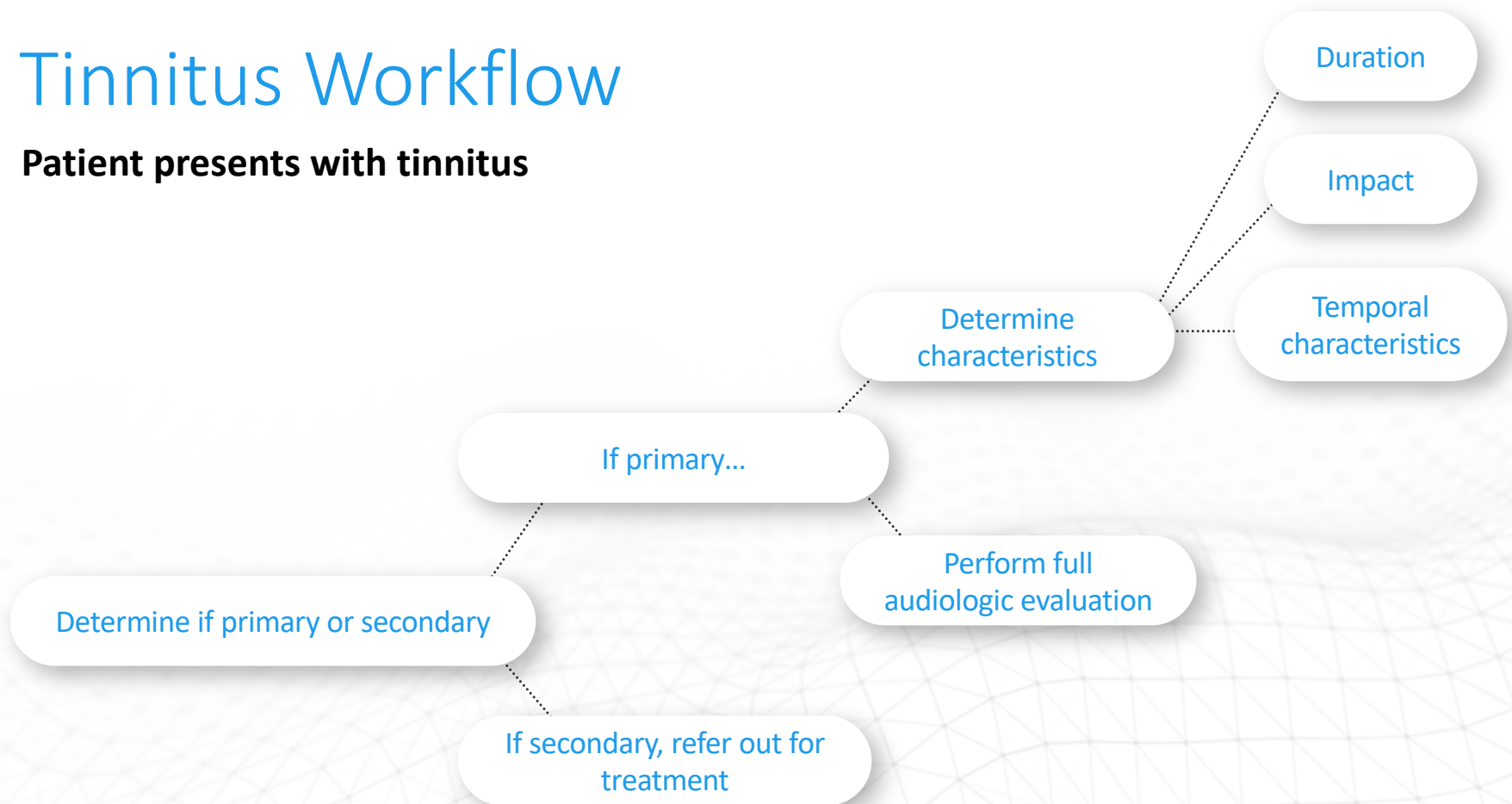
**Auditory
Imagination**



Tinnitus

Tinnitus Workflow

Patient presents with tinnitus





Tinnitus Risk Factors

Risk Factors and Other Mechanisms of Tinnitus



Hear better. Live better.

Risk Factors for Tinnitus

Thyroid
issues

Drugs and
medications

Ear
infections

Otosclerosis

Acoustic
Neuroma

Cardiovascular
disease

Sudden
hearing loss

Head or
neck trauma

Noise
exposure

Meniere's
disease

Possible Risk Factors for Tinnitus

Alcohol
usage

COVID-19

Anxiety

Genetics

Depression

Obesity

Geographic
region

Low weight

Smoking

Lyme
Disease

Health
status

COVID-19

ESTIMATED

7.6%

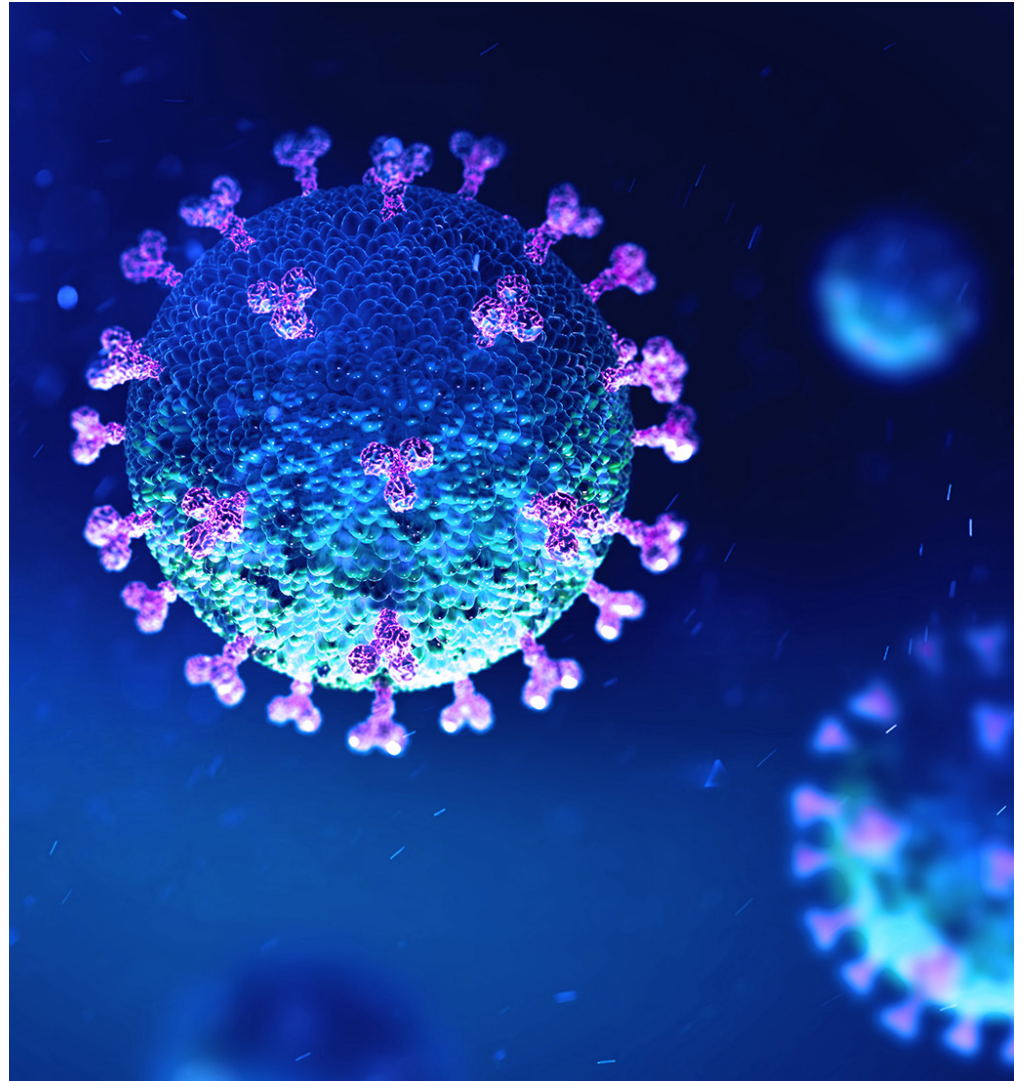
of people who had covid
experienced hearing loss

14.8%

suffered from tinnitus

7.2%

reported vertigo



COVID-19 Case Study

49-year-old male with new onset tinnitus following Covid-19 infection

Bilateral, constant, nonpulsatile tinnitus experienced

Audio eval revealed normal hearing through 8000 Hz

High frequency audio showed mild loss at 16k



At Risk Populations for Tinnitus

Veterans and Military Personnel

Over 2 million veterans receive
compensation for tinnitus

Men

Senior Citizens

Caucasians

Other At Risk Populations

Workers in loud environments

- Autoworkers
- Firefighters/Police/EMT
- Manufacturing Jobs

Those who have had a traumatic brain injury

- May be caused by the injury
- May be caused by medications used to treat injuries



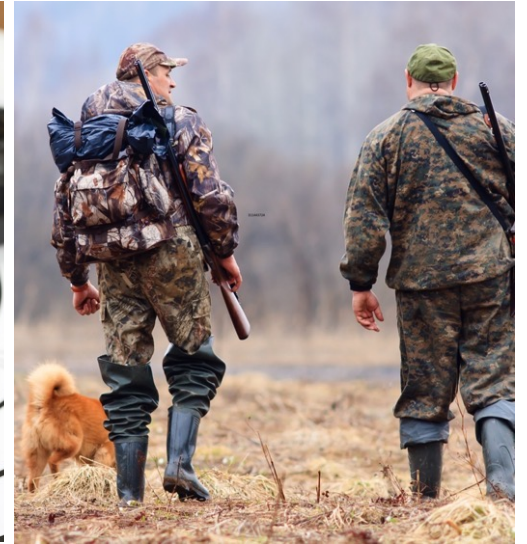
Recreational Noise Exposure

Musicians and Music Lovers

Motorsports and Hunting Enthusiasts

Gamers

iPod/Personal Listening Device Use



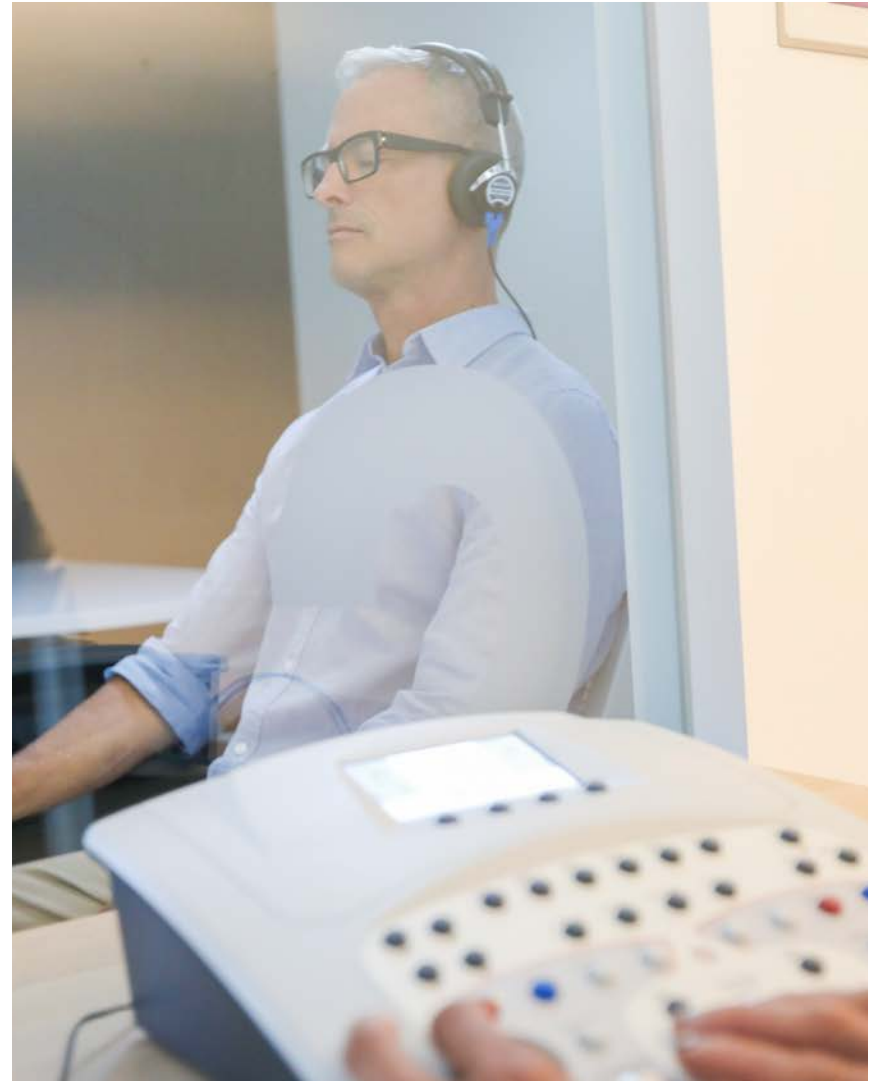
Tinnitus and Hearing Loss

Any degree of hearing loss

Any type of hearing loss

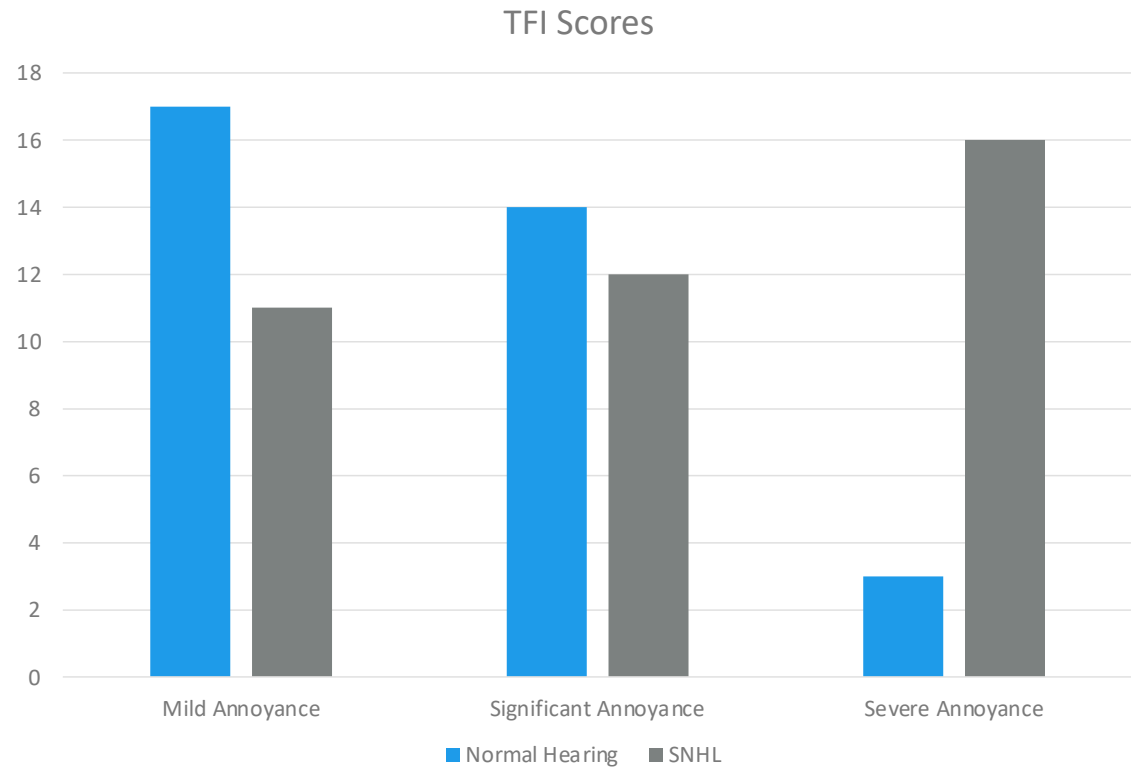
Any cause or type of onset

Changes in hearing loss and changes in tinnitus tend to occur independently of one another



