Tinnitus: the Siemens Package

Gisele Munhoes Dos Santos, Ph.D. & Leanne Powers, Au.D.
Abstract

It is known that the use of external sound(s) provide relief from tinnitus by inducing neurophysiologic functional changes in the different auditory pathways. The aim of sound therapy is to decrease prominence of the tinnitus and facilitate tinnitus habituation. To transform the individual's reaction to tinnitus, counseling is required. To reduce the perception of tinnitus, sound enrichment is recommended to decrease the perception and induce habituation. Sound therapy features are available in Siemens hearing instruments and can support a wide variety of acknowledged tinnitus treatment programs. This paper describes the numerous therapy signals options available in the Siemens hearing instruments product line.

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Introduction

Tinnitus is the perception of a sound in the ears or in the head with no corresponding external stimuli. There are more than 200 potential causes for tinnitus. They can originate from within or outside of the auditory system. Metabolic, pharmacological, dental, somatic and psychological disorders are all possible culprits for tinnitus. Therefore, it is important to note that every patient is different, and that a single treatment will never be able to satisfy the full spectrum of tinnitus patients. Furthermore, patients with other symptoms in addition to tinnitus need to be treated differently.

There are two types of tinnitus:

1) **Objective** – meaning the tinnitus is audible to someone else besides the patient. This type of tinnitus generally originates from middle ear or vascular system.

2) **Subjective** – meaning the tinnitus is audible just to the patient. It is often considered as the perceptual consequence of modified neural activity, generated by the central auditory pathway, after peripheral damage. High frequency hearing loss is the highest predictive risk factor for tinnitus.

Subjective tinnitus is a common problem affecting approximately 1 in 5 individuals, although the epidemiologic studies show variable rates. It is considered that 10-15% of the population has chronic and persistent tinnitus; and around 20% of those reporting tinnitus find the condition disruptive enough to seek specialized treatment.

There is strong evidence to suggest that acoustic therapy can help mitigate the effects of subjective tinnitus. Acoustic therapy can occur in many forms such as: fitting the patient with appropriate amplification, modifying advanced signal processing features for the purpose of tinnitus treatment, or following a formal tinnitus protocol such as Tinnitus Retraining Therapy (TRT). Siemens Hearing Instruments offers solutions that can be adapted for any therapy protocol to fit the needs of the Hearing Care Professional (HCP) and the patient. This paper will take a comprehensive look at the features available in Siemens Hearing Instruments for use in acoustic tinnitus therapy and provide some use case scenarios.

I. Use of Sound Therapy for Tinnitus

Sound therapy for tinnitus is defined as any use of sound intended to alter the tinnitus perception and reactions for clinical benefit. Besides hearing instrument use for tinnitus relief, numerous methods of sound therapy have been used since tinnitus masking was introduced in the 1970s. Two general types of sound therapy approaches have been investigated for tinnitus management:

1) Total masking- using an alternative stimulus to cover up (mask) the perceived tinnitus.
2) Partial masking- the addition of an alternative stimulus to reduce the focus of the patient’s subjective tinnitus on both a conscious (psychological level) and unconscious level (central auditory perception).

Both employ the use of broadband noise sound generators, hearing instruments, or combination devices. The clinical application of sound therapies has generally focused on managing reactions to tinnitus and suppressing perception of tinnitus. Sound therapy is thought to provide relief from tinnitus and reduce the emotional consequences of tinnitus. Some individuals experience residual inhibition following total or partial masking (i.e., tinnitus suppression or temporary disappearance of the tinnitus sensation after exposure to an external sound). Additionally sound therapy may promote habituation to the tinnitus by reducing the contrast between the tinnitus and environmental sound.

