

Clinical Management of Tinnitus: Past, Present, and Future

James Henry, PhD (retired)

Previously:

VA RR&D Senior Research Career Scientist
VA RR&D National Center for Rehabilitative Auditory Research
(NCRAR), VA Portland Health Care System, Portland, Oregon
Research Professor
Department of Otolaryngology – Head & Neck Surgery, Oregon
Health & Science University, Portland, Oregon

1

Where Am I?
Sequim, WA



2

My Tinnitus History

Exposed to loud music and carpentry in the 1970s and 1980s

Back to school – Audiology MS (1987)

Hired in auditory research lab at VA in Portland (1987) – Drs. John McDermott and Steve Fausti

Back to school again – OHSU and lab of Drs. Jack Vernon and Mary Meikle (1988-1994)

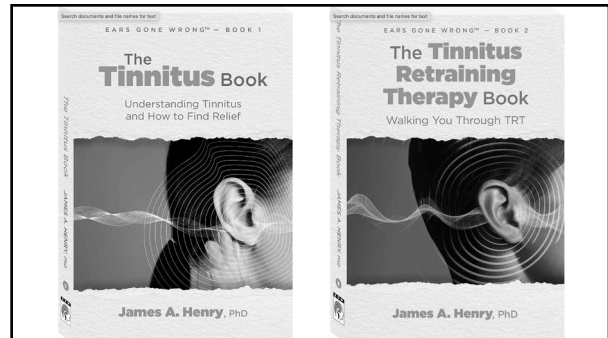
Continued to work half-time at VA

Funded at VA/NCRAR to conduct tinnitus clinical research (1995-2022)

Retired September 30, 2022

Currently focused on writing a series of books targeted to consumers

3



4

Books planned or in the works

The **Progressive Tinnitus Management Book**: Step-by-Step Through PTM

The **Deafness Book**: Answering Questions About Deafness From Different Perspectives

The **Hyperacusis and Misophonia Book**

The **Hearing Loss Book**

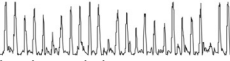
5

Terminology and Definitions


6

Different Forms of Tinnitus

Primary tinnitus: dysfunctional nerve activity in the brain that *is not associated with sound waves* and manifests itself as phantom sound
 aka subjective tinnitus, sensorineural tinnitus
 No known cure



Secondary tinnitus: mechanical activity in the head or neck that produces sound waves that are detected by the auditory system via bone conduction
 aka objective tinnitus, somatosounds—*not actually tinnitus?*
 ENT exam essential
 Cure possible if underlying cause can be corrected



7

Somatosensory Tinnitus aka Somatic Tinnitus aka Somatically Modulated Tinnitus

Tinnitus that can be changed (“modulated”) by some kind of physical contact or movement involving the head, neck, jaw, eyes, or even the arms and hands

Caused by complex interactions between the auditory and somatosensory systems

Not a form of secondary tinnitus
 A subtype of primary tinnitus

That can be modified by different physical (somatic) maneuvers. When this occurs, the sound of the tinnitus can become louder, softer, higher in pitch, lower in pitch, or even different with respect to its quality (timbre)

It is fairly common and does not normally pose any medical concerns

8

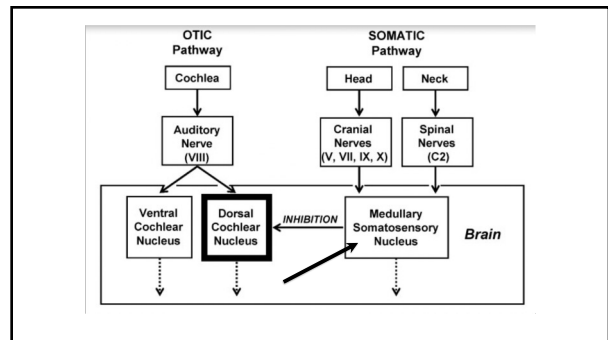
Modulating Tinnitus

Reported that 2/3 of people with tinnitus are able to alter the loudness and pitch of their tinnitus via somatic maneuvers, such as

