Tinnitus Patient Management

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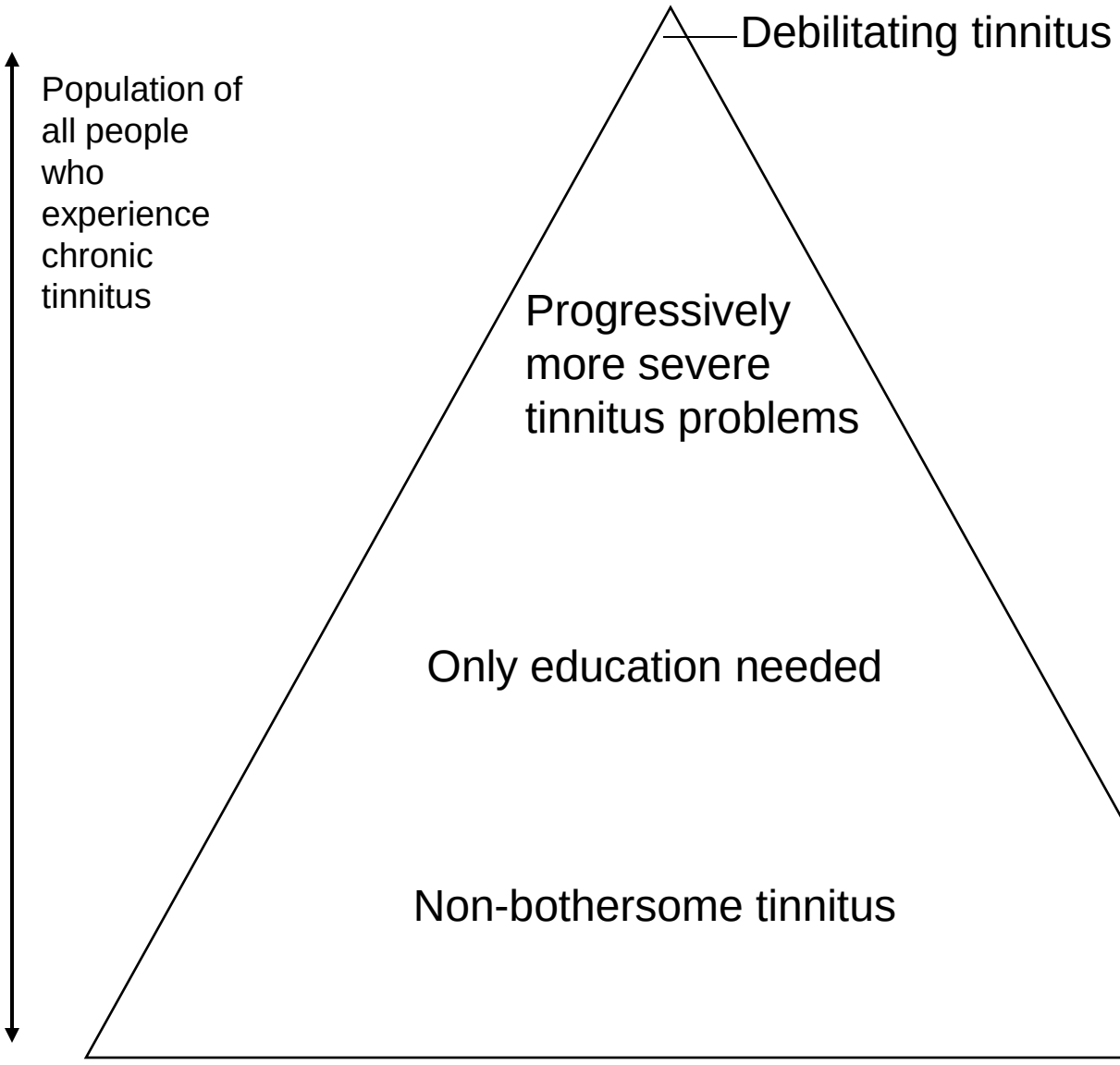
Tinnitus Facts

- Approximately 15% of the world’s population has tinnitus.
- More than 70% of hearing impaired individuals have had tinnitus at some point
- 80-90% of tinnitus patients have some evidence of hearing loss
- 10 - 20% of tinnitus sufferers seek medical attention


Debilitating tinnitus
Population of all people who experience chronic tinnitus
Progressively more severe tinnitus problems
Only education needed
Non-bothersome tinnitus

Dobie, 2004

Most common difficulties attributed to tinnitus

- Sleep
- Persistence
- Speech understanding
- Despair, frustration, depression
- Annoyance, irritation, stress
- Concentration, confusion
- Drug dependence
- Pain/headaches

Tyler and Baker, 1983

- Subjective tinnitus
    - idiopathic
    - sensory
    - neural
    - central
- Objective tinnitus
    - vascular
    - muscular

