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Tinnitus Demystified-A Look at Starkey's Options

Jake Hall, Au.D. Education and Training Audiologist

Starkey

Hear better. Live better.

Tinnitus Demystified-A Look at Starkey's Options

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Tinnitus Demystified-A Look at Starkey's Options

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- As healthcare is rapidly evolving, new findings may change the validity of the information presented in this course. Providers should always consult the latest research and guidelines from professional associations.
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- Providers should always evaluate the limitations of diagnostic and screening tools, considering their potential for false results as well as any ethical implications.
- It is the responsibility of course participants to critically evaluate the evidence from multiple sources to guide professional practice.

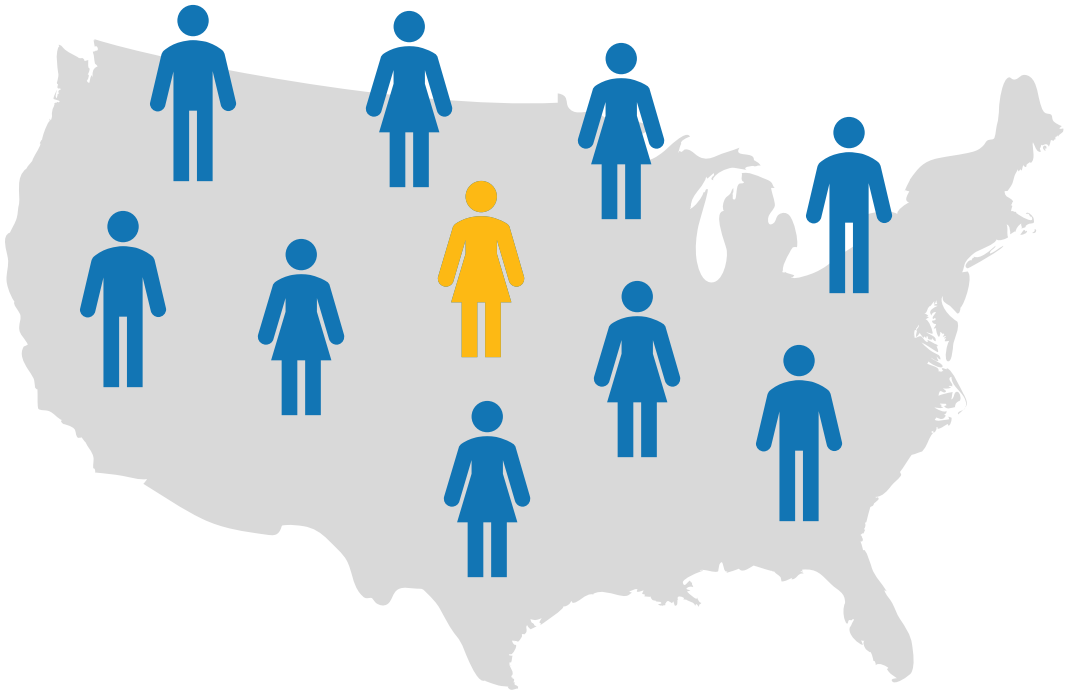
Learner Outcomes

1. Discuss what patient controls for tinnitus are available in My Starkey app
2. Discuss how to adjust tinnitus controls in Pro Fit
3. Describe the sound therapy stimulus options available from Starkey

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

Treatment

Starkey

Hear better. Live better.

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 Therapy Devices

Sound masking devices

Hearing aids

Modified-sound/
Notched-music devices

Sound and sleep apps

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

Maskers in Hearing Aids

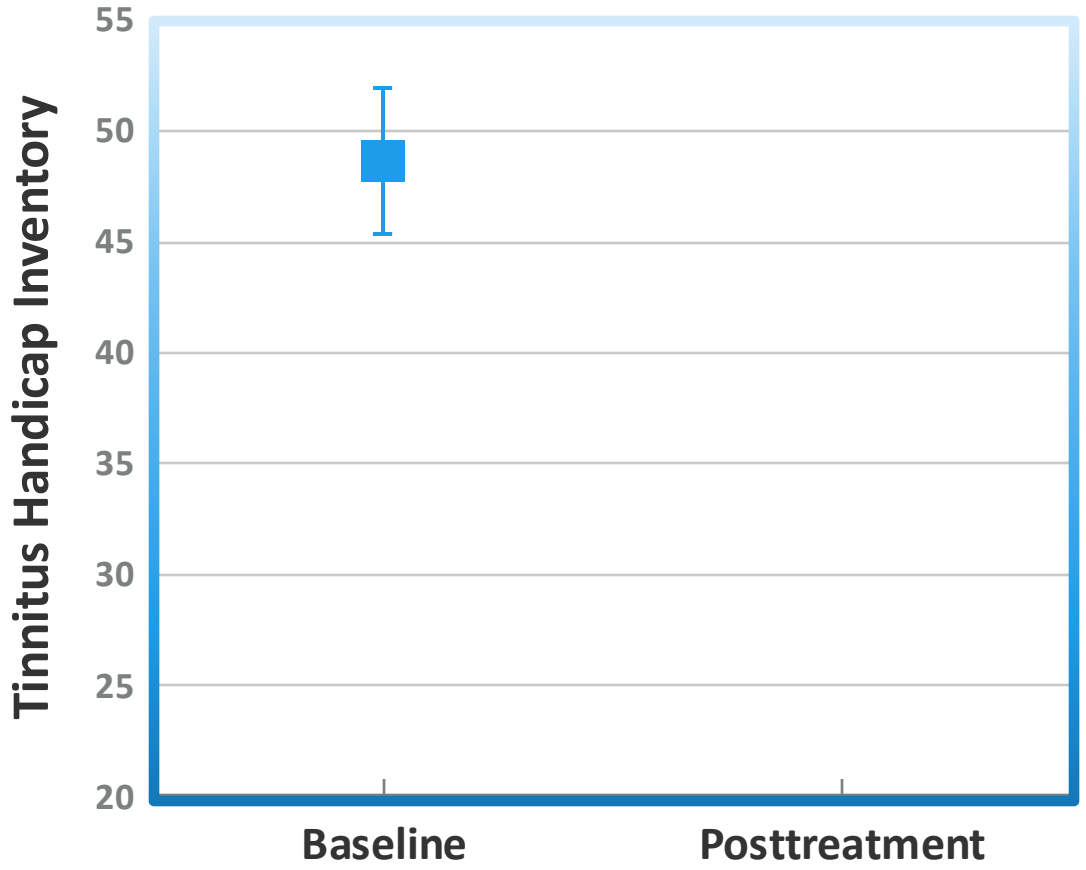
RESEARCH DATA

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.

Maskers in Hearing Aids

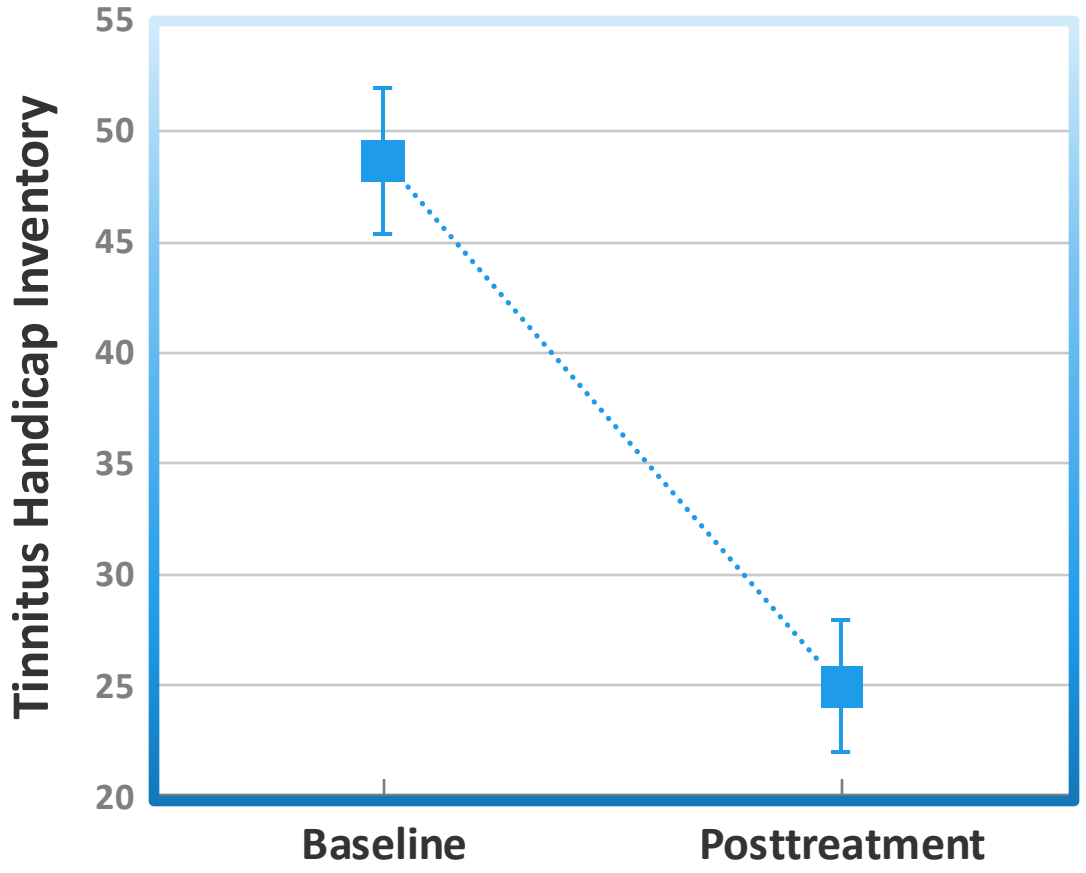
DATALOGGING RESULTS
Average hearing aid use was 9.4 hr (SD = 4.2 hr) during the field trial, and

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

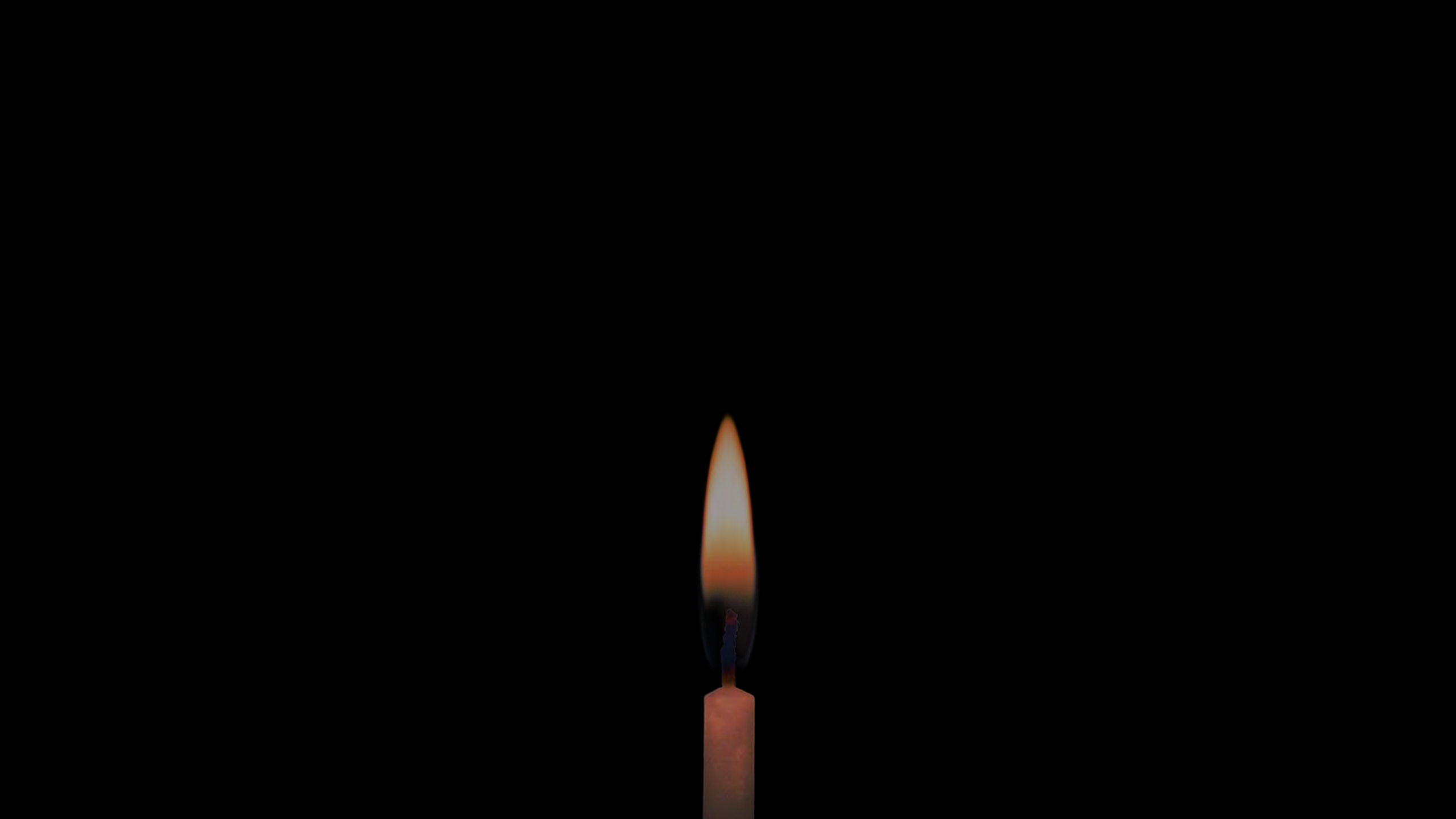
13.8% with white noise;

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.