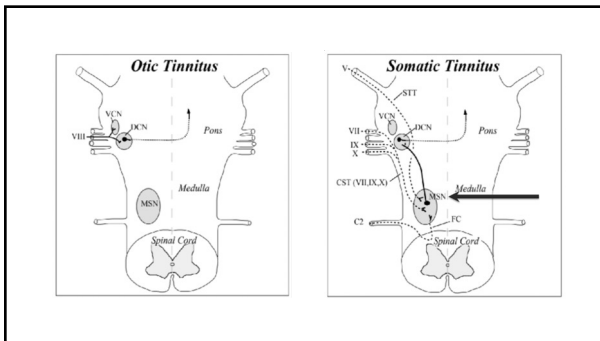
- Resisting an applied force to head/neck/extremities
- Applying pressure on head/neck/extremities
- Jaw clenching/protruding/sliding
- Tensing neck muscles
- Moving the head
- Moving the eyes
- Etc.

What are the neural connections between the auditory and somatosensory systems that could explain these phenomena?

9



10



11

A Brief History Of the Modern Tinnitus Era (1970s To the Present)

12

A lot has changed in 50 years

According to PubMed, in **1972** there were **eight** publications with “tinnitus” in the title

Some interest, and a few sporadic articles about tinnitus, but tinnitus was mostly unknown to both lay and professional people

In **2022** there were **520** peer-reviewed articles with “tinnitus” in the title

No cure and no proven breakthroughs in managing the effects of tinnitus

We do, however, understand tinnitus much better and interest keeps increasing

13

First Dedicated Tinnitus Clinic

Oregon Health & Science University (OHSU) Tinnitus Clinic


Founded by Dr. Jack Vernon in 1976

Pioneered the use of sound to mask tinnitus

Prolific author and presenter

Co-founded the American Tinnitus Association (ATA)

Retired in 1996 and the clinic was taken over by Drs. Billy Martin and Bob Folmer



14

What is “Masking”?

Vernon’s original approach was to use broadband noise to make tinnitus inaudible

After a few years he realized that total masking was not necessary—*partial* masking provided a sense of relief

The method was used successfully by Dr. Martin Schechter at the Portland VA audiology clinic for many years

The word “masking” is commonly misunderstood—the method might be more appropriately termed “sound-based tinnitus relief”

15

1980s: Methods In Early Stages of Development

Cognitive Behavioral Therapy (CBT) applied to tinnitus (Sweetow, 1985)

Tinnitus Retraining Therapy (TRT) (Jastreboff, 1990)

Tinnitus Activities Treatment (TAT) (Bentler & Tyler, 1987)

Each of these methods is now fully developed, well established, and can be considered an “evidence-based intervention for tinnitus”

All use variations of counseling and sound therapy

16

Cognitive Behavioral Therapy (CBT)

Cognitive components

Identify negative thoughts and beliefs and replace them with thoughts and beliefs that are more helpful in managing reactions to tinnitus (cognitive restructuring)

Behavioral components

Learn specific coping skills for self-managing the effects of tinnitus

- Distraction activities
- Relaxation techniques
- Education about the auditory system, improving sleep, general health, use of sound

Who provides CBT?

Psychologists, professional counselors, psychiatrists, advanced nurse practitioners, clinical social workers (*audiologists?*)

Very few behavioral health providers offer CBT for tinnitus

17

Third Wave CBT

First wave: different behavioral therapies (Δ behavior \rightarrow Δ feelings)

Second wave: included cognitive components (Δ thoughts \rightarrow Δ feelings)

Third wave: rather than changing thoughts and feelings, focus on becoming more accepting of ourselves the way we are

“Don’t focus on being relaxed and comfortable but living in accordance with our beliefs and values, even in the face of discomfort and hardship”

Includes mindfulness-based approaches and Acceptance and Commitment Therapy (ACT)

18

Tinnitus Retraining Therapy

Goals:
 Habituation of reactions to tinnitus
 Habituation of the perception of tinnitus

Treatment
 Structured counseling, based on the *neurophysiological model of tinnitus*, is the most important component of treatment
 All patients are instructed to “avoid silence” and “enrich their sound environment”
 Some patients use wearable devices (sound generators) that provide broadband noise

Who provides TRT? Mostly audiologists—some behavioral health providers and physicians

19

Tinnitus Activities Treatment (TAT)

