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Directionality

What is Directionality?

Hearing aids with directional microphone systems can focus on speech sounds, providing them with greater amplification than surrounding noise, which improves the patient's speech intelligibility in noise. Ultimately, directional options allow the patient to focus on the sounds they want to hear, while reducing unwanted noise. Directionality may benefit patients who have difficulty holding conversations in noisy situations. Directionality options are dependent on the chosen technology level.

Directionality options

- Omni-Directional
- Fixed Hypercardioid
- Adaptive Directionality
- Smart Beam
- Synchronized Speech Spotter Pro
- Spatial Directionality
- CrossLink Directionality
- CrossLink Directionality with Personal Sound ID
- CrossLink Directionality 2 with Personal Sound ID
- CrossLink Directionality 3
- CrossLink Directionality 4

Omni-Directional

Omni-directional microphones equally amplify sounds from all directions around the listener (Fig. 1). This microphone system provides the most environmental awareness, but typically does not improve the signal-to-noise ratio in a given environment.



Clinical Tip

Omni-directional microphones are suited for quiet, outdoor settings or other situations when the sound source is coming from all directions.

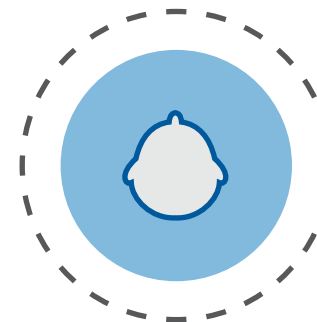


Figure 1. Sound is detected and amplified all around the patient with omni-directional microphones.

Fixed Hypercardioid

Fixed directionality uses a static directional pattern. Sounds in front of the listener receive amplification, while sounds behind the listener receive less amplification (Fig. 2). This directional pattern will not change even if the noise sources move. Therefore, the listener may still experience difficulty communicating in dynamic listening environments.



Clinical Tip

The fixed hypercardioid setting assumes that the signal of interest is always in front of the patient. Counsel your patients that sounds coming from behind and sides may be less audible, requiring the patients' to turn their head toward the signal of interest.

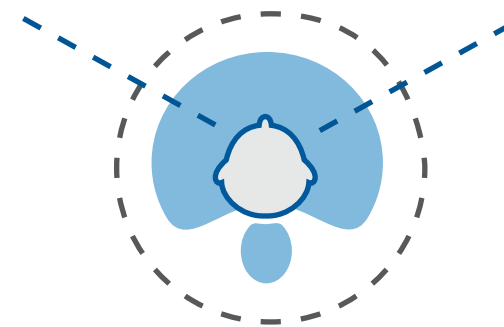


Figure 2. Sounds in front of the listener are amplified more than sounds from behind the listener.

Adaptive Directionality

An adaptive directional system is one in which the directional pattern changes based on the location of the noise sources and the signal-to-noise ratio (Fig. 3). Speech signals originating from in front of the listener are automatically differentiated from noise originating from behind the listener. In making this distinction, the system determines the best directional polar plots to reduce the surrounding noise, thereby improving the signal-to-noise ratio. Accordingly, the system will track the movement of the identified noises to keep them at reduced levels. Depending on the hearing instrument technology level chosen, a greater number of polar plots are used across the frequency range.

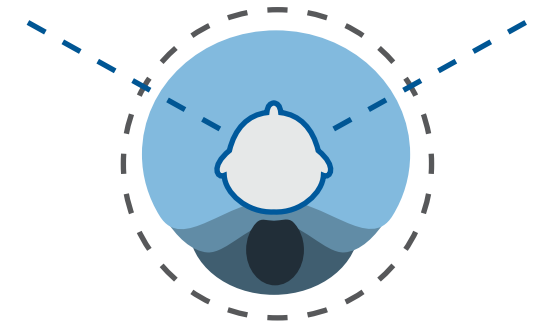
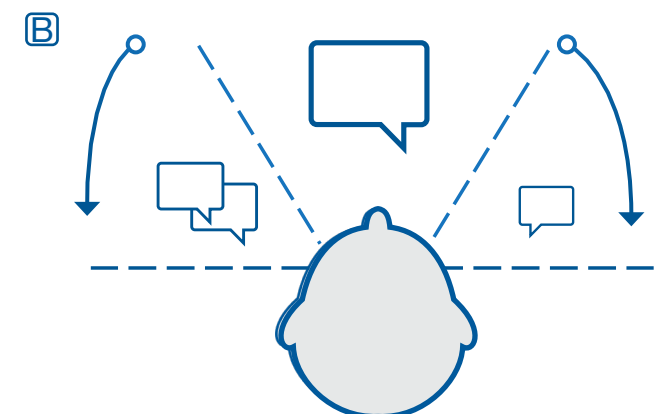
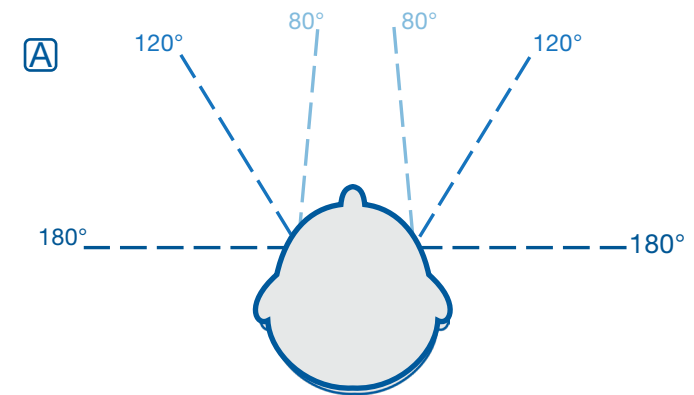


Figure 3. Signal-to-noise ratio is improved as the system determines the best directional polar plots.

Smart Beam

Smart Beam is an advanced version of our adaptive directional system. In addition to creating different polar plots to attenuate the greatest number of noise sources, Smart Beam also allows for further customization of the front beam that provides amplification of signals originating in front of the listener. The additional beam width options provided by Smart Beam include Narrow, Medium, Wide, or Smart Beam Steering (Fig. 4A).

The Smart Beam Steering option allows the system to automatically switch between Medium and Wide beam widths depending on the location of the speech and the signal-to-noise ratio in the environment (Fig. 4B).



Clinical Tip

The Smart Beam Steering **Wide setting** will encompass the majority of the area in front of the patient. Therefore, this setting is a very good starting point.

Try reducing the beam width to a **Medium setting** if the patient complains about hearing in noise.

The Narrow setting is recommended when the listener only regularly communicates with a single speaker who is located in front of the listener.



Figure 4A. Narrow (80°), Medium (120°), Wide (180°), or Smart Beam Steering are the beam width options. B. The Smart Beam Steering option automatically switches between Medium and Wide relative to the strength of speech and noise in the environment.

Synchronized Speech Spotter Pro

With Speech Spotter Pro, the hearing aids change automatically between omni (Fig. 5A) and adaptive directionality (Fig. 5B) by analyzing the surrounding environment. As a result, the instruments automatically choose the best microphone mode to improve communication. For example, in an environment with a poor signal-to-noise ratio, the system switches to an adaptive directional pattern with variable beam widths (Narrow, Medium, Wide or Smart Beam Steering) (Fig. 5C). Once the noise subsides or is no longer detected, the hearing aid returns to the omni-directional mode. Speech Spotter Pro allows the hearing aid wearer to enjoy a natural listening experience without having to remember to push a button.

Enabling Ear-to-Ear communication synchronizes the change in directional mode between the two instruments. This synchronization is built into the Speech Spotter Pro directional option. Accordingly, “Synchronized Speech Spotter Pro” is among the Directionality drop down menu options in Solus Max.

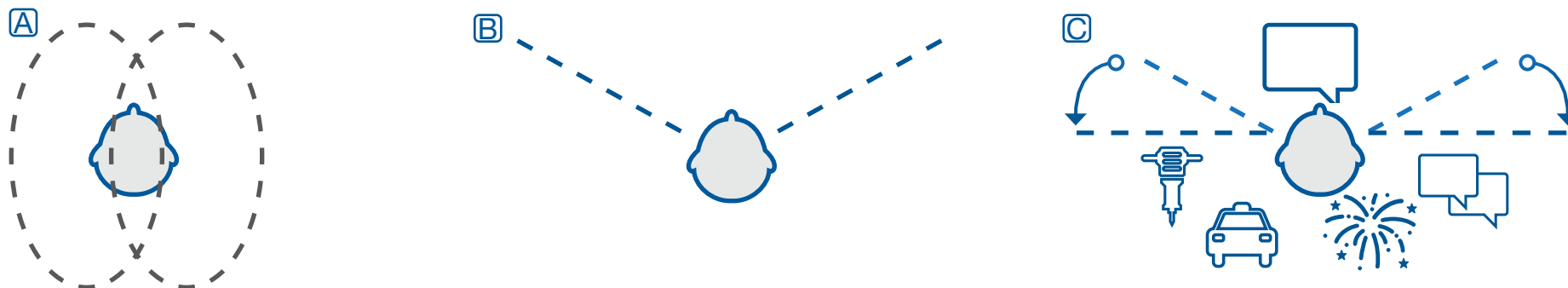


Figure 5A. Speech Spotter Pro enters omnidirectionality in quieter environments. 5B. Adaptive directionality is used in moderate speech babble or background noise. 5C. Smart Beam Steering selected for beam width to help in noisier environments.

Clinical Tip



It is important to counsel your patients that the hearing instrument may occasionally self-adjust in a manner that is different from the patient's wants or expectations. If the patient finds the Synchronized Speech Spotter Pro option unsatisfactory, but still only wants one program, then consider switching to a version of CrossLink Directionality.

Spatial Directionality

Spatial Directionality is a binaural fitting strategy in which the calculated “Focus” ear receives directional input and the “Monitor” ear receives omni-directional input (Fig. 6). Using these two microphone modes simultaneously provides the brain the required input to process sounds similarly to a healthy hearing system's sound processing. Spatial Directionality allows the hearing aid wearer to receive the directional benefit required for better hearing in noise, while experiencing the environmental awareness necessary to fully engage in one's surroundings.

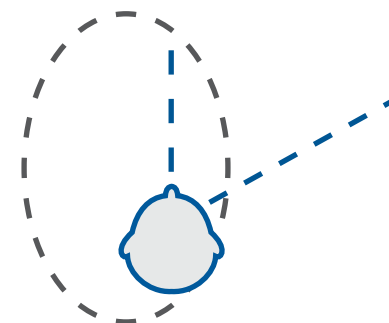


Figure 6. The “focus” ear (right ear) receives directional input and the “monitor” ear (left ear) receives omni-directional input.

CrossLink Directionality

CrossLink Directionality is a binaural fitting strategy that takes advantage of Ear-to-Ear Communication, which is wireless communication between hearing instruments. Together, the hearing aids monitor the environment using speech and noise detectors. Each instrument has a front and rear speech and noise detector to evaluate the presence of speech and noise in front of and behind the user in the environment. The set of instruments calculates the focus ear and monitor ear based on the signal-to-noise ratio, word recognition scores, and degree of hearing loss.

The speech and noise detectors in both hearing aids communicate with each other continuously using Ear-to-Ear Communication to identify the most beneficial microphone configuration for different situations. The possible combinations are omni/omni, omni/directional, directional/omni, and directional/directional (Fig. 8A-D). This option is for products with directional microphones and Ear-to-Ear.

CrossLink Directionality with Personal Sound ID

This directionality option, builds on CrossLink Directionality and introduces Personal Sound ID when in a bilateral omnidirectional mode. Personal Sound ID integrates two technologies to preserve the acoustic cues for spatial hearing, pinna restoration, and binaural compression (Fig. 7). Pinna restoration (directional name) when fitting monaurally reproduces the monaural spectral cues of the open ear that are disrupted by positioning the hearing aid microphone outside of the pinna. Binaural compression helps to preserve the natural loudness difference between the ears using Ear-to-Ear information.

CrossLink Directionality 2 with Personal Sound ID

This directionality option, builds on CrossLink Directionality with Personal Sound ID, which uses Ear-to-Ear communication to determine the best directionality mode for the environment. With CrossLink Directionality 2, the hearing aids are optimized when in the asymmetrical mode. This creates better speech recognition as well as improved localization because the wearer hears more sound coming from behind and to the side of them (over the shoulder). CrossLink Directionality 2 functions with Personal Sound ID to provide the sound cues that permit wearers to focus on speech without losing the important environmental sound.



Figure 7. Personal Sound ID delivers spatial awareness, localization, and speech understanding for users.

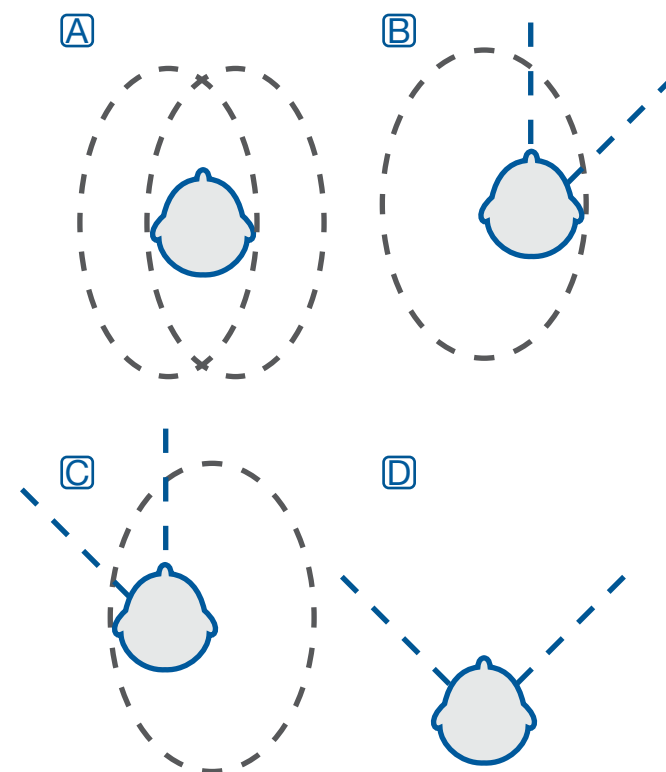


Figure 8A. Omni/omni mode. B. Omni/directional mode. C. Directional/omni mode. D. Directional/directional mode.