Habituation “is the reduction or elimination of CNS activity in response to repetitive stimuli” (Encyclopedia of Neuroscience, 1987). It is a natural process of the CNS and crucial to brain function enabling humans to perform many tasks simultaneously. Habituation is the basis for Dr. Pawell Jastreboff’s Neurophysiologic model of tinnitus, predecessor of Tinnitus Retraining Therapy - TRT. In this model, the starting point is the generation of tinnitus by the cochlea or 8th cranial nerve. The tinnitus is then detected on a sub cortical level and finally perceived for interpretation by the auditory cortex. At this point if the tinnitus results in an emotional reaction from the patient and involvement from the limbic system can occur. The limbic system controls motivation, mood, and emotion. Therefore, a limbic system reaction to tinnitus can cause insomnia, anxiety, depression, and fear. Further complication arises if the emotional reaction is not quelled as the patient may develop physical symptoms related to the patient’s autonomic nervous system.
Neurophysiologic model of tinnitus developed by Paweł Jastreboff, Ph.D.

Whether the patient has the ability to habituate to their tinnitus spontaneously is thought to correlate to the impact that tinnitus has on a patient's daily life. It has been reported that of those reporting the symptom of tinnitus: 80% report no impact on their lives, 15% feel their tinnitus impacts them, and 5% are incapacitated by their tinnitus.

The 80% with no impact are thought to be the patients that habituate with no intervention. The 15% with impact correlate to those tinnitus sufferers that have developed an emotional response to their tinnitus and the 5% correlate to individuals experiencing a physical response from the Autonomic Nervous System. Many researchers have theorized that if a tinnitus patient is treated early, with effective counseling and sound therapy, you may be able to mitigate the effects of the tinnitus before a patient enters into the incapacitated stage.

II. The Siemens product line for sound therapy

Beginning with the micon™ platform and continuing with the binax™ platform, Siemens Hearing Instruments offer a complete line of hearing instruments that include the tinnitus therapy features. Unlike other manufacturers which dedicate only a few instrument styles to include tinnitus features these features are available in all micon and binax models. The feature is software activated; meaning the Hearing Care Professional (HCP) can initiate it in the Connexx 7® fitting software at any time during instrument programming.

In addition to the micon and binax products a limited version of the tinnitus therapy feature is offered in the Orion hearing instrument line. The Orion products deliver essential features for more price conscious patients' and are available in a variety of styles, RIC, BTE (standard and thin tube open fit), and customs.

III. Introduction to Siemens Tinnitus Therapy feature

The tinnitus therapy feature can function as an independent sound generator or in a mixed mode with both the hearing instrument microphone and sound generator active. The tinnitus feature provides several therapy signal options which can be activated for individuals as needed, including 5 different types of static noise, 1 modulated noise with various tim-
ing and intensity options, as well as custom noise shaping by frequency handles, all of which allow for maximum flexibil-
ity.

The 6 noise types as seen in the Connexx 7.4 software in a 7bx instrument

The flexibility is twofold:

1) The HCP can select the noise type that is most comfortable to the wearer and/or offering the greatest relief of symptoms. The five noise types available are: White noise, Pink noise, Speech noise, High Tone noise and Brown noise. White noise is a signal with constant spectral density across all frequencies. In Pink noise, each octave carries an equal amount of energy. Speech noise corresponds to the frequency shaping of the Long-Term Average Speech Spectrum (LTASS). High tone noise has more intensity in the high frequency region. In Brown noise the power density decreases with increasing frequency. The modulated noise option, called Ocean Waves, is a sound similar to just that of waves arriving on the shore line. Ocean sounds have long been felt to have a calming effect on the listener making them a great addition to the therapy options (see section VIII. New Innovations for more information on use of modulated sound therapy).

The spectral shapes of the 6 noise types as seen in the Connexx 7.4 software in a 7bx instrument

2) If the desire is to utilize a specific noise type it is necessary to maintain the spectral characteristics of the noise by adjust-
ing all the handles simultaneously. To increase therapy volume in all handles at the same time utilize the Master Gain control in the tinnitus screen.
Regardless of the noise type the therapy signal starts at a predetermined intensity for each matrix. Therefore, the appropriate level of noise needs to be adjusted within the software while the patient is present. In most cases, determining the starting noise therapy level is accomplished using an ascending threshold finding technique similar to that used for pure tone testing. If you increase a desired noise type to the maximum setting and your patient is still unable to hear the therapy signal, change to a stronger receiver size for RIC instruments, or to a stronger matrix for custom and BTE instruments. The maximum sound level for the therapy signal is dependent on the output level of the receiver (a stronger receiver can produce a louder therapy signal).