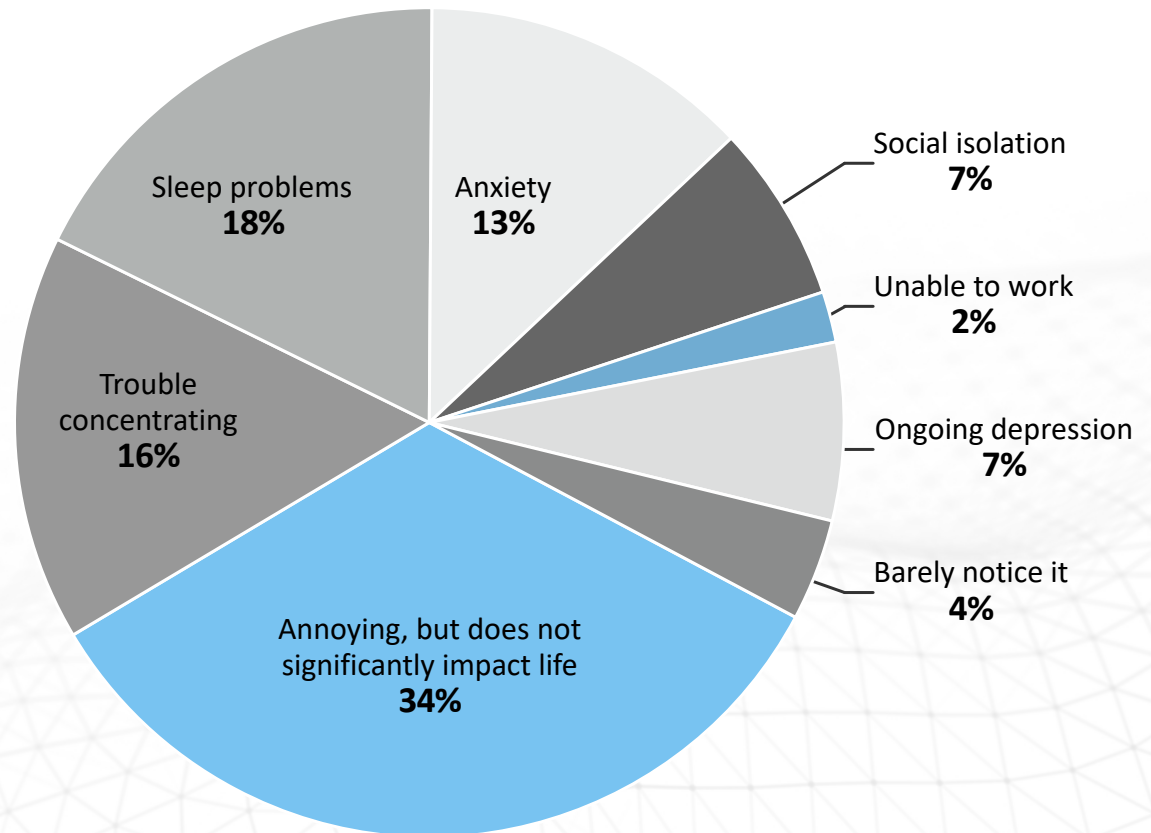
Tinnitus and Hearing Loss

No correlation between tinnitus severity and hearing threshold, though those with hearing loss are found to have a higher tinnitus severity.



Quality of life impacts

- Thoughts and Emotions
- Sleep
- Concentration
- Socialization
- Physical Health
- Economic well-being





Evaluation and Treatment



Hear better. Live better.

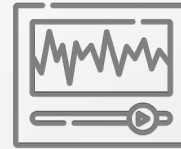
Evaluation



Self-
Assessment



Case History



Audiological
Assessment



Counsel/
Treatment

Treatment Options



Provider Driven



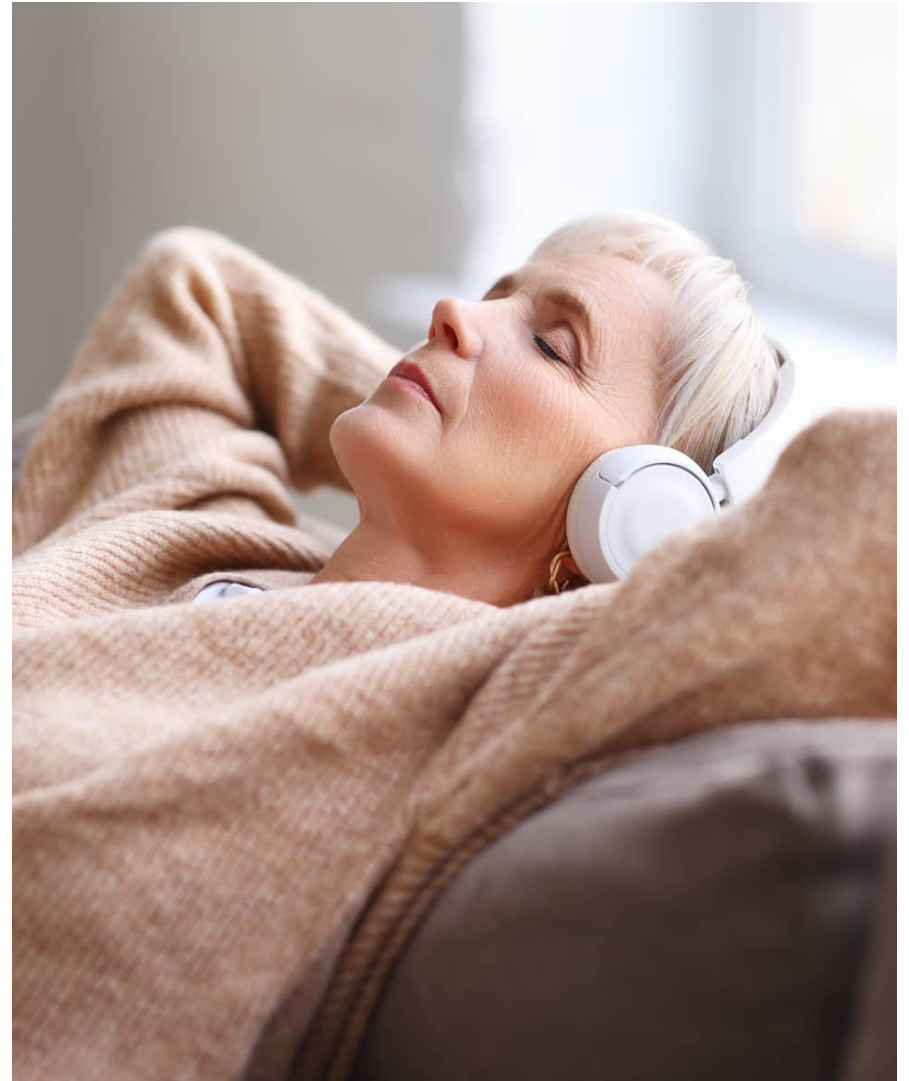
Patient Driven



Referral

Sound Therapy

Tinnitus sound therapy uses a process known as **habituation** to retrain the way the brain interprets tinnitus.



Sound Therapy Options

MASKING

DISTRACTION

HABITUATION

NEUROMODULATION

Sound Masking Devices

Hearing Aids

Modified-Sound/
Notched-Music Devices

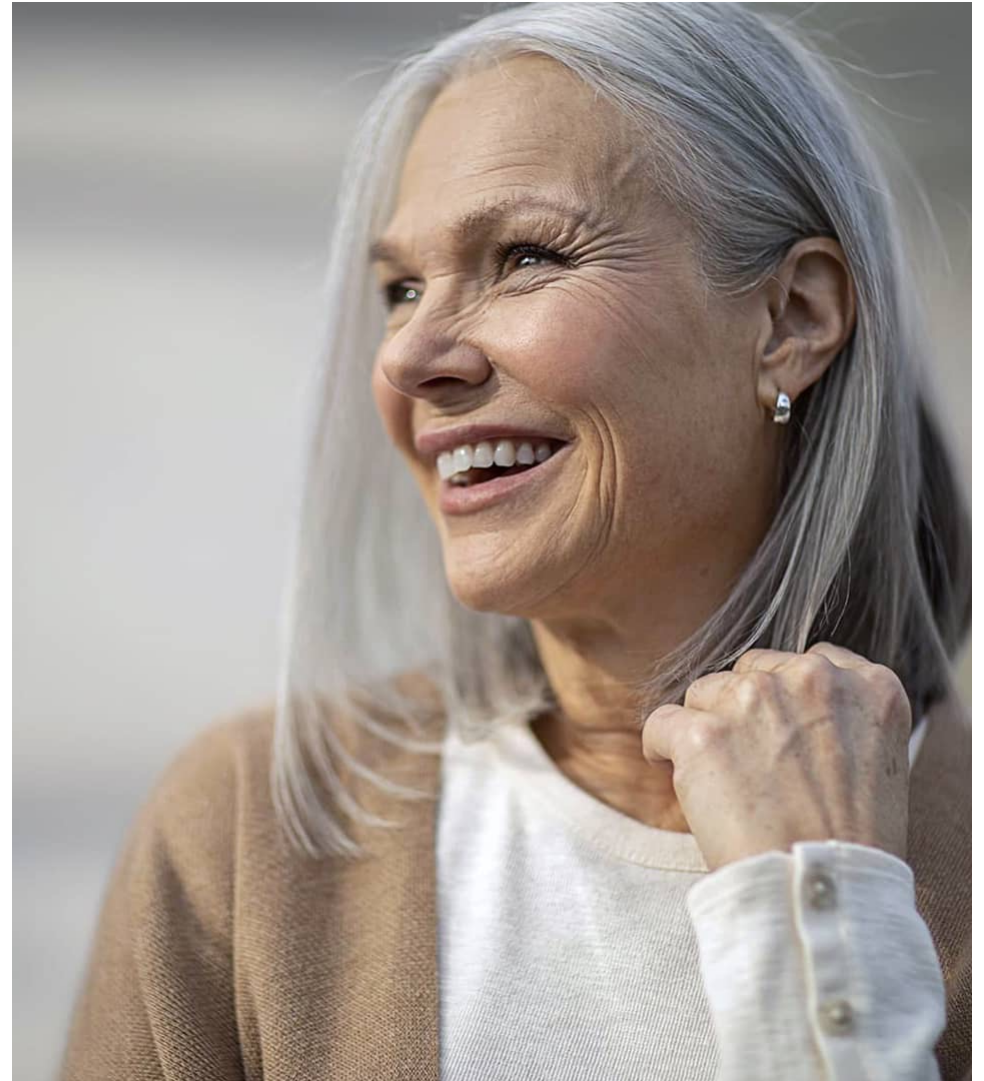
Sound and Sleep Apps

Sound Therapy
Devices

Maskers in Hearing Aids

Acoustic Therapy is using sound stimulation either from amplification of external sounds or the generation of additional sounds.

Tinnitus maskers are additional sounds generated that are typically set at a level below a patient's tinnitus to potentially cover it up.



Masks in Hearing Aids

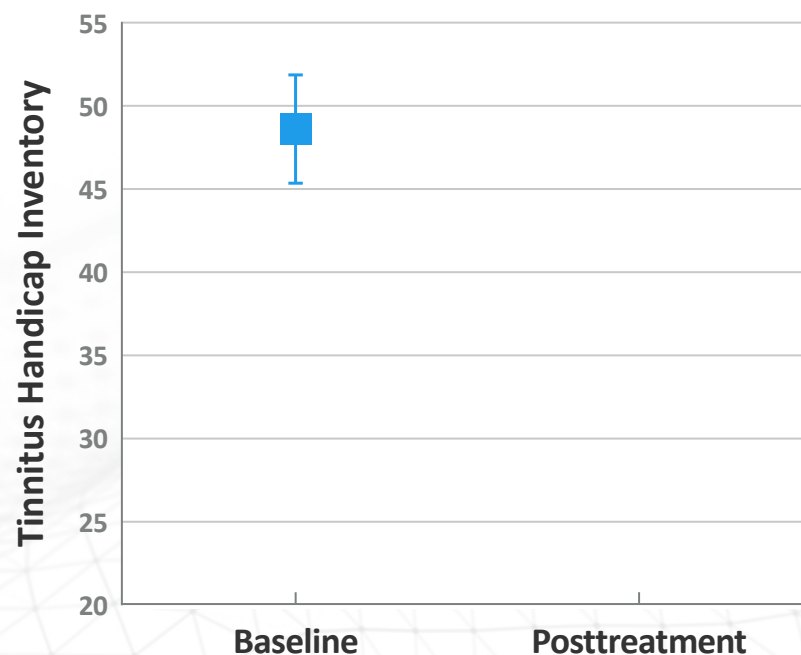
RESEARCH DATA

In this study, participants were provided multiple masker options to use at their discretion in order to achieve tinnitus relief.

Study was comprised of 26 individuals with hearing loss

Participants completed an 8-week field trial wearing hearing aids providing acoustic therapy via three tinnitus masker options set just below minimum masking level.

Tinnitus Handicap Inventory was used before starting acoustic therapy and posttreatment to measure the patients' tinnitus handicap.



Source: *Journal of Speech, Language, and Hearing Research*, Vol. 64, 1415, Figure 2, April 2021.