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

Signature SERIES

EDGE AI

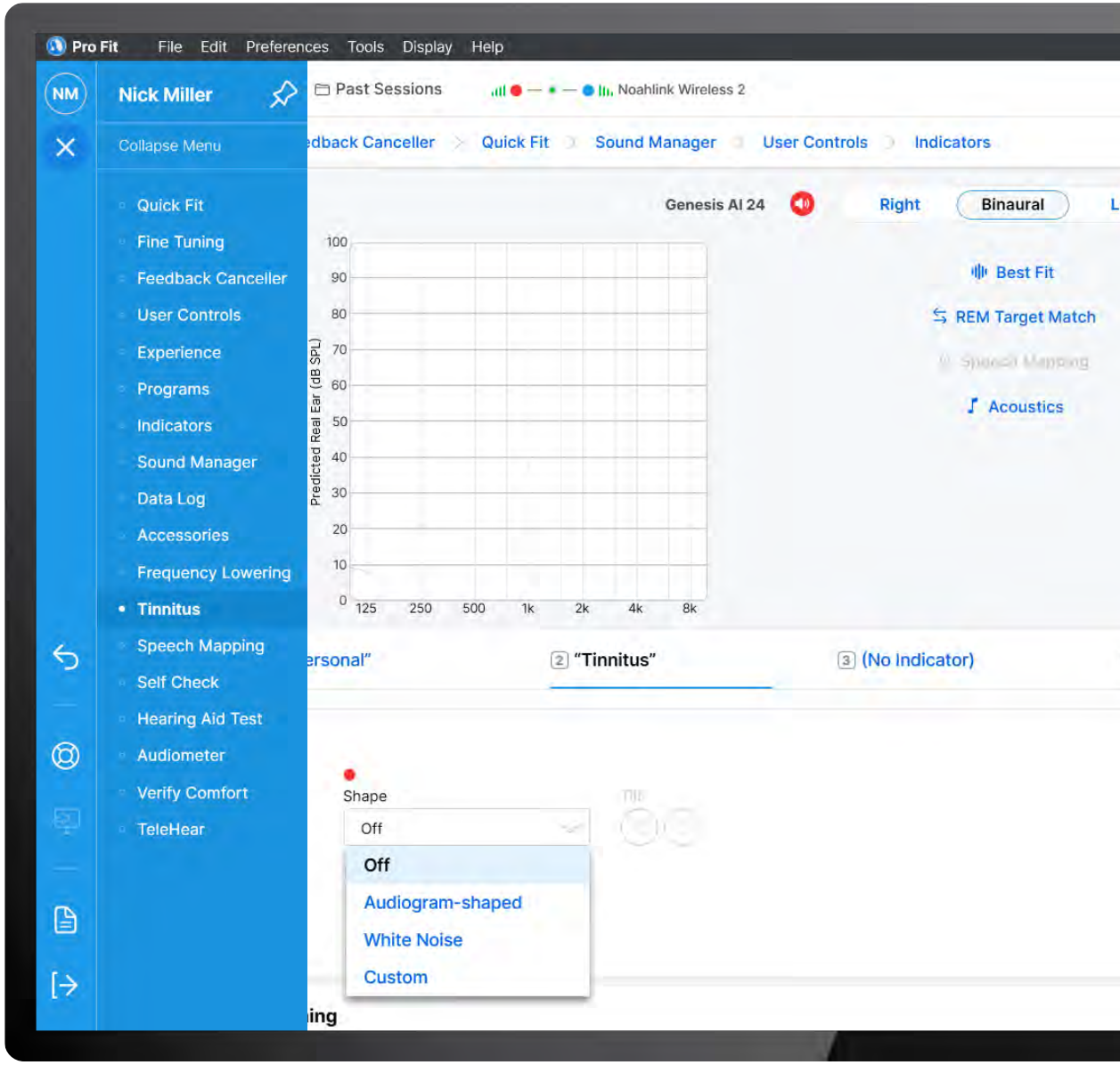
AVAILABLE ON ALL STYLES

Multiflex Tinnitus Pro

Accessed from the Fly Out Menu within Pro Fit

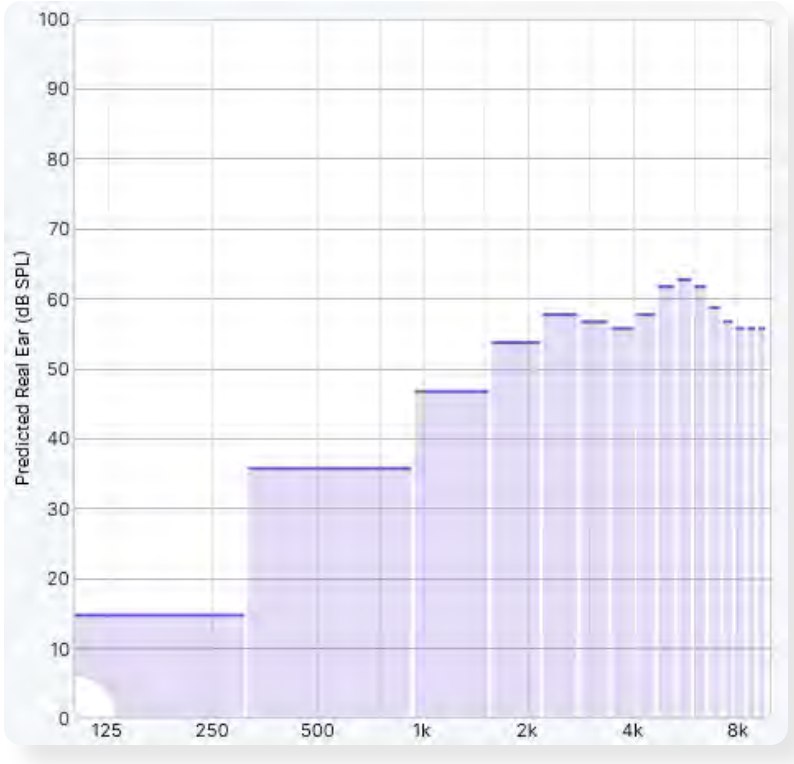
Use the dropdown menu to select the stimulus type

All options offer a 10,000 Hz bandwidth with 16 bands of adjustability

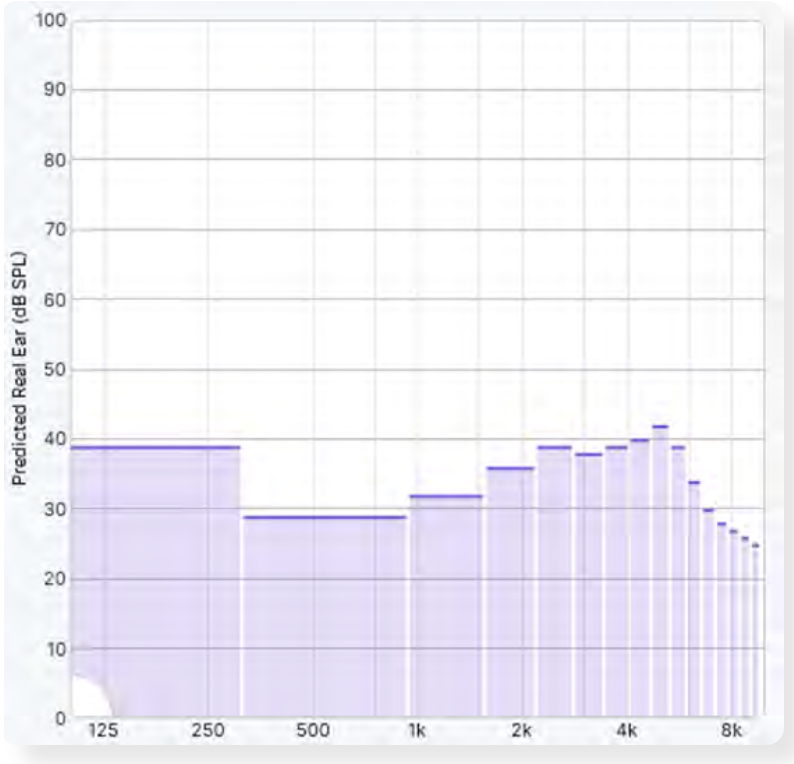


Starkey **Pro Fit**

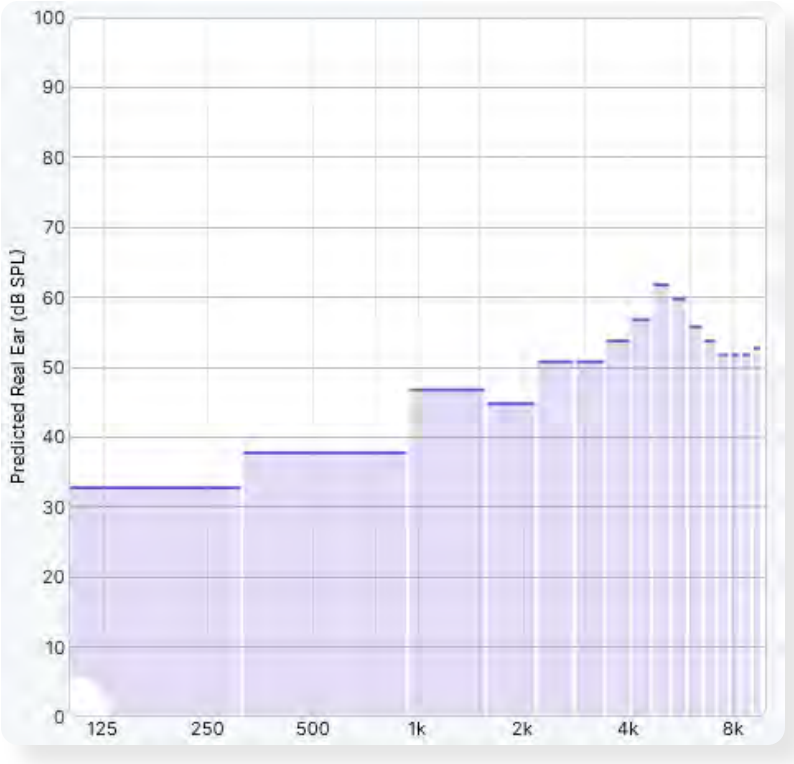
Tinnitus Stimuli



White Noise
Pure Tone Average
All Styles and Technology Tiers



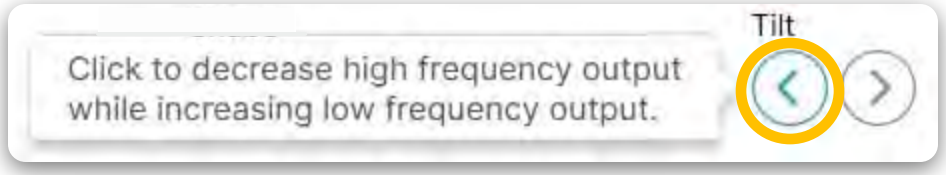
Audiogram Shaped
Hearing Loss
All Styles of the 24, 20, and 16
Technology Tiers