If desired, the HCP can create a personalized therapy signal by utilizing frequency shaping via the handles available in Connexx 7. The number of handles present for adjustment is dependent on technology level of the hearing aid. For example, a 7mi level hearing aid has 20 handles for manipulation; the 5mi level has 16 handles, the 3mi level has 12 handles, and the Orion instrument has 4 handles for therapy noise shaping.

Setting the tinnitus therapy signal according to TRT and TAT:

The Tinnitus Retraining Therapy (TRT) is the clinical application of the neurophysiologic model. It uses a precise and individual combination of sound therapy and teaching / demystification / learning about tinnitus and hyperacusis mechanisms, with directions about how to return to normal life without provoking symptoms. It provides relief from tinnitus because it induces habituation to the tinnitus perception. TRT can be done in conjunction with amplification or alone in cases of normal hearing level. Counseling and sound is used to produce an enduring sense of reduced tinnitus after the cessation of sound. The mitigation of the tinnitus is due to the decline in response to familiar auditory stimuli (tinnitus) after to repeated exposure with no emotional reaction. Siemens instruments are designed to work well for those HCP’s following a TRT approach.

To set the noiser according to the TRT protocol, The HCP needs to look for the mixing point: the point where the noise mixes with the tinnitus, without masking it! The HCP can choose one type of the existing sounds and then adjust in an ascendant technique by utilizing the Master Gain handle, decrease the Master Gain until the therapy signal is no longer audible to the patient and then increasing the noise level until the patient says that the sound is mixed to tinnitus. The HCP has to explain to the patient that to achieve habituation, the noise should not cover the tinnitus, but that both sounds should be heard: the therapy sound and the tinnitus itself.
The **Tinnitus Activities Treatment (TAT)** was implemented by Dr. Richard Tyler. This approach is also well supported by the Siemens solutions. TAT is a treatment for the reaction to tinnitus that also uses counseling, sound therapy and other activities based on behavioral cognitive therapy. In this case, counseling is structured into four topics:

1. Thoughts and Emotions
2. Hearing and Communication
3. Sleep
4. Concentration.

The sound therapy aims to decrease the prominence of tinnitus and facilitate habituation.
To set the therapy signal according to the TAT protocol, the HCP should also use the ascendant technique and stop when the patient says that the sound is audible and comfortable. Many patients report that broadband noise is easier to listen to than their tinnitus. While the goal here is not to find total masking or mixing point, it is possible to use total masking if the patient prefers it. The HCP can try one or two types of noise and at the end choose what gives more relief at the lowest level.

IV. General protocol for setting the therapy signal

The following are suggested protocols for programming the therapy signal if you are not following the guidelines of a specific tinnitus program such as TRT and TAT. Keep in mind that the Siemens instruments therapy signal was designed to be flexible and can be adapted to fit the needs of virtually any established protocol. This flexibility includes the ability to utilize the signal: in one or both ears, in one or multiple programs, at different intensities in each ear; at different intensities in each program, and with different noise types in each program and/or in each individual ear. The HCP may also give the patient a volume control to adjust the therapy signal independent from the hearing aid microphones. Therefore, if you follow set protocols already using a different device, consult your Siemens representative for individual instruction on how to program the Siemens therapy signal to suit your individual needs.

For patients that have tinnitus but no hearing loss:

When treating tinnitus without hearing loss the Noise Mode should be used. All binax, micon, and Orion instruments can be used as a simple masker, when selecting which technology level to utilize (7, 5, 3, or Orion) the amount of noise shaping desired is the primary consideration for these patients.

To activate the Noise only mode:

1) Go to the Fine Tuning menu, select Tinnitus Function and remove the check mark next to Mix with microphone. This activates the therapy signal only mode of the instruments.

2) If multiple programs with different noise types are desired; add additional programs choosing Tinnitus from the pull down menu in the Program Handling screen.
3) Once selected go back to the Tinnitus Function screen to choose different types of noise or use a custom noise shape. You can even create custom names to each program once the program parameters are chosen as seen below.