Masks in Hearing Aids

DATALOGGING RESULTS

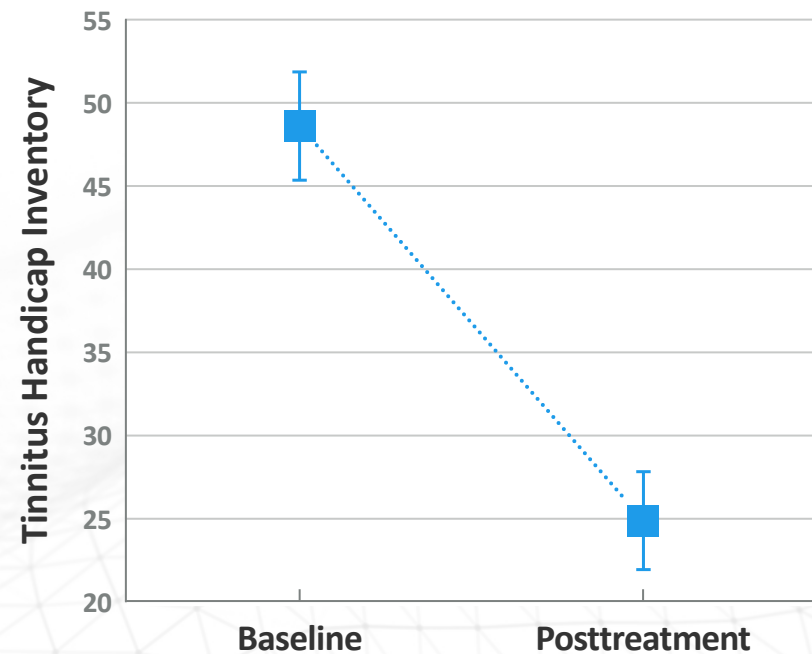
Average hearing aid use was 9.4 hr
(SD = 4.2 hr) during the field trial, and

Average of 34.4% of that time was spent
utilizing a tinnitus masker

13.8% with white noise;

10.5% with audiogram-shaped noise;

10.0% with custom noise



Source: Journal of Speech, Language, and Hearing Research, Vol. 64, 1415, Figure 2, April 2021.

Tinnitus Protocols

Tinnitus Retraining Therapy

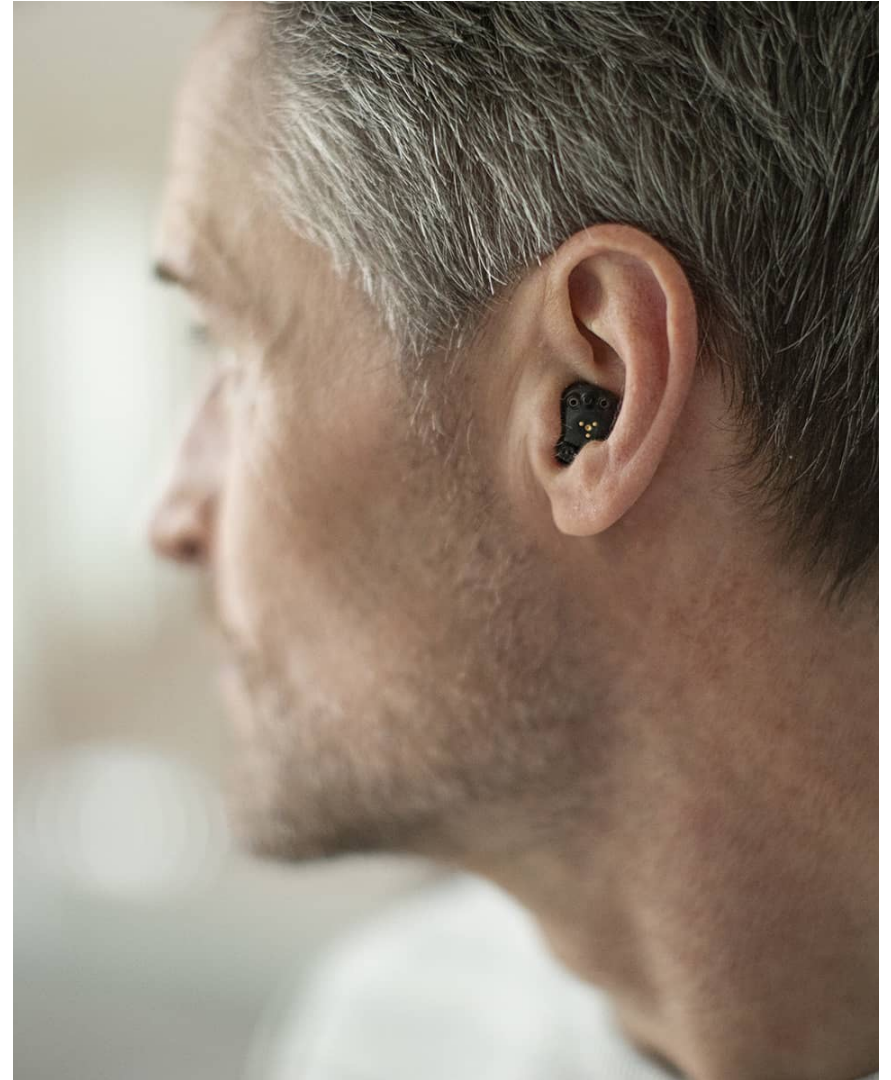
Dr. Pawell Jastreboff

Progressive Tinnitus Management

National Center for Rehabilitative Auditory Research

Tinnitus Activities Treatment

Dr. Richard Tyler at the University of Iowa



Treatment Options



Provider Driven



Patient Driven



Referral



Lifestyle Management

Quit Smoking

Diet Change

Getting a better night's rest

Relaxation/Meditation

Exercise

Support Groups

Treatment Options



Provider Driven



Patient Driven



Referral

Cognitive Behavioral Therapy

Modify thoughts and beliefs to decrease negative behaviors

Cognitive Skills

Reduce negative thinking, develop a habituation perspective on tinnitus, and become an effective self-coach to guide yourself through the process

Mindfulness Skills

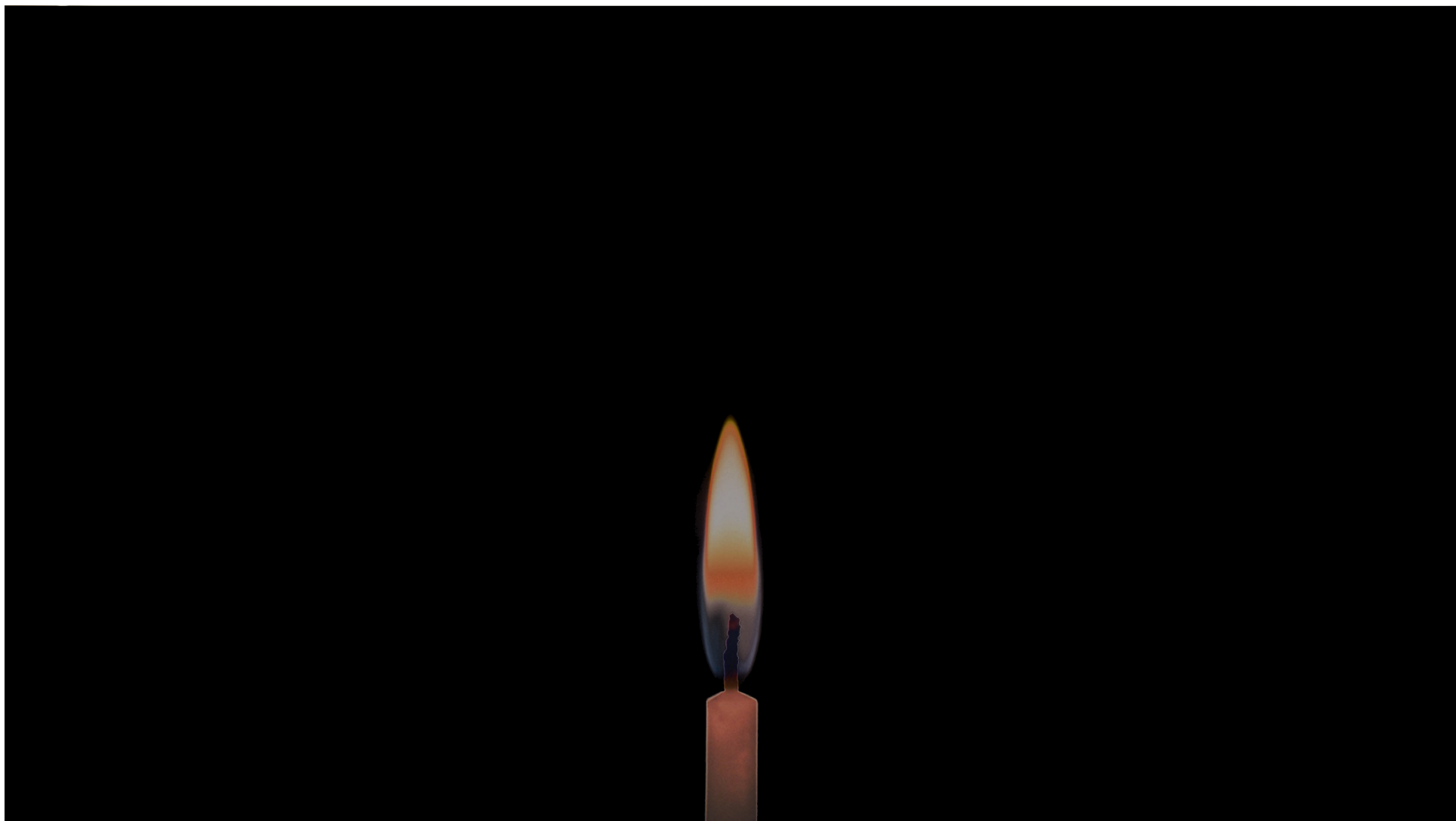
Calm down, promote tinnitus acceptance, and regain control of attention

Self-Guided Sound Enrichment

Soften your perception of tinnitus

Behavioral Skills

Take the courageous action needed to **fully** rejoin your life



Multiflex Tinnitus Pro

**Next generation feature for sound
therapy tinnitus management**

Three stimulus options to
effectively mask the user's tinnitus:

- White Noise
- Audiogram-shaped
- Custom

GENESIS^{AI}

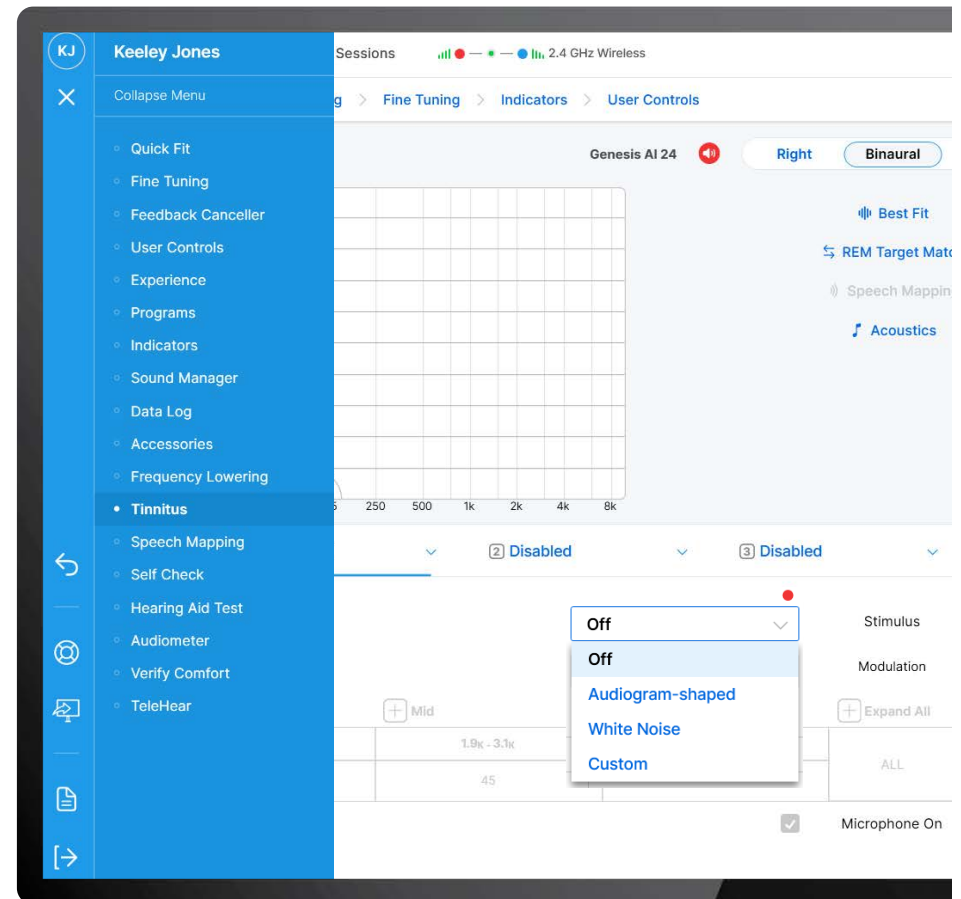
2400



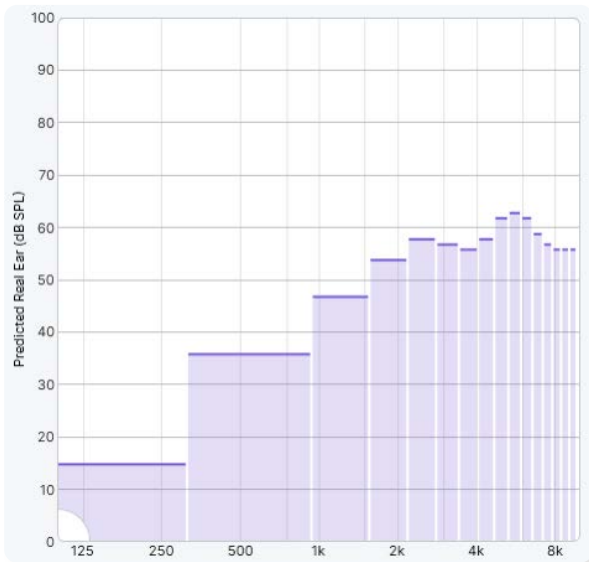
AVAILABLE ON ALL STYLES

Multiflex Tinnitus Pro

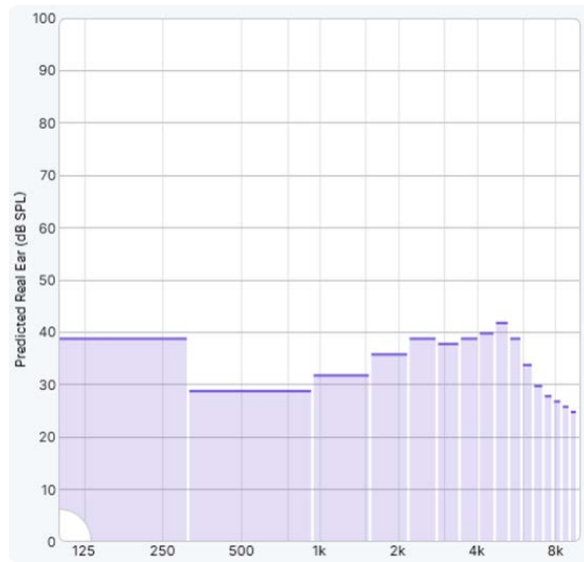
- Accessed from the Fly Out Menu within Pro Fit
- Use the dropdown menu to select the stimulus type
- All options offer a 10,000 Hz bandwidth with 16 bands of adjustability



