

SIEMENS

2015 Expert Series



June 18, 2015 at 1 PM ET
Interventional Audiology: When is it time to move out of the booth?
Presented by Catherine Palmer, Ph.D.

With more and more publications linking untreated hearing loss to cognitive decline, falls, hospital readmission, noncompliance with medical recommendations, social isolation, and depression, it is the perfect time for audiologists to position themselves as the profession that can facilitate effective, efficient communication for individuals whose primary concern may not be hearing. This is our chance to show other health care providers the essential role we play in their patient's success.



July 24, 2015 at 12 PM ET
Tinnitus mechanisms, assessment, and therapy options
Presented by Sridhar Krishnamurti, Ph.D.

Tinnitus refers to an auditory perception not produced by an external sound. This seminar will focus on understanding underlying mechanisms, evaluating available assessment options, and discussion of therapy strategies for tinnitus.



June 26, 2015 at 12 PM ET
Hearing aid selection and fitting tips gleaned from recent research
Presented by H. Gustav Mueller, Ph.D.

Hundreds of hearing aid articles are published each year, many with indirect clinical applications, although these useful tidbits are not always obvious. In this course, we review relevant applied research from the past year, and uncover many useful tips and techniques that can be immediately applied to day-to-day hearing aid selection and fitting.



July 9, 2015 at 12 PM ET
Frequency compression for adults: Lessons learned from a clinical field trial
Presented by Susan Scollie, Ph.D.

Frequency compression is one method for lowering the highest pitches of sound to an audible area for a hearing aid user with significant high frequency hearing loss. In this presentation, results will be shared from a recent clinical field trial on adults who have moderate to profound high frequency hearing loss, looking at both lab and real world outcomes.

To register for these courses and many more, visit [AudiologyOnline.com](http://www.audiologyonline.com), click the Continuing Education tab, Search by Company, and select Siemens. Or visit this link:
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Life sounds brilliant.

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2015 Expert Series with Sridhar Krishnamurti, Ph.D.

Tinnitus Mechanisms, Assessment, and Therapy Options

**If you are experiencing audio or visual difficulties, please contact
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- Brought to you in cooperation with AudiologyOnline
- Submitted to AAA, ASHA & IJHIS for one continuing education unit (CEU)
- Learning objectives for this course:
 - Participants will be able to describe a method of fine tuning the frequency compression using real ear measures to support an evidence-based method of hearing aid fitting.
 - Participants will be able to describe candidacy for frequency compression in the adult population.
 - Participants will be able to discuss real world expected benefit of frequency compression in adult hearing aid fittings.



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Introducing Sridhar Krishnamurti, Ph.D.

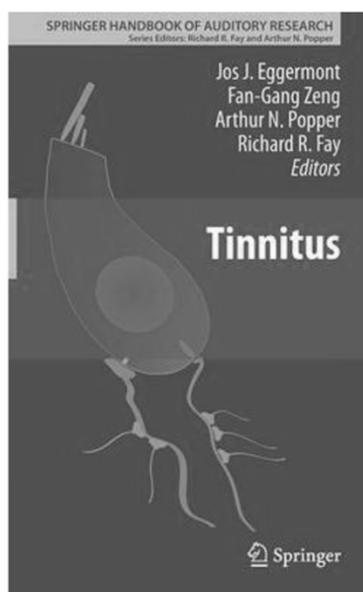
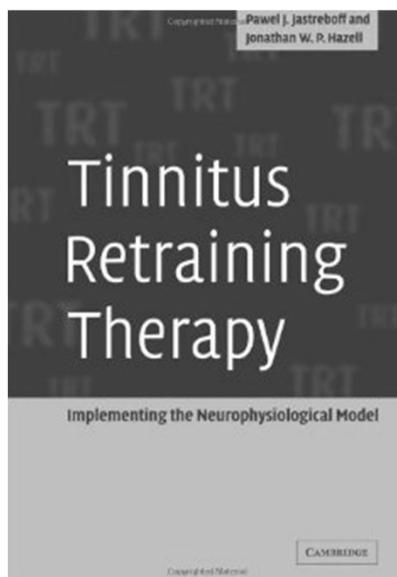


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Siemens Expert series seminar # 25626

Tinnitus Mechanisms, Assessment, and Therapy Options

Sridhar Krishnamurti, Ph.D., FAAA
Professor of Audiology
College of Liberal Arts Engaged Scholar
Auburn University

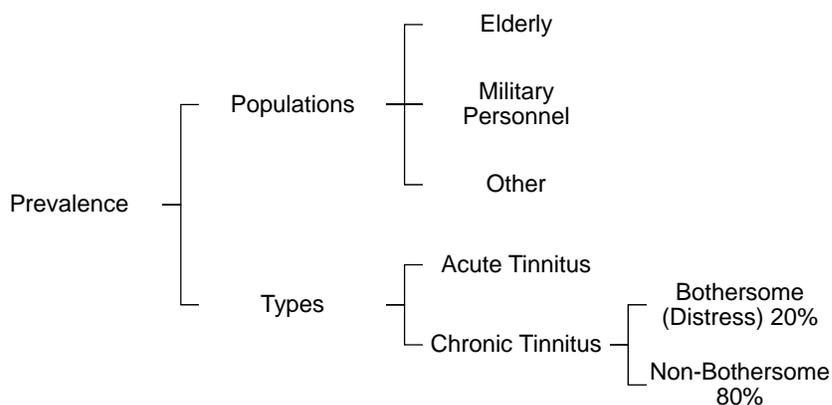


Definition

Tinnitus is the perception of sound in the absence of external noise (Moller, 2011).