For patients with tinnitus and hearing loss:

The majority of patients seen by HCP's need a form of combination treatment for hearing loss and tinnitus; for these patients, it is suggested to first try amplification only. For many patients with tinnitus (and hearing loss) simply wearing hearing aids mitigates the effects of their tinnitus. Remember hearing aid use is a form of acoustic therapy. If the amplification of the natural environment isn't sufficiently reducing the patient's reaction to tinnitus, a designated hearing instrument program in a Mixed Mode (microphone+noise) can be activated. Typical set up will include one program with amplification alone and another program with the mixed mode.

Two program set up. Program 1 Universal, is hearing aid only and program 2 Tinnitus mixed, is Mixed Mode acoustic therapy and hearing aid function

Utilize the ascending threshold finding approach discussed in section III to determine the starting level for the therapy signal. When desired, the HCP can set up the instruments to allow the wearer adjustment of the tinnitus therapy volume.
via the rocker switch on board the instruments (for RIC’s and BTE’s only), with a remote control, or via one of the smart phone app’s.

To set up a tinnitus volume control

For on board therapy volume control, go to the Configuration screen and Hearing Instrument. Select **Tinnitus Therapy volume** from the functionality pull down menu. You can then choose the therapy volume range under SoundBalance/Tinnitus Function.

Configuration menu-Hearing Instrument with “Tinnitus Therapy volume” chosen on the right side rocker switch and a tinnitus function range of 8dB

For remote control of the therapy volume activate the easyPocket under Remote Controls. The easyPocket allows for configuration of the right side buttons for Tinnitus volume up and Tinnitus volume down.

Configuration menu-Remote Controls screen with tinnitus volume up and down chosen for the side button function on the easyPocket

The therapy signal volume can also be controlled via the touchControl or easyTek App. The apps work with the binax line of Siemens instruments and are available for Smartphones: Android and iPhone.
V. Therapy signal alternatives

Acoustic therapy doesn’t always have to result in activating a noise therapy signal in the device or following an established tinnitus treatment protocol. Amplification via hearing instruments alone is a common treatment for tinnitus patients and is often the starting recommendation by the HCP. For many HCPs activating a noise therapy signal is only for patients not reporting benefit from wearing a traditional hearing aid. Historically, it was common for a patient with tinnitus to report relief from wearing a hearing instrument. This relief came from two phenomena:

1) The hearing instrument restored audibility of the patient’s environment. For those with moderate to profound hearing losses, simple amplification of the patient’s surroundings provided the necessary acoustic therapy. In other words, that patient’s annoyance from their tinnitus was exacerbated by the fact that they were hearing impaired. Once these patients received adequate amplification they were able to habituate to their tinnitus.

2) For patients with milder hearing losses, circuit noise in older hearing instruments often provided an incidental masking noise. Whether the patient was aware of it or not, they were receiving acoustic noise therapy and reports of diminished annoyance from tinnitus were common.

With modern hearing instruments, many patients with tinnitus continue to report benefit from traditional amplification as suggested in the first scenario. However as hearing instruments became more sophisticated (digital hearing instruments) circuit noise was greatly reduced which results in much “quieter” hearing aids. Additionally, modern hearing instruments focus on reducing background noise with the use of Wiener filters and directional microphones. Although these advances improved sound quality and comfort for traditional hearing aid wearers they may be counterproductive for our tinnitus patients.

When the treatment goal for your tinnitus patient is habituation, a standard recommendation is to avoid silence, however, not all patients are candidates for noise therapy. Perhaps the patient can’t tolerate an additional noise, they may feel it interferes with their ability to understand speech, or that additional noise makes it difficult to concentrate. Siemens hearing instruments offers some unique algorithm options for these tinnitus sufferers. We will explore these algorithms in the order that they appear within the Connexx 7 software:

1) Basic Tuning- Acoustic therapy with the hearing instrument alone typically involves making more of the environment audible for the patient. Some tinnitus patients will prefer a slight increase in soft level gain. This can be done over all frequencies in the Basic Tuning screen as seen below or in a particular frequency region via the Compression tab under Fine Tuning. Because micon and binax offer a 2 kneepoint/2 ratio compression system it is possible to increase gain for soft without effecting gain for medium and loud sounds.
2) Sound Management - If the desire is for the environment to provide natural masking noise for your patient you may choose to reduce or eliminate some of the noise reduction features.