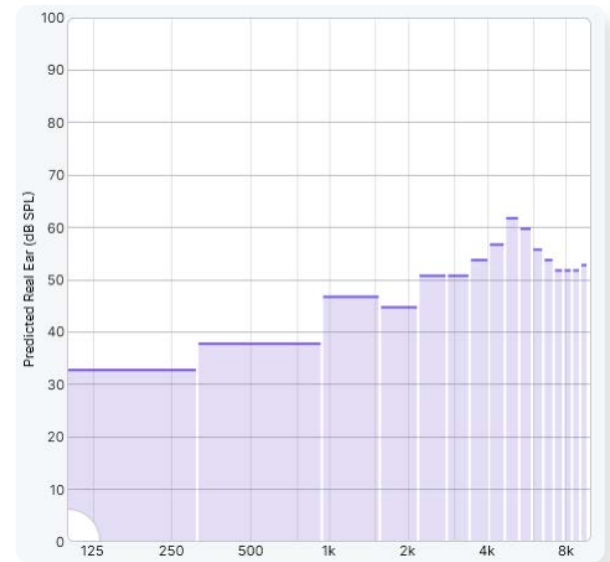
Starkey **Pro Fit** Tinnitus Stimuli



White Noise
Pure Tone Average
Genesis AI 24, 20, 16, and 12



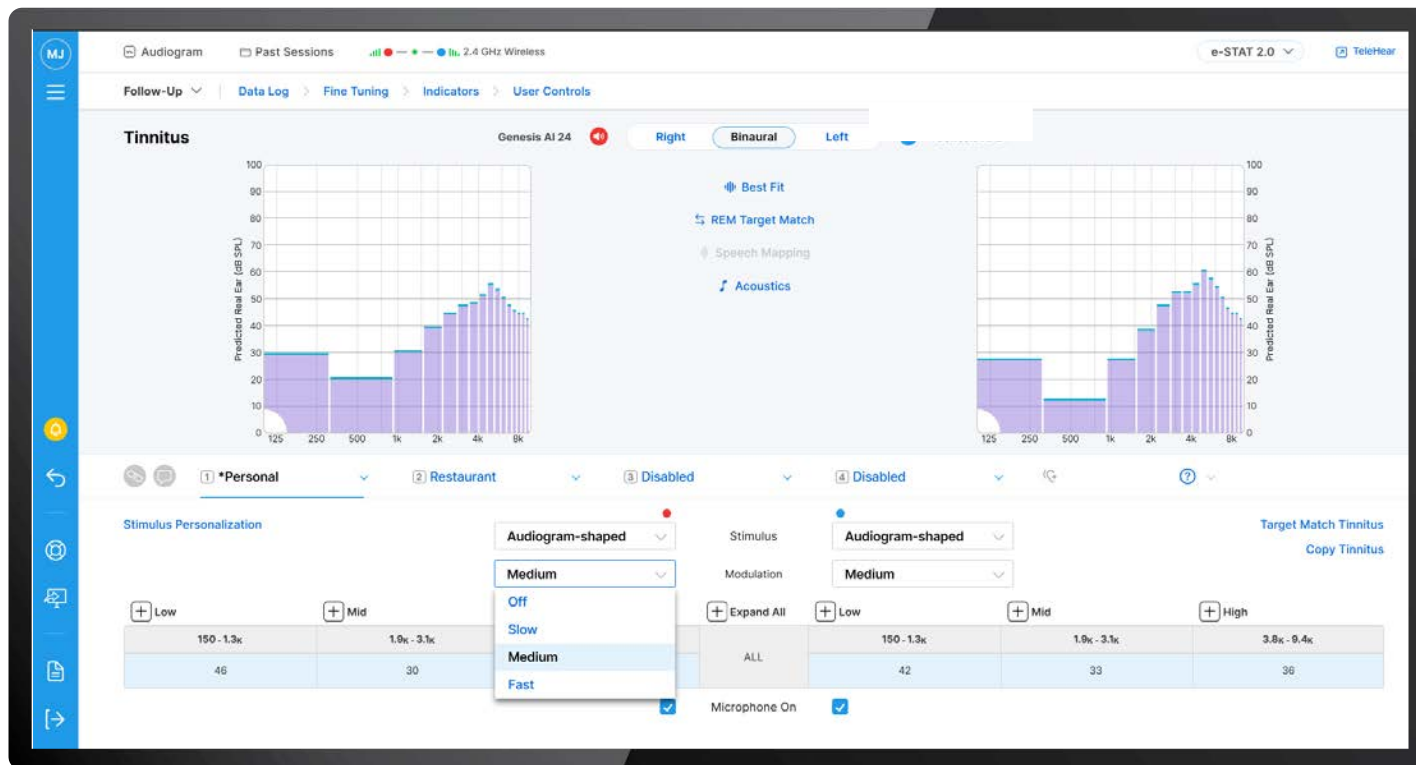
Audiogram Shaped
Hearing Loss
Genesis AI 24, 20, and 16



Custom
Custom Shaping
Genesis AI 24 and 20

Modulation

Modulation is available for all the Multiflex Tinnitus stimulus options



A healthcare professional, a woman with dark hair in a ponytail, is pointing at a computer monitor. A patient, a man with grey hair and glasses, is looking at the screen with his hands clasped. A young boy is also looking at the screen. The monitor displays a software interface with a map and various data points. The text "Patient Involvement" is overlaid on the image in a large, white, serif font. Below it, a quote is displayed in a smaller, white, sans-serif font.

Patient Involvement

“People actively involved in their health and healthcare tend to have better outcomes.”

("Health Policy Brief: Patient Engagement," Health Affairs, February 14, 2013)

Starkey **Pro Fit**

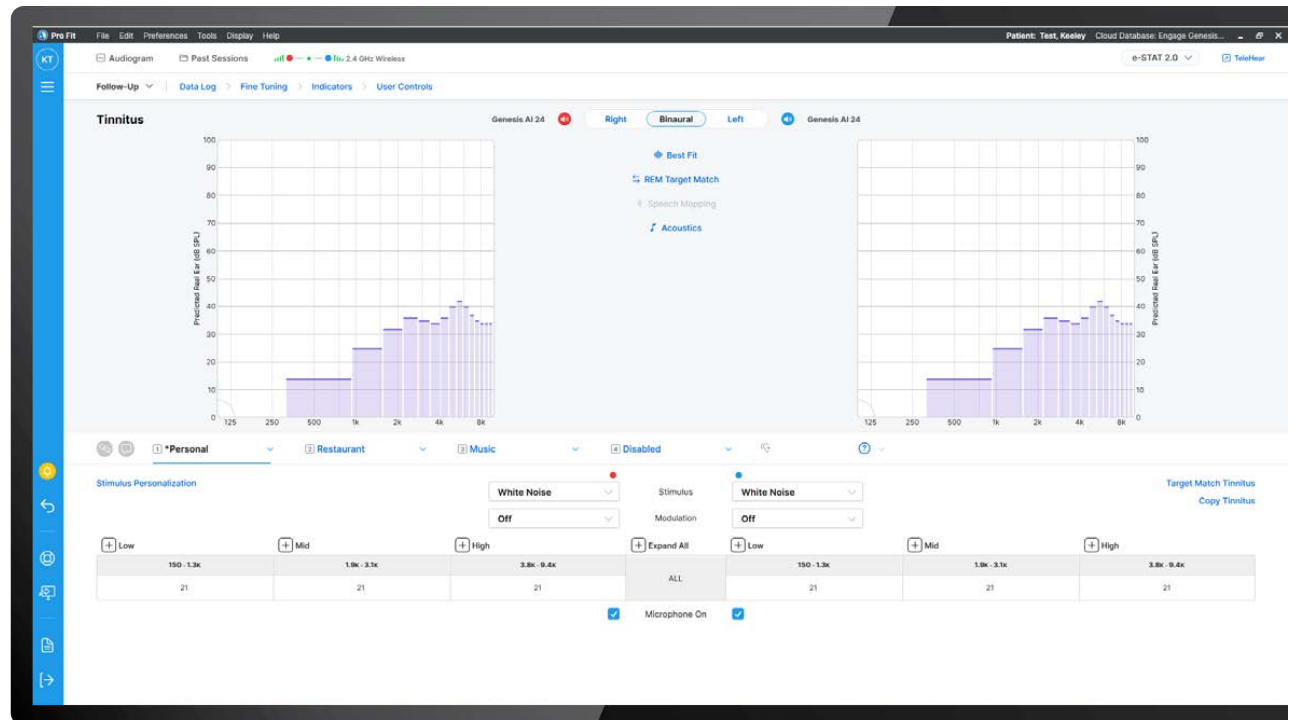
White Noise Tinnitus

Signal level based on the PTA and comprised of equal energy distribution across the frequencies.

Flat response may result in some segments of the stimulus being too loud or too soft

Vent interactions are accounted for

Stimulus is adjustable



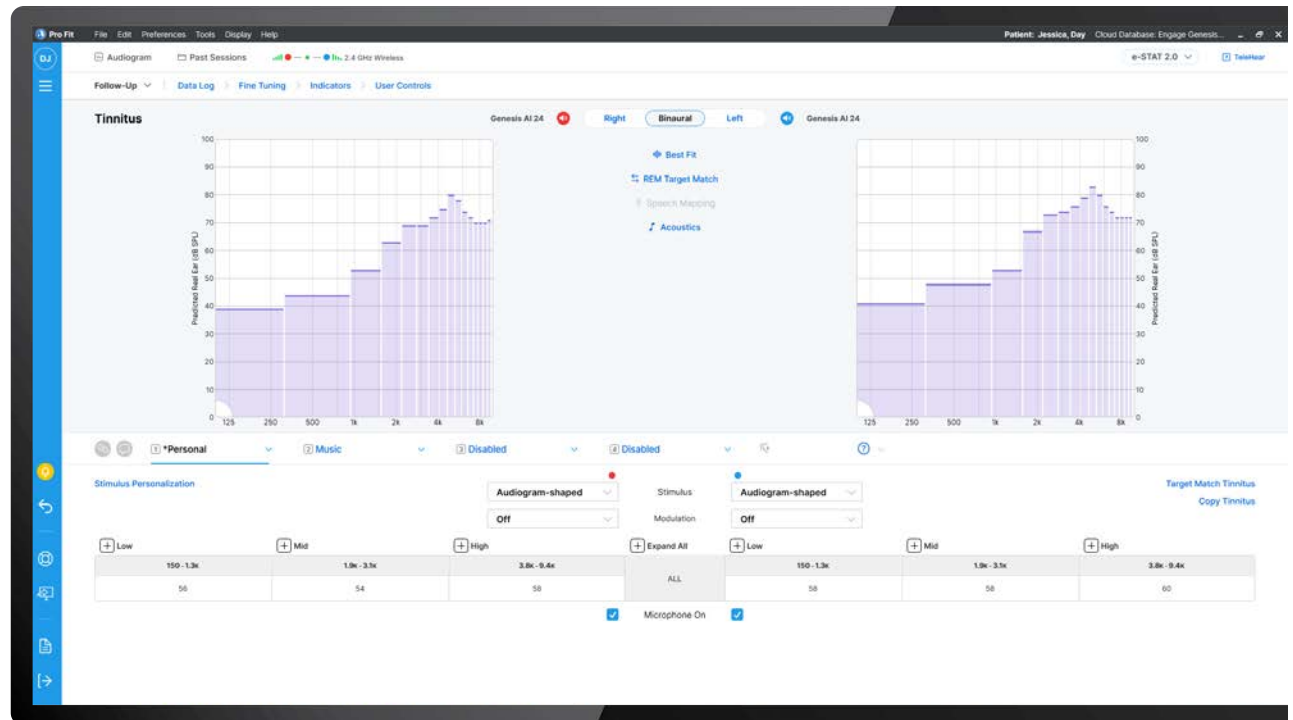
Starkey **Pro Fit**

Audiogram Shaped Tinnitus

Automatic shaping of the stimulus based on the hearing loss provides a more tailored masking stimulus

Vent interactions are accounted for

Stimulus is adjustable



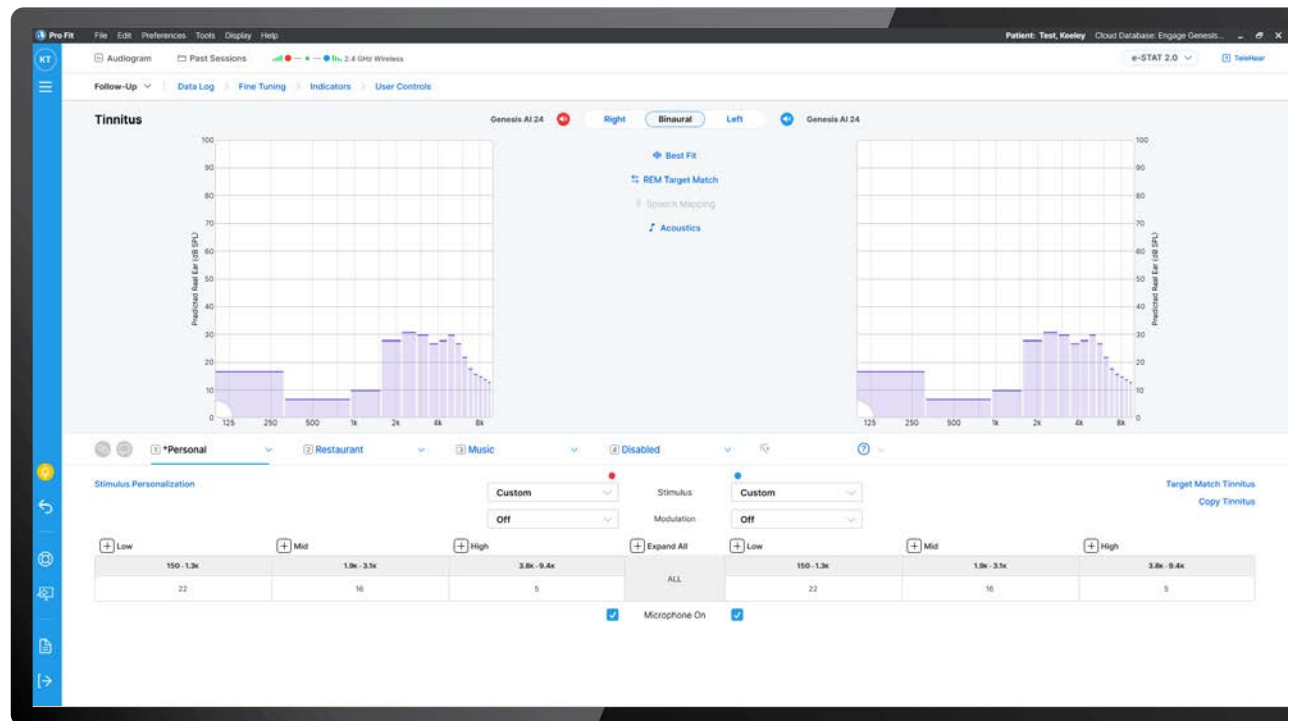
Starkey **Pro Fit**

Custom Tinnitus

Custom shaping of the stimulus provides a personalized stimulus for a greater degree of masking precision