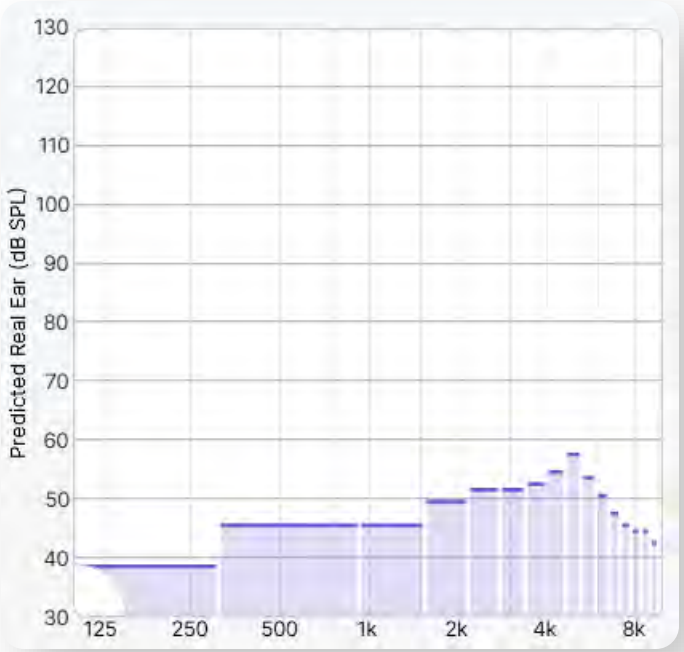


Custom
Custom Shaping
All Styles of the 24 and 20
Technology Tiers

Tilt Control

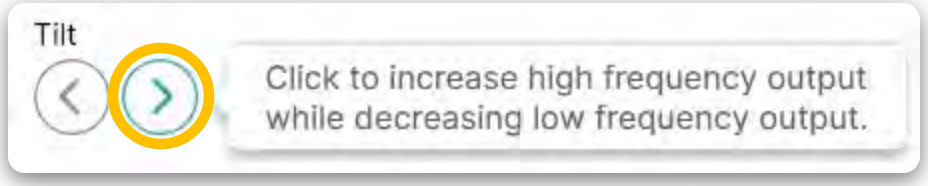
Low Frequency Emphasis

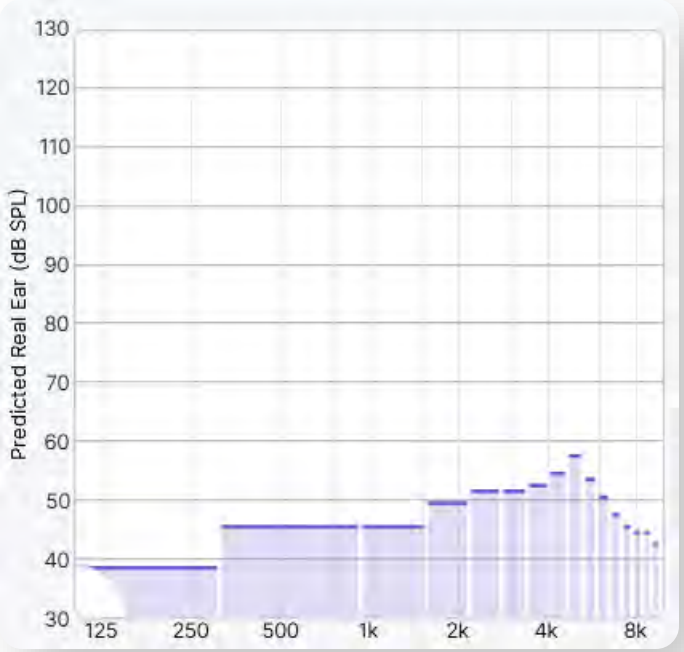




Start

High Frequency Emphasis

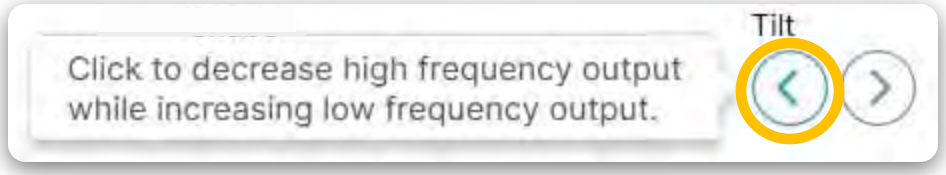


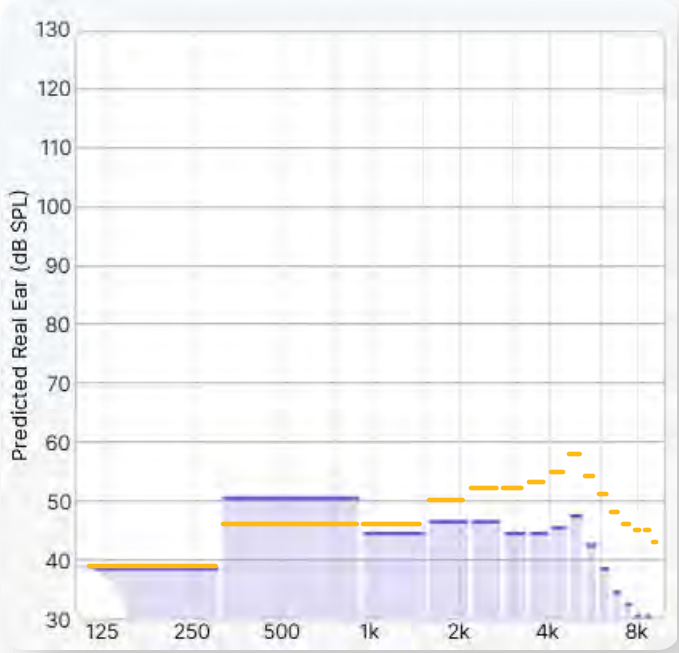


Start

Tilt Control

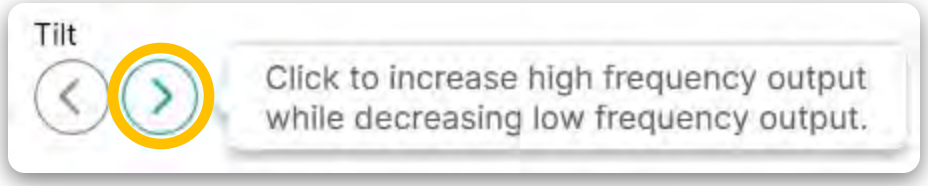
Low Frequency Emphasis

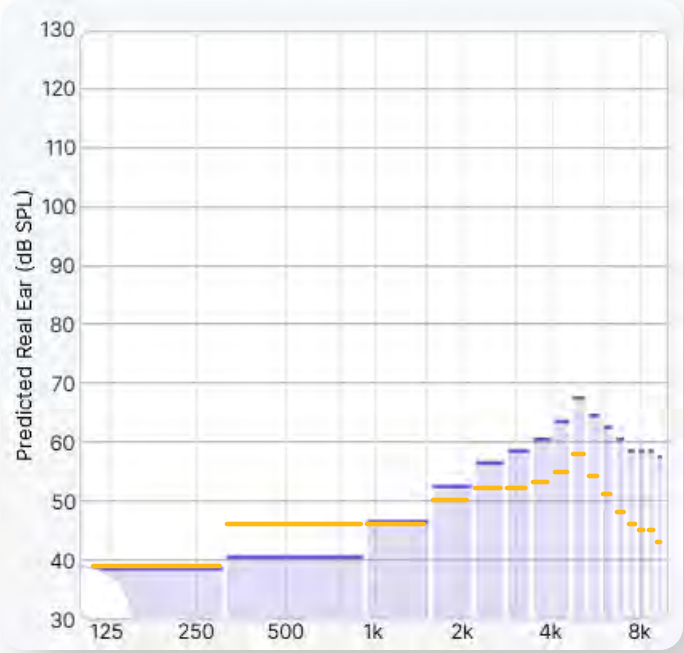




5 clicks

High Frequency Emphasis



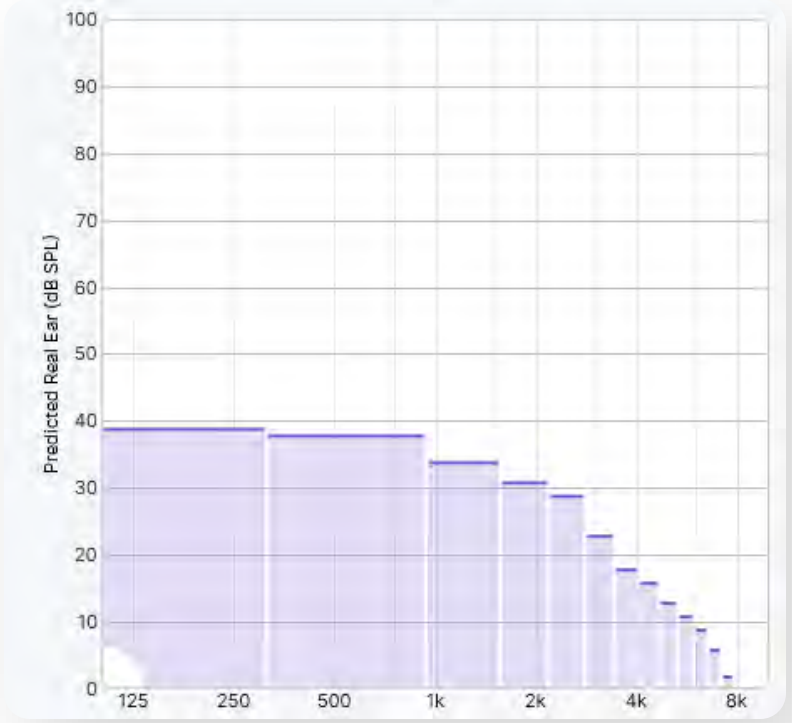


5 clicks

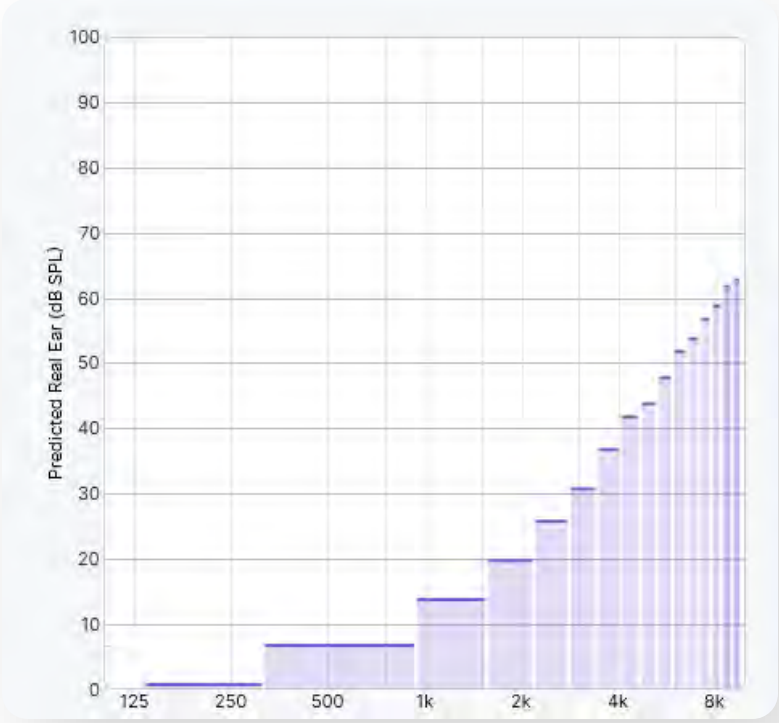
= Original response

Starkey **Pro Fit**

Customizing Noise Colors



Tilt

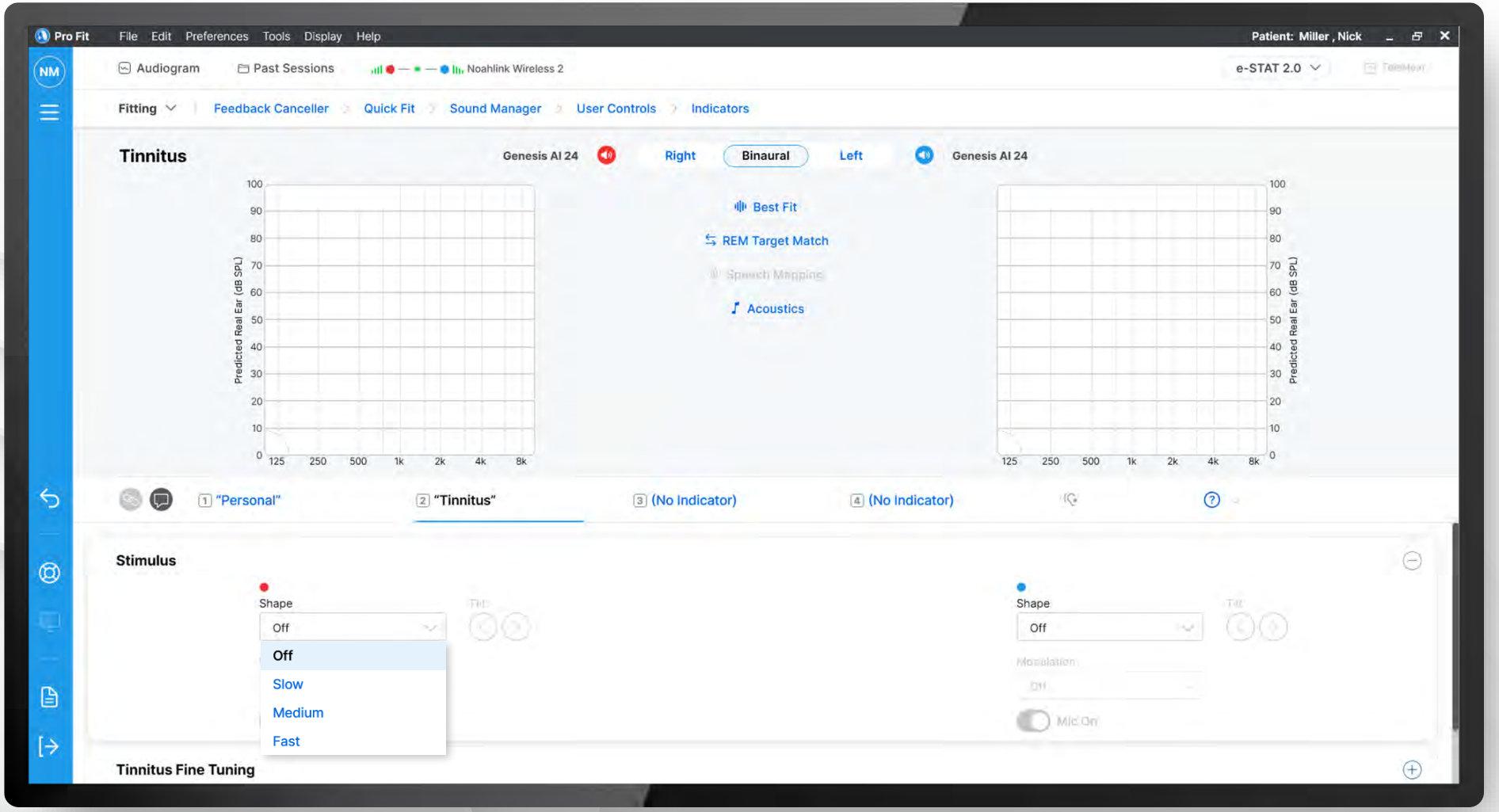


Tinnitus Fine Tuning

⊕ Low	⊕ Mid	⊕ High	⊕ Expand All	⊕ Low	⊕ Mid	⊕ High
150 - 1.3K	1.9K - 3.1K	3.8K - 9.4K	ALL	150 - 1.3K	1.9K - 3.1K	3.8K - 9.4K
48	16	-6		48	16	-6