Demographics

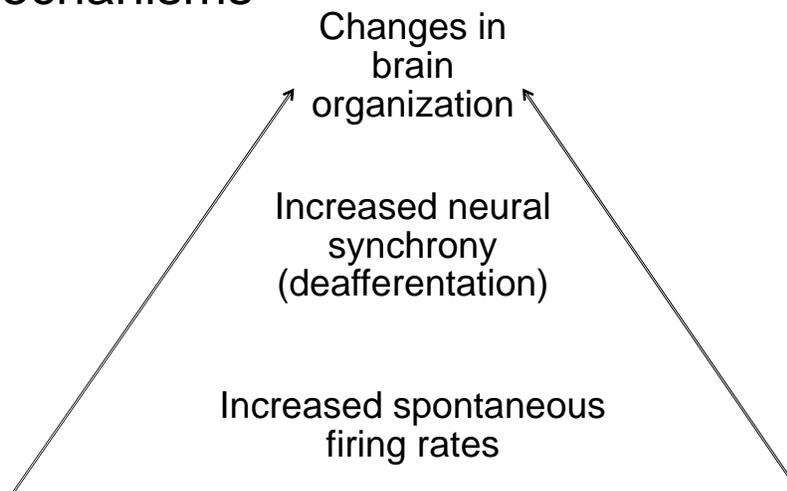
- The Department of Veteran Affairs report that tinnitus and hearing loss are the number one and two service connected disabilities respectively among Veterans across the U.S. Armed Forces every fiscal year since 2007.
- Public health problem for millions of people world-wide.
- Major service-related disability for soldiers returning from OIF and OEF.



Bothersome tinnitus (distress)

- Clinician must distinguish patients with bothersome tinnitus from patients with non-bothersome tinnitus.
- 80/20 rule: about 80% who experience tinnitus are not bothered by it.
- 20% of patients experience bothersome tinnitus that is associated with distress.

Mechanisms



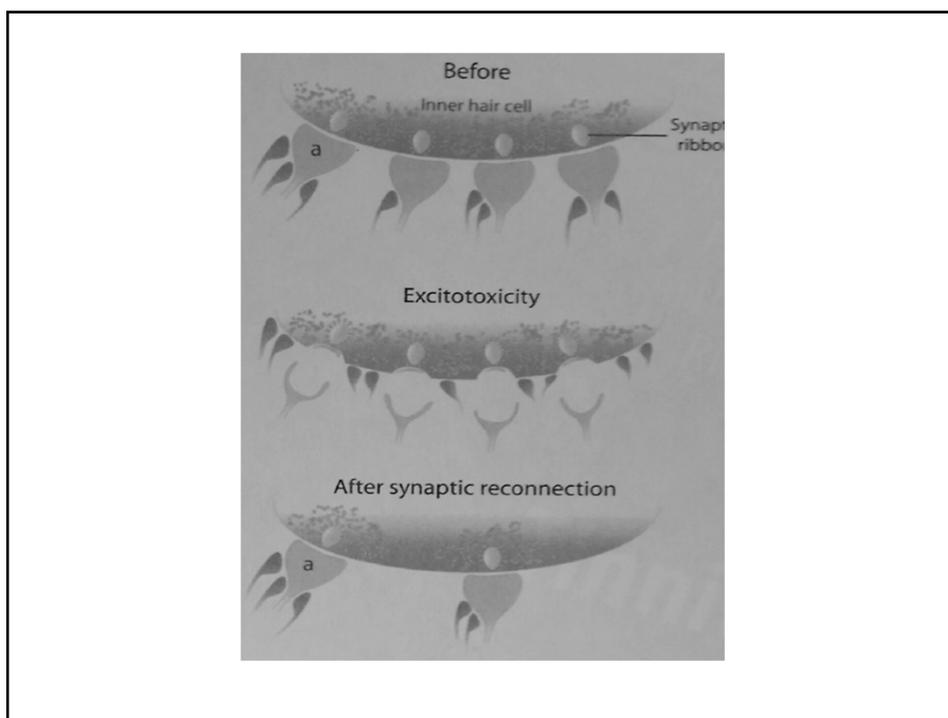
- Roberts, Eggermont et. al. (2010)
- Knipper, Van Dijk, Nunes, Ruttiger, Zimmermann (2013)
- Henry, Roberts, Caspary, Theodoroff, Salvi (2014)

Discordant dysfunction theory

- The discordant dysfunction theory postulates that the tinnitus signal originates in the inner ear when one type of sensory cells (OHCs), are more dysfunctional than another type (IHCs) within the same area of the basilar membrane in the cochlea.
- OHCs are primarily mechanical amplifiers and help to enhance soft sounds by providing 40-50 dB of amplification.
- IHC are the true receptors for sound transduction and convert mechanical energy into electrical impulses to reach the brain.