Vent interactions are accounted for

Stimulus is adjustable



Efficient and Effective Masking

Stimulus Personalization Testing in Inspire typically only takes a few minutes and is less time consuming than tinnitus measurements like pitch-matching

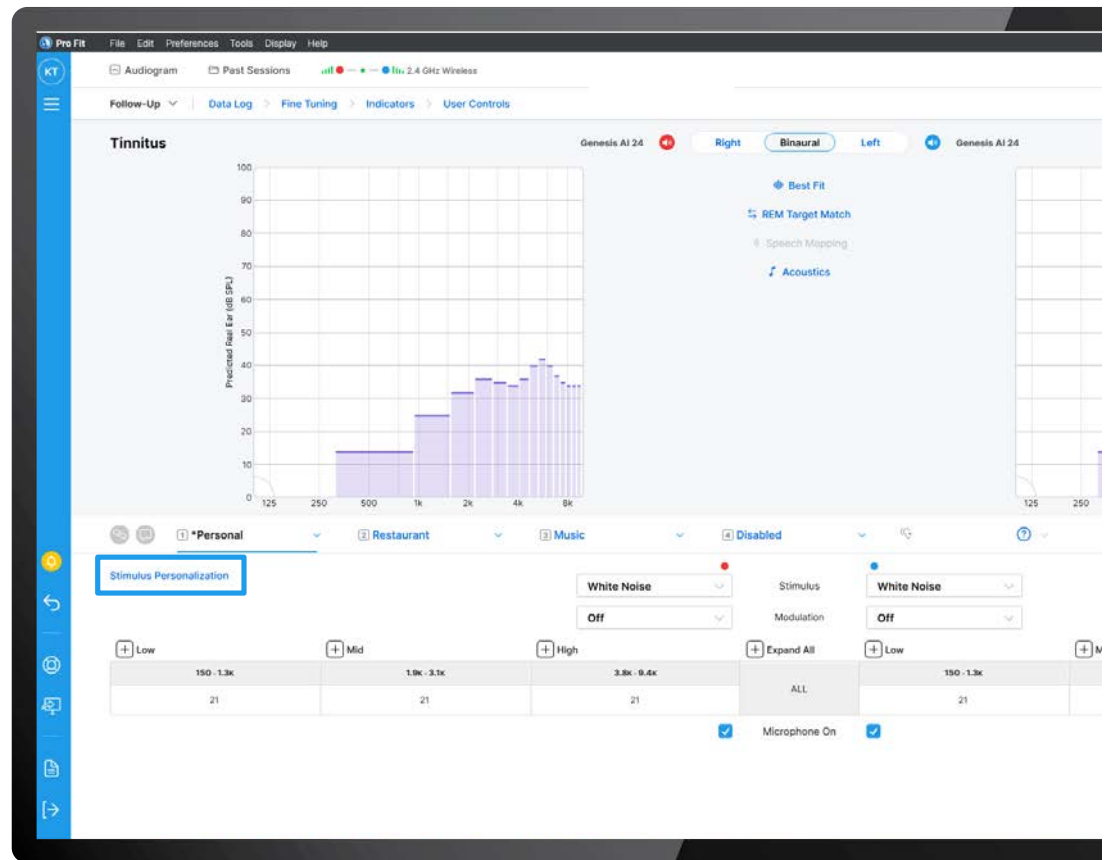
MDL and MML measurements can be used to rapidly design a stimulus that is both efficient and effective at masking tinnitus

To efficiently mask tinnitus, only those frequency bands that are effective at masking tinnitus should be included in the stimulus, and the level of the stimulus in these bands should be no greater than needed to achieve masking

Fournier et al., 2018

Multiflex Tinnitus Pro Tool

To create a Custom tinnitus stimulus, go to the Tinnitus screen in Inspire and click on “Stimulus Personalization”



Starkey Pro Fit

Custom Tinnitus

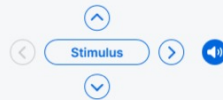
Stimulus Personalization



Minimum Detection Level Test

- To enable presentation of the masker, click the Stimulus button
- Presentation of the stimulus is constant when enabled
- First, determine stimulus Minimum Detection Level (MDL) for each of three frequency groups
- Click the arrow to move to the next frequency group
- Once MDL is measured for all three frequency groups, select Next to advance to the Minimum Masking Level (MML) test

[? more details](#)



Next

Cancel

Stimulus Personalization



Minimum Masking Level Test

- To enable presentation of the masker, click the Stimulus button
- Presentation of the stimulus is constant when enabled
- First, determine stimulus Minimum Detection Level (MDL) for each of three frequency groups
- Click the arrow to move to the next frequency group
- Once MDL is measured for all three frequency groups, select Next to advance to the Minimum Masking Level (MML) test

[? more details](#)

☐ Could Not Test

☐ Could Not Test



Apply Binaural

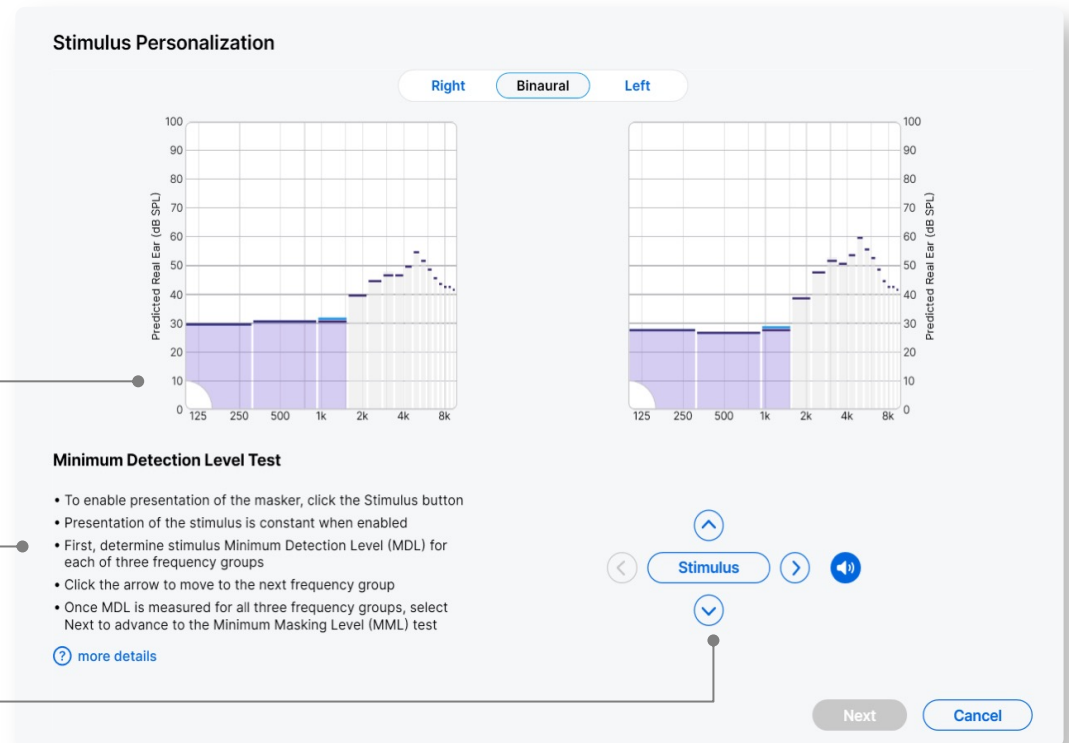
Cancel

Multiflex Tinnitus Pro Tool Display

Active frequency region

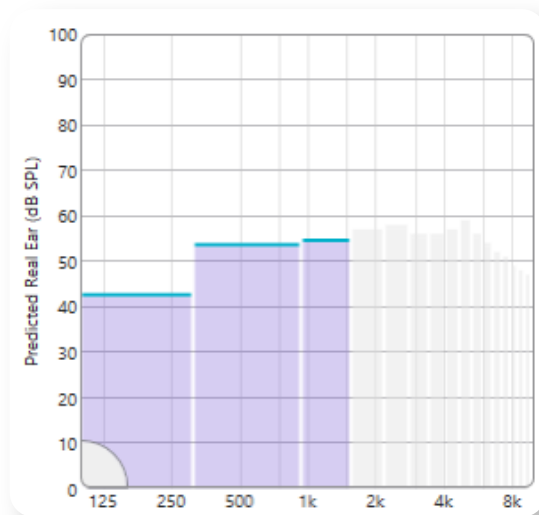
Instructions

Stimulus Controls

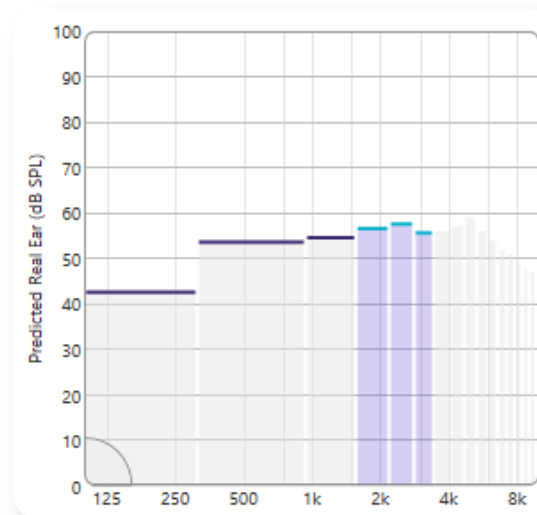


Frequency Groups

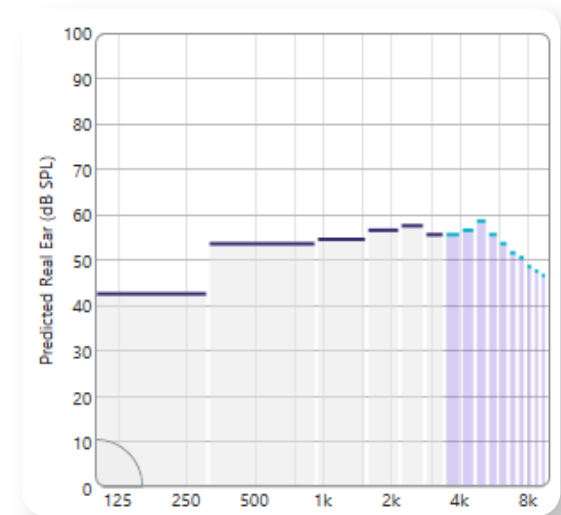
Frequency groupings are consistent with the low, mid and high band groupings in Inspire



Low
150 Hz to 1.3 kHz

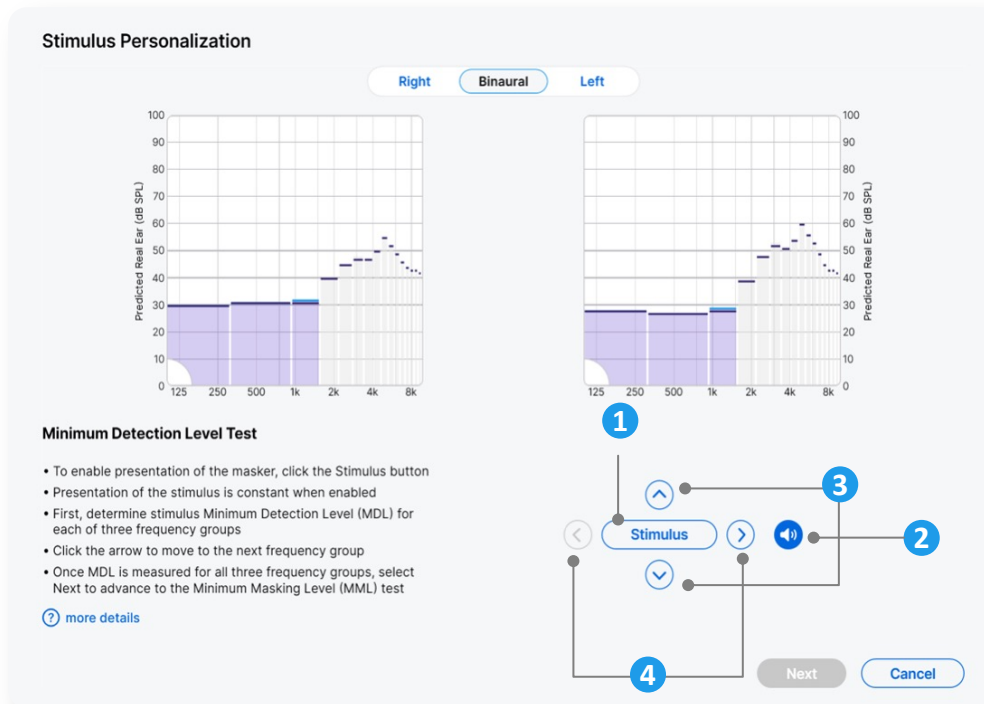


Mid
1.9 kHz to 3.1 kHz



High
3.8 kHz to 9.4 kHz

Minimum Detection Level (MDL) Test



GOAL

To identify the softest detectable level of the Multiflex Tinnitus stimulus

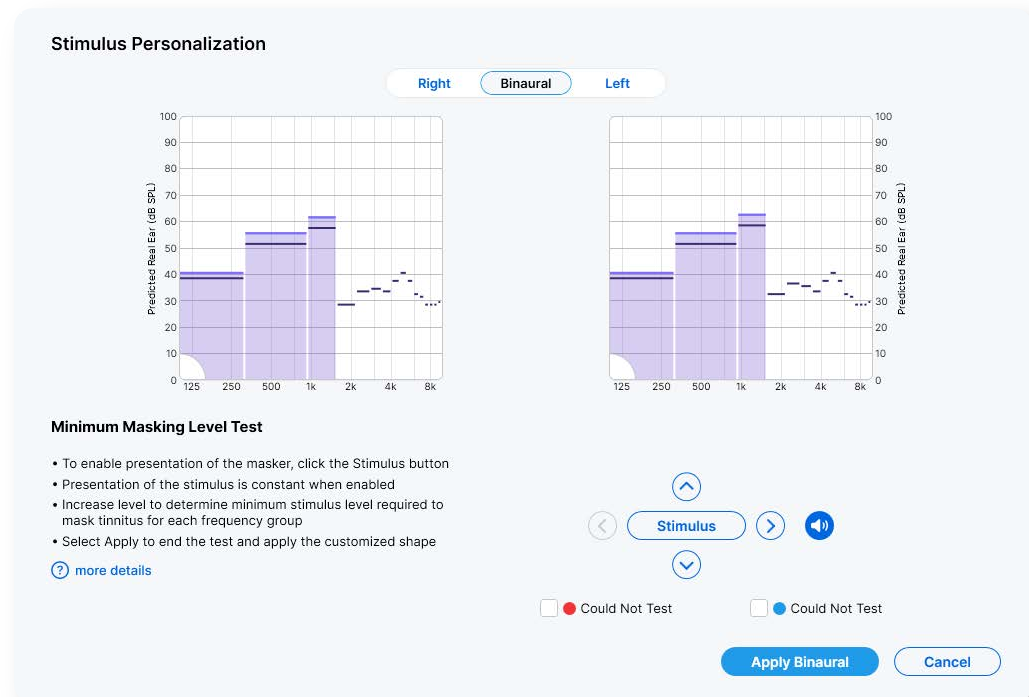
- 1 Click on the 'Stimulus' button to turn it ON
- 2 Hearing aid microphones will mute automatically when the stimulus is ON
- 3 Use the up and down arrows to increase or decrease the level of the stimulus in the frequency group displayed to **identify when the stimulus is just detectable**
- 4 Use the right and left arrows to make measurements in the other frequency groups