Clinical Tip

Personal Sound ID can be selected as a directional option for patients wanting to hear from all directions. Additional advantages include pinna restoration and binaural compression technologies.

CrossLink Directionality 3

Crosslink Directionality 3 builds on our previous generations, where the hearing aids continuously monitor the environment to automatically select the most appropriate directional setting. With CrossLink Directionality 3 an improved Ear-to-Ear binaural beamformer is used to generate narrower, more targeted directional beams. The result is less noise added into the directional signal when the patient is in a noisy environment. This helps improve speech recognition in noise without eliminating important spatial cues for a natural, less fatiguing hearing experience

Clinical Tip



Combining Crosslink Directionality 3 with a M&RIE provides the most natural sound quality, by using personalized pinna cues.

CrossLink Directionality 4

Building on the enhancements of CrossLink Directionality 3, which used a binaural beamformer for a narrower directional beam; with CrossLink Directionality 4 we improved our advanced adaptive bilateral beamformer by increasing the frequency resolution. This delivers a stronger directional signal, providing better speech understanding in noise. Additionally, Ear-to-Ear streaming is used to blend the omnidirectional information from the focus ear into the monitor ear. This helps to eliminate the head shadow effect while maintaining spatial awareness (Fig 9A-C).

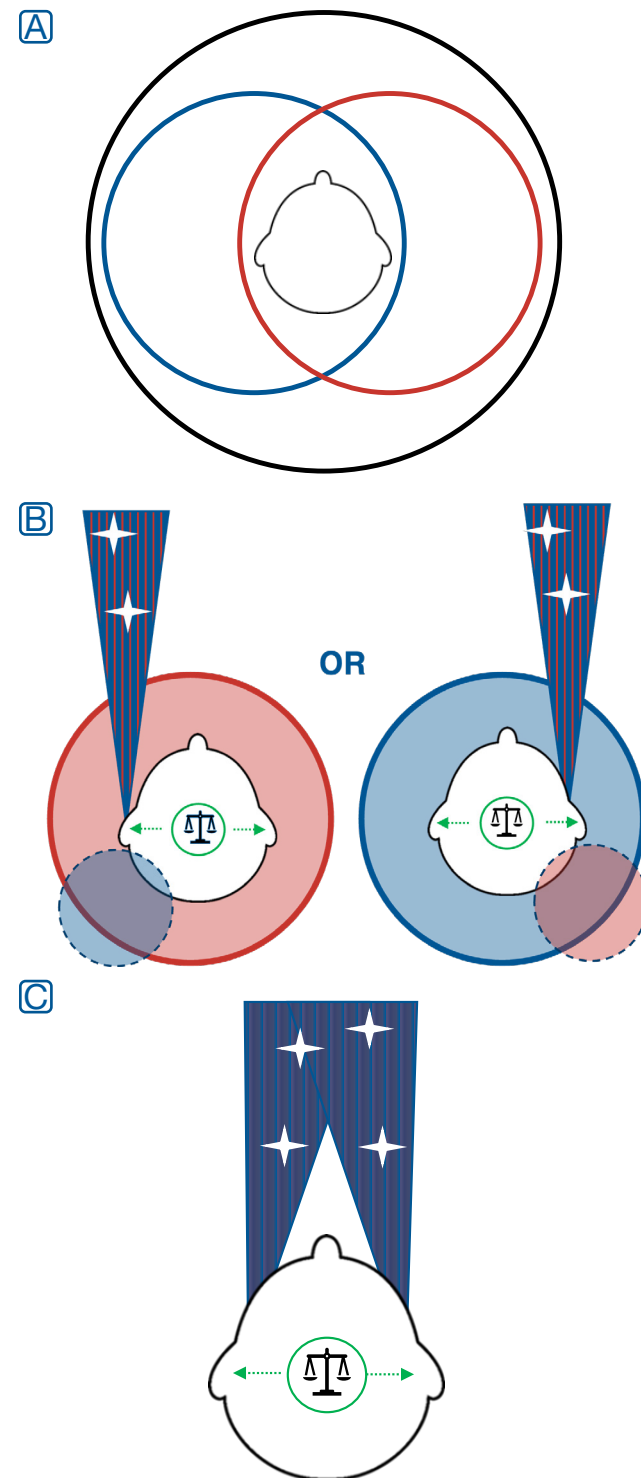
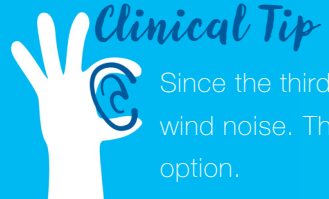


Figure 9. The three listening modes of CrossLink Directionality 4. A. Spatial Cue Preservation mode. B. Binaural Listening Mode. C. Speech Intelligibility Mode.

M&RIE

Provides an improved alternative to an omnidirectional microphone mode that is enhanced by using personalized pinna cues (Fig. 10). This preserves the spectral filtering of each ear, providing more natural sound quality when compared to both omnidirectionality and pinna compensation.



Clinical Tip

Since the third microphone is placed in the ear canal, it provides significant protection against wind noise. This is a great option for the Outdoor program and can be selected as a directional option.

Ultra Focus

In particularly tough situations, such as very noisy environments, users may require a stronger level of directionality in order to only focus on the person directly in front of them (Fig. 11.) Ultra Focus lets the user conveniently activate our strongest ultra narrow directionality to enhance sounds from in front. Accessing Ultra Focus directionality is easy from either the hearing aid or from the HearMax app. This allows users to control their sound experience by focusing in on what they want to listen to, providing a renewed confidence in situations that they might otherwise have avoided.

Ultra Focus 2

In addition to the benefits above, Ultra Focus 2 applies a precise advanced adaptive bilateral beamformer delivering significant improvements to speech understanding in noise by focusing the narrower beam on the signal in front (Fig 12). This provides improvement with one-to-one communication in the noisiest environments while preserving situational awareness. Just like with Ultra Focus, Ultra Focus 2 can be accessed from the hearing aid or the HearMax app.



Clinical Tip

Ultra Focus 2 and Ultra focus are found as directionality options in the Hear in Noise program.

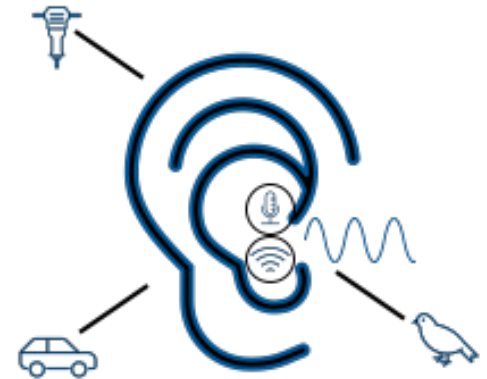


Figure 10. M&RIE is an enhanced version of omnidirectionality that uses the individual's own ear acoustic to provide even more natural sound quality.

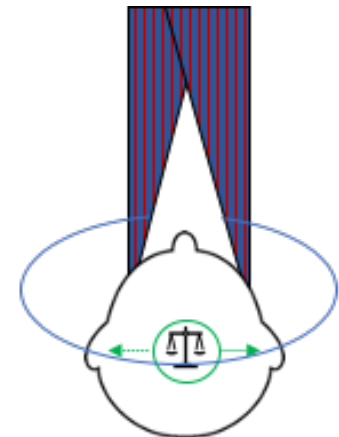


Figure 11. The Ultra Focus program allows for narrow directionality when in noisy situations.

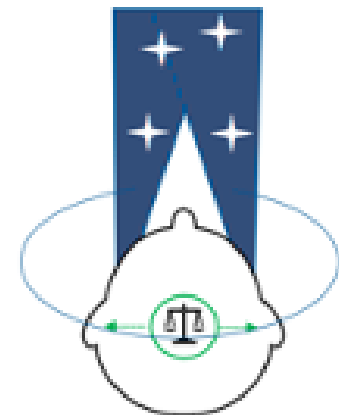


Figure 12: Ultra Focus 2 with enhanced frequency resolution in the narrow directional beams.

Mixing point frequency

What is Mixing Point Frequency?

Many directional processing systems require a trade-off between low-frequency noise and low pitch sound audibility. All of Beltone's directional options process low and high frequencies separately. To provide the best possible sound quality, high frequencies remain directional, while low frequencies always remain omnidirectional (Fig. 13A). Beltone enables mixing point frequency adjustment (technology-level dependent), which blends omnidirectional and directional processing (Fig. 13B). In most situations, it is unnecessary to adjust the mixing point frequency.

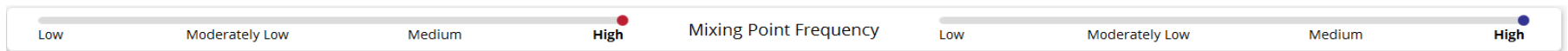
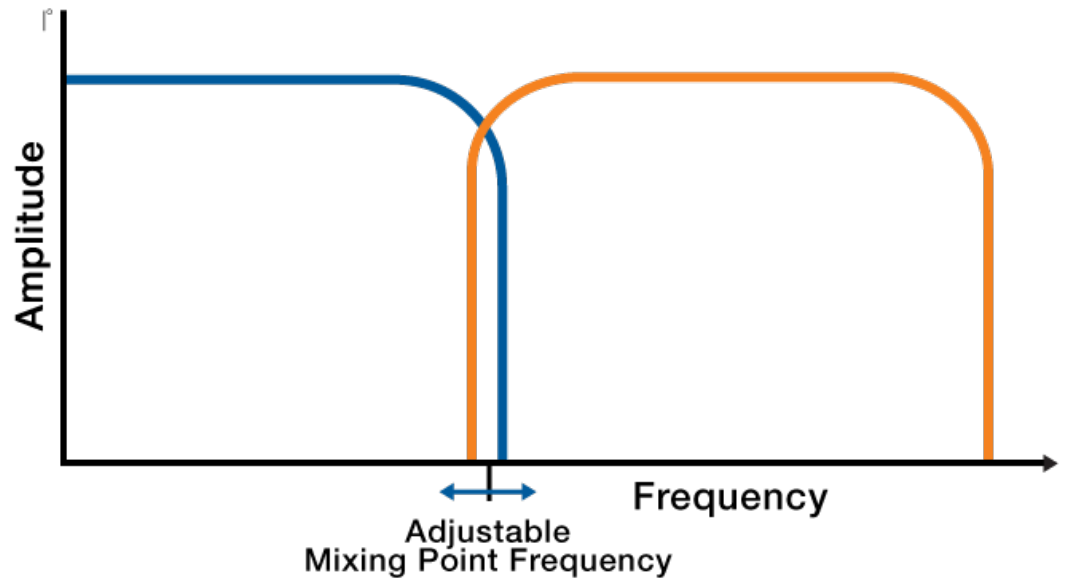


Figure 13 . Mixing Point Frequency is located in Advanced Features in Solus Max and usually does not require adjustment.



Clinical Tip

A **high mixing point frequency** suggests mostly omni-directional processing. A **low mixing point frequency** indicates mostly directional processing. Mixing point frequencies are calculated based upon the individual hearing loss as well as the hearing aid style.

Smart gain pro

What is Smart Gain Pro?

Smart Gain Pro customizes listening situations to the patient's preferred gain. It can be adjusted in seven environments. The hearing aid recognizes the type of listening environment based on the surrounding acoustic features and applies the adjustments for that environment (Fig. 14A). The seven environments are applicable across programs to deliver the best sound level to the patient regardless of the type of listening situation.

The addition of Ear-to-Ear Communication now allows for Smart Gain Pro volume change synchronization, which occurs seamlessly behind the scenes to prevent any artificial disparity between hearing instruments. So, once both instruments detect an environment they apply the appropriate volume setting, set up by the dispenser, for that environment.

Smart Gain Pro also combines environmentally-controlled noise reduction levels with our 17-level products. As a patient changes to noisier environments, they may prefer higher levels of noise reduction. The hearing aid also automatically implements these noise reduction settings.

Smart Gain Pro Seven Environments

1. Quiet
2. Soft Speech
3. Loud speech
4. Speech in moderate noise
5. Speech in loud noise
6. Moderate Noise
7. Loud noise

Figure 14A. Smart Gain Pro automatically adjusts the hearing aid gain based on the patient's listening environment. B. Smart Gain Pro gain sliders are adjustable for each environment in Solus Max in the Smart Gain Pro tab.

A

						
						
Quiet	Soft Speech	Loud Speech	Speech in Moderate Noise	Speech in Loud Noise	Moderate Noise	Loud Noise
< 54 dB	< 60 dB	> 60 dB	< 75 dB	> 75 dB	< 75 dB	> 75 dB

B

Smart Gain Pro ⓘ On Off Reset

Quiet		2
Speech (soft)		2
Speech (loud)		2
Speech in noise (moderate)		1
Speech in noise (loud)		0
Noise (moderate)		-2
Noise (loud)		-3

Clinical Tip



When patients complain of uncomfortably loud noise, try decreasing the gain in the Moderate or Loud Noise Smart Gain Pro sliders (Fig. 14B).