Involves informational counseling, focus on patients’ well-being, and teaching coping strategies
 For most patients, “partial masking sound therapy” is used
 Patients grouped into categories

- Curious: basic information about tinnitus
- Concerned: more detailed information about tinnitus and self-directed management strategies
- Distressed: full TAT protocol (counseling re: tinnitus and associated problems; teaching coping strategies; sound therapy with partial masking—optional)

Who provides TAT? Mostly audiologists

20

Progressive Tinnitus Management (PTM)

Concept introduced in 2005
 Stepped-care program—patients progress through increasingly higher levels of care depending on individual need
 Ensures that the services received do not exceed what is needed for each patient

Five levels of care

- 1 Referral (non-auditory healthcare providers)
- 2 Audiologic evaluation (audiologists w/some referrals to ENT)
- 3 Skills education (audiologists and behavioral health providers)
- 4 Interdisciplinary evaluation (audiologists and psychologists)
- 5 Individualized support (audiologists and behavioral health providers)

21

Tele-PTM

PTM Level 3, 4, and 5 services are provided remotely (telephone, teleconference)
 Patients must first be evaluated in person by an audiologist (Level 2 audiologic evaluation or equivalent)
 Same providers as for PTM

22

Summary of Established Methods of Tinnitus Management

CBT, TRT, TAT, and PTM are well established and evidence based
 Similar in many ways but different in many ways
 Although CBT has the strongest evidence, it cannot be assumed that CBT is more effective than any other method
 Biggest challenge for patients is finding a competent and experienced provider
 Before seeking any form of treatment (or searching the internet), they need factual, practical, and realistic information

23

Methods Involving Mostly Passive Treatment

<ul style="list-style-type: none"> Acupuncture Biofeedback Deep brain stimulation Electrical and magnetic stimulation Homeopathic remedies Hypnotherapy Nutritional supplements Off-label medications Over-the counter substances labeled for tinnitus treatment TMJ treatment Vagus nerve stimulation 	<p>What do they all have in common? They involve either taking some substance by mouth or receiving some procedure All of these methods have been studied to some extent and are reported in the literature Some tested in controlled trials and considered “promising” None has strong evidence of benefit for tinnitus treatment All helpful in some/anecdotal cases</p>
---	---

24

Behavioral (Self-care) Methods

<p>Various forms of counseling</p> <p>Various forms of sound therapy</p> <ul style="list-style-type: none"> Hearing aids Ear-level sound generators Combination instruments Sound machines Sound and sleep apps Notched music <p>Levo</p> <p>Emotional freedom technique</p>	<p>What do they all have in common?</p> <p>Patients learn what they can do to manage effects of tinnitus—to sleep better, concentrate better, and not react emotionally to the tinnitus</p> <p>Clinicians teach the skills and provide support as necessary</p> <p>Some self-care skills can be learned without a clinician's help from various books, videos, and websites</p>
--	---

25

The Future?

Bimodal stimulation?

Repetitive transcranial magnetic stimulation (rTMS)?

Sound therapies targeting the tinnitus sensation?

26

Bimodal Stimulation

27

Bimodal Stimulation to "Reduce Tinnitus"

- Dorsal cochlear nucleus (DCN) is the first central station of the auditory pathway that integrates auditory signals with sensory information
- Somatosensory projections synapse on certain DCN cells with plastic synapses, in contrast to nonplastic synapses from the ear
- Repeated somatosensory signals induce long-term plasticity in DCN neurons
- Properly timed auditory and somatosensory stimulation could be used to reduce tinnitus

28

Lenire – Third Clinical Trial

Neuromod Devices, Dublin, Ireland

Bimodal neuromodulation

Pairing sound with electrical stimulation of vagus and trigeminal nerves


Objectives:

- Evaluate contribution of different features of bimodal stimulation on outcome
- Study therapeutic effects of changing parameter settings over time for 12 weeks

Participants with chronic subjective tonal tinnitus

Exclusions: hearing aids previous 90 days; LDL <30 dB SL (.5 kHz); anxiety >120 (STAI)

Inclusions: Tinnitus duration: 3 mo – 10 yr; THI scores: 38-100; MML: 20-80 dB HL; Max hearing loss 40 dB HL (.25-1 kHz); 80 dB HL (2-8 kHz)