Modulation

Modulation is available for all the Multiflex Tinnitus stimulus options



Starkey **Pro Fit**

White Noise

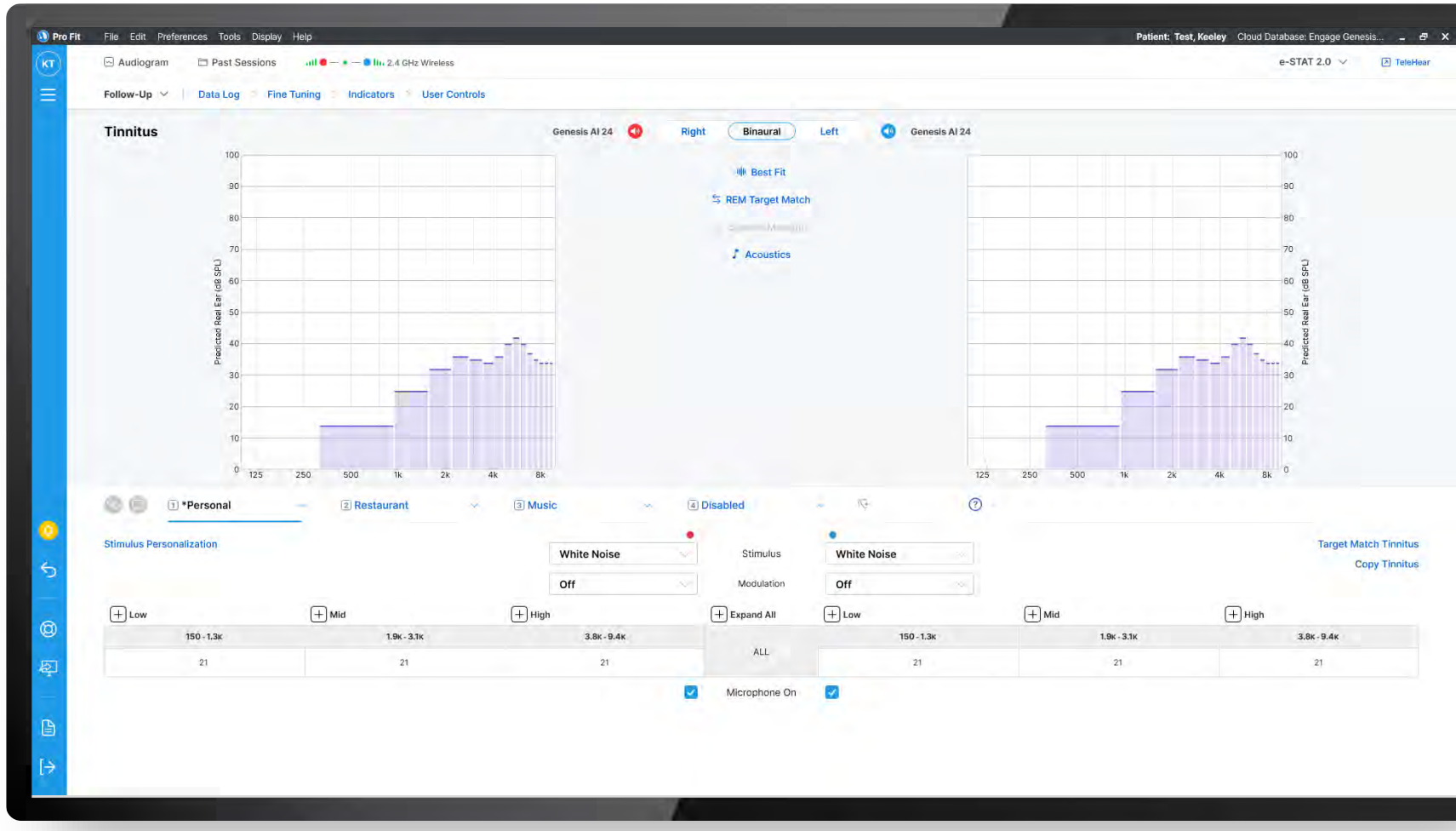
Tinnitus

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**

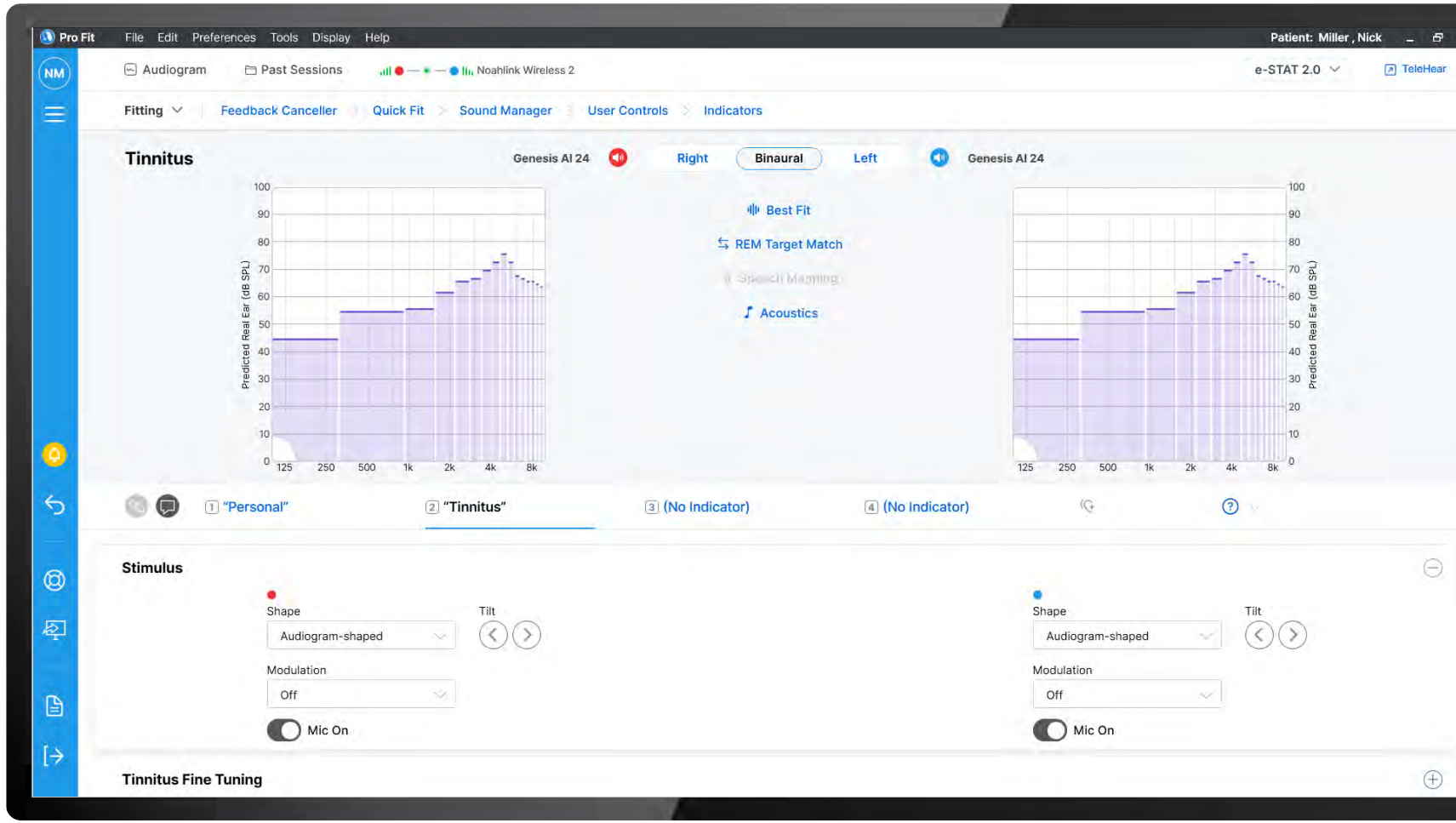
Audiogram Shaped

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



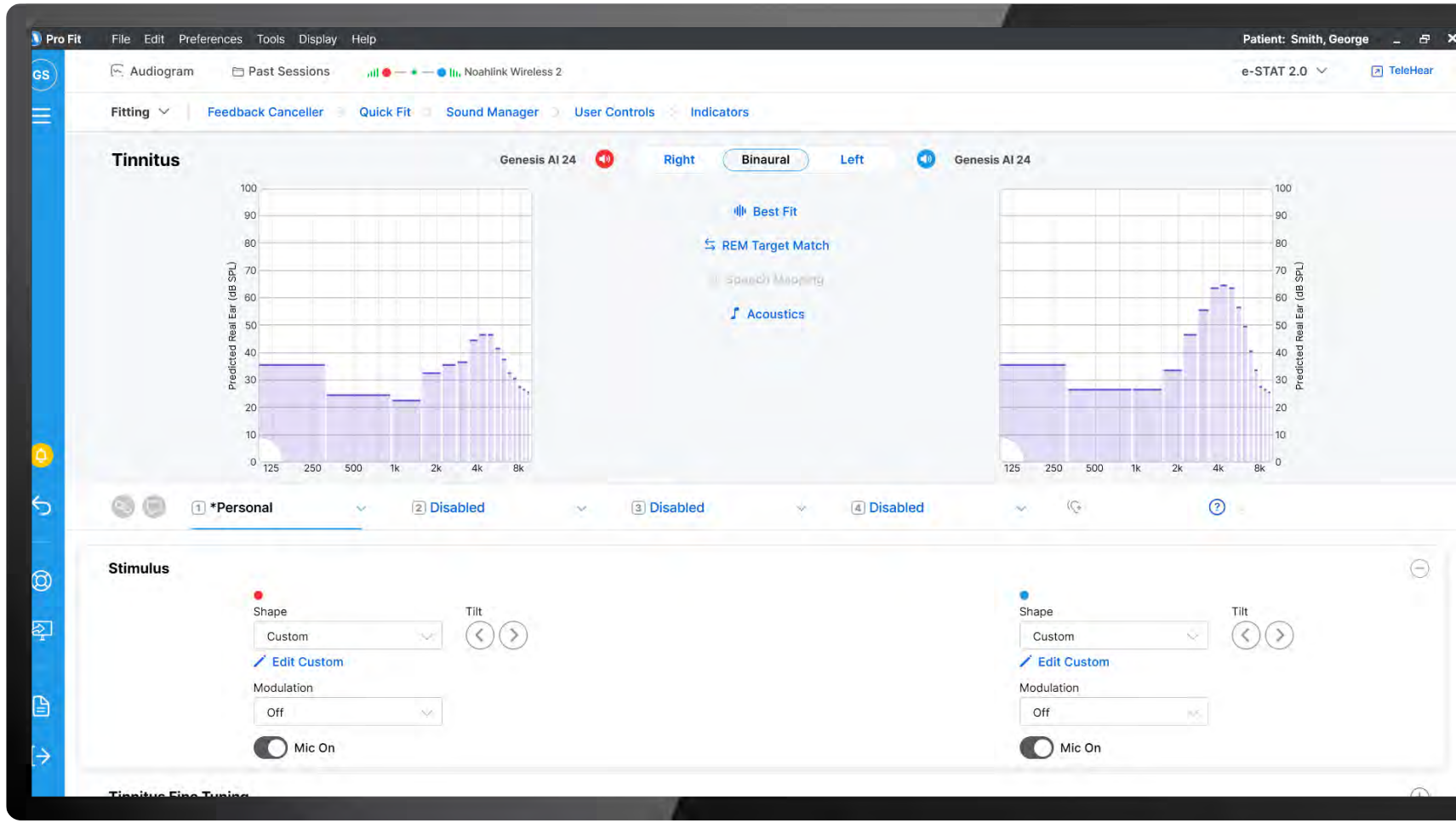
Starkey **Pro Fit**

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



Custom

Personalized shaping of the Multiflex Tinnitus stimulus

Multiflex Tinnitus Pro Tool is a research-based approach to improving the efficiency of the masking signal

Minimum Detection Levels (MDLs) and Minimum Masking Levels (MMLs) provide personalized shaping of the tinnitus stimulus

Efficient and Effective Masking

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

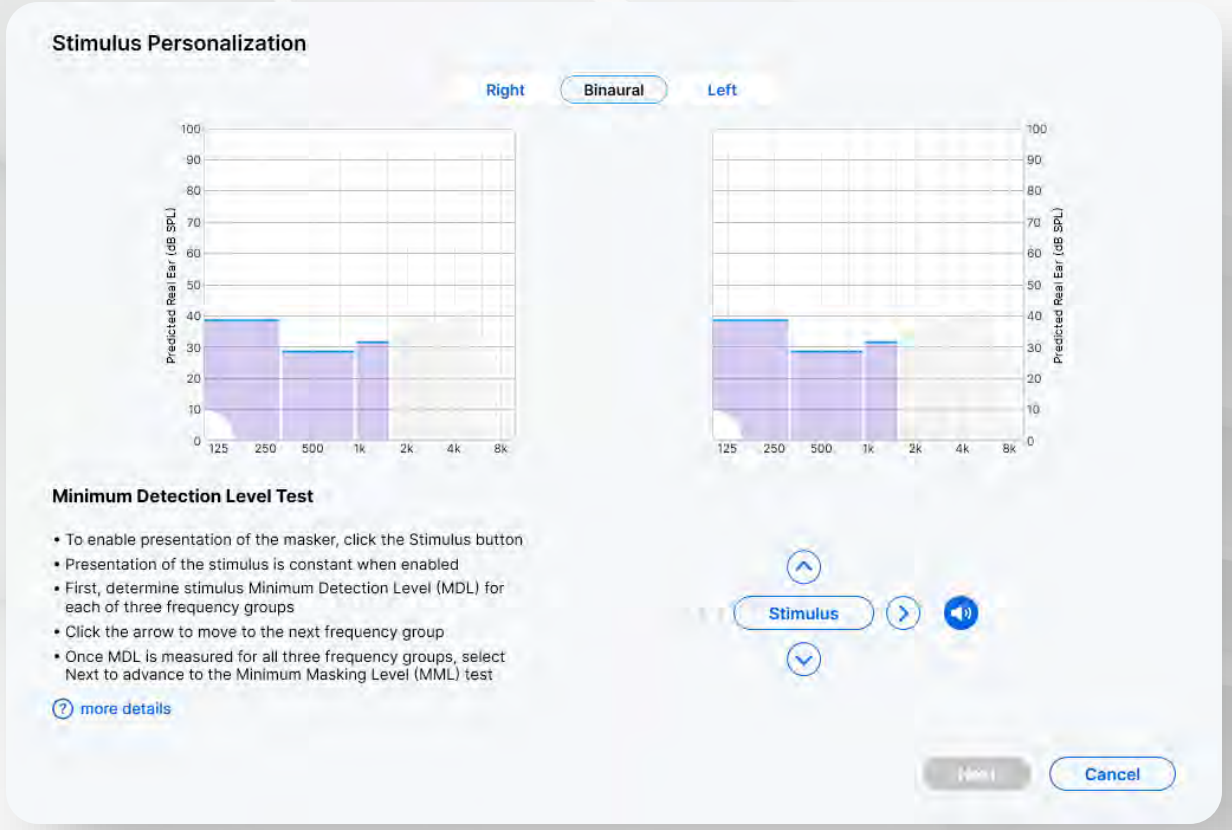
MDL and MML measurements can be used to rapidly design a stimulus that is both efficient and effective at masking tinnitus