Minimum Masking Level (MML) Test

GOAL

To identify the softest level of the Multiflex Tinnitus stimulus required to just notice or mask the tinnitus depending on the management approach of choice

- Display and controls are the same for this test
- Increase the stimulus level to determine ***the softest stimulus level required to just detect or mask the tinnitus*** for each of the three frequency groups



Tinnitus Stimulus

User Controls

Short Press	Short Press
Tinnitus Level	Volume
☒ Ear to Ear →	← ☒ Ear to Ear
Push & Hold	Push & Hold
Program	Disabled
☒ Ear to Ear →	☐ Ear to Ear
Double Tap	Double Tap
Edge Mode+	Smart Assistant
☒ Ear to Ear →	☐ Ear to Ear

Output Range and Step Size

User Control Settings

Manage Phone Calls

VC Range and Step Size

Tinnitus Output Range and Step Size

Tinnitus Output Range: -6dB to 6dB

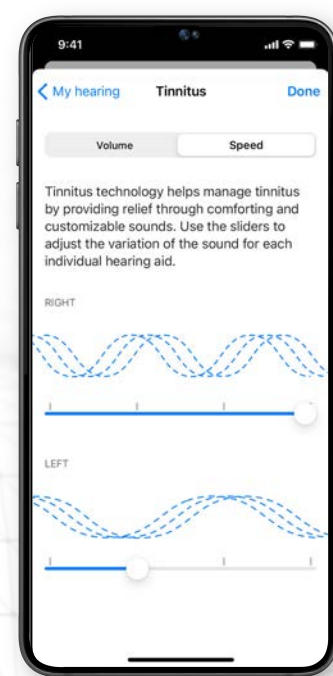
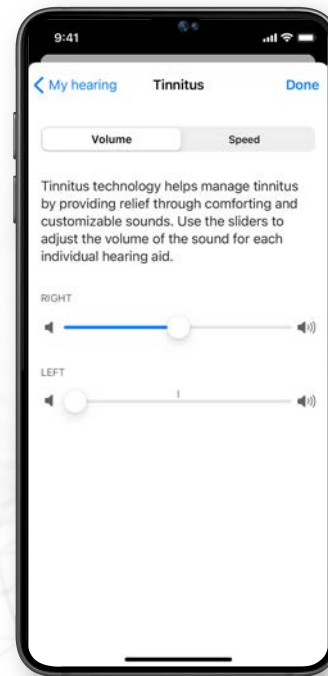
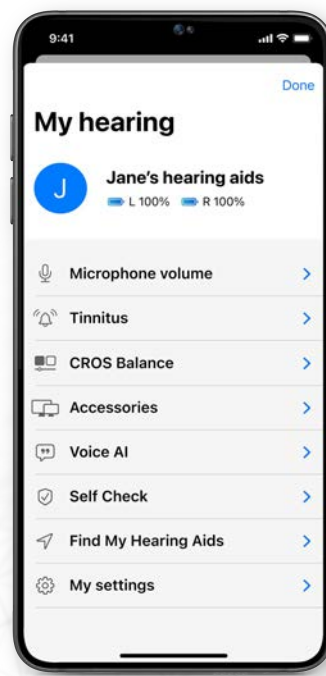
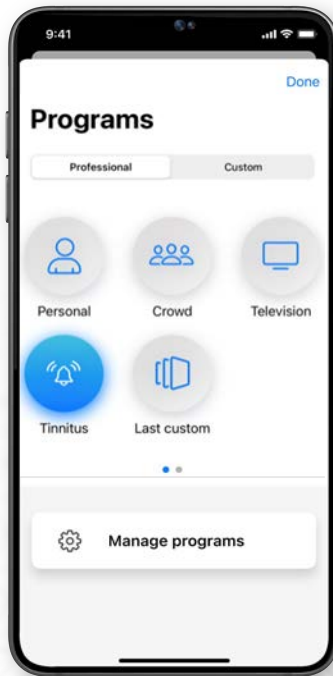
Step Size: 2 dB 4 dB

Tinnitus Output Range: -6dB to 6dB

Step Size: 2 dB 4 dB

Additional Configuration Options

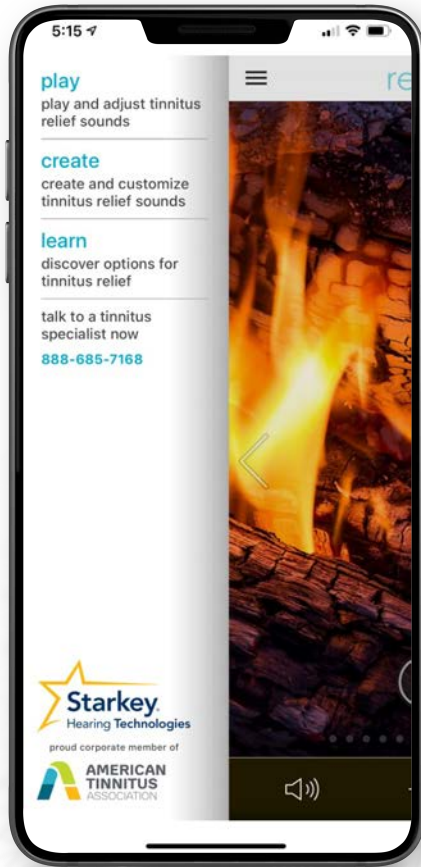
My Starkey Controls



relax

Relief sounds and
education for patients
who have tinnitus

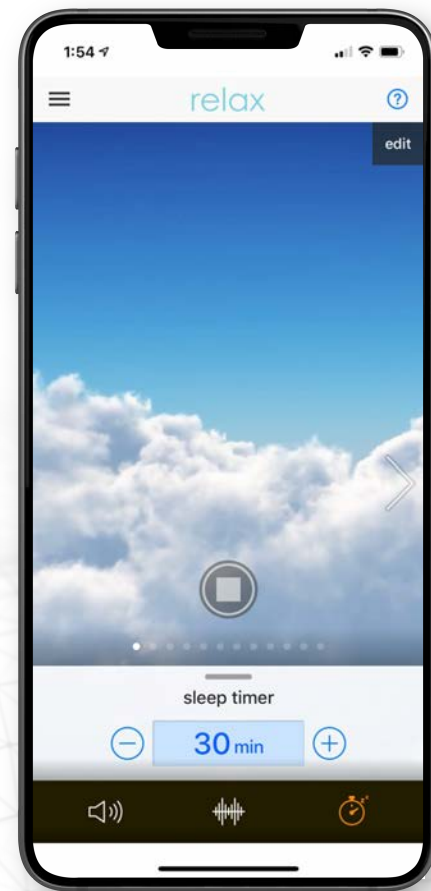
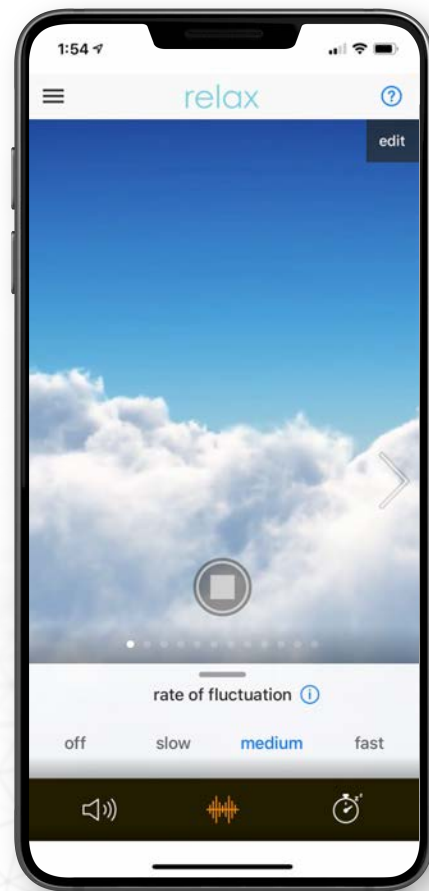


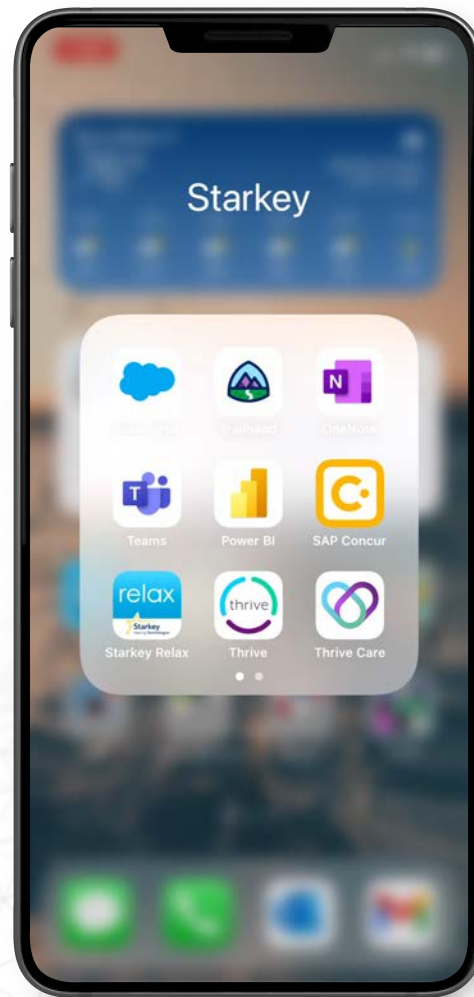


Easy to use app with a variety of sound stimuli and links to information from Starkey and American Tinnitus Association

12 different
stimuli options









Case Studies



Case Study 1

Daisy

- 36 years old
- Nurse
- Mild SNHL
- Binaurally fit with Genesis AI mRIC 2400

Daisy has binaural tinnitus and hearing loss from her Meniere's diagnosis that fluctuates in an unpredictable manner. She has not been successful with hearing aids alone in the past due to the rise in her tinnitus symptoms.

What tinnitus configuration would you recommend?



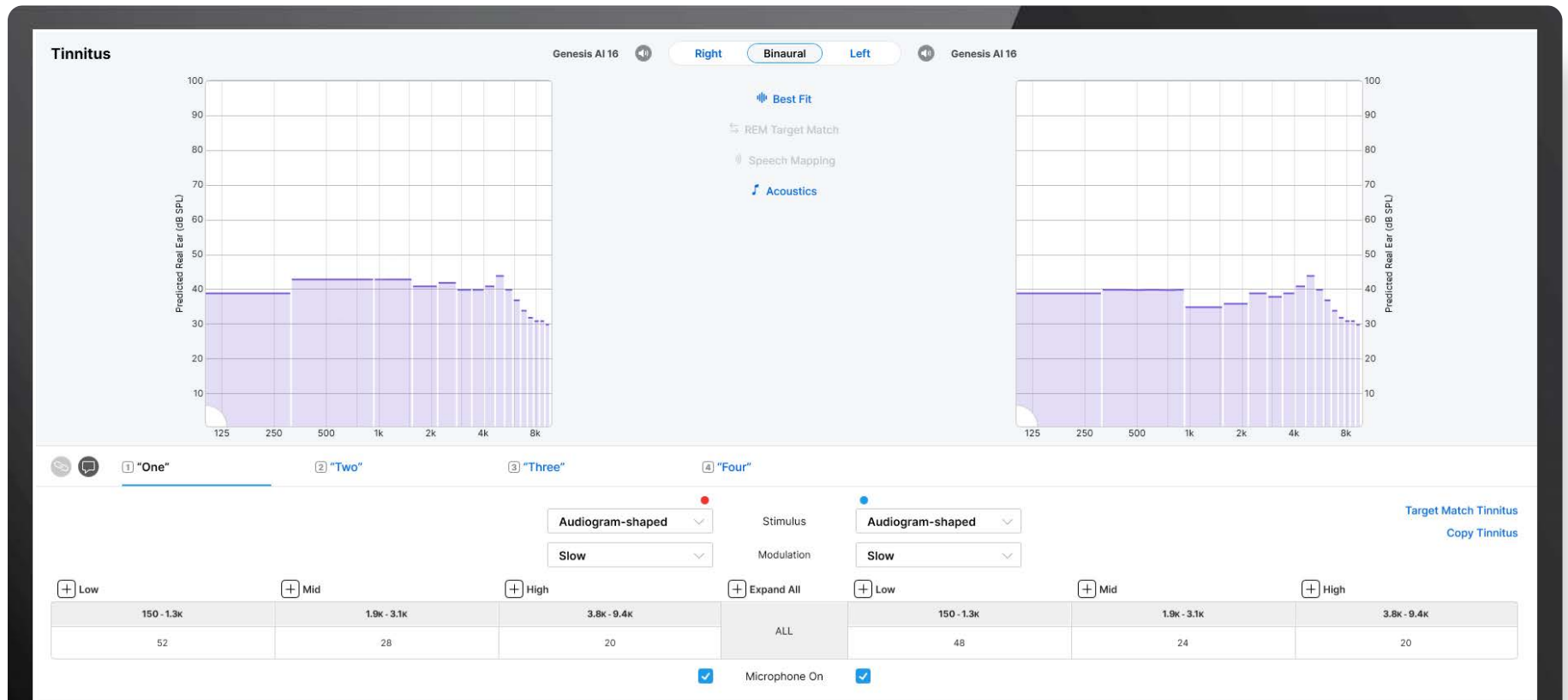
Pro Fit Configuration

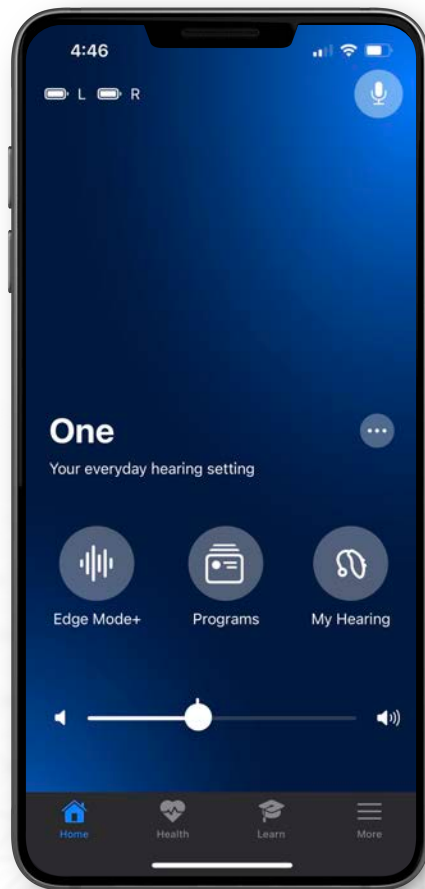
Multicurve View:

Multiple “Personal” Programs

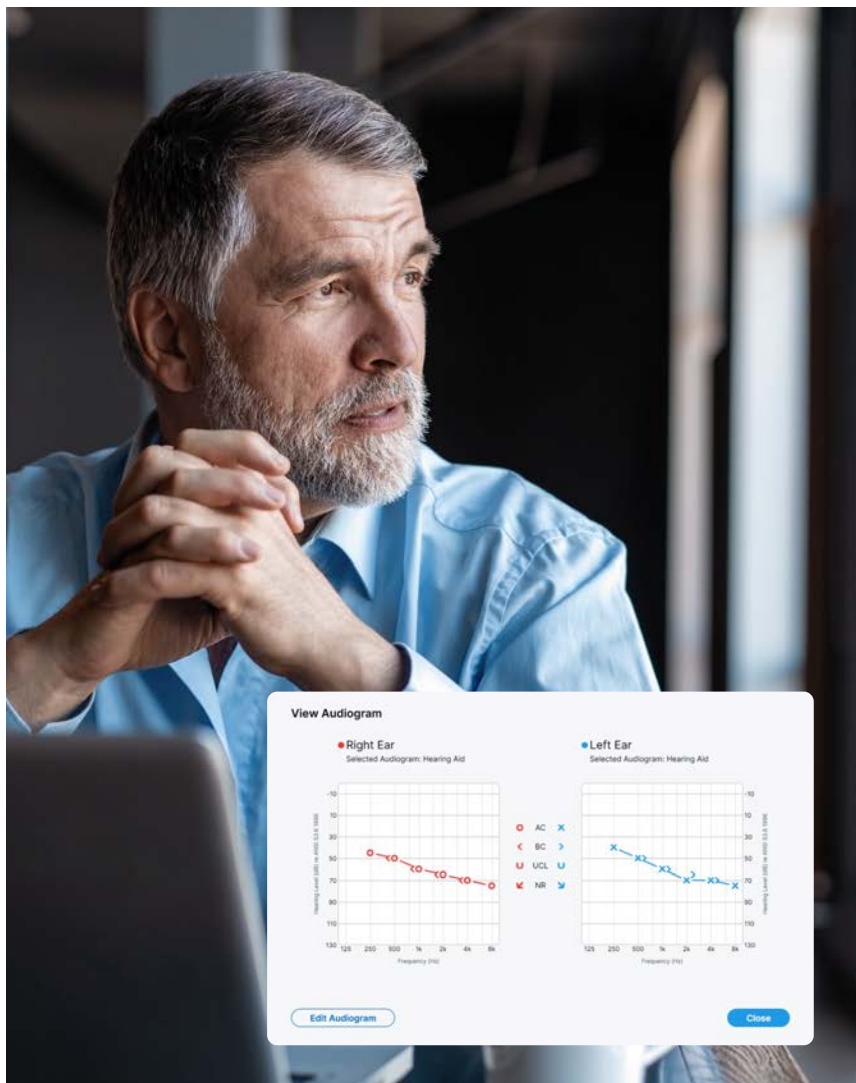
Varying amounts of gain for fluctuating hearing loss

Tinnitus Masker- Audiogram shaped with slow modulation for all four programs





My Starkey Options



Case Study 2

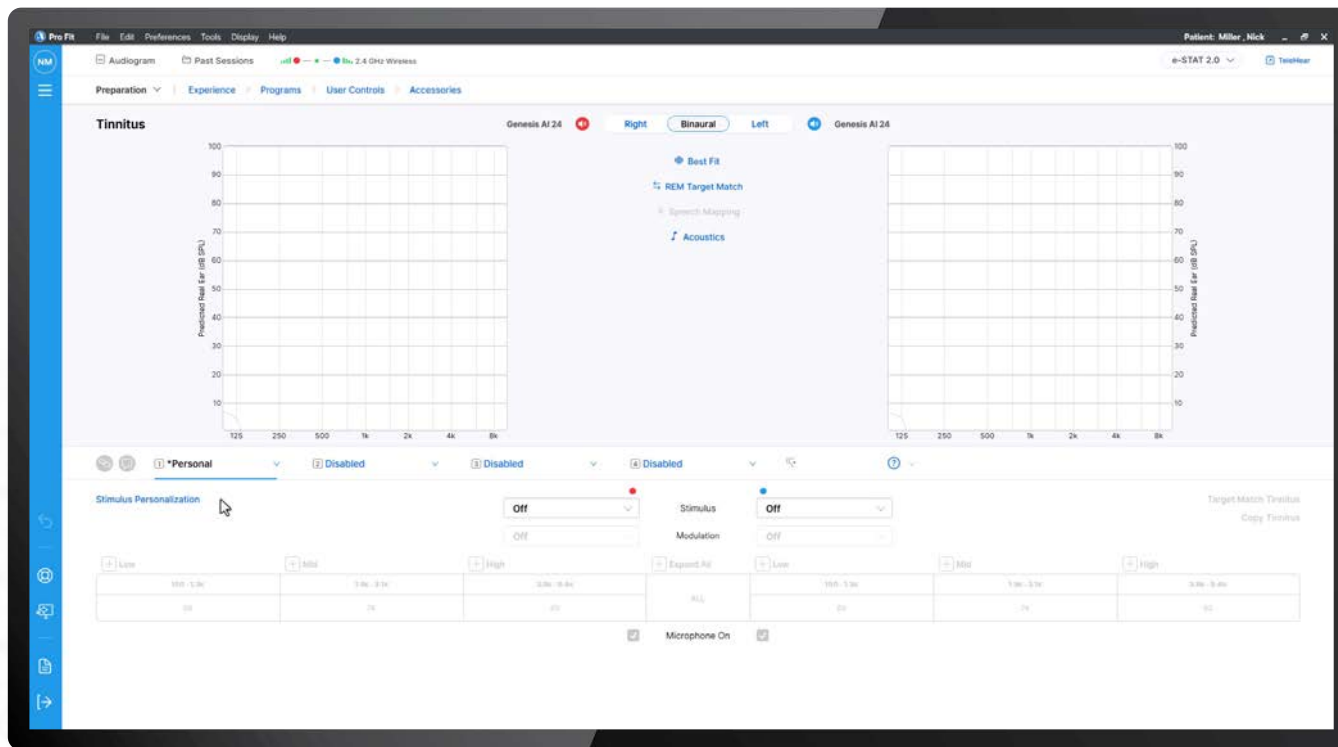
Nick

- 52 years old
- Office Manager
- Moderate to Severe SNHL
- Binaurally Fit with Genesis AI 2000 CIC NW

Nick suffers from misophonia and so when working in his office the flickering of the fluorescents in the office are a trigger.

What solution could be offered to Mark?





Solution

Use the Stimulus Personalization wizard to build a custom stimulus based on masking their misophonia triggers.



Case Study 3

John

- 48 years old
- Construction Manager
- Normal hearing
- No hearing aids fit at this time

John has been in the construction industry for 20 years. He reports constant, bilateral tinnitus which interferes with his sleep. He is extremely opposed to wearing hearing aids.

How can we help him?



Solution

Starkey Relax

Sound for Masking

Set Modulation, Volume, and Timer



Case Study 4

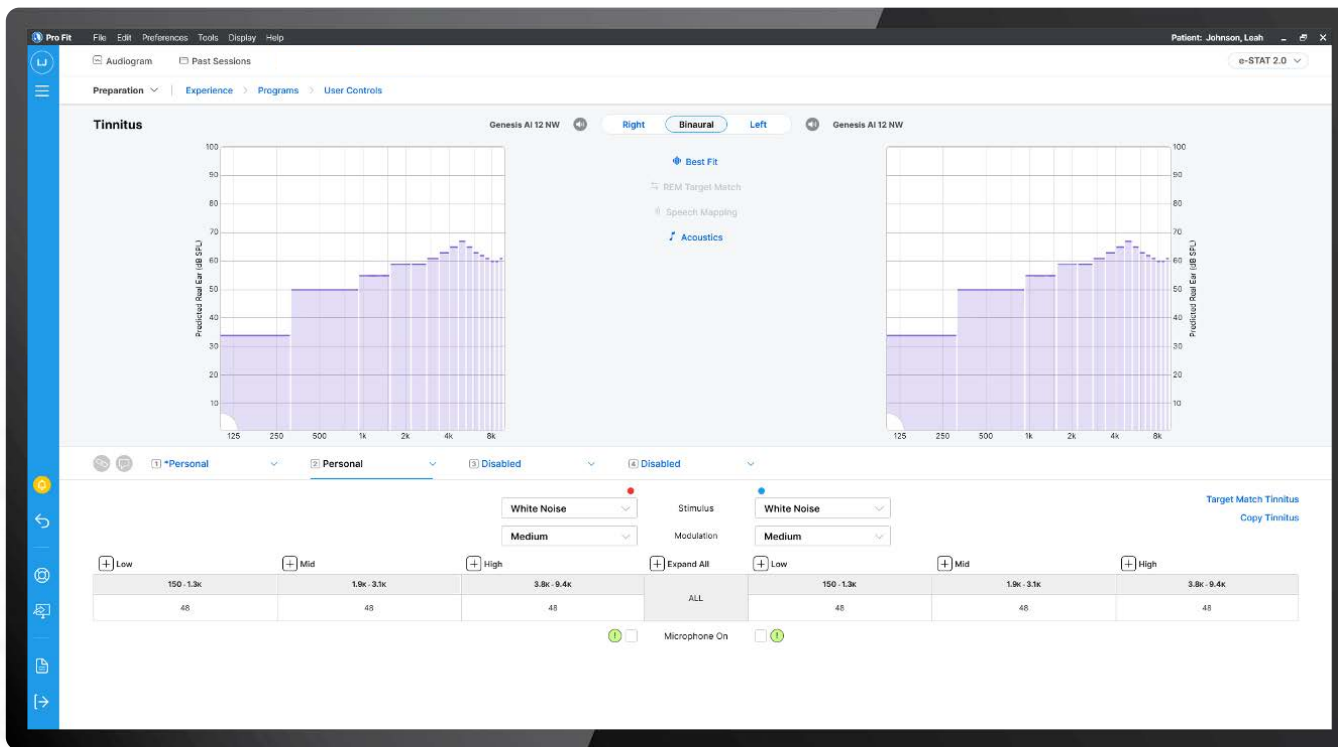
Leah

- 66 years old
- Cancer survivor
- Small business owner
- Moderate SNHL
- Fit with Genesis AI 1200 CIC NW

Leah reports hearing loss and tinnitus due to her treatment regimen. She reports intermittent, bilateral tinnitus with various expression. It flares up and becomes more intense when she has higher levels of stress.

How can we help her?





Solution

Gave her a secondary program just for a tinnitus masker



Case Study 5

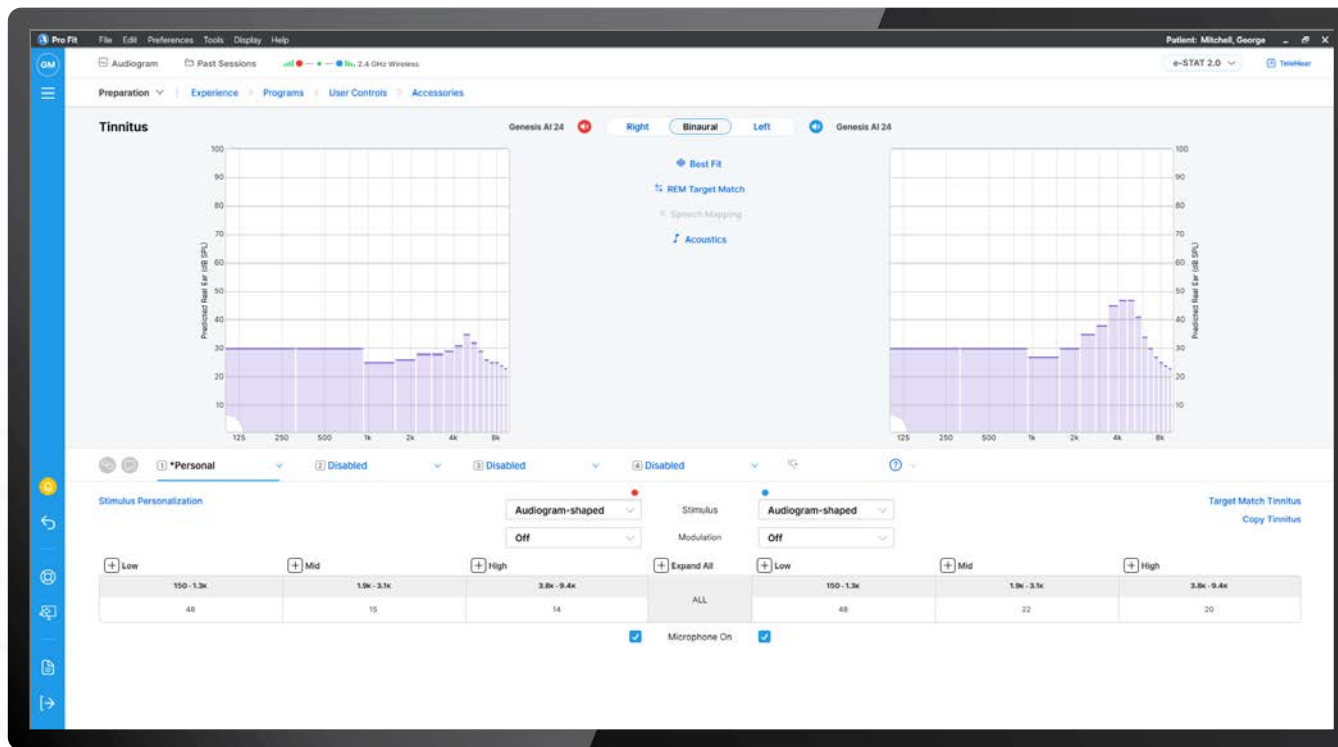
George

- 28 years old
- Martial Arts Instructor
- Noise Notch at 4k left ear only
- Bilateral tinnitus
- Fit with Genesis AI 16 RIC RT

George is a martial arts instructor who has essentially normal hearing with the exception of a mild noise notch in the left ear. All other medical evaluation came back clear but George struggles with bilateral tinnitus.