29

Prospective, randomized, double-blind, four-arm parallel study

2 30-min sessions per day for 12 wk

Follow ups at 6 wk, 6 mo, 12 mo

191 participants

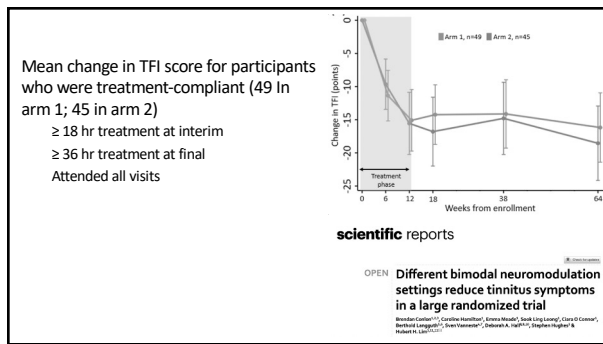
79 to arm 1 (w/noise); 80 to arm 2 (no noise)

"exploratory" arms 3 and 4 (different sound and tongue stimulation)

12-week treatment period (recommended 1hour/day)

12-month follow-up (FU) period (no treatment)

30



31

Michigan Device – Most Recent Trial

Michigan Health System, Ann Arbor, MI
 Bisensory (auditory and somatosensory) treatment
 Objective: “confirm and extend the findings of a pilot study, which suggested an increased efficacy of bisensory stimulation”
 99 participants

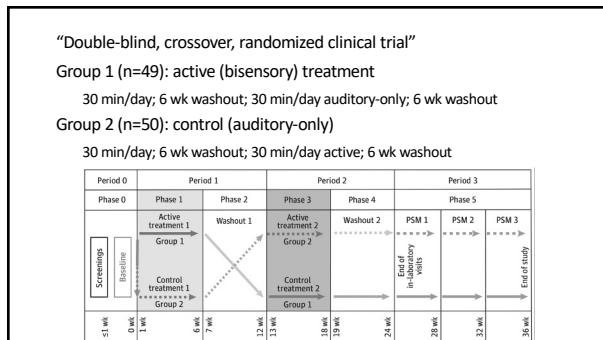
Exclusions: hearing loss greater than “moderate”; tinnitus treatment prior 6 mo
Inclusions: bothersome somatic tinnitus; TFI scores: 17-100

JAMA Network | Open

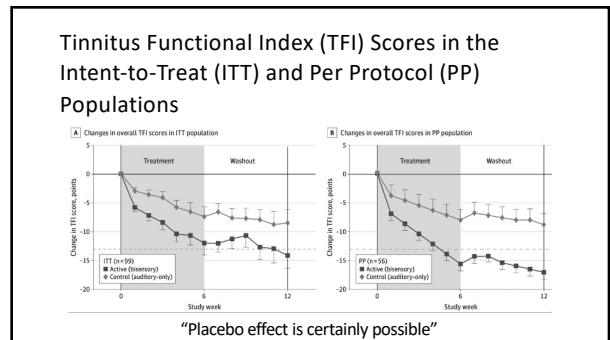
Original Investigation | Otolaryngology
Reversing Synchronized Brain Circuits Using Targeted Auditory-Somatosensory Stimulation to Treat Phantom Percepts
 A Randomized Clinical Trial

Garber B, Jansen ADH, Swartz M, et al. *JAMA*. 2023;329(12):1000-1010. doi:10.1001/jama.2023.10000

32



33



34

Neosensory Duo

Bimodal stimulation—tones paired with wrist stimulation (“haptic” feedback)
 Frequencies centered around tinnitus frequency (tested in app)
 1 octave above and 1 octave below tinnitus frequency
 120 tones per minute played in random order with random timing

Wristband with four vibratory motors
 256 “spatial locations” correspond with frequency of tones