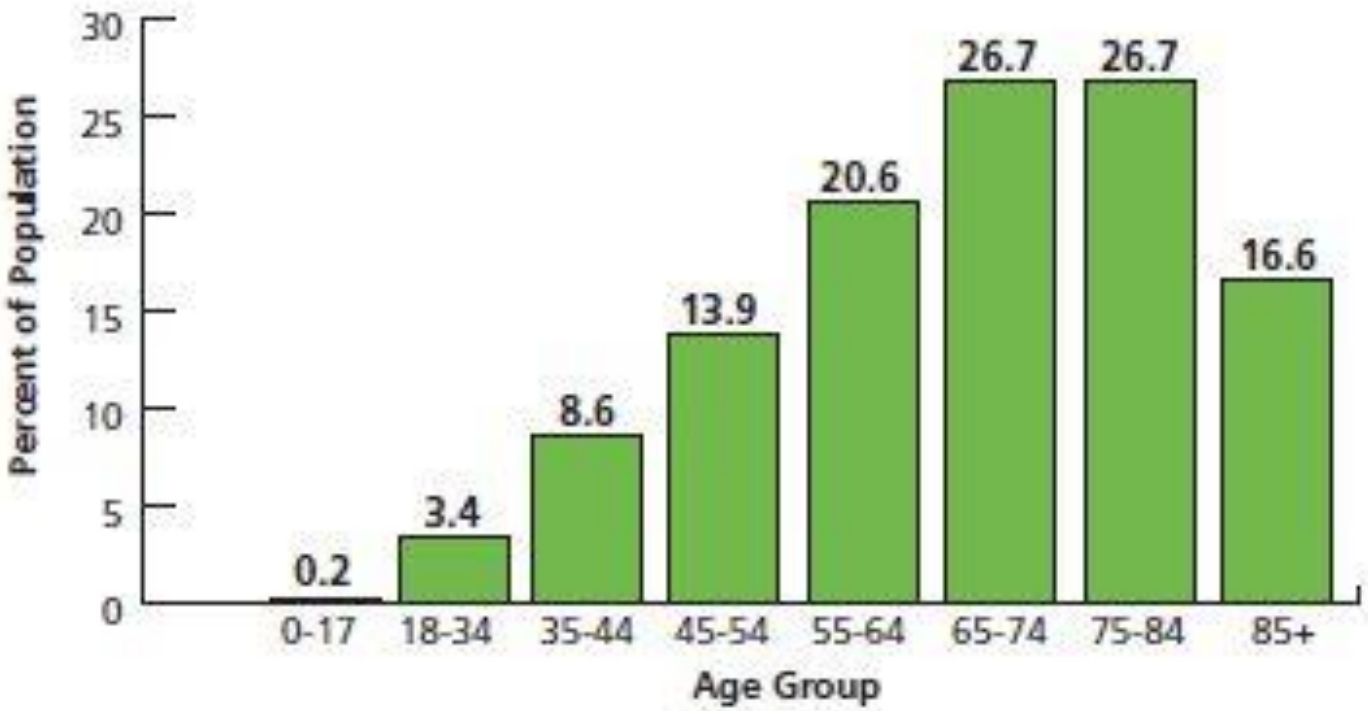
Some outer and middle ear pathologies associated with tinnitus

- cholesteotoma
- otosclerosis
- impacted cerumen
- palatal myoclonus
- patulous eustachian tube
- glomus jugulare tumor
- abnormal middle ear resonance
- mastoiditis
- otitis media
- allergies
- head/ear trauma