- All Siemens hearing instruments provide some level of noise reduction as a default. Consider reducing the level of noise reduction for patients with tinnitus.

- You may also find it beneficial to use a multichannel approach to noise reduction in which less noise reduction can be applied in the lower frequencies where “room noise” is typically present. Again allowing the natural noise of the environment to act as a masking therapy signal for your tinnitus patient.
In some cases it may be advantageous to give the patient a second dedicated program where noise reduction by the hearing instrument is completely eliminated. This can be easily accomplished by using a second, specially configured Universal program. For a patient with multiple programs, suggest that the patient switch to this second program when in quiet situations and speech is not the primary focus. They can then return to their regular Universal program when communication is the priority.

3)  **Microphone/Audio** - The microphone array chosen for patients whose primary concern is tinnitus may vary from a patient that does not have tinnitus. Hearing impaired patients without tinnitus tend to prefer a quiet world with primarily speech amplified. As mentioned earlier, for a tinnitus patient this can be counterproductive. For this reason, Siemens allows the HCP to choose alternative trigger points for the directional microphone modes and varying levels of directionality.

   - The settings menu in the directional microphone section allows a HCP to set the hearing aid to three levels.
     - i. Low-less noise than standard is needed to move the hearing instrument into a full directional pattern
     - ii. Standard-the default level of noise needed to move a hearing instrument into a full directional pattern
     - iii. High- more noise is required in the environment for the hearing aid to change into a directional pattern. For tinnitus patients this higher trigger point may be preferred

   - A tinnitus wearer may find they prefer the hearing instrument to stay in an omni directional mode when their tinnitus is more intense. This can also be achieved easily by adding a second Universal program and disable the directional processing.
There is no right or wrong combination of features as the patient’s reaction to the configuration of a particular hearing instrument is subjective when it comes to tinnitus treatment. It is recommended that the HCP try different combinations of features at various settings to find the preference of each patient using a multiple and program technique.

VI. The use of accessories for tinnitus relief and relaxation

With advancements in hearing instruments came the age of connecting to ancillary devices. Siemens miniTek™ and easyTek™ can turn a set of hearing instruments into a wireless headset. Streaming audio signals from a television, DVD player, MP3 player, Bluetooth-enabled cell or landline phone are commonly considered. However, the functionality of the miniTek and easyTek can be increased in other ways too.

To help manage tinnitus or enhance relaxation

Download apps to the wearer’s Smartphone, iPod, iPad, tablet and/or computer and stream these relaxing sounds to the hearing instruments.

A quick search in the app stores for "Tinnitus", "Relax", or "Audio" will direct you to some interesting Apps:

1. Bloom: "Zen"-sounding tones, but presented in stereo

2. Relax Noise 3: Masks nerveing ambient noise and also your tinnitus with white noise ... In nature, it sounds similar to waterfalls, heavy rainfalls or the sounds of the sea.

3. Nature space: A holographic audio journey (free but extra tracks may be purchased)

4. Relax melody samples: relaxing sounds of nature.

5. Ambiance: A huge catalog of sounds, everything from white, pink, and blue noise to fan noise, animal sounds, and crowd noise

6. Easy relax ultimate: Allows the user to choose a base background sound and then layer up to three
Additional sounds, all with adjustable volume and durations; plus one can add a binaural beat in the background.


The App stores offerings change regularly so you never know what kinds of sounds a new search will bring.

**VII. Counseling**

Traditional tinnitus treatment approaches tend to address physical symptoms. Treatments may be in the form of audiological devices (such as sound therapies), alternative interventions, dental adjustments, supplements and/or medications. This may reduce or alleviate stressors associated with the tinnitus, for example: depression, anxiety and insomnia. Habituation to tinnitus can take between 12-18 months even with appropriate sound therapy. Because of this many patients return to their HCP feeling discouraged, frustrated, and desperate. Unfortunately, what they often hear is, “There is nothing else that can be done” and they are going to have to “learn to live with it.” Such a message can quickly diminish hope, leaving the patient feeling misunderstood and afraid that things cannot improve.