45 participants recruited via online ad
 Inclusion: TFI scores: 25-100

Bimodal stimulation for the reduction of tinnitus using vibration on the skin

Michael V. Parrotta¹, Izzy Kohler¹, David M. Engelman^{1,2}

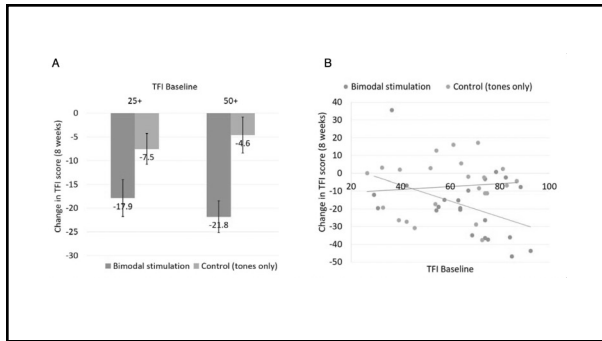
¹Neurosciences, ²Psychiatry, ³Psychology, ⁴Department of Psychiatry and Behavioral Sciences, Stanford University School of Medicine, Stanford, CA 94304

35

Neosensory Duo – Methods

Participants randomly assigned
 Experimental condition (bimodal stimulation with tones + wristband)
 Control condition (tones only)
 10 minutes daily treatment for 8 weeks
 Completed the TFI each week

36



37

Repetitive Transcranial Magnetic Stimulation (rTMS)

38

Repetitive Transcranial Magnetic Stimulation (rTMS)

Intermittent magnetic fields are produced by a coil in contact with the scalp that delivers electromagnetic pulses

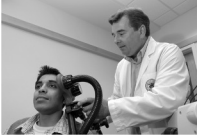
Magnetic fields pass largely undistorted through the cranium and affect the neuronal activity of the brain beneath

Currently used to treat anxiety, depression, insomnia

Studies have shown rTMS to be effective for tinnitus

Other studies claim lack of efficacy

More research needed



Journal of Clinical Medicine

Review: Unresolved Issues Associated with Transcranial Magnetic Stimulation (TMS) Treatment of Chronic Tinnitus

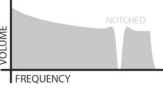
Robert L. Fabry, MD

39

Sound Therapies Targeting the Tinnitus Sensation

40

Notched-Noise Therapy



Removing ("notching") the sound in the frequency region surrounding the tinnitus pitch match

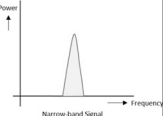
Hypothesized to produce lateral inhibition of neurons associated with the tinnitus, thereby reducing their hyperactivity

Has been used in a number of studies to notch music

Has also been used with hearing aids by eliminating the amplification in the frequency region of the individual's tinnitus

41

Matched-Noise Therapy



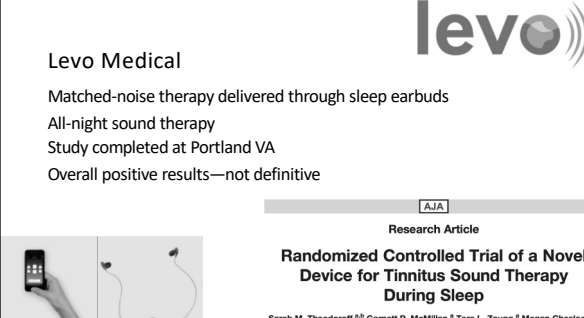
Exact opposite of notching

Method presents sound in the region of the tinnitus center frequency

Purpose: increase neural signals to areas of hyperactivity to restore normal spontaneous activity

A number of products have been developed that use this approach

42



Levo Medical
 Matched-noise therapy delivered through sleep earbuds
 All-night sound therapy
 Study completed at Portland VA
 Overall positive results—not definitive

Research Article
Randomized Controlled Trial of a Novel Device for Tinnitus Sound Therapy During Sleep

Sarah M. Theodoroff,^{1,2} Garnett P. McMillan,³ Tara L. Zaugg,⁴ Megan Cheslock,⁵ Chav Roberts,⁶ and James A. Henry^{1,2}

43

Neural Desynchronization Therapy

Theory: Tinnitus might be caused by deafferentation-induced neural synchrony in the hearing loss region
 Acoustic Coordinated Reset Neuromodulation (**Desyncra**) developed to counteract this synchrony
 Derived from a treatment for Parkinson's disease
 Many studies conducted with promising results, but not definitive

INTERNATIONAL JOURNAL OF AUDIOLOGY
 https://doi.org/10.1080/14992027.2021.2094335