Sound Cleaner Pro

Speech and Noise Spectra

Speech and noise have two different spectra. Speech is highly modulated with rapid changes in amplitude, while noise has less modulation with only small changes in amplitude. Beltone hearing aids analyze the incoming sounds and recognize when speech is present within the individual bands. A spectral analysis is continuously occurring whenever speech is not present. This effectively “subtracts” the noise spectrum from the total signal without affecting speech. The amount of noise subtracted depends on the setting and is weighted according to a speech importance. This specificity in noise detection allows the hearing aids to reduce noise only in the bands where noise is present.

What is Sound Cleaner Pro?

Sound Cleaner Pro may improve listeners' performance and comfortability in background noise. Our 9-level instruments feature the standard Mild, Moderate, and Considerable settings in the Sound Cleaner system. Sound Cleaner Pro for our 17-level instruments includes the additional levels of Strong and a setting called Per Environment (Fig. 15A). For greater customizations, this setting allows noise reduction adjustments across the seven environments, which are classified by the Smart Gain system (Fig. 15B).

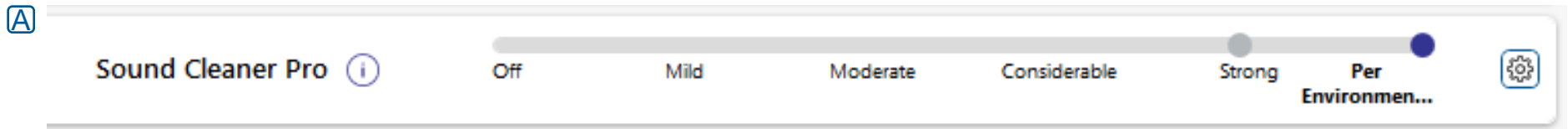
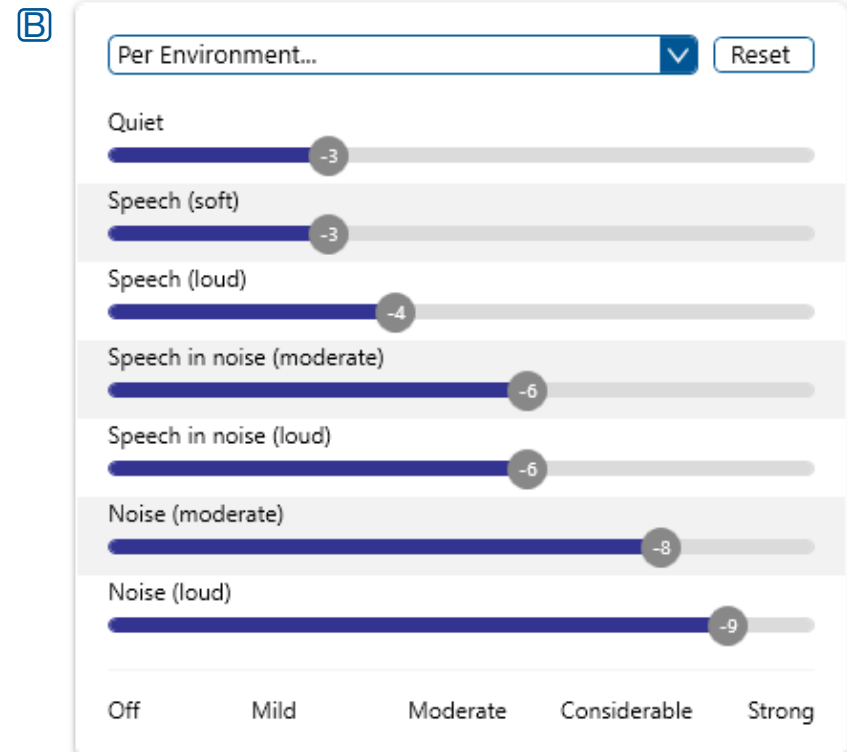


Figure 15. The Per Environment setting is available in 17-level instruments and reduces noise in seven environments.



Clinical Tip

When complaints arise regarding too much environmental noise or discomfort due to noise, **increase the strength of Sound Cleaner Pro**. If the problem is only experienced in certain environments, increase the noise reduction in only the types of environments described by the patient by using the **Per Environment setting**.



Impulse Noise Reduction

What is Impulse Noise Reduction?

This feature, optimizes comfort. Sudden loud sounds like a slamming door or clinking glasses can be over-amplified by hearing aids, which can startle and cause discomfort for the user. Impulse Noise Reduction prevents this by quickly detecting sudden loud sounds and ensuring appropriate gain to maximize comfort for the user (Fig. 16A). There are four available settings for Impulse Noise Reduction (Fig. 16B).

A



Impulse Noise Reduction Available Settings

1. Off
2. Mild
3. Moderate
4. Strong

B

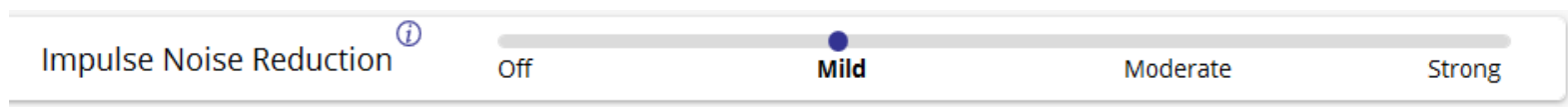


Figure 16A. Impulse Noise Reduction prevents over amplification of sudden loud noises which increases comfort for patients. The sudden, loud noise does not alarm or cause discomfort to the patient because Impulse Noise Reduction applies appropriate gain. B. There are four settings: Off, Mild, Moderate, and Strong.

Feedback Calibration Systems

Maximum Stable Gain (MSG) Calibration

Feedback Eraser, a digital feedback suppression system, eliminates the annoying high-pitch whistle from hearing aids. **In order for this technology to work, it needs to be calibrated in the office.** Calibration provides a reference tone for which the hearing aid can make filters to eliminate feedback waves. Running the MSG calibration will reduce the risk of whistle and improve patient satisfaction. To obtain the best MSG curves the hearing aids need to be placed in the patient's ears, otherwise there is increased risk for feedback (Fig. 17).

Clinical Tip



Make sure to run the MSG calibration **every time the instrument is repaired or there are changes to the instrument's physical properties.** These changes include but are not limited to: new tubing, new earmolds, and vent adjustments. Be sure to calibrate in a quiet environment to ensure the most accurate calibration possible.

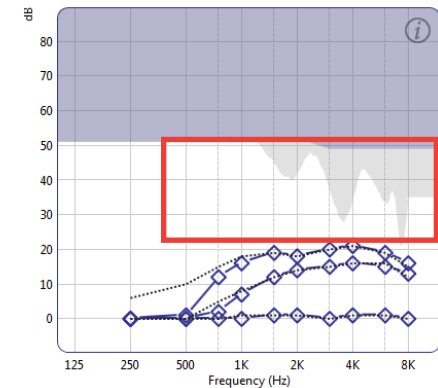


Figure 17. Calibrate while the hearing aids are in the patient's ear to obtain the best MSG curves to reduce whistle risk.

Feedback Eraser

Poor physical fit, high gain settings, and objects too close to the hearing aids are all possible causes of feedback. Feedback Eraser measures the pathway sound travels around the hearing aid and creates a digital signal opposite in phase to cancel the feedback (Fig. 18). MSG calibration initiates Feedback Eraser and automatically activates it after the calibration completes. The Feedback Eraser offers several levels of reduction to achieve feedback elimination in both static and dynamic situations without impacting gain or sound quality (Fig 19).

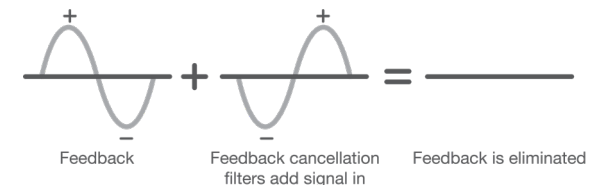


Figure 18. Feedback Eraser measures the incoming sound pathway and creates a signal in opposite phase to produce an output sound pathway that filters the feedback.



Figure 19. MSG calibration completion initiates Feedback Eraser. The Feedback Eraser offers five settings: Off, Mild, Moderate, and Strong and Music Mode. For our 17-level products, WhistleStop is also available.

Feedback Eraser 2

The new Feedback Eraser 2 delivers better sound quality in any listening environment by providing more overall comfort and gain with less trade-offs such as artifacts. Additionally, allows for faster processing and efficiency which is needed to carry out the complex processing that is needed by adding a third microphone with M&RIE. When using a M&RIE an MSG calibration must be completed, Solus Max will not let you save the fitting without a calibration.

The music mode setting is designed for feedback and artifact free music listening. In this mode, the input sound is analyzed over a longer period of time to better distinguish feedback from other tonal sounds. The Music Mode option is available in all environmental programs and is the default in the "Music" program.

What is Feedback?

Feedback is that annoying, sometimes embarrassing high-pitched whistle produced by a patient's hearing aids.



WhistleStop is our most aggressive Feedback Eraser setting and is only available on 17-level products (Fig. 20). While WhistleStop reduces feedback most of the time, this aggressive level may impact audibility and sound quality for very severe losses. This setting is especially useful for acoustic telephone use.

Safeguard Feedback Control

Safeguard Feedback Control is a convenient option when an MSG calibration is not possible. Safeguard Feedback Control learns the feedback path of the individual to efficiently cancel feedback. It is like a feedback safety net. The default for Safeguard Feedback Control is “On” and active for all programs in the instrument once it is connected to the software (Fig. 21). This is a global setting, so one program cannot have safeguard Feedback Control set to “On” while another program has it set to “Off”. The Safeguard Feedback Control automatically turns off after the MSG calibration completes.

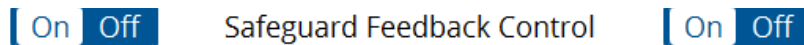


Figure 21. SafeGuard Feedback Control can be turned on or off globally for all programs in the Advanced Features tab in Solus Max.

Vent Corrections

Venting allows the low frequencies to flow freely out of the ear, the larger the vent the more these frequencies can flow out. Depending on hearing aid style during the connection flow, dome type, tube type or vent size will be selected. Solus Max has the Vent Correction feature set to “Yes” by default. This means that on the gain graph the estimated effect of the selected vent option will be visualized, but this does not affect the hearing aid output. For example, when venting is changed, the amount of roll-off in the low frequencies adjusts to show how this physical change affects the expected real ear response. If the preference is to view the gain graph without the effect of venting on a case-by-case basis, uncheck the Vent Corrections box under the Display Options on the Fine Tuning Screen (Fig.22A). If this is a wanted permanent change then under Edit, Preferences, change the Vent Correction feature to “No” (Fig.22B).



Figure 20. Feedback may occur when a patient answers the telephone. When Feedback Eraser detects feedback, WhistleStop is initiated to maximize patient comfort.

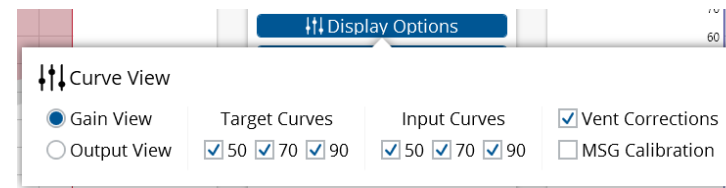


Figure 22A. Changing Vent Corrections per patient as needed

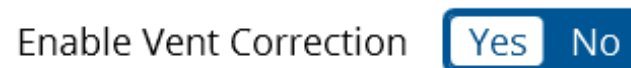


Figure 22B. Changing the Vent Correction permanently from preferences.

Phone Options

Telecoil (T-Coil)

A Telecoil is a component inside the hearing aid that detects magnetic audio signals from hearing aid compatible telephones, inductive loops systems, or assistive listening devices. An activated Telecoil signal in the hearing aid bypasses the microphone(s) and the listener hears the audio signal detected directly by the Telecoil. For customization, use the microphone balance sliders within the program to allow the patient to hear some surrounding sound while in the Telecoil mode (Fig. 23).



Figure 23. Customization of the Mic relative to the Telecoil are available.

Acoustic Phone

When Telecoil is not an option, there is an acoustic telephone option. The acoustic telephone program uses the hearing aid microphones' frequency shaped to work best with the phone. Feedback may occur when the phone is placed near the hearing aid since the microphone(s) are on.

Asymmetrical Phone Handling

Wireless Ear-to-Ear Communication can be applied to phone usage by allowing one instrument to let the other know that it's on the phone. Once an instrument communicates that it is listening to a phone, the microphone input in the opposite ear is reduced by 6 dB. This is called Asymmetrical Phone Handling (Fig. 24). This feature allows the instrument wearer to comfortably hear their phone conversation while reducing the competing environmental noise. This reduction in gain is automatically built into the AutoPhone functionality. This feature is available for both Acoustic Telephone and Telecoil programs.



Figure 24. Asymmetrical Phone Handling.

Clinical Tips



By bypassing the microphone(s), the **Telecoil** enables the patient to hear well on the telephone by reducing feedback and greatly improves the signal-to-noise ratio in venues with an induction loop.

Wind Noise Reduction

What is Wind Noise?