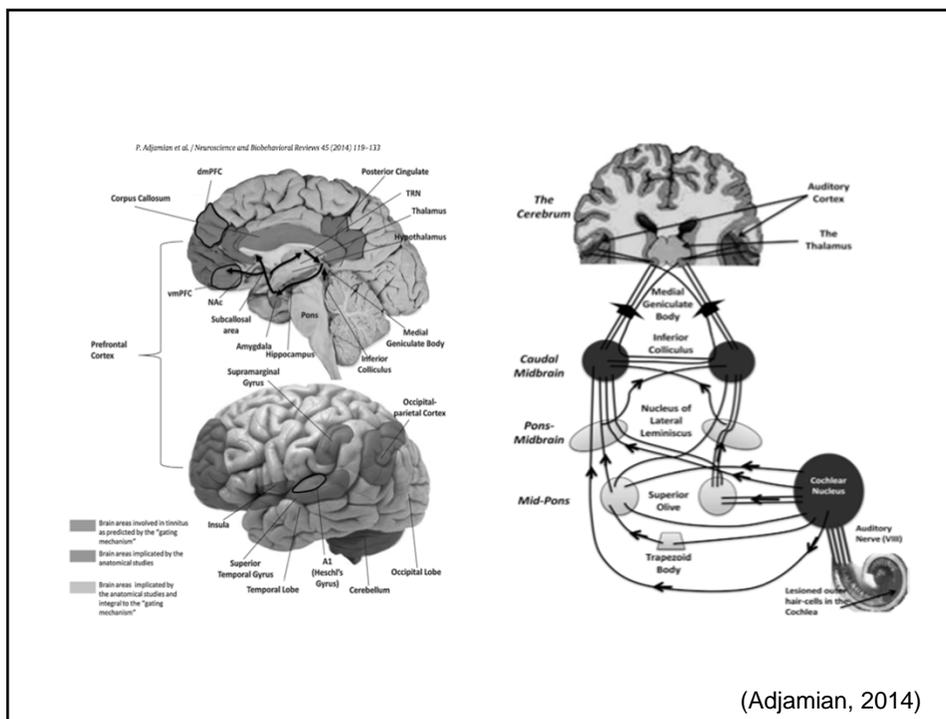
Neural gain is altered

- SNHL (involving OHC dysfunction) gives rise to a measurable increase in the sensitivity of a high percentage of neurons in the auditory pathway (Gerken, 1979; Gerken, Saunders & Paul, 1984).
- Decreased auditory input to the auditory system results in compensation within neuronal pathways.
- The extent of OHC damage is related to tinnitus (Kaltenbach et al, 2004; Mitchell & Creedon, 1995).
- Synaptic reorganization can occur over time.