Some inner ear pathologies associated with tinnitus

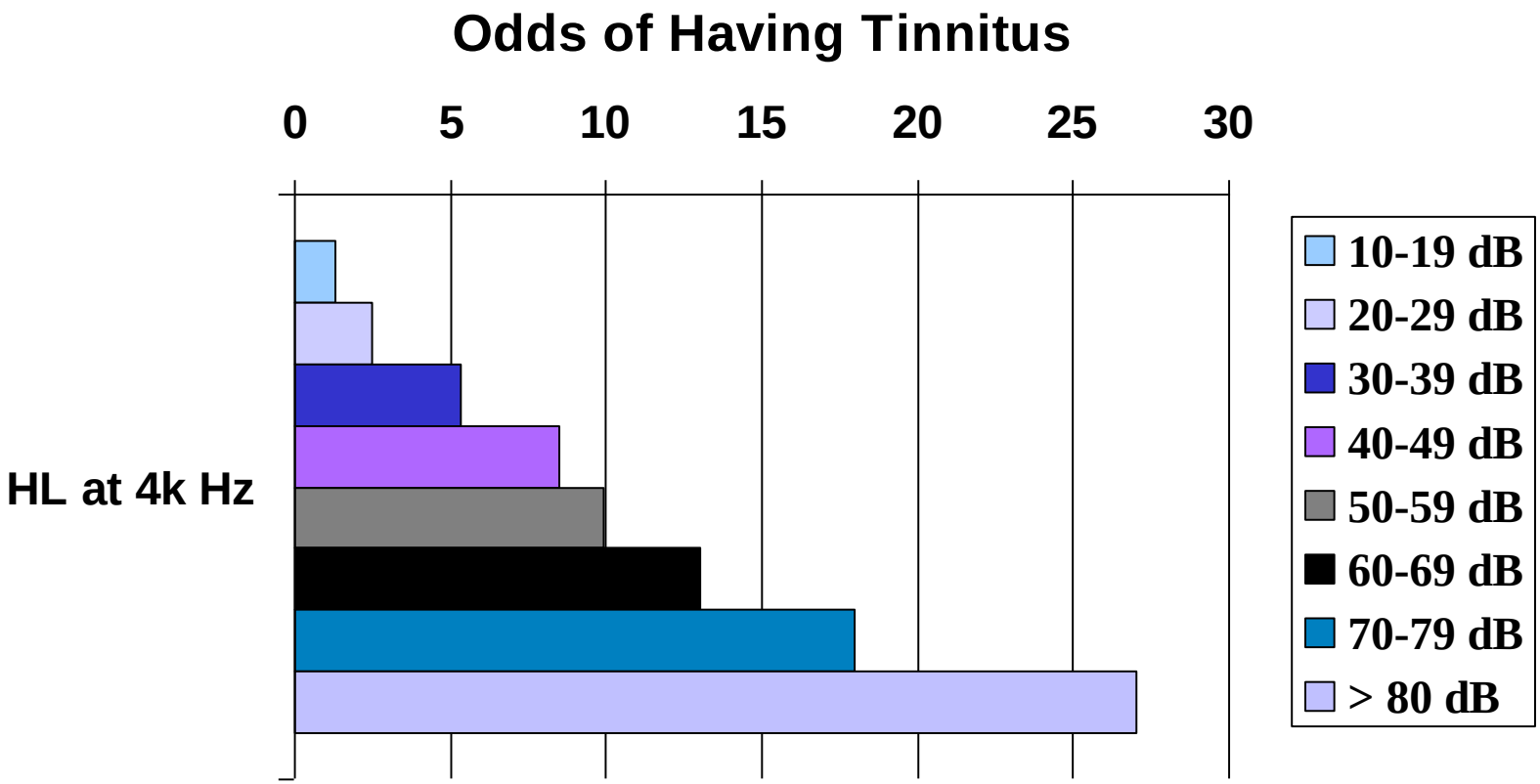
- acoustic trauma
- noise exposure
- labyrinthitis
- head/ear trauma
- meningitis
- presbycusis
- meniere's disease
- acoustic neuroma
- ototoxicity
- perilymph fistula
- autoimmune inner ear disease
- vestibular schwannoma
- sudden hearing loss

Figure 2. Incidence of tinnitus by age group.