ORIGINAL ARTICLE
Randomised controlled trial of interventions for bothersome tinnitus: Desyncra™ versus cognitive behavioural therapy

Sarah M. Theodoroff^{1,2}, Garnett P. McMillan³, Caroline J. Schmidt⁴, Serena M. Dann⁵, Christian Hauptmann⁶, Marie-Christine Goodworth¹, Ruth Q. Leibowitz², Chan Random³ and James A. Henry^{1,2}

44

Residual Inhibition

Temporary suppression or elimination of tinnitus following appropriate auditory stimulation
 Using the standard clinical test, RI (typically <1 minute) occurs for 80-90% of patients
 Extended RI could provide an important clinical treatment for tinnitus

A Pilot Study to Evaluate a Residual Inhibition Technique in Hearing Aids for Suppression of Tinnitus

Candice M. Quinn, Au.D., Ph.D.,^{1,2} Jay J. Vachhani, Au.D.,^{3,4} Emily J. Thielman, B.A.,¹ Deyan Kulkarni, Au.D.,¹ Anneka Sonstrom, B.A.,¹ James A. Henry, Ph.D.,^{1,4} and Sherril L. Smith, Au.D., Ph.D.^{1,5}

45

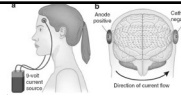
Other Methods

46

Transcranial Electrical Stimulation

Transcranial direct current stimulation (tDCS)
 Weak, constant current applied via scalp electrodes and passes through the cerebral cortex
 Depending on the polarity of the stimulation tDCS can increase or decrease cortical excitability in the brain regions to which it is applied

Transcranial alternating current stimulation (tACS)
 Frequency of applied ACs allows for the manipulation of intrinsic cortical oscillations and it is therefore possible that tACS can interact with rhythmic neuronal activity
 Despite the plausibility of this theoretical model, no effect on the tinnitus percept has been obtained—further investigation does not seem merited



47

Other Experimental Methods

- Transcranial random noise stimulation
- Neurofeedback
- Vagus nerve stimulation
 - Implanted
 - Transcutaneous
- Invasive brain stimulation
 - Focused on altering the neuronal tinnitus network through the electrical stimulation of cortical (epidural or subdural) or deep brain areas using implanted electrodes

48

What Research is Needed?

Systematic research to achieve definitive standards
To provide a solid evidence base for different methods of tinnitus evaluation and treatment
To determine if any form of sound therapy or electrical/magnetic stimulation can permanently reduce or eliminate the sensation of tinnitus
Standardization in the assessment of outcomes
Coordinate basic science research seeking a cure for tinnitus

49

What's Needed In the Clinic?

Establish a credentialing program for tinnitus management that verifies competency
Standardization in the assessment of outcomes
Establish a network of providers and patients who interact and communicate to continually improve tinnitus services ("learning health network")
Use the "living guideline" concept for faster updates of clinical practice guidelines

50

Feel free to contact me

503-998-0864
drhenry@earsgonewrong.org

51

James A. Henry Annual Tinnitus Seminar



Dr. James A Henry, VA Senior Research Career Scientist, is an audiologist with a doctorate in behavioral neuroscience. His years working on his doctorate under the tutelage of Drs. Mary Meikle and Jack Vernon ignited his passionate interest in tinnitus research. During his career of over 35 years, he received funding of \$28 million as principal or co-principal investigator for 43 projects and grants. He has authored 240 articles, including 135 in peer-reviewed journals and six books about tinnitus. He gave lectures and presentations nationally and internationally. His accomplishments resulted in numerous awards, including the VA Rehabilitation Research and Development 2016 Paul B. Magnuson Award (“the highest honor for VA rehabilitation investigators”) and the Jerger Career Award for Research in Audiology from the American Academy of Audiology Honors Committee. Dr. Henry who retired in 2022 continues to give lectures and training workshops, serves as a consultant, and has maintained his role as editor-at-large for the American Tinnitus Association’s journal Tinnitus Today. His primary efforts are directed toward writing books about tinnitus, hyperacusis, and hearing loss.

Dr. Henry’s research, commitment, and dedication to Veteran hearing health will always be valued and remembered. It is in his honor that we established this annual tinnitus seminar.