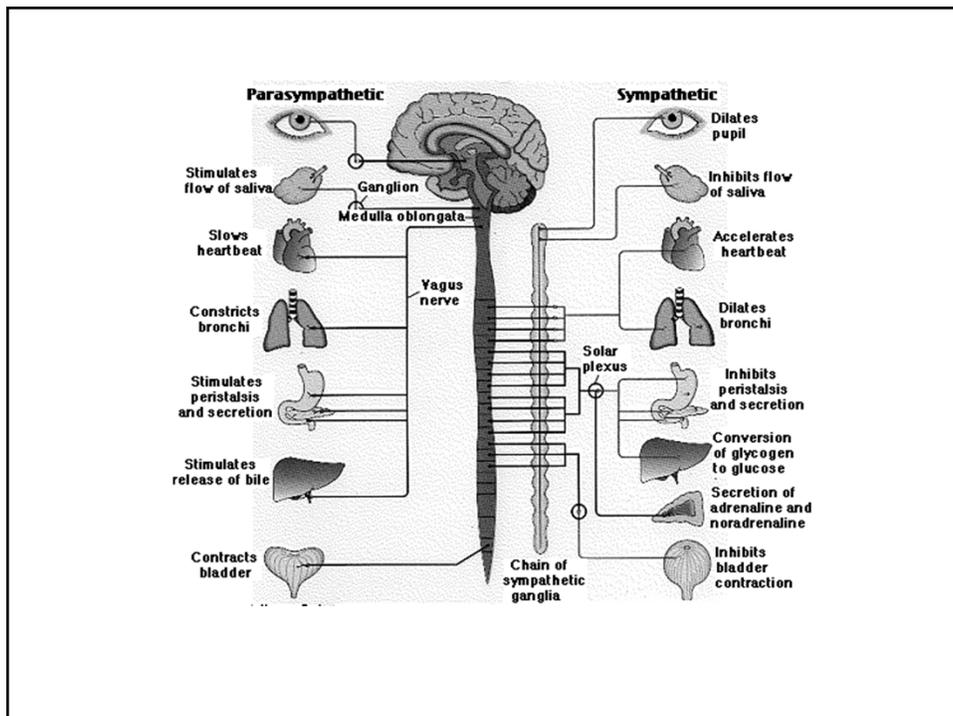
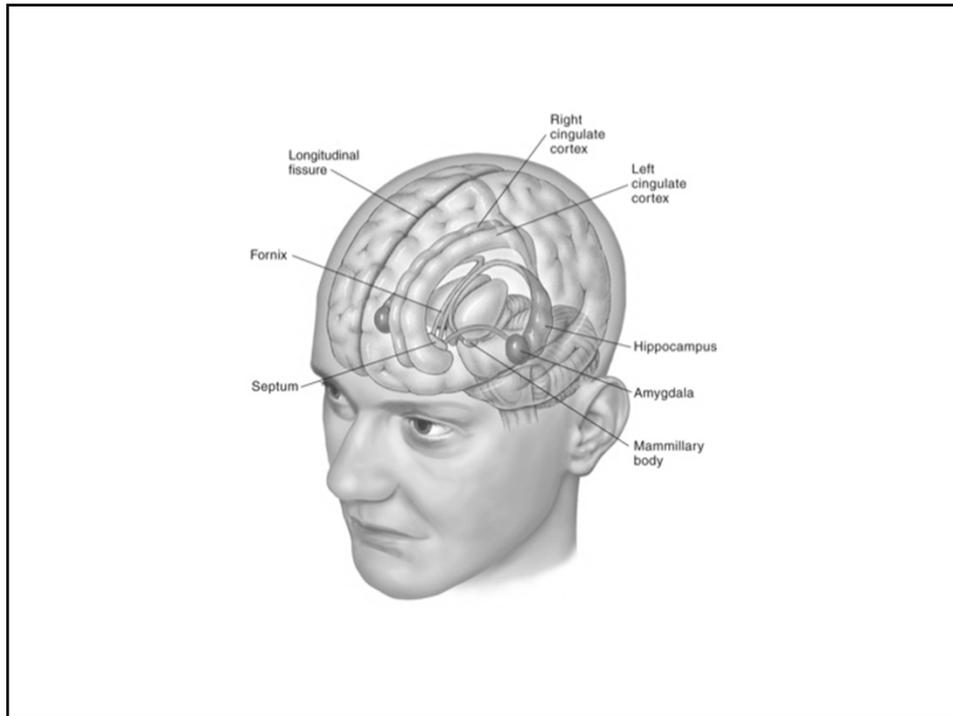
Imaging Findings

- Dysfunction in primary auditory cortex
- Dysfunction in auditory association areas
- Gating mechanisms associated with Prefrontal cortex and limbic system

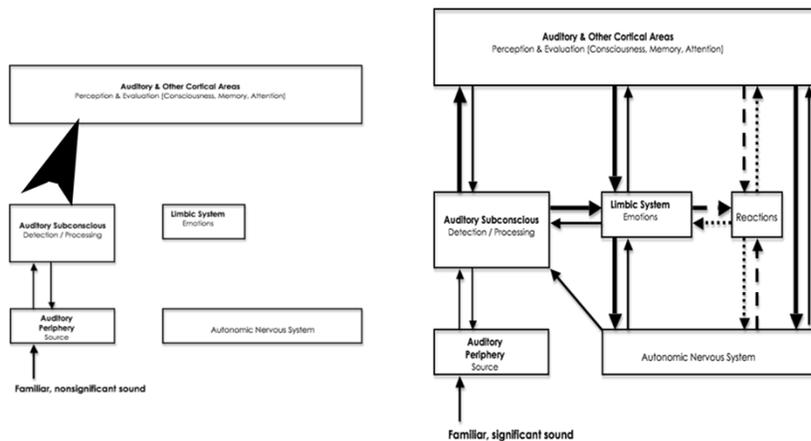


Bothersome tinnitus (distress)

- The limbic system controls our emotions, both positive and negative. Fear, joy and happiness are examples of emotions controlled and mediated by this system.
- The autonomic nervous system deals with 'fight or flight' reactions that are involved stressful situations. This system may be associated with an increasing level of alertness (sympathetic response) or controlling negative reactions (parasympathetic response) such as thirst or hunger.
- It is important to realize that the limbic (emotional) and autonomic nervous system are normally activated by both pleasant and unpleasant stimuli but their involvement in tinnitus is exaggerated and not habituated.



In clinically significant tinnitus, the auditory centers are strongly connected to the limbic and the autonomic nervous system.



Adapted from Jastreboff, TRT model

OHNS Guideline #1,2a & 2b

1. Clinicians should perform a targeted history and physical examination at the initial evaluation of a patient with presumed primary tinnitus to identify conditions that if promptly identified and managed may relieve tinnitus.
- 2a. Clinicians should obtain a prompt, comprehensive audiologic examination in patients with tinnitus that is unilateral, persistent (< 6 months), or associated with hearing difficulties.
- 2b. Clinicians may obtain an initial comprehensive audiologic examination in patients who present with tinnitus (regardless of laterality, duration, or perceived hearing status).