Turbulent air flow over the microphone ports caused by even a moderate level of wind can tremendously increase low frequency input into the hearing instruments. Not only does this wind noise create a loud, unpleasant listening situation for the hearing aid wearer, it can also detrimentally affect speech understanding.

Wind Noise Reduction

Beltone's Wind Noise Reduction correlates the inputs between the two microphones. In this manner, the wind noise detector only activates wind noise reduction if there is wind present at the microphones. This system provides a reliable and effective way to rid the patient of troublesome wind noise. Thus, it allows the patient to fully enjoy outdoor environments

(Fig. 25). Naturally, this two microphone wind noise reduction is only available for dual microphone devices. Depending on the technology level chosen, there are varying offset options available: Mild offset of 6, Moderate offset of 3, and Strong offset of 0 (Fig. 26).

Clinical Tip



Wind Noise Reduction is a key feature in the "Outdoor" program. If other programs require wind noise reduction, you need to manually turn it on from the Advanced Features tab.

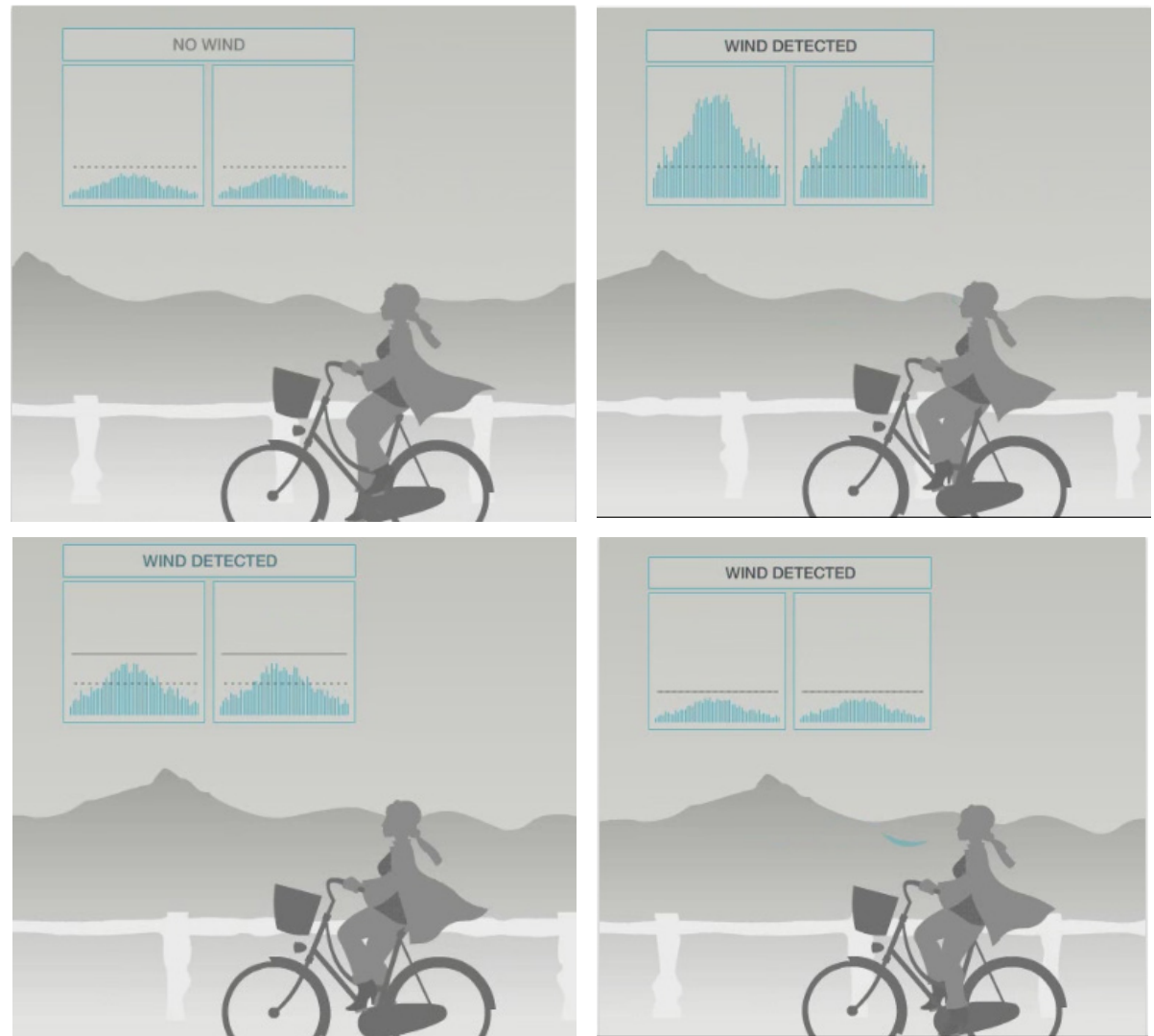


Figure 25. Wind Noise Reduction only initiates when wind is detected as seen in the first two images. Wind noise is reduced as long as wind continues to be detected as seen in the last two images.

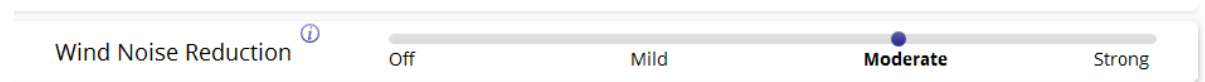


Figure 26. Wind Noise Reduction provides better listening comfort in outdoor environments. There are four available settings: Off, Mild, Moderate, and Strong.

Silencer

What is Silencer?

Belton's term for expansion is Silencer (Fig. 27), which reduces amplification for very soft sounds that are not of interest to the wearer. Examples of such sounds are very low-level environmental sounds or noise generated internally by the hearing aid. As the sound intensity decreases below a set kneepoint, gain reduces. This provides less gain for sounds that are softer than conversational speech. The purpose of activating Silencer is to improve sound quality in quiet environments by reducing low-level noise (Fig. 28).

Figure 28A. In the Off setting, Silencer does not eliminate low-level noise, like a humming refrigerator. B. In the Mild setting, some low-level noise is reduced. C. In the Moderate setting, unwanted low-level noise is reduced more. D. In the Strong setting, the low-level noise is silenced.



Figure 27. Belton's term for expansion is Silencer, which features four setting options of Off, Mild, Moderate, and Strong.



Sound Shifter

What is Sound Shifter?

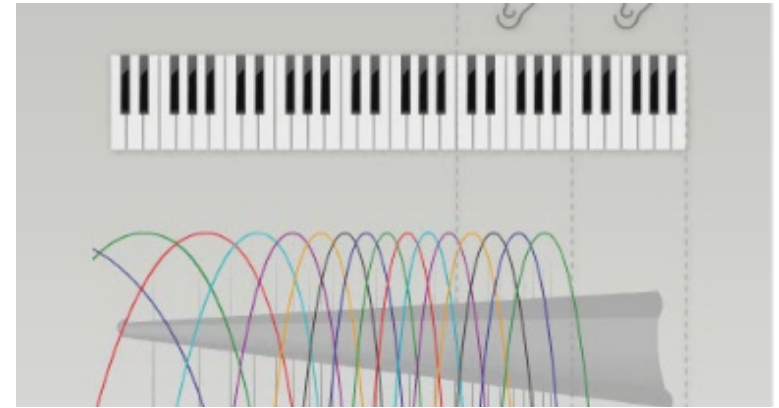
Sound Shifter is a frequency lowering approach that improves high frequency audibility with minimal degradation of sound quality. Frequency lowering strategies displace signals from higher frequencies to lower frequencies, where beneficial amplification may be achieved. Frequency compression changes the input to a more usable output above a cut-off threshold, or kneepoint. Sound Shifter compresses the frequencies above the kneepoint, effectively moving them closer together. It amplifies input frequencies in a narrower frequency region that is more usable to the hearing aid wearer (Fig. 29). The need for frequency compression is not generalizable to particular hearing losses or patient characteristics; thus, the feature default is set to “off” in each program. The patient’s audiogram informs the recommended setting, which appears in bold typeface as either “Very Mild”, “Mild”, “Moderate” or “Strong” (Fig. 30).

Clinical Tip

Recommendations for Sound Shifter are specific to the ear’s audiometric thresholds. It is possible that different settings for each ear may be recommended, as in the case of asymmetric hearing losses. In such cases, it is recommended to set Sound Shifter to the mildest of the recommended settings for both ears. Furthermore, Sound Shifter may be activated in one or more programs, binaurally or monaurally, depending on the hearing aids wearer’s needs.



A



B

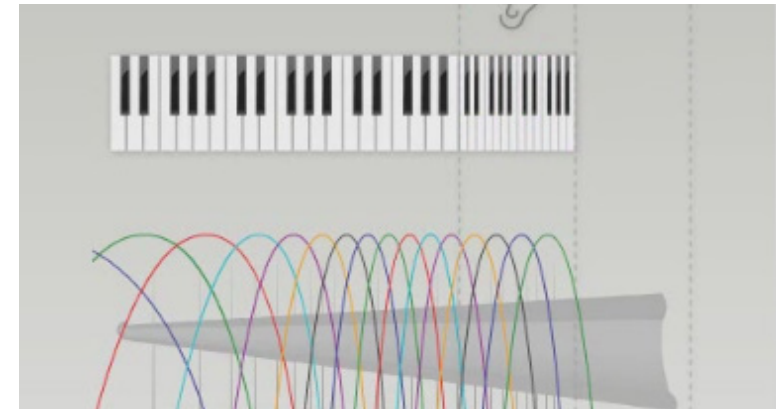


Figure 29A. Without Sound Shifter On, high frequency sounds are inaudible. B. With Sound Shifter activated, higher frequency information is moved into a lower frequency range that is audible for the wearer.

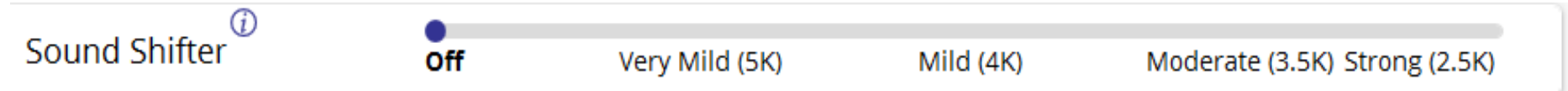


Figure 30. Sound Shifter offers four settings: Off, Very Mild (5K), Mild (4K), Moderate (3.5 K), and Strong (2.5 K). Solus Max will bold the recommended setting for your patient based on the audiogram.

Tinnitus Breaker Pro

What is Tinnitus Breaker Pro?

Tinnitus Breaker Pro is a unique, state-of-the-art feature that offers clinicians the flexibility to address patient needs for both hearing loss and tinnitus relief. The feature consists of a sound generator that can be used alone or added to existing amplification programs. Tinnitus Breaker Pro can serve as a component of sound therapy or simply as a masker to temporarily lessen the tinnitus perception. Tinnitus Breaker Pro is a standard feature for most of our products.

Activating Tinnitus Breaker Pro

The Solus Max software allows for the adjustment of both the hearing instrument features, as well as the features in the sound generator, which includes shaping of the generated white noise, modulation speed, and volume control. These parameters are helpful in customizing the sound generator noise and providing more comfort for tinnitus patients.

Tinnitus Breaker Pro can be activated in any acoustic program by clicking on the “On” radio button. When Tinnitus Breaker Pro has been added to a program, it is designated in the program tab as “Tinnitus Breaker Pro+” the name of the program (Fig. 31).

What is Tinnitus?

Tinnitus can be an acute (temporary) condition or a chronic (ongoing) health concern that is defined as the experience of hearing sound without an external, acoustic source. While it is commonly referred to as “ringing in the ears,” tinnitus can also be described as buzzing, hissing, whistling, swooshing, and clicking.

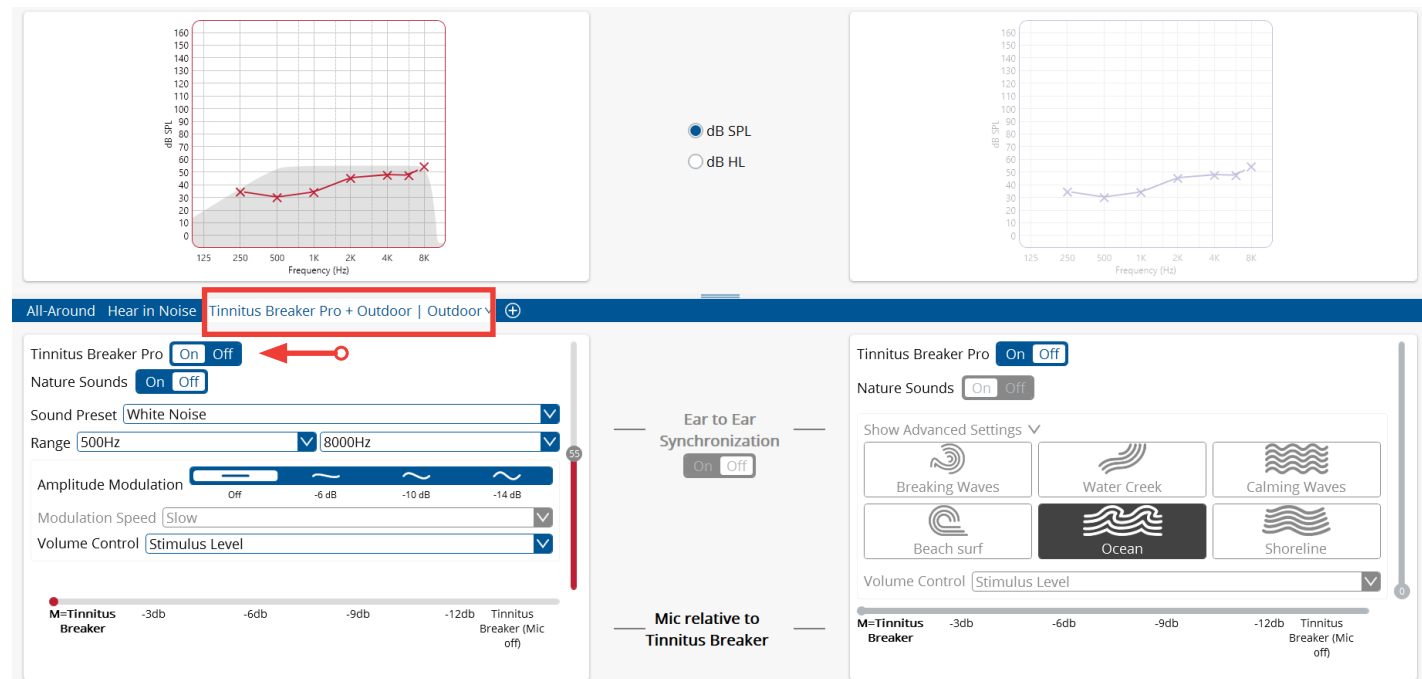


Figure 31. The red arrow and box note how to turn on Tinnitus Breaker Pro in a program and the new program name.