The clinician should emphasize to patients that although there is no “cure” at present, there are many things that they can do to make tinnitus less of a problem and thereby to improve their quality of life. There are a wide variety of tinnitus counseling options available. These options range from providing basic information, to focused activities in the areas primarily affected by tinnitus (thoughts and emotions, hearing and communication, sleep, and concentration).

In TRT therapy, the link between the limbic system and the tinnitus is decreased by using a process called “directive counseling”. This involves a series of intense educational sessions where anatomy, physiology and real examples are discussed in story format to make the tinnitus phenomenon understandable and demystified (Jastreboff et al, 1996).

On the other hand, Tinnitus Activities Treatment includes counseling of the whole person, and considers individual differences and needs. They provide a structured counseling focused in four areas: thoughts and emotions, hearing and communication, sleep, and concentration. They consider that a picture-based approach facilitates engagement of the patient. They also engage the patient by including homework and activities to demonstrate understanding and facilitate progress (Tyler, 2007). The counseling material can be easily found at the website http://www.medicine.uiowa.edu/oto/research/tinnitus/

Counseling is an essential part of tinnitus treatment. The patient must understand what tinnitus is in order to overcome or avoid the negative associations that inhibit habituation. For some patients a simple explanation of the causes of tinnitus and the relationship between hearing loss and tinnitus is enough to facilitate a positive outcome. For others more in depth counseling may be necessary. This counseling can come from the HCP themselves utilizing tools such as the TAT counseling materials or it can come from a referral to a mental health professional. Many Psychologists and Psychiatrists specialize in Cognitive Behavior Therapy which is commonly used in treating a patient’s psychological response to tinnitus. A HCP may consider a multidisciplinary approach to tinnitus treatment where the HCP fits and adjusts the hearing instrument for effective sound therapy and provides the initial tinnitus counseling. This should include the anatomy of the ear and auditory system involved and how tinnitus relates to hearing loss. Once sound therapy has begun a Psychologist or Psychiatrist can provide additional counseling and Cognitive Behavior therapy to further support the emotional well being of the patient.

**VIII. New Innovations**

Sivantos is dedicated to constantly updating the tinnitus treatment options available for your patients. Therefore, we would like to introduce an innovation added to the tinnitus function tab. The addition of modulated sounds to the therapy signal is available from Cxx7.4 onwards. Recent research in tinnitus therapy signals suggests that though the long term effects of modulated sounds have yet to be determined they can be considered for use on a case by case basis: “In addition to a traditional masking approach using unmodulated pure tones and white noise, modulated sounds should be used for tinnitus suppression because they may be more effective in reducing hyperactive neural activities associated with tinnitus” (Reavis 2012).

This new function has been added in addition to the 5 static noise choices available in the Connexx 7 software and is called Ocean Waves.
The modulated signal offers customizable settings to simulate variations such as a rough stormy sea breaking on a boulder beach from that of calm deep waters breaking on a sandy beach.

Software choices to customize the modulated therapy signal

The Sivantos commitment to acoustic therapy for tinnitus relief is to continue to offer new innovations and treatment options as further research in the area of tinnitus therapy become available.

Conclusion

Sivantos is leading the industry in the advancement of utilizing combination (hearing and tinnitus masker) instruments for acoustic tinnitus therapy. With the Siemens products Sivantos has the largest portfolio of instruments available utilizing the most flexible therapy options. Whether your clinic follows a recognized protocol for tinnitus treatment such as TRT /TAT or you individualize your protocol for each patient, Siemens products offer what you are looking for. The multi-function, software based features are essential in providing a complete package that can be customized to meet the needs of all tinnitus sufferers. Since tinnitus therapy options are available on all micon, binax and Orion products there is no additional cost associated with the sound therapy options and no special ordering requirements. For this reason Siemens is quickly becoming the number one choice for HCP’s specializing in tinnitus treatment.

References

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