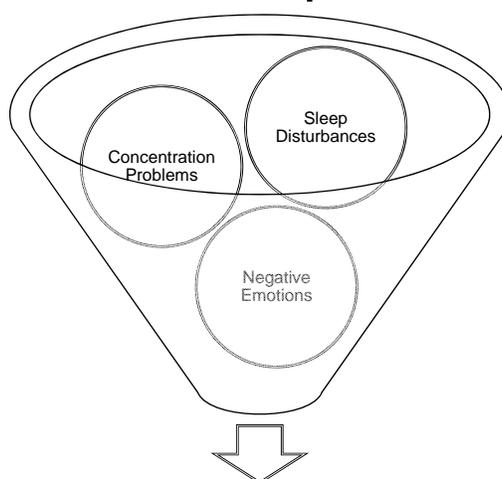
OHNS Guidelines, 2014, Volume 151

Tinnitus Evaluation

- Determine the impact of tinnitus on the patient's life
- Determine auditory aspects related to tinnitus
- Characterize the type of tinnitus
- Determine possible etiology
- Determine treatment strategy for tinnitus

Determine if the impact of tinnitus on the patient's life

- Is it bothersome?



- Is it non-bothersome?

Tinnitus-Related Distress

TINNITUS HANDICAP INVENTORY

Patient Name: _____ Date: _____

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

1. Because of your tinnitus, is it difficult for you to concentrate?	Yes	Sometimes	No
2. Does the loudness of your tinnitus make it difficult for you to hear people?	Yes	Sometimes	No
3. Does your tinnitus make you angry?	Yes	Sometimes	No
4. Does your tinnitus make you feel confused?	Yes	Sometimes	No
5. Because of your tinnitus, do you feel desperate?	Yes	Sometimes	No
6. Do you complain a great deal about your tinnitus?	Yes	Sometimes	No
7. Because of your tinnitus, do you have trouble falling to sleep at night?	Yes	Sometimes	No
8. Do you feel as though you cannot escape your tinnitus?	Yes	Sometimes	No
9. Does your tinnitus interfere with your ability to enjoy your social activities (such as going out to dinner, to the movies)?	Yes	Sometimes	No
10. Because of your tinnitus, do you feel frustrated?	Yes	Sometimes	No
11. Because of your tinnitus, do you feel that you have a terrible disease?	Yes	Sometimes	No
12. Does your tinnitus make it difficult for you to enjoy life?	Yes	Sometimes	No
13. Does your tinnitus interfere with your job or household responsibilities?	Yes	Sometimes	No
14. Because of your tinnitus, do you find that you are often irritable?	Yes	Sometimes	No
15. Because of your tinnitus, is it difficult for you to read?	Yes	Sometimes	No

16. Does your tinnitus make you upset?	Yes	Sometimes	No
17. Do you feel that your tinnitus problem has placed stress on your relationships with members of your family and friends?	Yes	Sometimes	No
18. Do you find it difficult to focus your attention away from your tinnitus and on other things?	Yes	Sometimes	No
19. Do you feel that you have no control over your tinnitus?	Yes	Sometimes	No
20. Because of your tinnitus, do you often feel tired?	Yes	Sometimes	No
21. Because of your tinnitus, do you feel depressed?	Yes	Sometimes	No
22. Does your tinnitus make you feel anxious?	Yes	Sometimes	No
23. Do you feel that you can no longer cope with your tinnitus?	Yes	Sometimes	No
24. Does your tinnitus get worse when you are under stress?	Yes	Sometimes	No
25. Does your tinnitus make you feel insecure?	Yes	Sometimes	No

FOR CLINICIAN USE ONLY

Total Per Column	<input type="text"/>	<input type="text"/>	<input type="text"/>	
	x4	x2	x0	
Total Score	<input type="text"/>	+	<input type="text"/>	+
				= <input type="text"/>

Newman, C.W., Jacobson, G.P., Spitzer, J.B. (1996). Development of the Tinnitus Handicap Inventory. Arch Otolaryngol Head Neck Surg, 122, 143-8.

To interpret the score please refer to the Tinnitus Handicap Severity Scale shown on the reverse side.

TINNITUS HANDICAP INVENTORY SEVERITY SCALE

GRADE	SCORE	DESCRIPTION
1	0-16	Slight: Only heard in quiet environment, very easily masked. No interference with sleep or daily activities.
2	18-36	Mild: Easily masked by environmental sounds and easily forgotten with activities. May occasionally interfere with sleep but not daily activities.
3	38-56	Moderate: May be noticed, even in the presence of background or environmental noise, although daily activities may still be performed.
4	58-76	Severe: Almost always heard, rarely, if ever, masked. Leads to disturbed sleep pattern and can interfere with ability to carry out normal daily activities. Quiet activities affected adversely.
5	78-100	Catastrophic: Always heard, disturbed sleep patterns, difficulty with any activity.