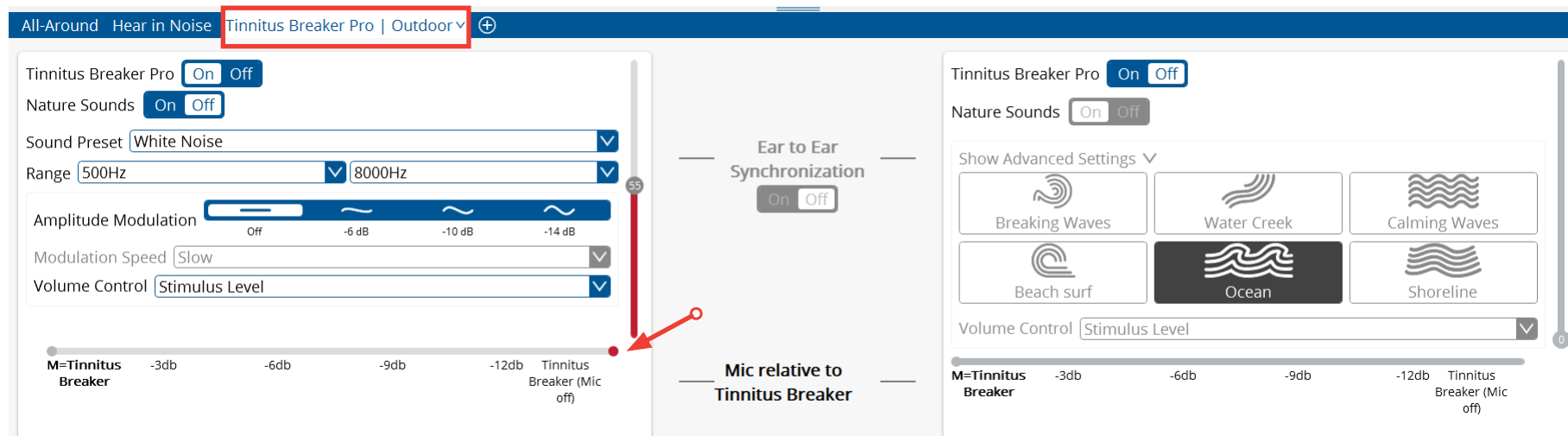


Figure 32. The red box and arrow indicate that the hearing aid microphone must be off to have a Tinnitus Breaker Pro only program.

If the hearing instrument microphone is on, amplification will be provided. It might be advantageous to manually disable the noise reduction and silencer features because often hearing extra environmental sounds can be helpful in achieving the goal of tinnitus habituation.

To create a Tinnitus Breaker Pro only program, turn off the hearing instrument microphones. This is done from the Mic relative to Tinnitus Breaker by moving the slider to the Tinnitus Breaker (Mic off) position (Fig. 32). In this case, only the generated noise will be heard from the hearing instrument.

When the Tinnitus Breaker Pro is on, the hearing thresholds along with the spectral shape and gain level of the generated sound are displayed (the gray area) (Fig. 33). This provides the fitter with an indication of generated sound. The graph can be viewed on a dB HL or dB SPL scale.

Clinical Tip

Patients with tinnitus often report that it sounds the loudest in quiet environments (ex. prior to falling asleep or while reading). Naturally, a Tinnitus Breaker Pro program with no amplification may provide beneficial relief in these situations.

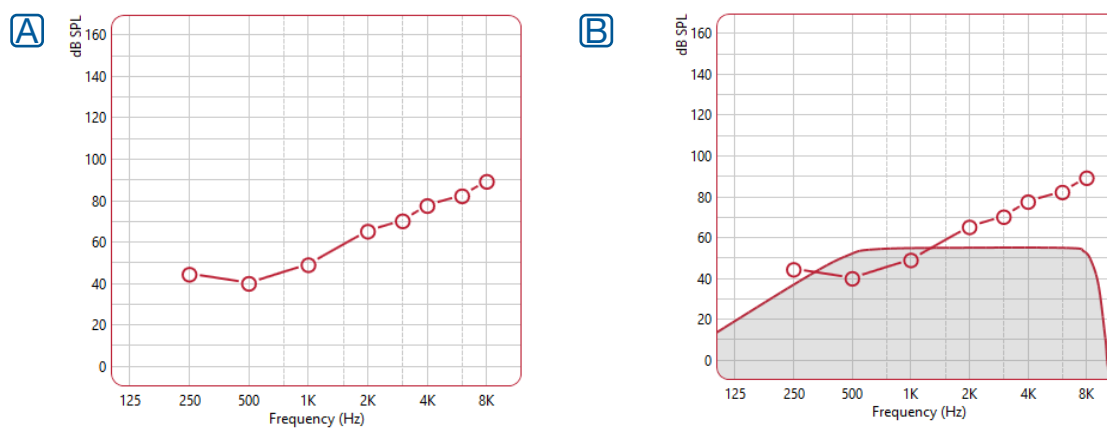


Figure 33A. Tinnitus Breaker Pro is off. B. The spectral shape and gain level are displayed when Tinnitus Breaker Pro is on.

Gain Level

The gain of the generated noise can be set using the vertical gain slider (Fig. 34). The gain level selected on the slider corresponds to the gray-shaded area displayed on the gain graph. The maximum, allowable gain level is 100 dB.

There are several approaches for setting the subsequent gain level when using the Tinnitus Breaker Pro feature. The chosen approach depends on whether the goal is to treat the tinnitus with the hope of long-term reduction or to mask it. Masking may temporarily relieve the tinnitus perception while using the Tinnitus Breaker Pro. One well-known method used in tinnitus treatment is called the Mixing Point Method. The mixing point is the level at which the tinnitus and the generated sound start to “blend” together. Consequently, the patient is unsure as to whether they are hearing the tinnitus or the generated noise. This allows the brain to ignore tinnitus even though it is still perceived. To use this method, first establish the threshold of the Tinnitus Breaker Pro noise. Once this threshold has been found, slowly increase the volume of the Tinnitus Breaker Pro noise in 1-2 dB increments to find the mixing point. Then, reduce the Tinnitus Breaker Pro noise 1 to 4 dB below the mixing point level to establish the baseline setting.

When using Tinnitus Breaker Pro as a tinnitus masker, the goal is for the patient to only perceive the generated noise and not the tinnitus. Generally, raising the gain in 1-2 dB increments above the mixing point until the patient is no longer able to perceive the tinnitus achieves this goal.

Frequency Shaping

The frequency of the generated noise can be adjusted by using the low and high cut filters. The low cut filter reduces to 500 Hz while the high cut filter extends up to 8000 Hz (Fig. 34). The default noise setting for the Tinnitus Breaker Pro is a broadband filter setting, but can be adjusted using the low and high cut controls to meet patients' preferences and provide more individualized comfort.

Amplitude Modulation and Modulation Speed

Another feature that can be customized for patient comfort is the modulation amplitude (Fig. 35). The modulation amplitude is a fluctuation in the level of the noise signal. The modulation amplitude is randomized, so that the amount of attenuation will not always be the same.

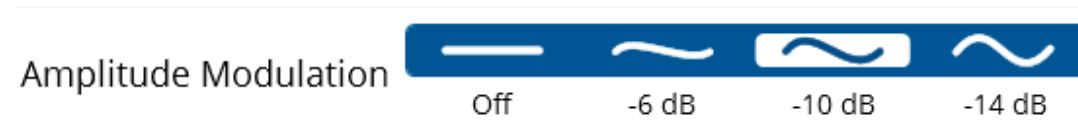


Figure 35. Amplitude Modulation has four settings: Off, Mild, Moderate, and Strong.

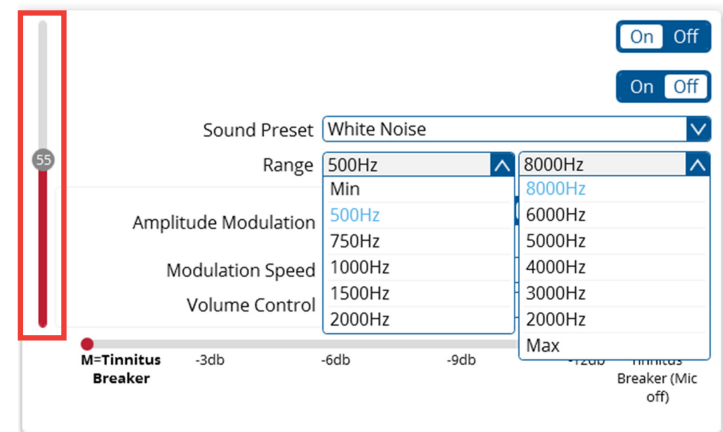


Figure 34. The red box highlights the gain adjuster. Noise frequency adjustments are available in the low and high cut filters which range from 500 Hz to 8000 Hz.

Clinical Tip

For gain level, take care in setting the generated noise at 100 dB SPL, as this represents an increased risk to the patient's hearing thresholds due to noise exposure. At this level, limit use of the Tinnitus Breaker Pro to a maximum of one hour of use time.

For frequency shaping, most literature suggests using a broadband stimulus since this setting activates the most neurons. Therefore, it is most effective when used as a part of a sound therapy strategy. If using the Tinnitus Breaker Pro feature as a part of a masking strategy, shape noise to more closely match the frequency of the patient's tinnitus. In this instance, shaping the noise may mask the tinnitus more effectively and create a more pleasant listening experience.



There are four options in Solus Max:

- Off (0 dB)
- Mild (-6 dB)
- Moderate (-10 dB)
- Strong (-14 dB)

If you chose a 'Moderate' level, the white noise energy can fluctuate up to -10 dB from the programmed volume of the Tinnitus Breaker Pro. For example, if the programmed volume is 65 dB SPL, and you apply a 'Moderate' modulation amplitude, the volume will randomly fluctuate between 65 dB SPL and 57 dB SPL.

If you activate modulation amplitude, there is also an option to activate modulation speed, which controls the speed at which the fluctuations occur (Fig. 36). This time represents how often a fluctuation will occur in the white noise energy. Modulation amplitude and modulation speed are strictly comfort features. Consider them on a case-by-case basis. The three options for modulation speed are:

- Slow (8 sec)
- Medium (4 sec)
- Fast (2 sec)

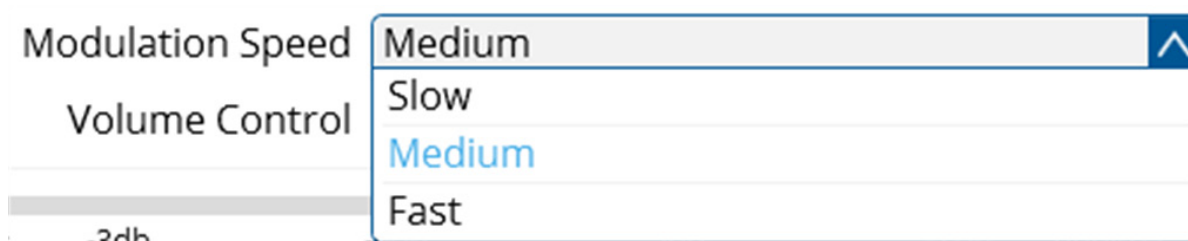


Figure 36. Speed modulation features three options: Slow, Medium, and Fast.