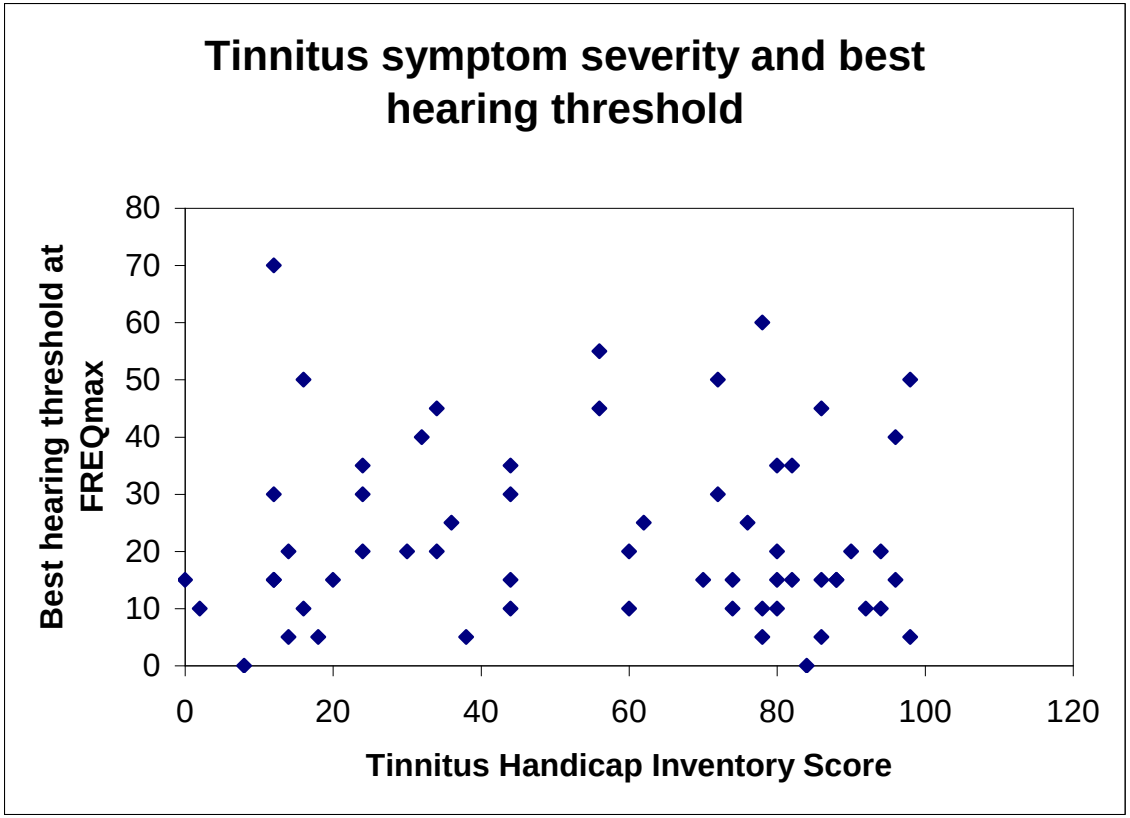


Kochkin et al, 2012

Tinnitus and Hearing Loss



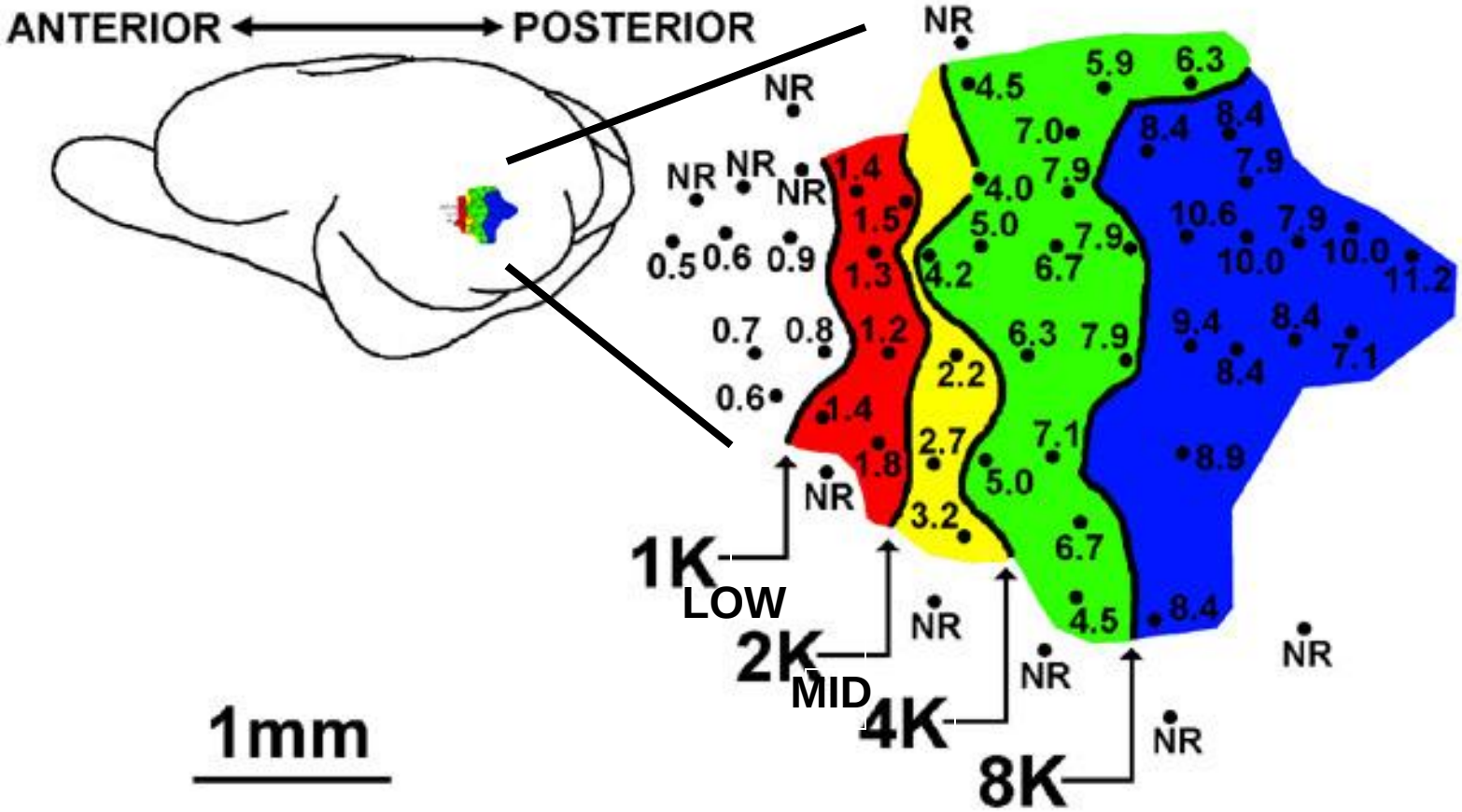
Correlation between tinnitus severity and auditory threshold