Tinnitus Reaction Questionnaire (TRQ)

Name _____

Date Completed: _____

This questionnaire is designed to find out what sort of effects tinnitus has had on your lifestyle, general well-being, etc. Some of the effects below may apply to you, some may not. Please answer **all** questions by circling the number that **best** reflects how your tinnitus has affected you **over the past week**.

	Not at all	A little of the time	Some of the time	A good deal of the time	Almost all of the time
1. My tinnitus has made me unhappy.	0	1	2	3	4
2. My tinnitus has made me feel tense.	0	1	2	3	4
3. My tinnitus has made me feel irritable.	0	1	2	3	4
4. My tinnitus has made me feel angry.	0	1	2	3	4
5. My tinnitus has led me to cry.	0	1	2	3	4
6. My tinnitus has led me to avoid quiet situations.	0	1	2	3	4
7. My tinnitus has made me feel less interested in going out.	0	1	2	3	4
8. My tinnitus has made me feel depressed.	0	1	2	3	4
9. My tinnitus has made me feel annoyed.	0	1	2	3	4
10. My tinnitus has made me feel confused.	0	1	2	3	4
11. My tinnitus has "driven me crazy".	0	1	2	3	4
12. My tinnitus has interfered with my enjoyment of life.	0	1	2	3	4

13. My tinnitus has made it hard for me to concentrate.	0	1	2	3	4
14. My tinnitus has made it hard for me to relax.	0	1	2	3	4
15. My tinnitus has made me feel distressed.	0	1	2	3	4
16. My tinnitus has made me feel helpless.	0	1	2	3	4
17. My tinnitus has made me feel frustrated with things.	0	1	2	3	4
18. My tinnitus has interfered with my ability to work.	0	1	2	3	4
19. My tinnitus has led me to despair.	0	1	2	3	4
20. My tinnitus has led me to avoid noisy situations.	0	1	2	3	4
21. My tinnitus has led me to avoid social situations.	0	1	2	3	4
22. My tinnitus has made me feel hopeless about the future.	0	1	2	3	4
23. My tinnitus has interfered with my sleep.	0	1	2	3	4
24. My tinnitus has led me to think about suicide.	0	1	2	3	4
25. My tinnitus has made me feel panicky.	0	1	2	3	4
26. My tinnitus has made me feel tormented.	0	1	2	3	4
Total					

Wilson et al. 1991

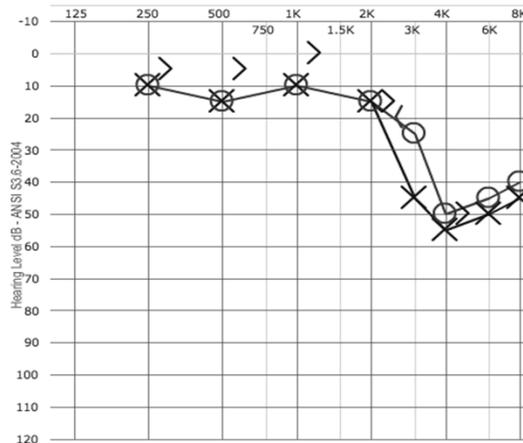
Significant benefit for clinical success observed with at least a 40 percent reduction in the TRQ score (Davis, Paki, and Hanley, 2007).

Determine auditory aspects related to tinnitus

- Audiograms: hearing closer to normal vs. sensorineural hearing loss
- Tympanometry
- DPOAES: OHC function
- BBN MLs
- LDLs

EXAMPLE:

	RE	LE
Type	A	A
MEP	5	5
SC	1.6	0.5
CV	1.6	1.5
Grad.	0.7	0.5



	Left Contra	Right Ipsi	Right Contra	Left Ipsi
500 Hz	95	85	95	90
1000Hz	85	90	85	85
2000 Hz	90	90	90	90

SRTs: 10 dB, bilaterally
 WRs: 96% for RE & 92% for LE @ 50 dBHL, bilaterally

Characterize the type of tinnitus

- Frequency matching
- Loudness matching
- Subjective vs. objective
- Steady vs. pulsatile

EXAMPLE:

	RE	LE
Frequency matching	10 kHz	9 kHz
Loudness matching	60 dBHL	55 dBHL
BBN MMLs	38 dBHL	38 dBHL

Determine possible etiology

Type	Unilateral vs. bilateral	Pulsatile vs. steady
Hearing loss	Conductive vs. sensorineural	Sudden vs. gradual onset
Possible Etiology	NIHL, ototoxic drugs Meniere's Disease; AN?	Idiopathic
Vertigo	Cochlear	Retrocochlear or central
Distress	Anxiety or depression	Cognitive decline

Determine treatment strategy for tinnitus

- Sound therapy devices (STDs)
- Hearing Aid Management (HAM)
- Cognitive Behavioral Therapy (CBT)
- Tinnitus Retraining Therapy (TRT)