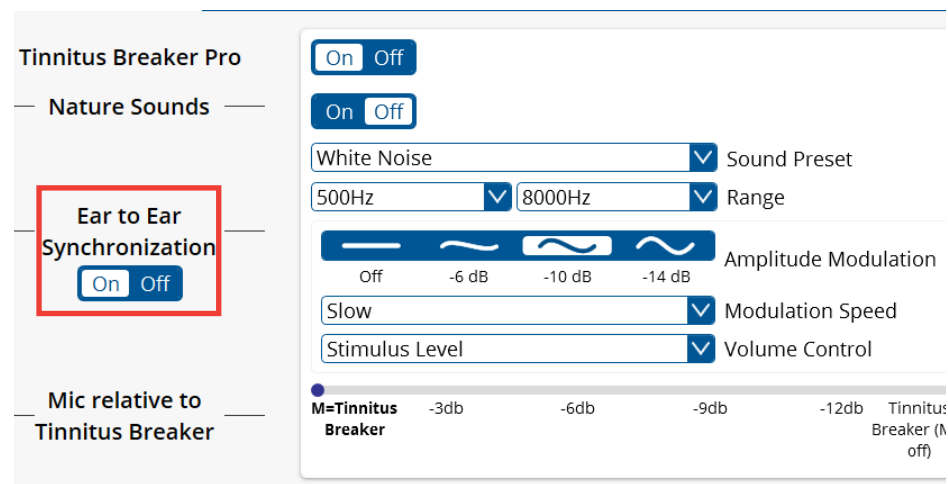
Clinical Tip

Many tinnitus sufferers prefer some modulation in the generated noise signal. Rather than listening to static white noise at a particular level, changing the amplitude modulation and modulation speed can make the generated signal more tolerable. A good starting point is to set the amplitude modulation level to moderate and the modulation speed to medium.

Synchronize

With Ear-to-Ear technology, it is possible to synchronize the noise generated by the Tinnitus Breaker Pro. If the Tinnitus Breaker Pro is activated, dispensers can choose to synchronize the Amplitude Modulation, Modulation Speed, and Volume Control settings between the two instruments. To do this, turn on the radio button for Synchronization when setting up the Tinnitus Breaker Pro program (Fig. 37).

Figure 37. The red box highlights the option to synchronize Tinnitus Breaker Pro settings.



Volume Control

The Tinnitus Breaker Pro offers two options for volume control: Stimulus Level and Stimulus Level + Environmental Steering. Select the options in the Volume Control dropdown (Fig. 38).

Since the tinnitus perception loudness can change throughout the day, the ability to control the noise volume may be advantageous. If the patient would like to manually control the volume of the noise, then set the Volume Control option to “Stimulus Level”.

The “Stimulus Level + Environmental Steering” setting of the Tinnitus Breaker Pro allows the user to utilize the benefit of the “Environmental Steering” setting, but does allow the patient to manually override that and make volume control changes as needed in 1 dB steps. Environmental Steering automatically adjusts the stimulus level as the amount of environmental noise fluctuates.

Nature Sounds

To expand the flexibility of the Tinnitus Breaker Pro feature, there is another option called Nature Sounds. This offers alternative sounds to the white noise generator. Each Nature Sound is a broadband stimulus extracted with the natural amplitude modulations of the respective environment.

When the Nature Sounds radio button is set to “On”, the six environments appear: Breaking Waves, Water Creek, Calming Waves, Beach Surf, Ocean and Shoreline (Fig. 39). Breaking Waves was the most preferred sound in an internal trial and therefore is the default environment.

Gain adjustment and volume control settings are available when using Nature Sounds. To set the gain when using Nature Sounds, use the same method as if fitting with the white noise generated by the Tinnitus Breaker Pro. If the same environment is selected for both ears, the sound will be played in stereo. If different environments are selected for each ear, the sound will not be heard in stereo.

Advanced Settings

For more customizations, apply low, mid and high frequency gain cuts to the selected environment. It is not recommended that changes to these frequency filters be made, as it can greatly change the sound quality. If changes are needed, it is recommended they be made in small dB increments.

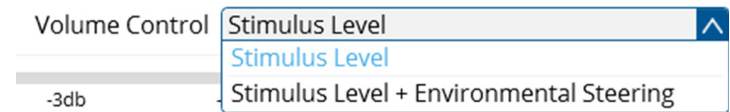


Figure 38. Volume control options for the generated sound.

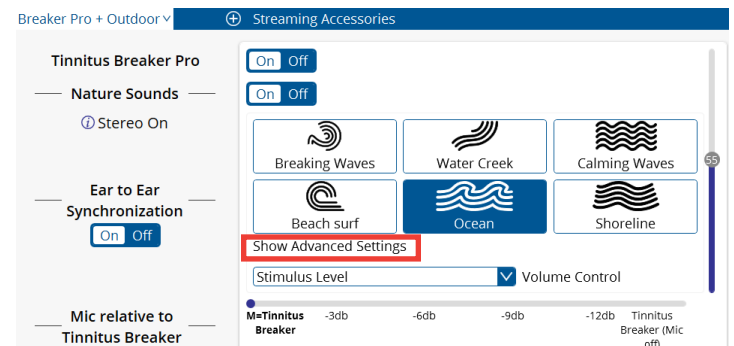


Figure 39. Turn on Nature Sounds to view the six environments as well as make any gain or volume control adjustments. Show Advanced Settings navigates to more customization options.

Clinical Tip

The recommended initial setting for the Tinnitus Breaker Pro includes a broadband frequency response, amplitude modulation set to moderate, modulation speed set to medium, and environmental steering volume control.



Compression Mode

Types of Compression Modes Available

For super and ultra power hearing aids, there are three compression modes available, Wide Dynamic Range Compression (WDRC), Semi-linear, and Linear (Fig. 40).

WDRC provides higher amplification for softer sounds and can be used with any type of hearing loss.

Semi-linear compression might be preferable for those hearing aid wearers who require more amplification for loud sounds than WDRC provides, but less amplification for loud sounds than linear compression provides. Semi-linear mode provides a compromise between audibility for soft sounds and loudness. At the same time, it can reduce the feedback.

Linear provides more amplification for loud input signals, which might be preferable for some hearing aid users with profound hearing loss who are experienced with this type of amplification.

Compression Limit Mode

When linear compression mode is chosen, an output limiting feature called Compression Limit Mode is available (Fig. 41). It offers two options for limiting the output: soft peak clipping and hard peak clipping. Soft peak clipping is the defaulted setting and adds less distortion to the sound signal. Hard peak clipping should be used with previous analog wearers who want more power. Hard peak clipping allows maximum output, but introduces some distortion (Fig. 42).

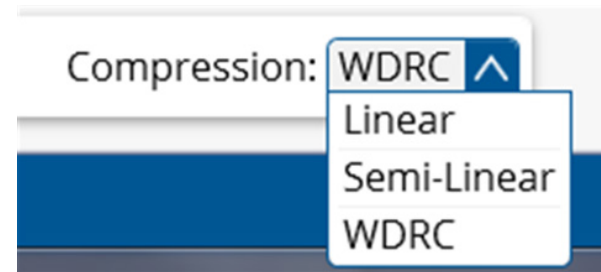


Figure 40. Available compression options for super and ultra power aids.

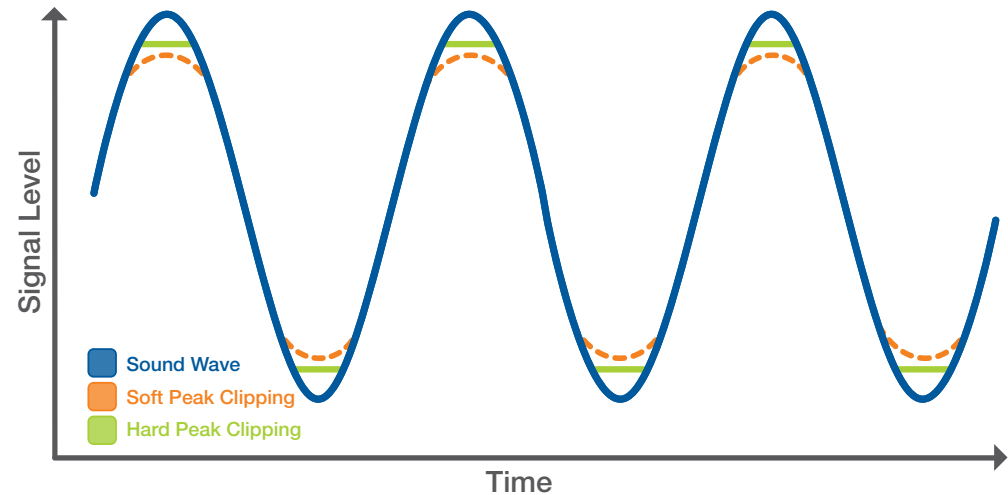


Figure 41. The orange, dashed-line represents soft peak clipping that occurs in compression limit mode. The solid, green line represents hard peak clipping which introduces some distortion, but allows maximum output for users who want more power.



Figure 42. Options for compression limit mode.

Low Frequency Boost

What is Low Frequency Boost?

Low Frequency Boost is another feature for super and ultra power hearing aids. This feature adds additional gain in the low and mid frequencies, and can be applied per program. When applied, there will be a visible change in the gain levels of the affected frequencies.

Clinical Tip



The Low Frequency Boost will only be applied if the maximum gain for the hearing aid has not been reached.

Low Frequency Boost

off

Mild

Moderate

Strong

Figure 43. Low Frequency Boost offers four settings: Off, Mild, Moderate, and Strong.

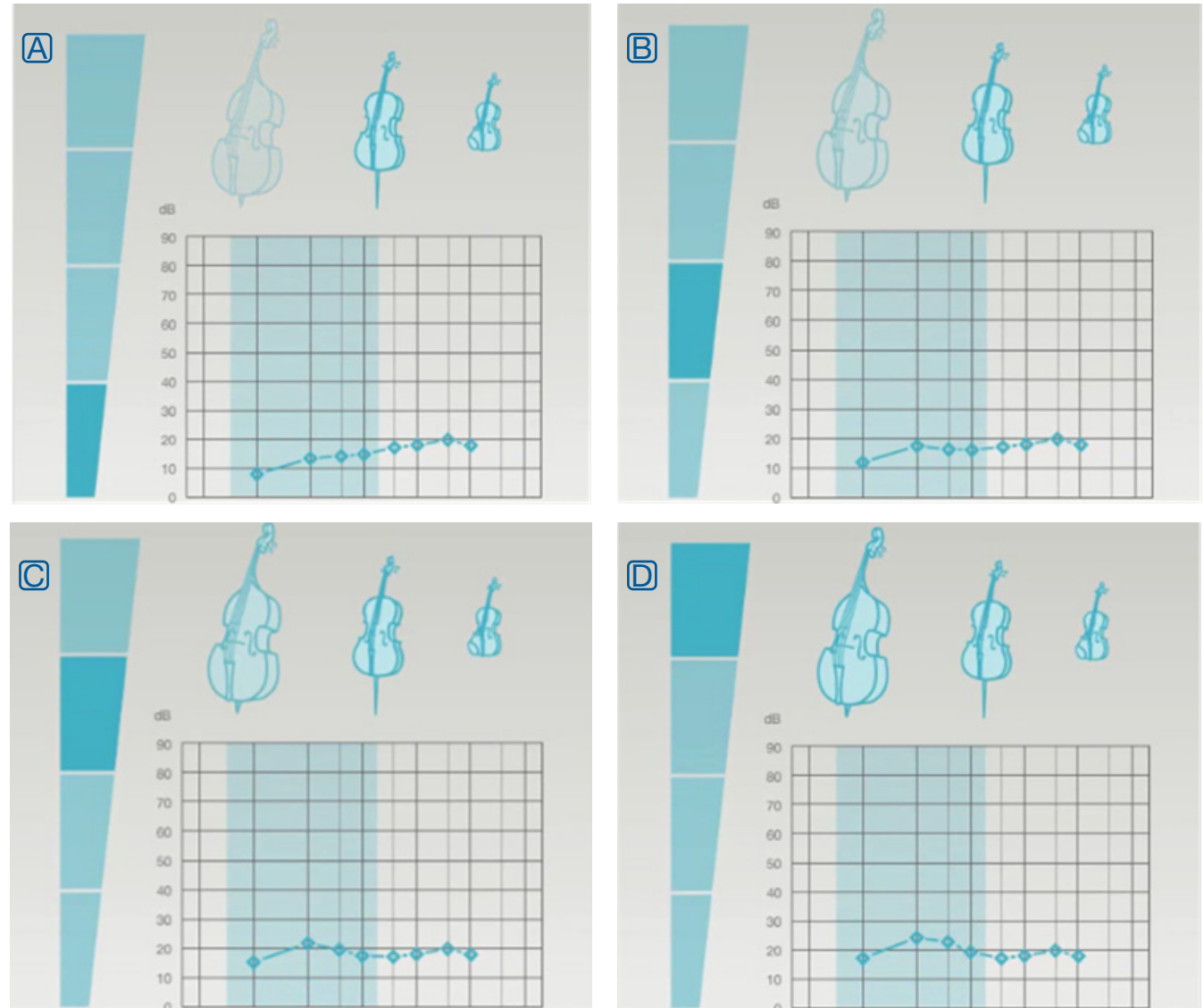


Figure 44. Low Frequency Boost adds gain in the low and mid frequencies if the hearing aids' maximum gain has not been reached.

Accessory Adjustments

Streaming Bass Boost

Streaming Low Frequency Boost provides low frequency enhancement to audio signals streamed through wireless hearing aids from our accessories or direct from smartphones (Fig. 45A). Utilize this beneficial feature to enrich the sound quality of the streamed audio that may otherwise be perceived as thin or tinny sounding (Fig. 46).

Microphone Balance Sliders for Accessories and Mobile Devices

The microphone sliders adjust the input of the microphones versus other inputs, like the telecoil or accessories, in a particular program (Fig. 45B). For instance, in a TV accessory program, the hearing aid wearer needs to hear the television, but might still also want to hear what's happening in the surrounding environment. In this situation, it would be advantageous to have some input from the hearing aid microphone at a lower level than the TV accessory input. In the example the bolded default of -3 dB means that the hearing instrument microphone will have 3 dB less gain than the TV accessory. There are individual tabs for the different accessories and mobile devices (Fig 45C) each tab has adjustments for streaming bass boost and microphone balance.