He is here today to discuss options





Solution

Used the Audiogram Shaped stimuli to account for his noise notch.

The quickest way to ruin a customer experience in healthcare is to treat everyone the same.

Patients don't want to feel like just another number.

They crave personalized service that helps them find the right solutions.

Hyken, S.

Personalized Customer Experience Increases Revenue And Loyalty.

Tinnitus Resources

American Tinnitus Association

www.ata.org

Tinnitus Research Initiative

www.tinnitusresearch.net

**National Center for Rehabilitative Auditory
Research (NCRAR)**

[www.ncrar.research.va.gov/Education/Documents/
TinnitusDocuments](http://www.ncrar.research.va.gov/Education/Documents/TinnitusDocuments)

American Academy of Audiology

www.audiology.org

Tinnitus Retraining Therapy

www.tinnitus-pjj.com

**University of Iowa Tinnitus & Hyperacusis
Research**

[www.medicine.uiowa.edu/oto/research/tinnitus-
and-hyperacusis](http://www.medicine.uiowa.edu/oto/research/tinnitus-and-hyperacusis)

Resources

StarkeyPro.com

- Multiflex Tinnitus Pro QuickTIP
- Multiflex Tinnitus Technology Handbook
- Tinnitus Handicap Inventory Questionnaire
- Tinnitus Consumer In Office Poster
- Patient Education Brochure: Tinnitus
- Tinnitus Technology Options Brochure

TINNITUS HANDICAP INVENTORY

Patient Name: _____ Date: _____

INSTRUCTIONS: The purpose of this questionnaire is to identify difficulties that you may be experiencing because of your tinnitus. Please answer every question. Please do not skip any questions.

1. Because of your tinnitus, is it difficult for you to concentrate?	Yes	Sometimes	No
2. Does the loudness of your tinnitus make it difficult for you to hear yourself?	Yes	Sometimes	No
3. Does your tinnitus make you angry?	Yes	Sometimes	No
4. Does your tinnitus make you feel frustrated?	Yes	Sometimes	No
5. Because of your tinnitus, do you feel depressed?	Yes	Sometimes	No
6. Do you compare a great deal about your tinnitus?	Yes	Sometimes	No
7. Because of your tinnitus, do you feel lonely when you sleep at night?	Yes	Sometimes	No
8. Do you feel as though you cannot escape your tinnitus?	Yes	Sometimes	No
9. Does your tinnitus interfere with your ability to enjoy your social activities (such as going to the movies, to the restaurant)?	Yes	Sometimes	No
10. Because of your tinnitus, do you feel that you have a nervous disorder?	Yes	Sometimes	No
11. Because of your tinnitus, do you feel that you have a nervous disorder?	Yes	Sometimes	No
12. Does your tinnitus make it difficult for you to sleep at night?	Yes	Sometimes	No
13. Does your tinnitus interfere with your job or household responsibilities?	Yes	Sometimes	No
14. Because of your tinnitus, do you feel that you are often lonely?	Yes	Sometimes	No
15. Because of your tinnitus, is it difficult for you to hear?	Yes	Sometimes	No
16. Does your tinnitus make you angry?	Yes	Sometimes	No
17. Do you feel that your tinnitus prevents you from doing as much as you would like to do?	Yes	Sometimes	No
18. Do you feel it difficult to focus your attention away from your tinnitus and on other things?	Yes	Sometimes	No
19. Do you feel that you have no control over your tinnitus?	Yes	Sometimes	No
20. Because of your tinnitus, do you often feel lonely?	Yes	Sometimes	No
21. Because of your tinnitus, do you feel depressed?	Yes	Sometimes	No
22. Does your tinnitus make you feel nervous?	Yes	Sometimes	No
23. Do you feel that you are not sleeping properly with your tinnitus?	Yes	Sometimes	No
24. Does your tinnitus get worse when you are under stress?	Yes	Sometimes	No
25. Does your tinnitus make you feel frustrated?	Yes	Sometimes	No

TOTAL SCORING AND DATA

Total Per Column: ☐ Yes ☐ Sometimes ☐ No

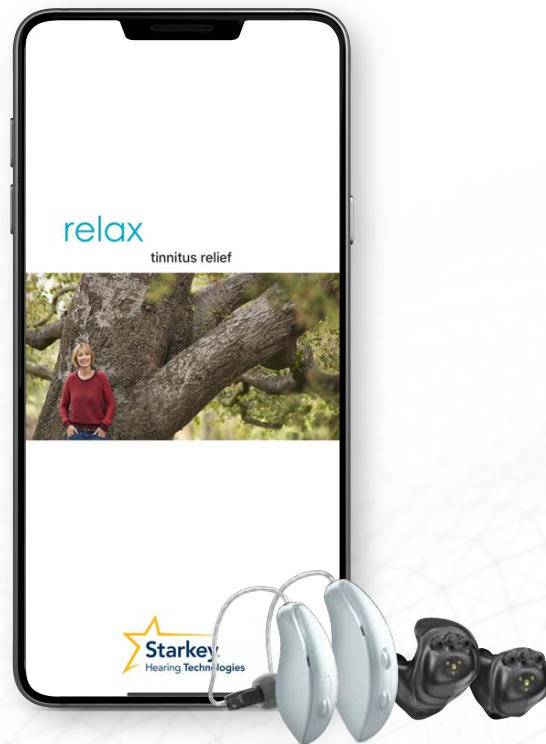
Total Score: ☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4

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Research Note

Changes in Heart Rate Variability Following Acoustic Therapy in Individuals With Tinnitus

Paul Reinhart,¹ Kendra Griffin,² and Christophe Michéy¹

Purpose: The aim of the study was to investigate changes in autonomic function, as measured by heart rate variability, in individuals with tinnitus following acoustic therapy implemented using tinnitus maskers presented via hearing aids.

Method: Twenty-five individuals with tinnitus and hearing impairment completed an 8-week fast-paced hearing aid wearing acoustic therapy via three tinnitus masker options: left and right tinnitus masking mode, tinnitus masking and active tinnitus masking mode. Tinnitus handicap was measured using the Tinnitus Handicap Inventory at baseline before starting acoustic therapy and postbaseline at end of 8-week trial. Hearing heart rate and

heart rate variability were measured using electrocardiography at baseline and postbaseline.

Results: There was a significant decrease in tinnitus handicap postbaseline compared to baseline. There was no change in heart rate, but there was a significant increase in heart rate variability postbaseline compared to baseline.

Conclusions: Acoustic therapy using tinnitus maskers delivered via hearing aids provided tinnitus relief and produced a significant increase in heart rate variability, suggesting a decrease in stress. Heart rate variability is a potential biomarker for hearing efficacy of acoustic therapy; however, further research is required.

Key Words: tinnitus, heart rate variability, acoustic therapy, hearing aids, tinnitus maskers

Supplemental Material: Supplemental material for this article is available at <https://www.jslhr.org/>.

new to acoustic therapy via hearing aid tinnitus maskers. Individuals with tinnitus, as indicated by a candidate score ≥ 4 on the Tinnitus Handicap Inventory of the Tinnitus and Hearing Survey, were excluded from the study (Harris et al., 2010). Participants were in good general health at time of testing and did not report any history of cardiac, vascular impairment. Participants completed an informed consent process and were compensated for their time.

Acoustic Therapy

Acoustic therapy was implemented using tinnitus maskers via "tinnitus maskers" presented via hearing aids. The participants received behind-the-ear devices with tinnitus maskers, and 21 participants received receiver-driven devices with either open (OITE), closed (CITE), or power dome (DTE) depending on audiometric configuration. All devices were identical, except for one participant using the NAL-NL2 prescription formula (Killion et al., 2011) and was verified by matching the real ear aided response to a 45-dB target using the International Speech Test Signal (Dillon et al., 2010) presented at each (36 dB SPL), average (40 dB SPL), and loud (48 dB SPL) speech levels. In addition, new controls were enabled so that participants could adjust the hearing aid volume in 4 dB increments via remote control accuracy.

There is no one-size-fits-all approach to tinnitus acoustic therapy, with different maskers providing varying relief across individuals (e.g., McCall et al., 2012; Schell et al., 2016). As such, the study hearing aids were programmed with three different tinnitus maskers available as part of Starkey's MyAidTinnitus Pro technology:

1. White noise—a noise with acoustically flat spectrum (i.e., constant sound level per band across frequencies).
2. Audiogram-shaped noise—a noise spectrally shaped based on individual participants' audiograms to provide approximately equal audibility across all frequencies.
3. Custom noise—a noise based on psychophysical measurements of minimum masking level (MML), which were used to generate a customized audiogram primarily estimating energy of frequency bands where masking is most effective (Frost et al., 2016; Vanaja & Moak, 2016).

The reason for providing multiple masker options was that participants could adjust the acoustic therapy options that provided them the most tinnitus relief (Killion et al., 2010). Any potential changes in HRV following acoustic therapy were specific to the specific tinnitus masker that participants used to mask their tinnitus, as that their tinnitus relief was achieved. Participants could later be divided into three groups by tinnitus maskers: white noise, audiogram-shaped noise, and custom noise. The level of each tinnitus masker was set to just below MML (i.e., the level at which their tinnitus was completely masked), consistent with tinnitus

Results
Descriptive results extracted at the end of the study indicate that average hearing aid use was 9.4 h (SD = 2.3) during the field trial, and an average of 14.4% of test time was spent wearing a tinnitus masker (15.0% with white noise, 10.7% with audiogram-shaped noise, 10.0% with custom noise).

THI, heart rate, and HRV data were analyzed using analysis of variance (ANOVA) to compare data at baseline (beginning of study) versus postbaseline (end of 8-week trial). There was a significant decrease in THI postbaseline ($M = 14.4$, $SD = 8.7$, $t(24) = 4.08$, $p < .001$, Cohen's $d = 1.10$) (see Figure 2). There was no significant change in heart rate between baseline ($M = 68.4$, $SD = 11.7$) and postbaseline ($M = 67.4$, $SD = 9.0$, $t(24) = 1.422$, $p = .168$) (see Figure 3, left panel). There was a significant decrease in HRV postbaseline ($M = 50.2$, $SD = 17.3$) compared to baseline ($M = 51.1$, $SD = 11.5$, $t(24) = -2.122$, $p = .05$, Cohen's $d = 0.43$) (see Figure 3, right panel). A Pearson correlation was conducted to measure the relationship between change in HRV baseline (HRV—postbaseline HRV) and change in THI baseline (THI—postbaseline THI). The test failed to reach significance, $r(25) = .124$, $p = .522$.

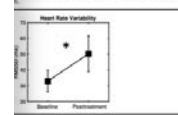
Discussion

In this study, participants exhibited a decrease in the tinnitus handicap and an increase in HRV following an 8-week acoustic therapy field trial. The findings were consistent with our prediction and supported the hypothesis that acoustic therapy reduces an increase in parasympathetic activity in order to reduce autonomic dysregulation. This potential application of HRV is further supported by another study that observed a change in HRV following tinnitus intervention via transcranial vagus nerve stimulation (Vidali et al., 2017). This application is somewhat limited by the lack of correlation between change in THI and change in HRV, which could be partially attributed to the low inter-rater reliability of the THI and the multitude of factors affecting individual HRV (e.g., Smetana & Richman, 2016).

Given the potential relationship between tinnitus handicap and HRV, patients with tinnitus may be able to benefit from HRV biofeedback training (Lafren & Gerst, 2014). This training teaches individuals to maximize HRV resulting from respiratory stress reduction through controlled breathing (Lafren et al., 2011). HRV biofeedback training has been shown to provide clinical benefit for a range of conditions, such as pain (Hedberg et al., 2011) and anxiety (Rimes, 2009). It is possible that individuals with tinnitus could also benefit from HRV biofeedback training, as one mechanism and relaxation techniques have shown benefit in individuals with chronic, bothersome tinnitus (Lafren et al., 2017).

In conclusion, this study found a significant increase in HRV, corresponding to a significant decrease in tinnitus

Beginning of study and postbaseline (end of 8-week trial). Left: Heart rate variability in real-time square of autonomic difference.



caused by being able to choose among three masker options. This would suggest that tinnitus patients might benefit most when provided multiple masker options. However, this requires further research. HRV has been linked to an underlying and has primarily been used as a measure of acute listening-related stress occurring during challenging listening speech perception, such as speech in noise (Dillon et al., 2012; Mackenzie et al., 2011; Smetana & Richman, 2016) or time-compressed speech (Mackenzie & Calhoun-Morris, 2016). While valid self-report measures, such as THI (Newman et al., 1998), Tinnitus Functional Index (Mackenzie et al., 2012), and Tinnitus Reaction Questionnaire (Wilson et al., 1993), remain the gold standard for measuring tinnitus intervention outcomes (Harris et al., 2010), the present findings suggest that HRV could be a potential biomarker for tracking efficacy of tinnitus intervention via acoustic therapy. This potential application of HRV is further supported by another study that observed a change in HRV following tinnitus intervention via transcranial vagus nerve stimulation (Vidali et al., 2017). This application is somewhat limited by the lack of correlation between change in THI and change in HRV, which could be partially attributed to the low inter-rater reliability of the THI and the multitude of factors affecting individual HRV (e.g., Smetana & Richman, 2016).

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Thank you



Hear better. Live better.