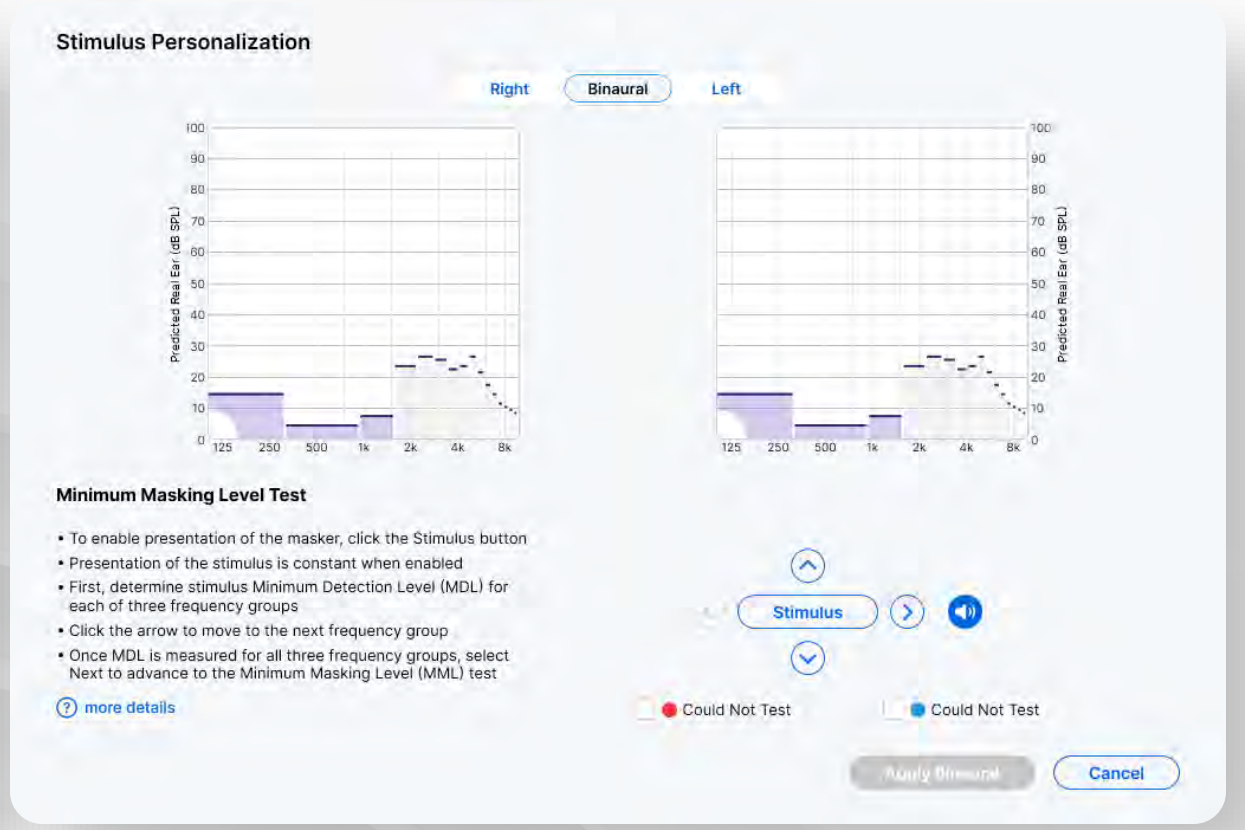
To efficiently mask tinnitus, only those frequency bands that are effective at masking tinnitus should be included in the stimulus, and the level of the stimulus in these bands should be no greater than needed to achieve masking