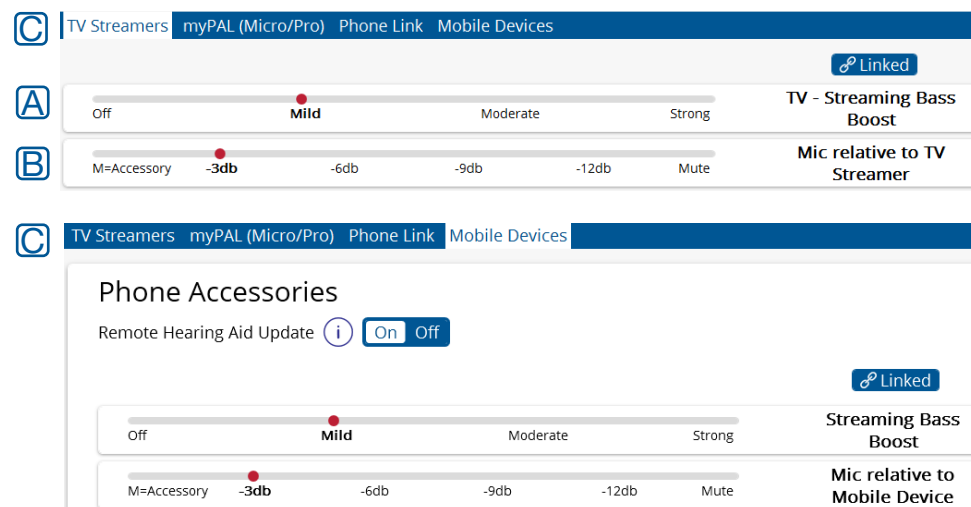


Figure 46.

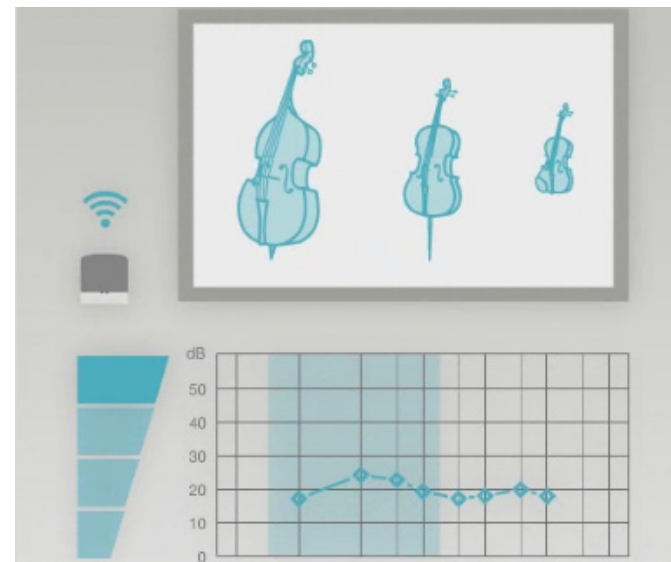


Figure 45. The low frequency enhancement can provide a much richer sound quality much like being able to increase the bass on a home stereo system. The low frequency enhancement may be less noticeable for open fittings.

Direct Audio Input

What is Direct Audio Input?

Direct Audio Input (DAI) is an alternative audio signal to the hearing aid. When the DAI is activated, the hearing aid microphone(s) or Telecoil is bypassed, allowing the patient to hear the audio signal being delivered directly through the DAI input. The routing is accomplished through a specially-designed audio shoe that automatically engages the DAI when connected to the external case. The DAI allows for connections to devices such as the TV, radio, or external microphones (like an FM system). Use the microphone balance sliders within the program to allow the patient to hear some surrounding sound while using a DAI device (Fig. 47).



Figure 47. Mics are set 6dB less than the input to the DAI.



Clinical Tip

Using the DAI can improve sound quality for these devices and improve hearing in noise, as room reverberation and/or ambient noise are not amplified along with the desired signal.

Solus Max Guide

What is the Beltone Solus Max Guide?

The Beltone Solus Max Guide (Text Wizard) is a tool to help dispensers with problems they encounter during a fitting. Open the guide, select a category, select a subsequent issue, then choose from the offered solutions (Fig. 48). When applicable, apply the solution to the right, left, or both instruments.

All-Around Hear in Noise Outdoor

1. Select a Category

Search Results

Loudness

Sound Quality

Speech Intelligibility

Own Voice

Feedback

Tinnitus

Wireless Ear to Ear communication

Wireless Accessories

Search a category

2. Select a Problem

Own voice sounds hollow, in a barrel, echoes

Own voice sounds tinny, sharp, too high pitched

Own voice sounds too loud

Own voice sounds full, muffled, or "plugged-up"

3. Apply a Solution

Increase low frequency gain

Increase low and mid frequency gain

Decrease high frequency gain

Search a category

Clear

Apply Right

Apply Left

Apply to Both Ears

Figure 48. The Beltone Solus Max Guide can be accessed under the Menu tab or under the Tools Fitting drop down on the top bar in Solus Max. Select a category which will generate problems that can be selected which will result in a list of applicable solutions that can be applied to one or both ears.

Data Logging

What is Data Logging?

The data logging features is called the Satisfaction Journal. It tracks and records the patient's hearing aid use. The Satisfaction Journal includes information on: total use time, use time per program and environment, and volume control changes made over time (Fig. 49). The information obtained is useful when making hearing aid changes over time, such as volume control settings and program needs. Satisfaction Journal will be reset every time a programming change is made in order to track the patient's use with the new changes.

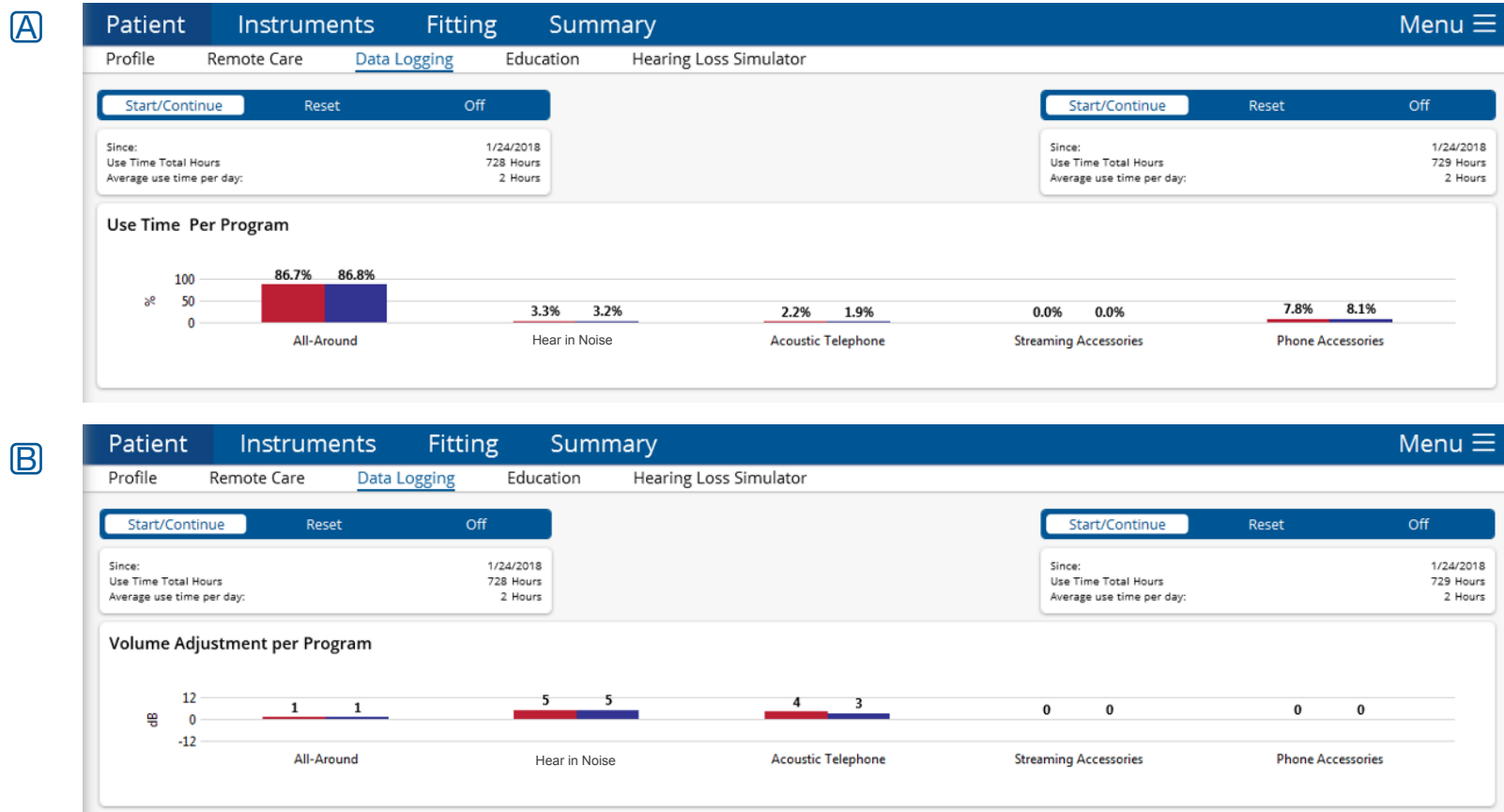


Figure 49. Data logging tracks use time and volume adjustments per program as seen in A and B above.

Clinical Tip



Use the total use time and program use information as a way to make changes to the hearing aid or as discussion points when counseling the patient on the importance of consistent wear time and the benefits of proper program changes. The lack of program changes may be a good indication that a single program utilizing Speech Spotter Pro or a version of CrossLink Directionality should be considered, rather than multiple manual programs.

Time Constants

What are Time Constants?

Time Constants are attack and release compression times. The attack time is the delay that occurs between the onset of compression and the resulting reduction of gain. The release time is the delay that occurs between the offset of compression and the increase of gain or back to normal (Fig. 50). In most situations, adjusting the time constant is unnecessary. The options for time constants are

Syllabic has a fast attack and release time, so that each syllable can be heard above the noise in the environment.

Normal has a fast attack time and a slow release time.

Moderate has a slightly slower attack time than Normal, but with the same slow release time as Normal.

Slow has the same attack time as Moderate, but a very slow release time.

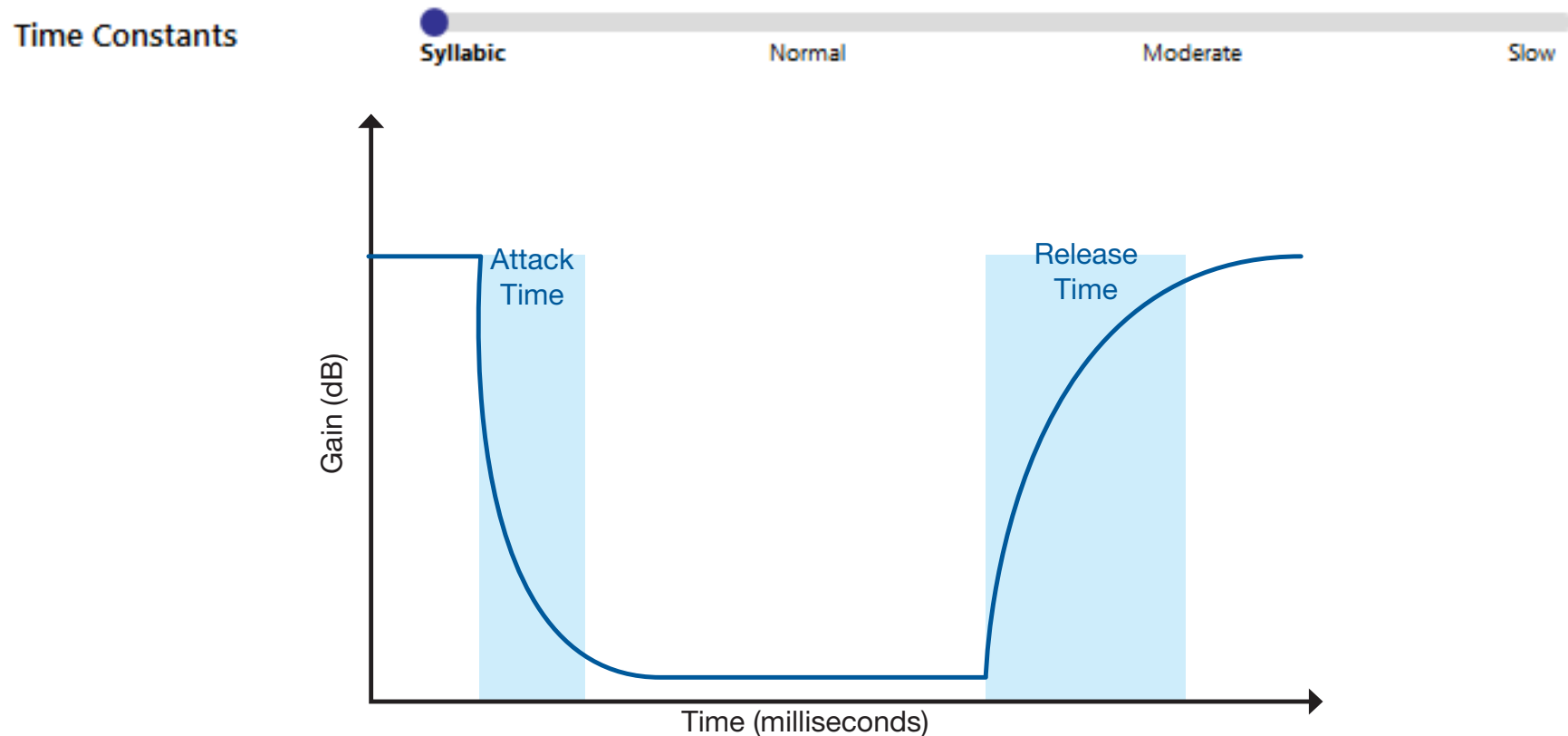


Figure 50. A schematic representation of hearing aid behavior associate with input changes. When the input exceeds the knee point, gain reduces.