Tsai, Cheung, and Sweetow, 2007

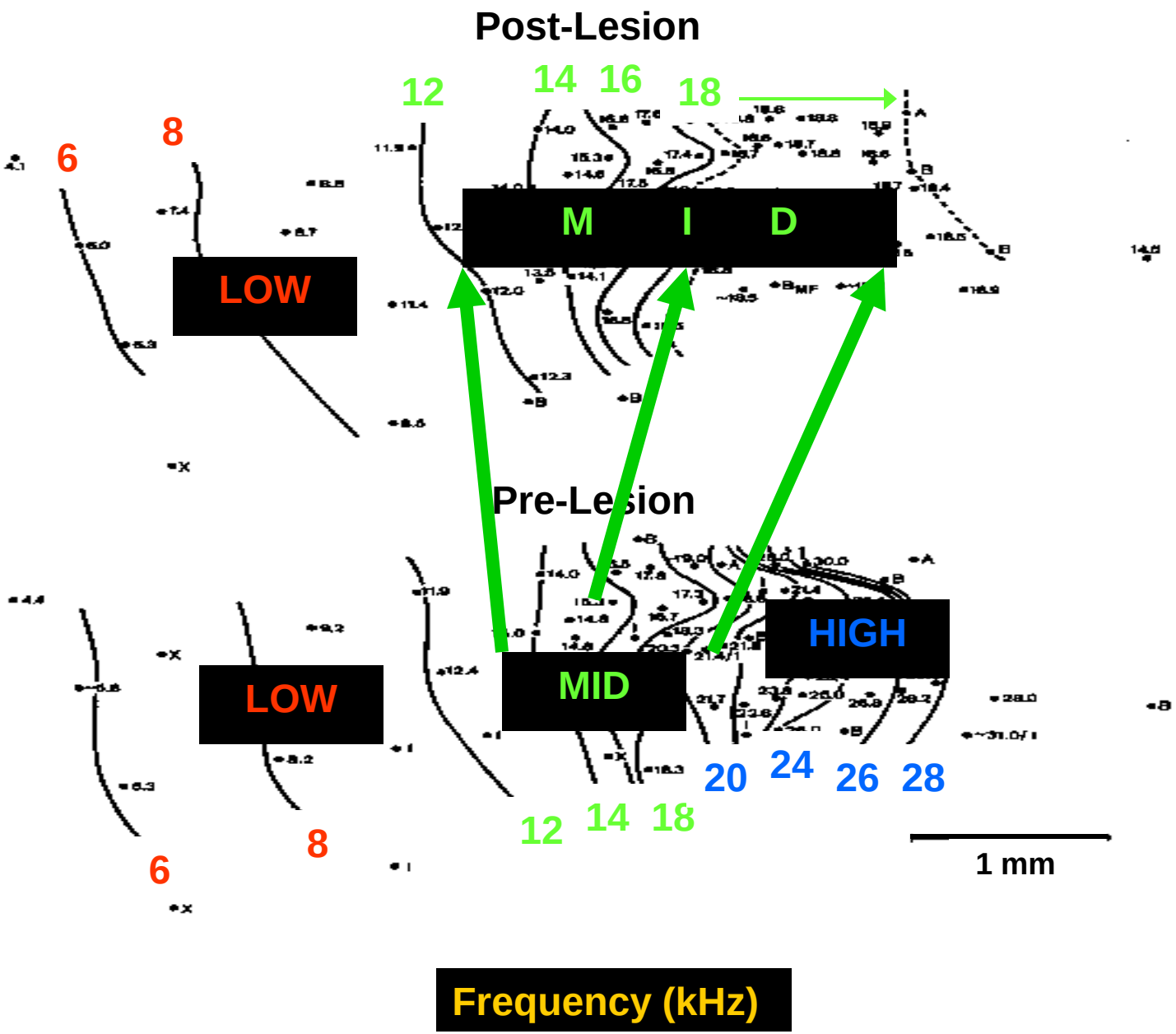
Restricted cochlear lesions in adult animals produce a dynamic reorganization of the representation, or map, of the cochlea in the primary auditory cortex

AUDITORY CORTEX



http://www.sickkids.on.ca/otolaryngology/EVOKD-PT.asp

Cat Auditory Cortex



Irvine and Rajan (1995)

Research supporting central location

- Heller and Bergman, 1953
- Andersson, et al 1997; Baguley et al, 1992 (translabyrinthine surgery)…
- Lockwood and Salvi, 1998; Burkard, 2001(PET)
- Kaltenbach, 2000 (cochlear nucleus hyperactivity despite cochlear destruction)
- Zacharek, 2002 (sustained DCN acitivity following noise damaged cochlear ablation)

Some central nervous system pathologies associated with tinnitus

- vascular
- dementia
- cardiovascular disease/hypertension
- blood disease /anemia
- multiple sclerosis

Other factors associated with tinnitus

- temporomandibular disorders
- cervical misalignment
- renal disease / Alport’s / kidney transplants
- lyme disease
- zinc deficiency
- poor circulation
- hypothyroid/ hyperthyroid disorders

Psychological contributions

- Cognition: maladaptive cognitive strategies “The reaction is the key to whether a person with tinnitus becomes a tinnitus patient” (Sweetow, 1986; 2000)
- Habituation: intolerance results from individual’s failure to adapt (Hallam et al, 1984; 2006)
- Attention: failure to shift attention away from tinnitus (Hallam and McKenna, 2006)
- Enhanced tinnitus perception is learned response resulting from “negative” emotional reinforcement involving limbic system and autonomic activation (Hallum;Jastreboff and Hazell, 1993; McKenna, 2004)…..de-emphasizes connection with peripheral hearing loss

Tinnitus exacerbating factors

- caffeine
- alcohol
- nicotine
- sodium
- high cholesterol, hyperlipidemia, hyper and hypothryroidism
- **noise exposure**
- **stress**