Fournier et al., 2018

Starkey **Pro Fit**

Custom Tinnitus



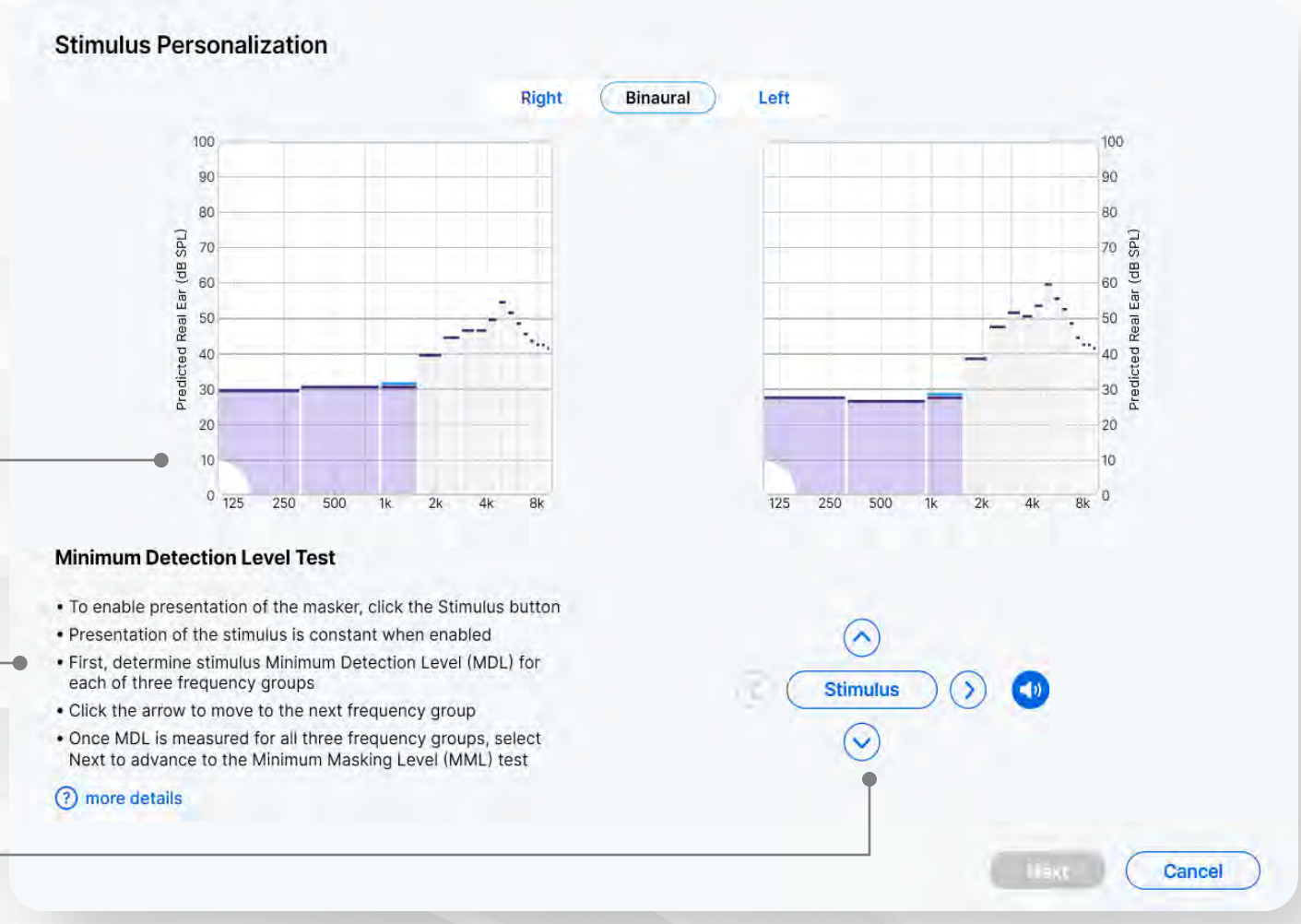


Multiflex Tinnitus Pro Tool Display

Active frequency region

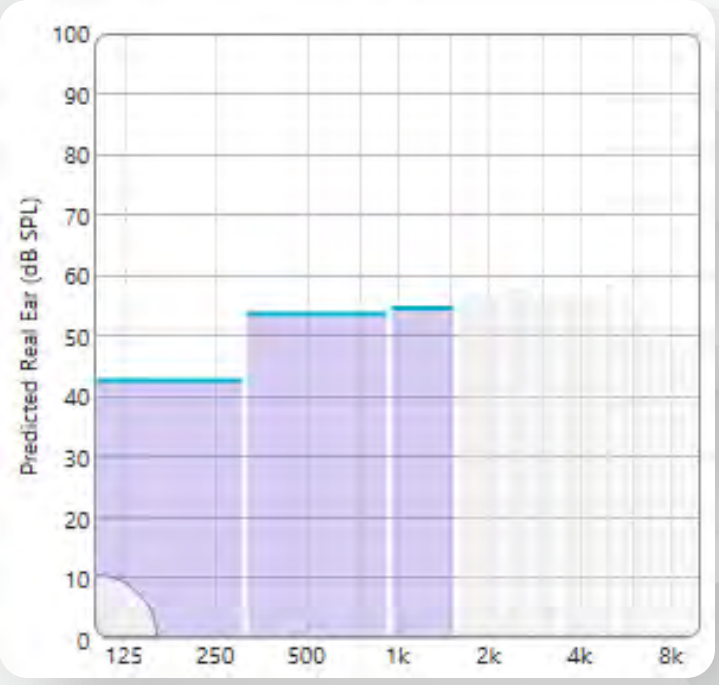
Instructions

Stimulus Controls



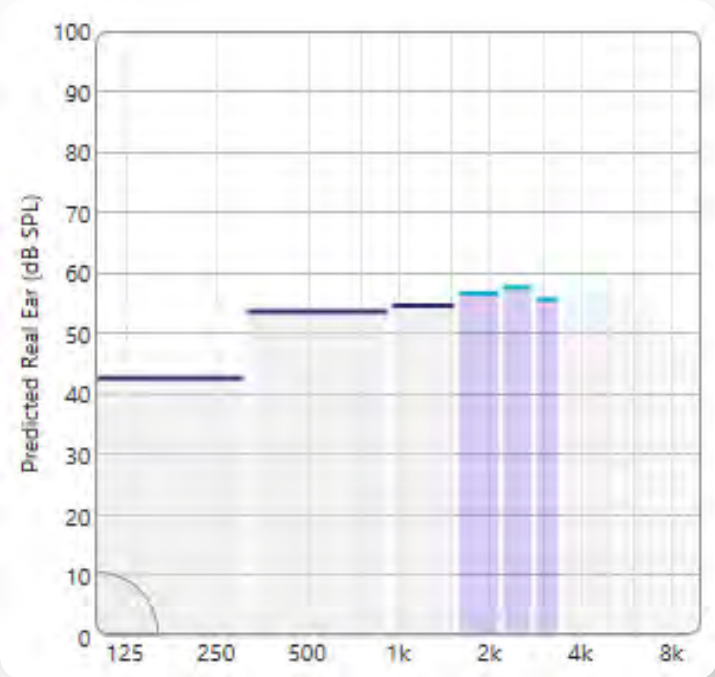
Frequency Groups

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



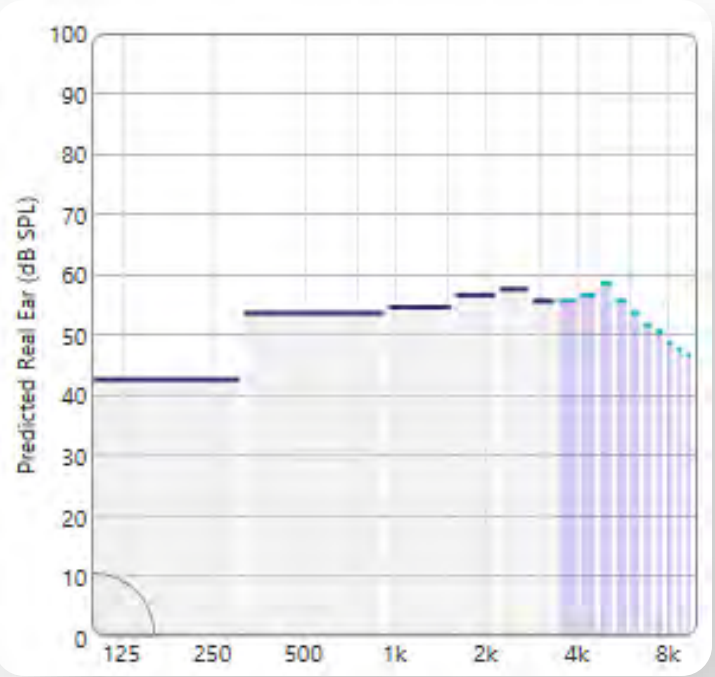
Low

150 Hz to 1.3 kHz



Mid

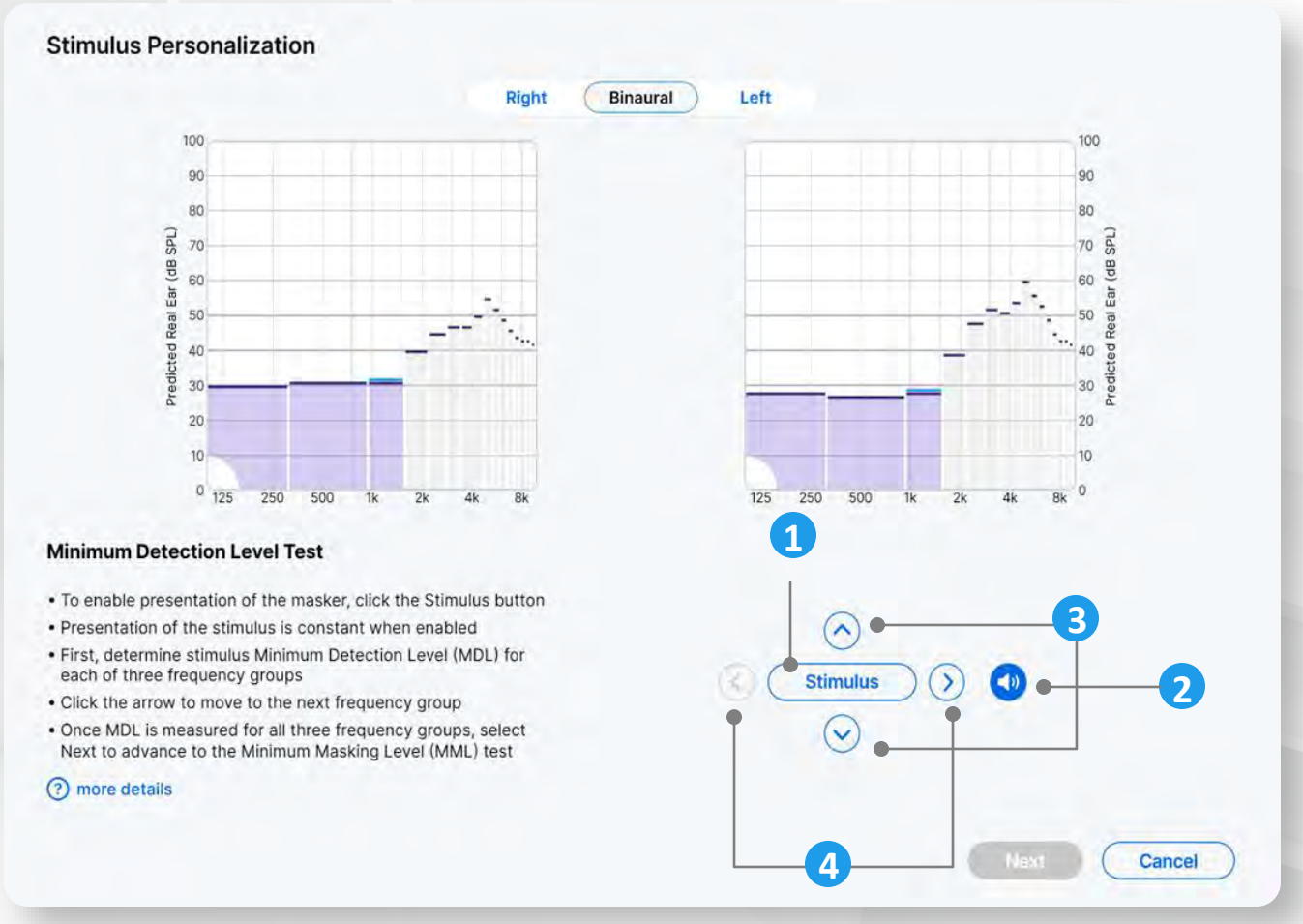
1.9 kHz to 3.1 kHz



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

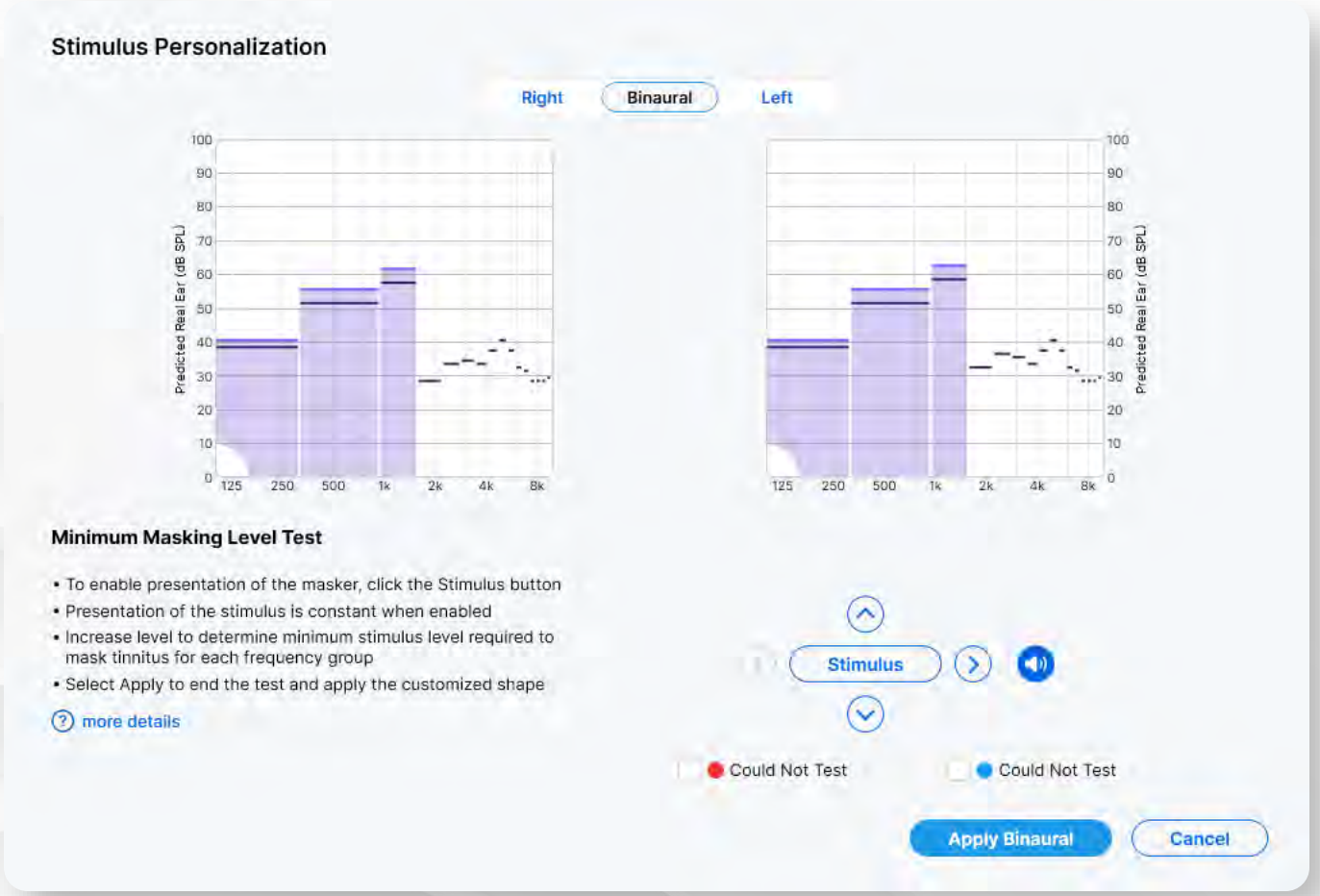
Minimum Masking Level (MML) Test

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



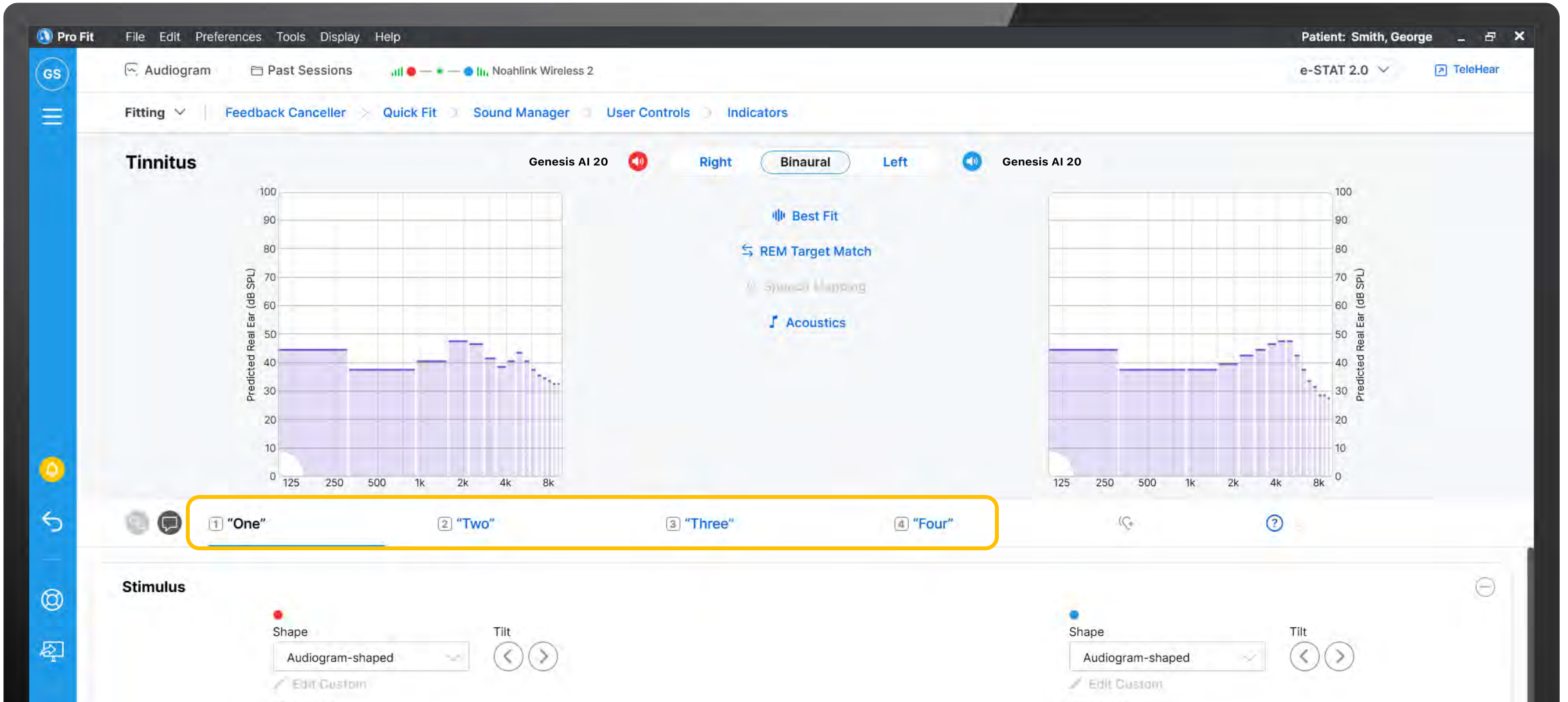
Tinnitus Stimulus

User Controls

Output Range and Step Size

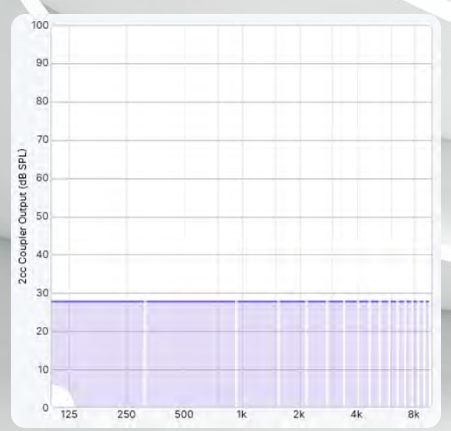
Pro Fit Configuration

Multicurve View:
Multiple “Personal” Programs
Varying amounts of gain for fluctuating hearing loss
Tinnitus Masker- Audiogram shaped with slow modulation for all four programs



Multiflex Tinnitus Pro

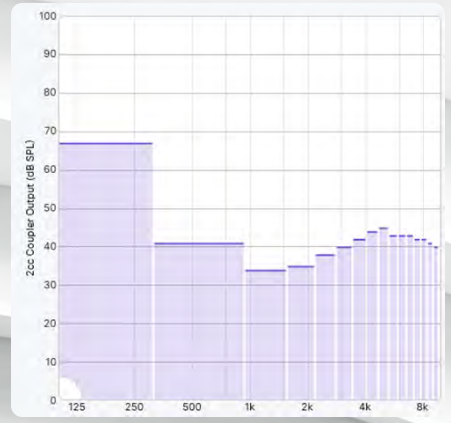
Personalized Sound Therapy for Tinnitus Management