Synchronized Satisfy

What is SATISFY / Synchronized Satisfy?

Slow Adaptation To Ideal Settings For You (SATISFY) is a feature that allows gradual and automatic changes within the hearing aid for gain, compression, and frequency response (Fig. 51). These changes are so gradual that they go unnoticed by the hearing aid user. SATISFY is useful for first-time wearers or those with hyperacusis who feel the targeted gains are too loud. The feature acclimates wearers to the amplification by automatically transitioning from a starting gain level to an end gain level over a period of time without the need of an in-person appointment (Fig. 52). As such, SATISFY is helpful when patients cannot return to the clinic regularly for appointments due to distance or illness. SATISFY can be applied to any fitting rule included in Solus Max and is available for fittings with Wide Dynamic Range Compression (WDRC).

Ear-to-Ear Communication enables gain change synchronization between the two hearing aids in a binaural fitting. Synchronization of this feature is recommended in case of a loss of one hearing instrument during the acclimatization time, as this will prevent the remaining hearing instrument from progressing more than 10% past the progression of the lost hearing instrument, in the event it is found. Once activated, the Satisfy progress will appear on the Fitting screen.

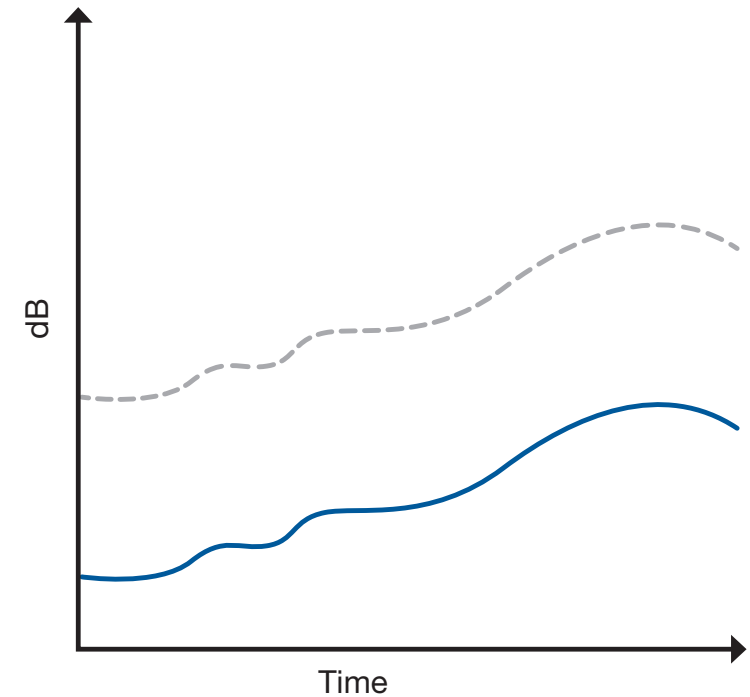


Figure 51. Over time, gain changes are made automatically and gradually.

1. Duration

How long would you like the SATISFY to be active?

Duration

4 weeks

2. Settings

Gain settings are currently:

☒ Too loud for the patient
(Current gains are desired the end-point)

50% Current dB 100%

☐ Comfortable for the patient
(Current gains are the desired starting-point)

100% Current dB 125%

Preview

3. Confirmation

Activate SATISFY

Figure 52. With SATISFY, the duration and gain settings can be adjusted and previewed. When pleased with settings, activate SATISFY. Return to these options to deactivate SATISFY.

Tools Tab

What is located in the Tools Tab?

All of the program changing functions are located in the tools tab and include manage programs, recalculate, autorelate, manage program names, copy program, and paste program (Fig. 53).

Reorder Programs

This feature allows program reordering and deletion within one easy function window (Fig. 54). Clicking Manage Programs opens a window with the assigned programs in order. By selecting a program, options to reorder the program (change the program location from P2 to P4), or to delete that program appear. To reorder a program, use the arrow keys on the side to move the program up or down with the corresponding key. The changes will be seen in the Manage Programs window, click apply to confirm, and the changes will be applied to the Fitting screen. To delete a program click on the "X" and the program will be deleted. The change will be seen in the Manage Programs window and will only be confirmed once the apply button is clicked. At this point, the changes will be applied to the Fitting screen.

Recalculate

This feature does exactly what it sounds like; it quickly returns the gain curves to the first fit prescribed targets. When you click on 'Recalculate', a window opens asking if you want to recalculate the gain and MPO or just the gain and for just the current program or all programs. (Fig. 55). You also have the ability to refit the right or left hearing aid individually or to refit both hearing aids together.

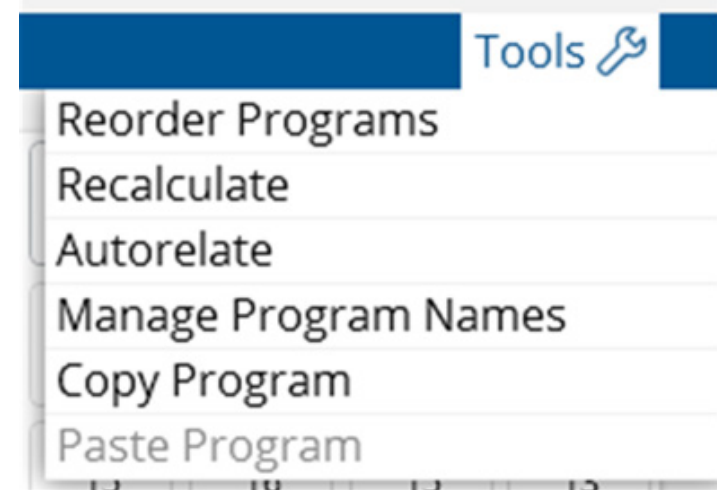


Figure 53. Options for program changes.

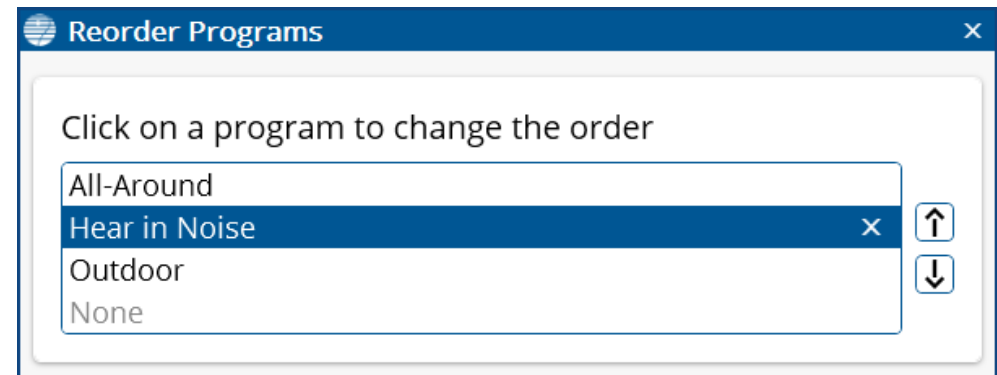


Figure 54. Reorder or delete programs using Reorder Programs option.

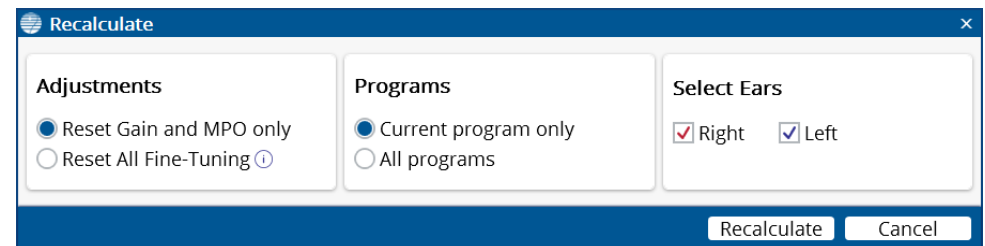


Figure 55. Recalculate options for gain and program.

Autorelate

This feature allows dispensers the convenience to apply gain changes from one program to another program. When you click on 'Autorelate', a window appears where you can select which program to apply gain changes from and select which other programs to apply those gain settings to, including accessory programs (Fig. 56). You can select if you want MPO and/or Sound Shifter settings to be applied. For super power, or ultra-power fittings you can select the compression mode and the preferred compression limit mode setting to be applied as well. When all selections have been completed, choose which ear(s) for the changes to be applied.

Manage Program Names

This feature allows dispensers the flexibility to change the program names (Fig. 57). This is especially useful to name programs more meaningfully for patients who view the program names on our remote control or on one of our apps.

Copy/Paste

This feature allows you to copy gain and feature settings from one program and paste them into another program. To begin this process be in the program environment from which you want to copy and click on the 'Copy' button. Select the program to which the settings should be pasted by selecting the appropriate program tab. Once the program has been selected, click on the 'Paste' button (Fig. 58). Prior to finalizing the paste of the settings, the fitting software will require the dispenser verify the action. Once the program has successfully pasted to the new location, the fitting software will display the same program name as the copied program.

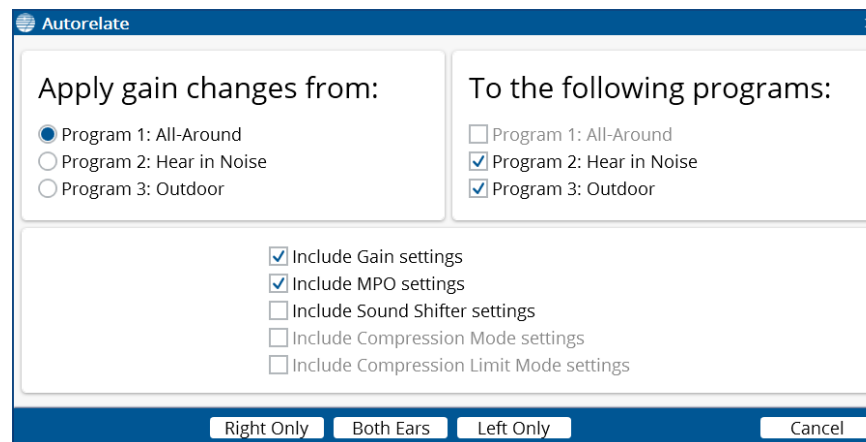


Figure 56. When you click on 'Autorelate', a window appears where you can select which program to apply gain changes from and select which other programs to apply those gain settings to, including accessory programs.

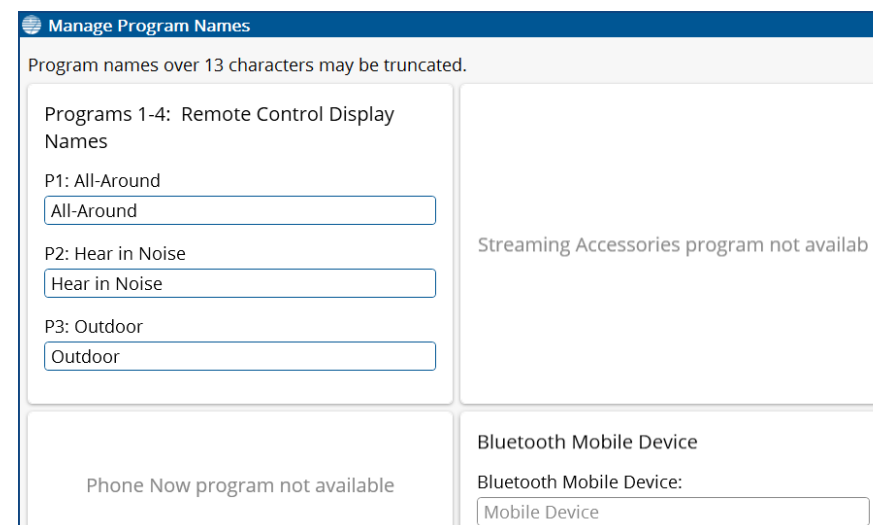


Figure 57. Please note with our new accessory only the patient can rename their streaming programs.

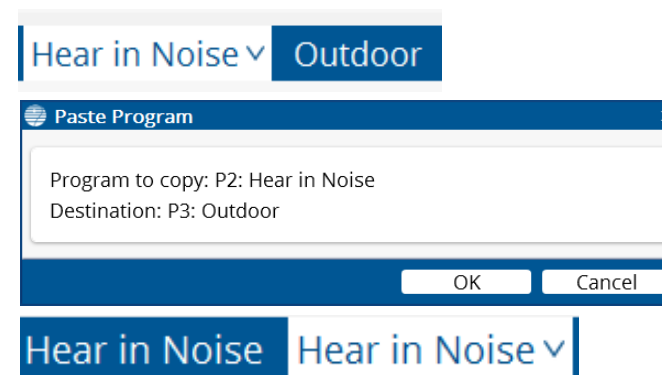


Figure 58. The images show the process on-screen in Solus Max when copying and pasting program settings.