Influence of noise and stress on probability of having tinnitus

- N = 12, 166 ; N with tinnitus) = 2,024 (16%)
- Each year of age increased the odds ratio of tinnitus by about 3%.
- Men generally showed a higher risk for tinnitus compared with women.
- Exposure to noise and stress were important for the probability and level of discomfort from tinnitus. However, for the transition from mild to severe tinnitus, <u>stress turned out to be more important</u>.
- Reduction of likelihood of tinnitus if noise is removed = 27%, if stress is removed =19%), if both removed = 42%.
- Conclusions: Stress management strategies should be included in hearing conservation programs, especially for individuals with mild tinnitus who report a high stress load.
  - Baigi, et al; Ear and Hearing 2011. 32, 6:787-789

Modern theories of tinnitus origin

- Disruption of auditory input (e.g., hearing loss) and resultant increased gain (activity) within the central auditory system (including the dorsal cochlear nucleus and auditory cortex)
- Decrease in inhibitory (efferent) function
- Over-representation of edge-frequencies (cortical plasticity)
- Dysfunctional gating in basal ganglia
- Other somatosensory influences (cervical disturbances, etc.)
- Increased attention related to reticular activating system involvement
- Association with fear and threat (limbic system)

Summary of Recent Basal Ganglia Theory

- Phantom percepts are represented in the central auditory system.
- Permission to gate phantom percepts for conscious awareness is controlled by the dorsal striatum.
- Action to attend, reject or accept phantom percepts, and form perceptual habits is decided by the ventral striatum.
- Determination of tinnitus distress severity is mediated through the limbic and paralimbic system-nucleus accumbens-ventral striatum loop.

Another “gatekeeping” theory

- The linked network of brain structures involved in emotion, behavior, and long-term memory—acts as a gatekeeper to keep the tinnitus signal from reaching the auditory cortex.
- Sensory information enters both the auditory and the limbic systems through the medial geniculate nucleus (MGN)
- Before the signal is processed, it travels through the thalamic reticular nucleus (TRN), which evaluates whether or not it should be passed on.
- **There is a significant loss of volume in the medial prefrontal cortex (mPFC) in people with tinnitus. This structure projects into and activates the TRN. If the volume loss creates a loss of neurons, the mPFC and TRN will malfunction.**