WHITE NOISE

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

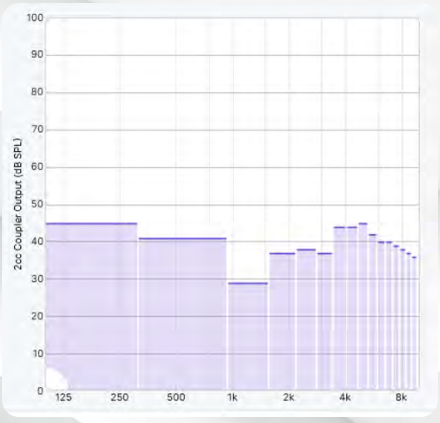
All Styles and Technology Tiers



AUDIOGRAM-SHAPED NOISE

Automatic shaping of the tinnitus stimulus **based on the hearing loss**

All Styles of the 24, 20 and 16 Technology Tiers



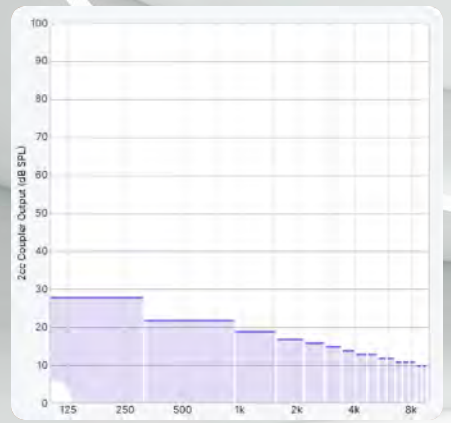
CUSTOM NOISE

Custom shaping of the tinnitus stimulus based on MDLs and MMLs

All Styles of the 24 & 20 Technology Tiers

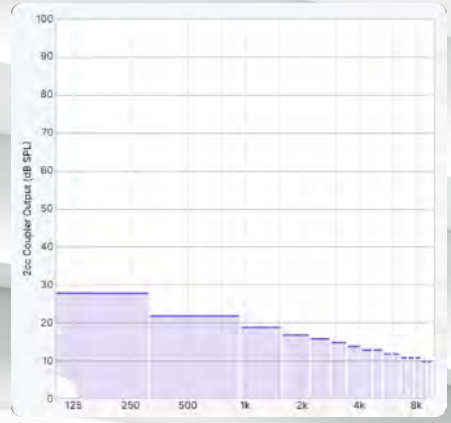
Multiflex Tinnitus Pro

Low-frequency weighted options



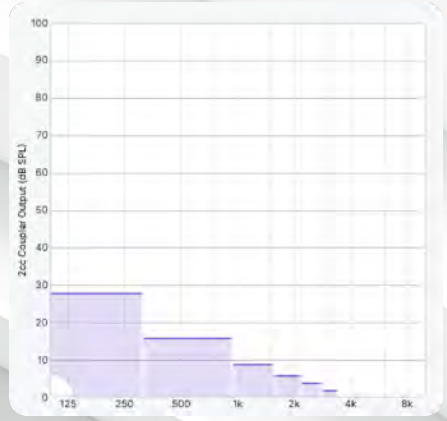
OCEAN NOISE

Mimics the sound of the ocean for an alternative masker to traditional options



PINK NOISE

Comprised of less high-frequency energy compared to White Noise



RED NOISE

Comprised of less high-frequency energy compared to Pink Noise

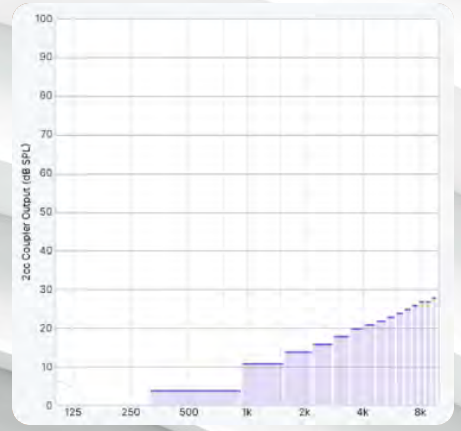
All Styles and Technology Tiers of Edge AI and Signature Series

Multiflex Tinnitus Pro

High-frequency weighted options

BLUE NOISE

Comprised of less low-frequency energy compared to White Noise



PURPLE NOISE

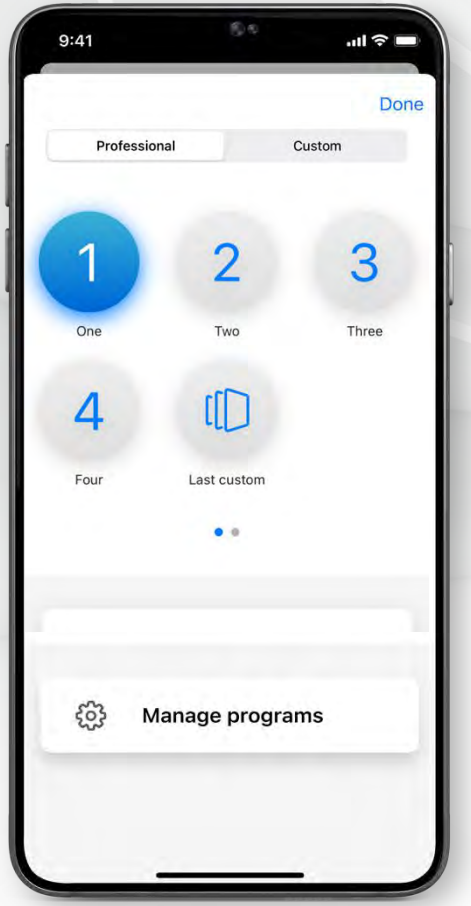
Comprised of less low-frequency energy compared to Blue Noise

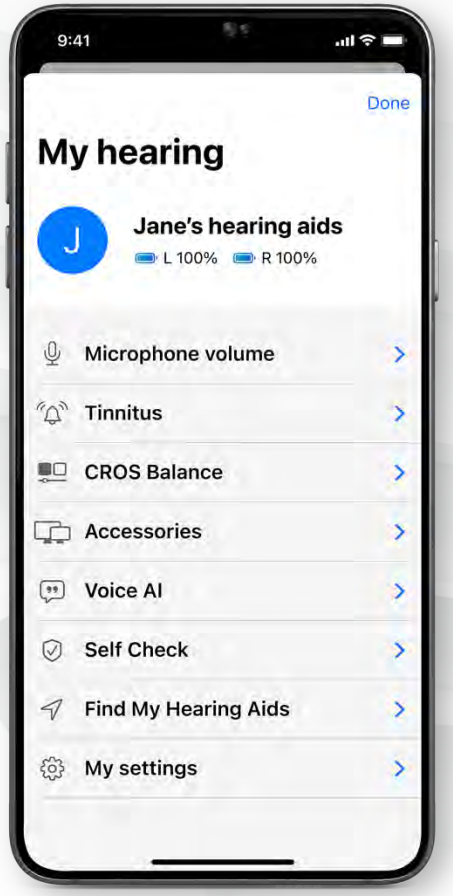
All Styles and Technology Tiers of Edge AI and Signature Series

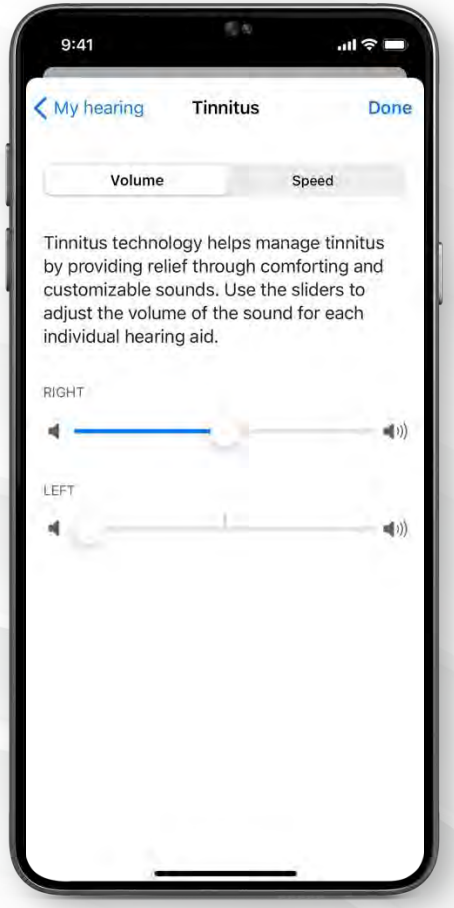
Tech Tier and Style Differences

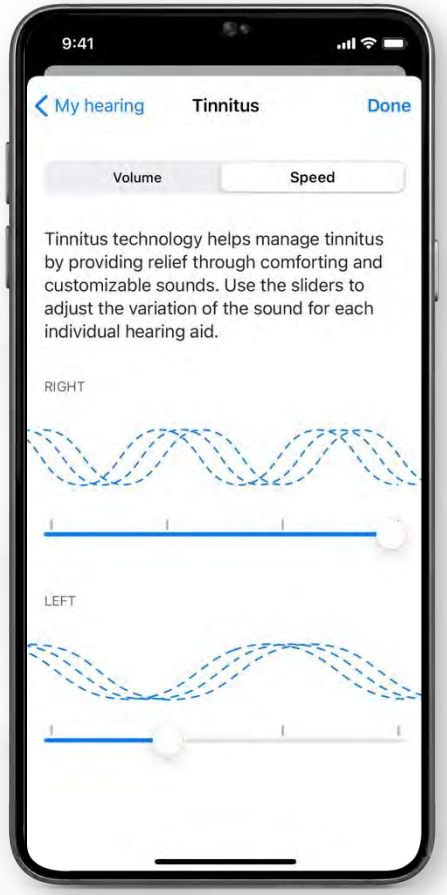
	Edge AI & Signature Series	Genesis AI
White Noise	All styles and tiers	All styles and tiers
Audiogram-shaped	All styles and tiers	All styles; 24, 20, & 16
Custom Masking	All styles; 24 & 20	All styles; 24 & 20
Color Masking	All styles and tiers	N/A
Ocean	All styles and tiers	N/A

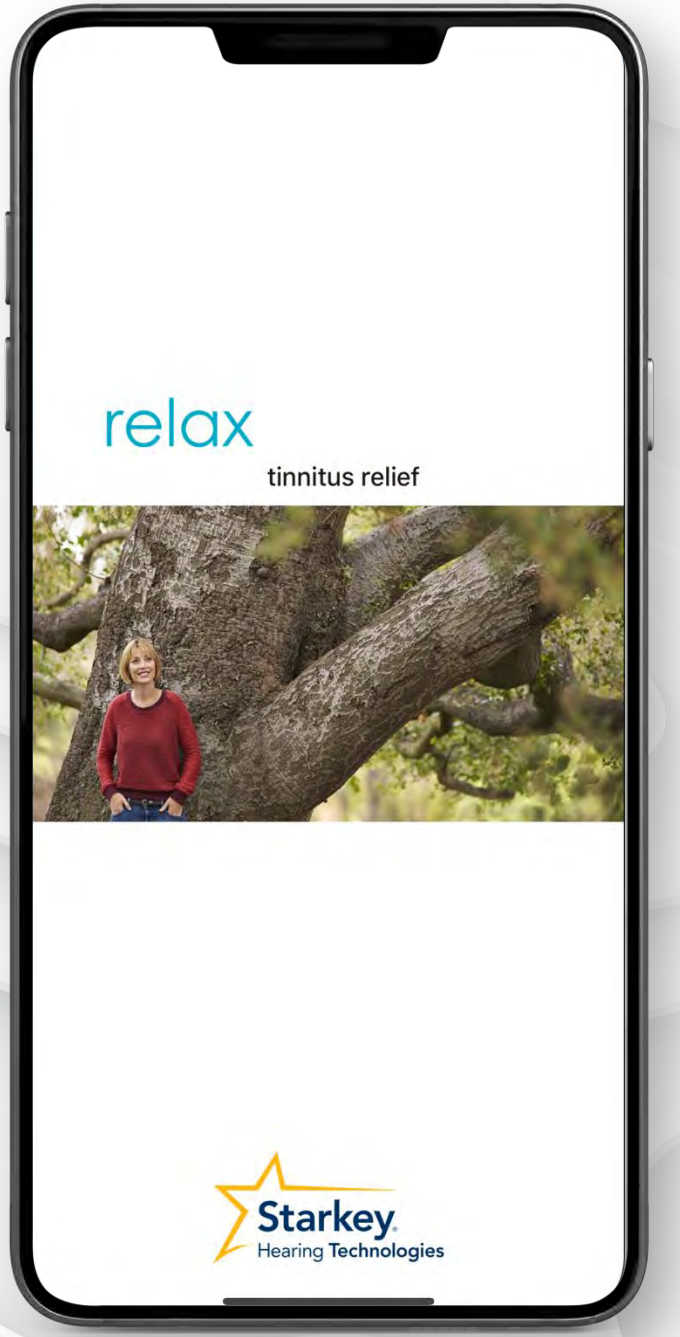
My Starkey Controls











relax
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Hearing Technologies

Relief sounds and education for patients who have tinnitus

Starkey Relax

Set Sound for Masking

Set Modulation, Volume, and Timer

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

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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