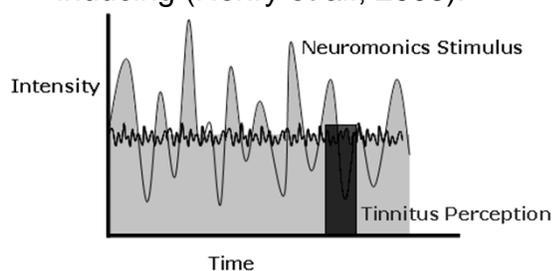
Type	Hearing loss+Tinnitus	Tinnitus
	HAM	STDs, CBT, TRT
Assessment	Audiological measures	BBNMML
Treatment	Hearing aid	TRT, CBT, Sound therapy devices
Primary goal	Amplification	Habituation
Distress	Evaluate change	Evaluate change

Sound Therapy Option 1: Tinnitus Maskers

- Three types of therapeutic sound have been recommended for relief from tinnitus (Henry et al., 2008).
 - Soothing sound is used to induce a sense of relief from stress or tension caused by tinnitus.
 - Background sound is an effective in managing tinnitus by reducing the contrast between the tinnitus percept and the acoustic environment.
 - Interesting sound is used to directly or indirectly shift attention away from tinnitus.

Sound Therapy Option 2: Neuromonics

- Intervention with NTT involves at least 6 months of using a proprietary, wearable listening device 2 to 3 hours per day.
- The Neuromonics device is similar to an MP3 player or New Age music that is specially selected for relaxation-inducing (Henry et al., 2008).



OHNS Guideline #7

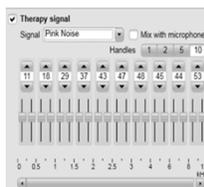
Clinicians should recommend a hearing aid evaluation for patients with hearing loss and persistent, bothersome tinnitus.

Hearing aids and tinnitus

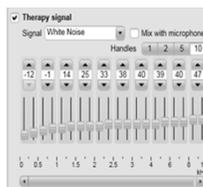
- Amplify environmental sounds and suppress tinnitus
- For patients with significant SNHL, the enriched background sound is further amplified by hearing aids
- Separate tinnitus control program available
- Possible to mix background signals with specific hearing aid programs



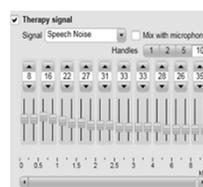
Therapy Signals



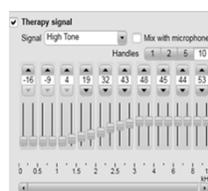
Pink Noise - each octave carries an equal amount of energy



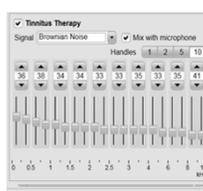
White Noise - constant spectral density across all frequencies



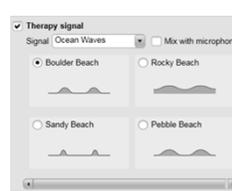
Speech Noise - corresponds to the frequency shaping of the Long-Term Average Speech Spectrum (LTASS)



High Tone - more intensity in the high frequency region



Brownian Noise - the power density decreases with increasing frequency



Ocean Waves - modulated therapy signals, producing a sound similar to waves arriving on the shore line

Hearing Aids

- Surr, Montgomery, and Mueller (1985): About half of 200 new hearing aid users reported partial or total relief from tinnitus after hearing aid use.
- Surr, Kolb, Cord, and Garrus (1999): Means scores on the Tinnitus Handicap Inventory (THI) were significantly reduced after hearing aid use.
- Trotter and Donaldson (2008): More than two thirds of consecutive patients (2,153) who were fitted with hearing aids over a 25-year period reported improvements in tinnitus.

OHNS Guideline #9

Clinicians should recommend cognitive behavioral therapy to patients with persistent, bothersome tinnitus.

Cognitive Behavioral Therapy (CBT)

- CBT is not intended to eliminate the tinnitus or reduce its perceived loudness. CBT is intended to reduce reactions to tinnitus and to aid in coping with the deleterious effects of tinnitus on quality of life.
- Henry (2005) recommends educational counseling that includes maintaining: 1) avoidance of exposure to loud noise, 2) a background of constant low-level sound, 3) a healthy life-style, 4) a busy schedule, 5) educational awareness of tinnitus.