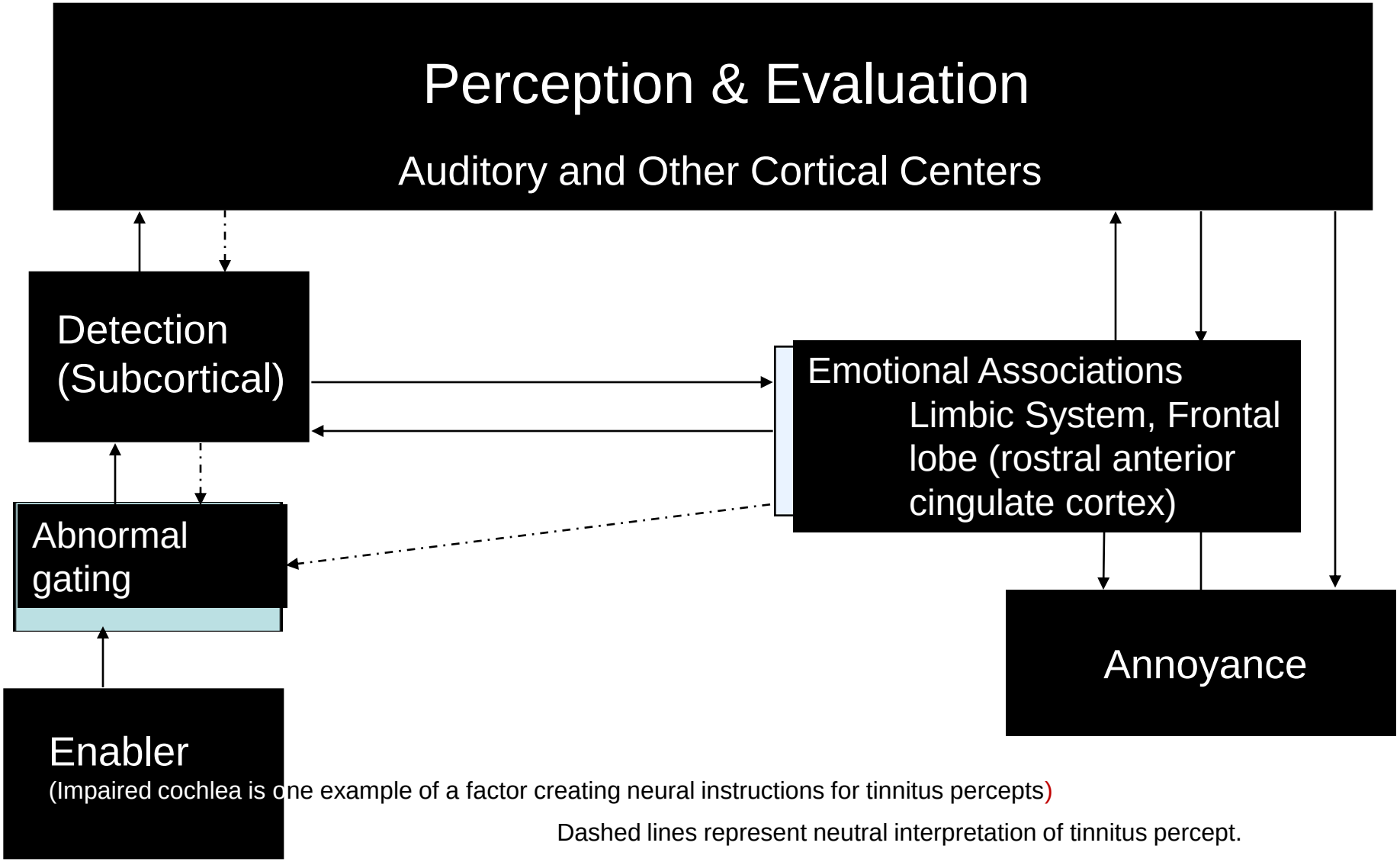
Rauschecker, et al; Neuron, 2010

Tinnitus is associated with abnormal EEG-patterns, showing enhanced activity in the δ band and reduced activity in the α band (Weisz, Moratti, Meinzer, Dohrmann, & Elbert, 2005)

MEG data indicating that subjects with tinnitus

< 4 years have gamma network predominantly in the temporal cortex; but subjects with tinnitus of a longer duration show a widely distributed gamma network into the frontal and parietal regions (deRidder, 2011)

Revised habituation model



Dashed lines represent neutral interpretation of tinnitus percept.

Questions requiring more clarification

- Why don’t all hearing impaired individuals have tinnitus; for example, why do only 20-40% of persons with noise induced hearing loss have it; is it blocked sub-cortically?
- Based on discordant damage theory, shouldn’t the largest group of tinnitus patients have a ~50 dB loss?
- Do the 30% of tinnitus patients who have normal hearing, all have undocumented OHC damage? Why don’t OAEs show this?
- Why can’t we accurately predict laterality percept?
- Why is tinnitus merely a minor distraction for 80%?
- Why can’t we “counsel away” abnormal autonomic nervous system activation for more patients?
- Why do so many patients report intermittent or fluctuating tinnitus?
- Why do some people have “reactive” tinnitus?

Three aspects of tinnitus that should be addressed

- auditory
- attentional
- emotional

Tinnitus Questionnaire

- Otologic
- Medical
- Audiologic
- Diet
- Exercise
- Emotional Pattern
- Sleep
- Previous Treatments

Assessment Inventories

- Tinnitus Handicap Inventory - Newman et al
- Tinnitus Handicap Questionnaire - Kuk, et al
- Tinnitus Effects Questionnaire - Hallam, et al
- Tinnitus Reaction Questionnaire - Wilson, et al
- Tinnitus Cognitive Questionnaire (TCQ) - Wilson and Henry
- Tinnitus Functional Index – Miekle, et al

Tinnitus Handicap Inventory (THI) -

Newman, et al, 1998

- 25 items (yes - 4; sometimes - 2; no - 0)
  - functional
  - emotional
  - catastrophic
- THI = 0-16; No handicap
- THI = 18-36; Mild handicap
- THI = 38-56; Moderate handicap
- THI = 58-100; Severe handicap

- 20 point difference = significant change

Tinnitus Functional Index (TFI)

- 25 items designed to address 8 important domains of negative tinnitus impact:
  - intrusiveness, reduced sense of control, cognitive interference, sleep disturbance, auditory difficulties attributed to tinnitus, interference with relaxation, quality of life reduced and emotional distress.
- Each of the 8 subscales consist of 3 items except for the quality of life subscale which consist of 4 items.
- All items are scored using a percentage score or a 0-10 scale giving a maximum possible score of 250 (which is then divided by 25 and multiplied by 10 for a max score of 100).
- The TFI is useful for scaling the severity and negative impact of tinnitus, for use in intake assessment and for measuring treatment-related changes in tinnitus.

TINNITUS FUNCTIONAL INDEX

Today's Date _____ Month / Day / Year Your Name _____ Please Print

Please read each question below carefully. To answer a question, select *ONE* of the numbers that is listed for that question, and draw a *CIRCLE* around it like this: (10%) or (1).

P	Over the PAST WEEK...

1. What percentage of your time awake were you consciously **AWARE OF** your tinnitus?

Never aware ► 0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100% ◄ *Always aware*

2. How **STRONG** or **LOUD** was your tinnitus?

Not at all strong or loud ► 0 1 2 3 4 5 6 7 8 9 10 ◄ *Extremely strong or loud*

3. What percentage of your time awake were you **ANNOYED** by your tinnitus?

None of the time ► 0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100% ◄ *All of the time*

SC	Over the PAST WEEK...