American Academy of Audiology
www.audiology.org

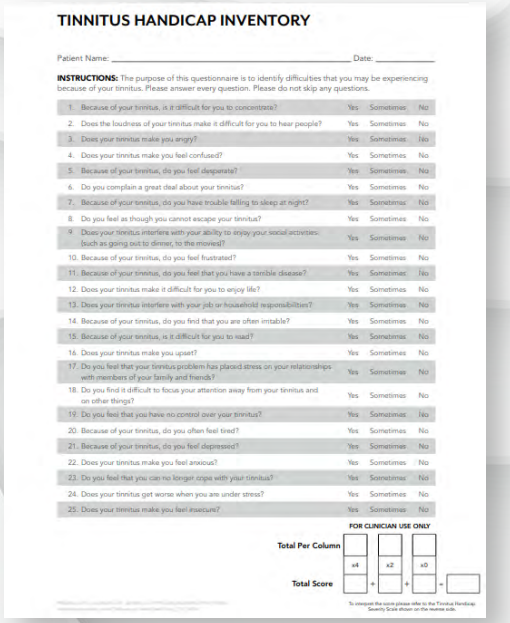
Tinnitus Retraining Therapy
www.tinnitus-pjj.com

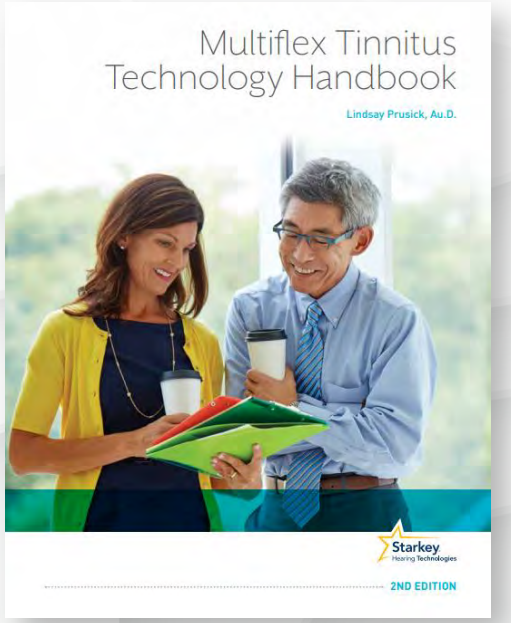
University of Iowa Tinnitus & Hyperacusis Research
www.medicine.uiowa.edu/oto/research/tinnitus-and-hyperacusis

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





Starkey Resources

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JSLHR

Research Note

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

Paul Reinhart,[a] Kendra Griffin,[a] and Christopho Micheyl[b]

Purpose: The aim of this 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-six individuals with tinnitus and hearing impairment 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 was measured using the Tinnitus Handicap Inventory at baseline (before starting acoustic therapy) and posttreatment (at end of 8-week trial). Resting heart rate and heart rate variability were measured using electrocardiography at baseline and posttreatment.
Results: There was a significant decrease in tinnitus handicap posttreatment compared to baseline. There was no change in heart rate, but there was a significant increase in heart rate variability posttreatment compared to baseline.
Conclusions: Acoustic therapy using tinnitus maskers delivered via hearing aids provided tinnitus relief and produced a concurrent increase in heart rate variability, suggesting a decrease in stress. Heart rate variability is a potential biomarker for tracking efficacy of acoustic therapy; however, further research is required.

Tinnitus refers to auditory perceptions that do not have a corresponding acoustic source in the external environment. Estimates of the prevalence of tinnitus vary widely, ranging from 5% to 43%, depending on the population sampled, and what type of tinnitus is considered (e.g., fleeting or chronic, bothersome or not; McCormack et al., 2016). Chronic tinnitus can interfere with the ability to fall asleep or concentrate, and often induces stress, anxiety, and depressive feelings, in turn reducing quality of life (Weidt et al., 2016). It has been hypothesized that tinnitus-related distress is related to an imbalance of sympathetic and parasympathetic branches of the autonomic nervous system, which modulate active and rest states, respectively (Jastreboff & Jastreboff, 2000). Consistent with this hypothesis, individuals with tinnitus exhibit decreased autonomic function (increased sympathetic activity and suppressed parasympathetic activity) indicative of being in a constant elevated stress state (Dineev et al., 1999; van Der Loo et al., 2011; Vanneste & De Ridder, 2013; Ylikoski et al., 2017).

Heart rate variability (HRV) is a common, noninvasive measure reflecting sympathetic and parasympathetic branches of the autonomic nervous system (Berntson et al., 1997; O'Brien et al., 1986; Task Force of the European Society..., 1996). The heart, which is regulated by the autonomic nervous system (Glück et al., 1965; Valenza et al., 2018), contracts with slight beat-to-beat irregularity; the quantification of this interbeat irregularity is referred to as HRV (Acharya et al., 2006). HRV is commonly used as an autonomic biomarker of stress and health, with lower HRV associated with increased stress and negative health outcomes (Kemp & Quintana, 2013; Thayer et al., 2012).

Acoustic therapy, also known as "sound stimulation" or "sound therapy," constitutes an important aspect of comprehensive tinnitus management strategies used in audiology today (Henry et al., 2010; Jastreboff & Jastreboff, 2000; Schad et al., 2018; Tunkel et al., 2014). Acoustic therapy involves sound stimulation resulting, either or both, from the amplification of external sounds, or the generation of additional sound, commonly referred to as a "tinnitus masker" or "tinnitus stimulus." Tinnitus maskers are commonly set to a level below their tinnitus, so that their tinnitus is partially covered up (Jastreboff & Jastreboff, 2000). Because hearing loss is a common comorbidity for tinnitus

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new to acoustic therapy via hearing aid tinnitus maskers. Individuals with hyperacusis, as indicated by a cumulative score > 4 on the Sound Tolerance section of the Tinnitus and Hearing Survey, were excluded from the study (Henry et al., 2010). Participants were in good general health at time of testing and did not report any history of cardiovascular impairment. Participants completed an informed consent process and were compensated for their time.

Acoustic Therapy

Acoustic therapy was implemented using tinnitus maskers (aka "tinnitus stimulus") presented via hearing aids. Participants were fit with Starkey 24-channel hearing aids—five participants received behind-the-ear devices with custom earmolds, and 21 participants received receiver-in-canal devices with either open (3/21), closed (16/21), or power domes (2/21), depending on audiometric configuration. All fittings were bilateral, except for one participant with unilateral hearing loss. Hearing aid gain was calculated using the NAL-NL2 prescriptive formula (Keidser et al., 2011) and was verified by matching the real-ear aided response to a ±5-dB target using the International Speech Test Signal (Holube et al., 2010) presented at soft (50 dB SPL), average (65 dB SPL), and loud (80 dB SPL) speech levels. In addition, user controls were enabled so that participants could adjust the hearing aid volume in 4-dB increments via remote control accessory.

There is no one-size-fits-all approach to tinnitus acoustic therapy, with different maskers providing varying relief across individuals (e.g., McNeill et al., 2012; Schaette et al., 2010). As such, the study hearing aids were programmed with three different tinnitus maskers available as part of Starkey's Multiflex Tinnitus Pro technology:

1. White noise—a noise with nominally 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 psychoacoustic measurements of minimum masking level (MML), which were used to generate a customized masker spectrum primarily containing energy at frequency bands where masking is most effective (Fournier et al., 2018; Vernon & Meikle, 2003).

The reason for providing multiple masker options was so that participants could utilize the acoustic therapy option that provides them the most tinnitus relief (Reinhart et al., 2020). Any potential changes in HRV following acoustic therapy were agnostic to the specific tinnitus masker or combination of tinnitus maskers utilized, so long as tinnitus relief was achieved. Participants could listen to the different maskers by changing memories via hearing aid rocker switch or remote control accessory. The level of each masker was initially set to just below MML (i.e., the level at which their tinnitus was completely masked), consistent with tinnitus

Results

Datalogging results extracted at the end of the study indicated that average hearing aid use was 9.4 hr (SD = 2 hr) during the field trial, and an 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).

THI, heart rate, and HRV data were analyzed using paired-samples t tests to compare data at baseline (beginning of study) versus posttreatment (end of 8-week trial). There was a significant decrease in THI posttreatment (M = 4.9, SD = 14.8) compared to baseline (M = 48.8, SD = 6.7), $t(24) = 6.946$, $p < .001$, Cohen's $d = 1.389$ (see Figure 2). There was no significant change in heart rate between baseline (M = 69.4, SD = 11.7) and posttreatment (M = 67.0, SD = 9.5), $t(24) = 1.422$, $p = .168$ (see Figure 3, left panel). There was a significant increase in HRV posttreatment (M = 50.2, SD = 57.5) compared to baseline (M = 33.1, SD = 35.5), $t(24) = -2.142$, $p < .05$, Cohen's $d = 0.430$ (see Figure 3, right panel). A Pearson correlation was conducted to examine the relationship between change in HRV (baseline HRV – posttreatment HRV) and change in THI (baseline THI – posttreatment THI). This test failed to reach significance, $r(23) = .124$, $p = .522$.

Discussion

In this study, participants exhibited a decrease in tinnitus handicap and an increase in HRV following an 8-week acoustic therapy field trial. This finding was consistent with our prediction and supported the hypothesis that acoustic therapy induces an increase in parasympathetic activity in order to restore autonomic sympathetic–parasympathetic balance in individuals with chronic, bothersome tinnitus. Previous tinnitus research has found a correlation between HRV and activity in the dorsal and subgenual anterior cingulate cortex, suggesting that those brain regions could be

Figure 2. Results of Tinnitus Handicap Inventory showing a significant reduction ($p < .0001$) in tinnitus handicap posttreatment (end of 8-week trial) compared to baseline (beginning of study). Error bars represent ±1 standard error.

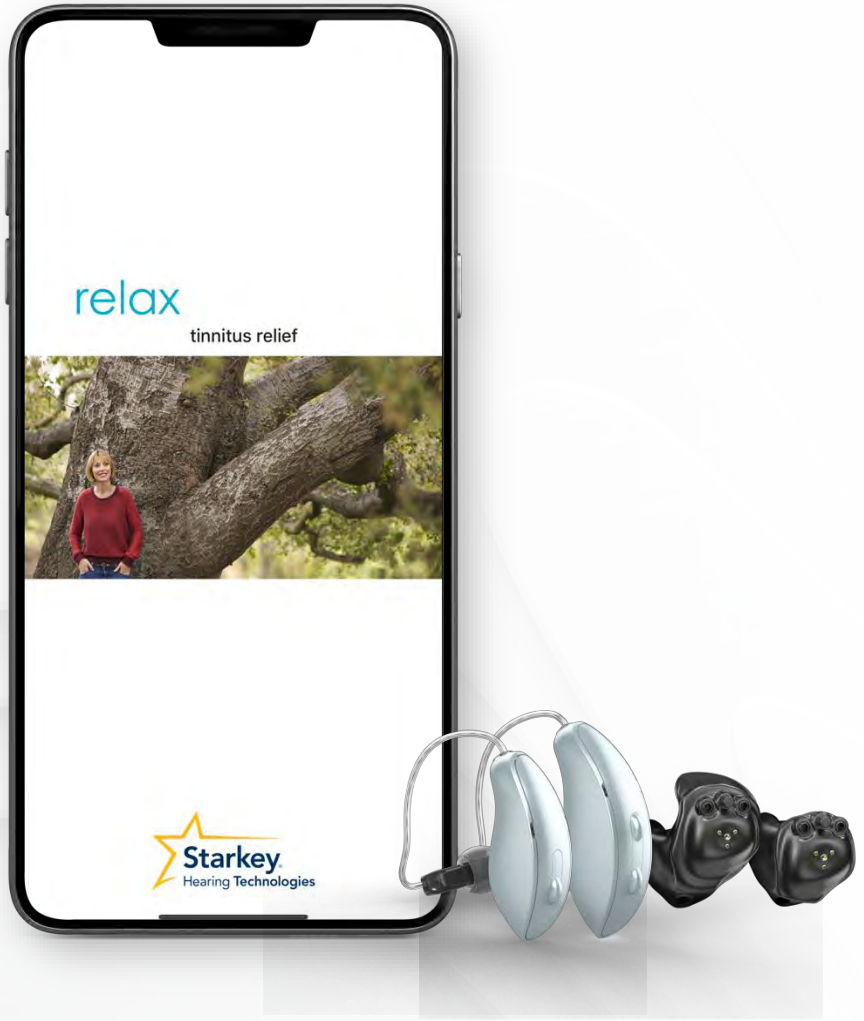
(beginning of study) and posttreatment (end of 8-week trial). Left: heart rate variability (in root-mean-square of successive differences).

control 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 had limited use in audiology and has primarily been used as a measure of acute listening-related stress occurring during challenging listening speech perception, such as speech in noise (Dorman et al., 2012; Mackersie et al., 2015; Seeman & Sims, 2015) or time-compressed speech (Mackersie & Calderon-Moultrie, 2016). While validated self-report measures, such as THI (Newman et al., 1998), Tinnitus Functional Index (Meikle et al., 2012), and Tinnitus Reaction Questionnaire (Wilson et al., 1991), remain the gold standard for measuring tinnitus intervention outcomes (Henry 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 noninvasive vagus nerve stimulation (Ylikoski 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 test–retest reliability of the THI and the multitude of factors affecting individuals' baseline HRV (e.g., Sammito & Böckelmann, 2016).

Given the potential relationship between tinnitus handicap and HRV, patients with tinnitus may be able to benefit from HRV biofeedback training (Lehrer & Gevirtz, 2014). This training teaches individuals to maximize HRV resulting from respiratory sinus arrhythmia through controlled breathing (Lehrer et al., 2013). HRV biofeedback training has been shown to provide clinical benefit for a range of conditions, such as pain (Hallman et al., 2011) and anxiety (Reiner, 2008). It is possible that individuals with tinnitus could also benefit from HRV biofeedback training, as other meditation and relaxation therapies have shown benefit in individuals with chronic, bothersome tinnitus (Arif et al., 2017).

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



Thank you

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