OHNS Guidelines, 2014, Volume 151

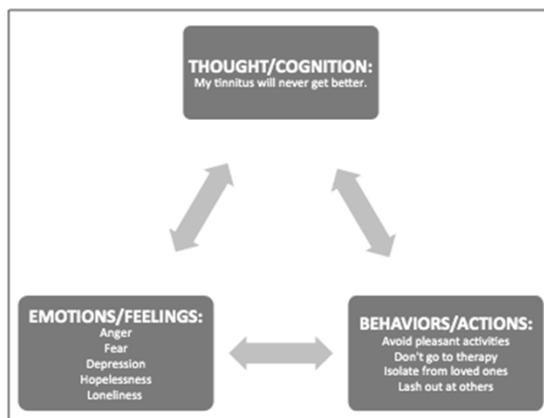
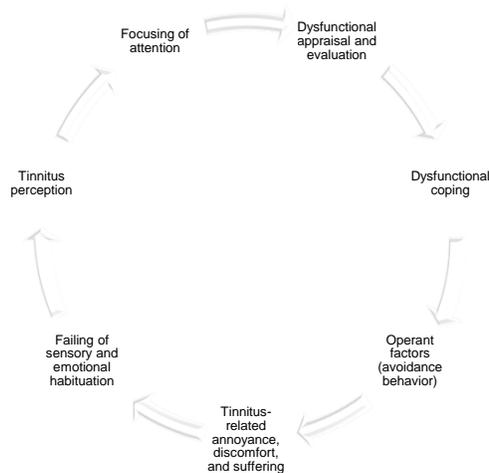


Figure 2. Cognitive behavioral therapy for tinnitus-related distress.

Tunkel et al., 2014

Vicious-circle model of tinnitus (Kroner-Herwig, 1997)



OHNS Guideline #6

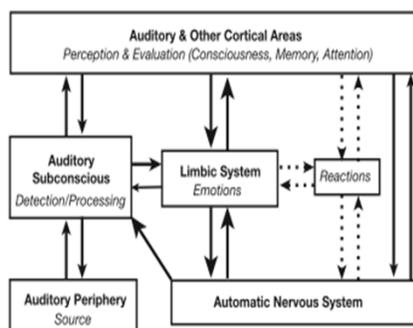
Clinicians should educate patients with persistent, bothersome tinnitus about management strategies.

Sound therapy facilitates tinnitus habituation by decreasing the strength of the tinnitus signal. In practice, this is achieved by instructions to the patient to avoid silence and to enrich the background sound environment.

Sound therapy facilitates tinnitus habituation by decreasing the strength of the tinnitus signal. In practice, this is achieved by avoiding silence and to enrich the background sound environment.

Habituation insures that neural activity of tinnitus is blocked from reaching the limbic and autonomic nervous systems.

Tinnitus Retraining Therapy



- Basis for Jastreboff model: Tinnitus generation may involve a dysfunction of the outer and inner hair cells but is associated with increased spontaneous activity of auditory nerve fibers and/or abnormal patterns of activity in the auditory pathways that can be erroneously interpreted as sound.
- Both limbic and Autonomic nervous systems are involved leading to distress.

Objectives of TRT (Henry et al., 2007)

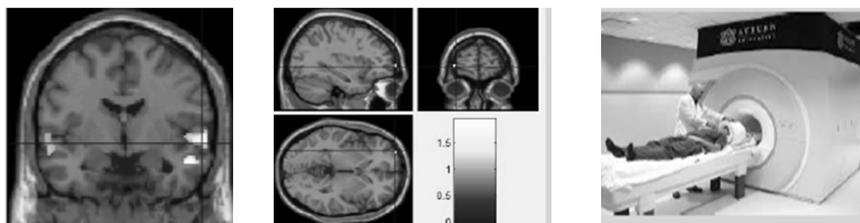
- Primary objective of TRT is habituation of the negative reactions associated with the tinnitus (achieved through structured educational counseling).
- The second objective can be met only if the primary objective has been achieved and involves habituation of tinnitus from conscious perception (sound therapy).
- For sound therapy, patients with more severe tinnitus are normally fitted with ear-level wearable devices (maskers and hearing aids).

OHNS Guideline #3

Clinicians should not obtain imaging studies of the head and neck in patients with tinnitus, specifically to evaluate the tinnitus, unless they have 1 or more of the following: tinnitus that localizes to 1 ear, pulsatile tinnitus, focal neurological abnormalities, or asymmetric hearing loss.

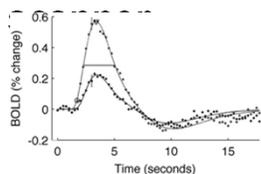
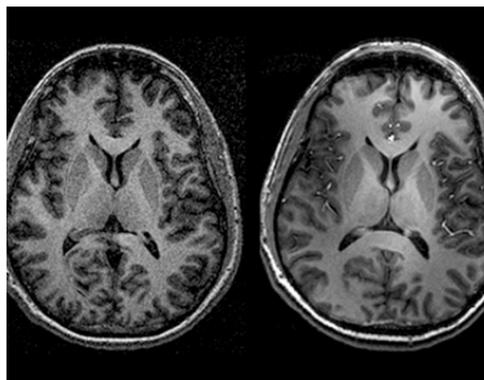
Upcoming study

- fMRI of mechanisms involved in tinnitus masking
- Structural MRI
- fMRI studies are useful in discovering the underlying mechanisms in tinnitus which lead to new tinnitus management choices.



3T vs. 7T

- The 7T Seimens scanner has higher spatial resolution and a greater signal-to-noise ratio than the 3T



fMRI: baseline, masking applications



b) Apple iPod Touch™



a) Tinnitus Relief™



b) Tinnitus Masker™