4. Did you feel **IN CONTROL** in regard to your tinnitus?

Very much in control ► 0 1 2 3 4 5 6 7 8 9 10 ◄ *Never in control*

5. How easy was it for you to **COPE** with your tinnitus?

Very easy to cope ► 0 1 2 3 4 5 6 7 8 9 10 ◄ *Impossible to cope*

6. How easy was it for you to **IGNORE** your tinnitus?

Very easy to ignore ► 0 1 2 3 4 5 6 7 8 9 10 ◄ *Impossible to ignore*

C	Over the PAST WEEK how much did your tinnitus interfere with...

7. Your ability to **CONCENTRATE**?

Did not interfere ► 0 1 2 3 4 5 6 7 8 9 10 ◄ *Completely interfered*

8. Your ability to **THINK CLEARLY?**

Did not interfere ► 0 1 2 3 4 5 6 7 8 9 10 ◄ *Completely interfered*

9. Your ability to **FOCUS ATTENTION** on other things besides your tinnitus?

Did not interfere ► 0 1 2 3 4 5 6 7 8 9 10 ◄ *Completely interfered*

SL	Over the PAST WEEK...

10. How often did your tinnitus make it difficult to **FALL ASLEEP** or **STAY ASLEEP**?

Never had difficulty ► 0 1 2 3 4 5 6 7 8 9 10 ◄ *Always had difficulty*

11. How often did your tinnitus cause you difficulty in getting **AS MUCH SLEEP** as you needed?

Never had difficulty ► 0 1 2 3 4 5 6 7 8 9 10 ◄ *Always had difficulty*

12. How much of the time did your tinnitus keep you from **SLEEPING** as **DEEPLY** or as **PEACEFULLY** as you would have liked?

None of the time ► 0 1 2 3 4 5 6 7 8 9 10 ◄ *All of the time*

Please read each question below carefully. To answer a question, select *ONE* of the numbers that is listed for that question, and draw a *CIRCLE* around it like this: (10%) or (1).

A	**Over the PAST WEEK, how much has your tinnitus interfered with...**	*Did not interfere*										*Completely interfered*
	13. Your ability to **HEAR CLEARLY**?	0	1	2	3	4	5	6	7	8	9	10
	14. Your ability to **UNDERSTAND PEOPLE** who are talking?	0	1	2	3	4	5	6	7	8	9	10
	15. Your ability to **FOLLOW CONVERSATIONS** in a group or at meetings?	0	1	2	3	4	5	6	7	8	9	10

R	**Over the PAST WEEK, how much has your tinnitus interfered with...**	*Did not interfere*										*Completely interfered*
	16. Your **QUIET RESTING ACTIVITIES**?	0	1	2	3	4	5	6	7	8	9	10
	17. Your ability to **RELAX**?	0	1	2	3	4	5	6	7	8	9	10
	18. Your ability to enjoy **"PEACE AND QUIET?"**	0	1	2	3	4	5	6	7	8	9	10

Q	**Over the PAST WEEK, how much has your tinnitus interfered with...**	*Did not interfere*										*Completely interfered*
	19. Your enjoyment of **SOCIAL ACTIVITIES**?	0	1	2	3	4	5	6	7	8	9	10
	20. Your **ENJOYMENT OF LIFE**?	0	1	2	3	4	5	6	7	8	9	10
	21. Your **RELATIONSHIPS** with family, friends and other people?	0	1	2	3	4	5	6	7	8	9	10

22. How often did your tinnitus cause you to have difficulty performing your **WORK OR OTHER TASKS**, such as home maintenance, school work, or caring for children or others?

Never had difficulty ► 0 1 2 3 4 5 6 7 8 9 10 ◄ *Always had difficulty*

E	**Over the PAST WEEK....**

23. How **ANXIOUS** or **WORRIED** has your tinnitus made you feel?

Not at all anxious or worried ► 0 1 2 3 4 5 6 7 8 9 10 ◄ *Extremely anxious or worried*

24. How **BOTHERED or UPSET** have you been because of your tinnitus?

Not at all bothered or upset ► 0 1 2 3 4 5 6 7 8 9 10 ◄ *Extremely bothered or upset*

25. How **DEPRESSED** were you because of your tinnitus?

Not at all depressed ► 0 1 2 3 4 5 6 7 8 9 10 ◄ *Extremely depressed*

Defining the tinnitus problem

- time
- behaviors affected
- attitudes and thoughts
- what affects the tinnitus?

Tinnitus triggers

- Physical (viral, medication, hearing loss (imbalance between excitatory and inhibitory neurons), neurotoxicity from noise, somatic influences)
- psychological
- retirement syndrome
- stress related

Give the patient a chance to vent

But only for a while!!!!!!!

….And less time each visit

Potentially useful diagnostic procedures

- audiogram
- assessment (severity) scales
- psychological profiles
- tinnitus matching (do loudness match first)
- loudness discomfort levels
- minimum masking levels
- OAEs
- ultra high frequency testing
- immittance/reflexes/decay

Tinnitus matching

- usually less than 6 dB SL
- may be more appropriate to convert to sones

- 82% match above 3KHz
- 14% match above 9KHz

- **0-3 dB = easy to mask**
- **4-10 dB = masking may be intrusive**
- **> 10 dB = difficult to mask**

Tinnitus Management Team

- Audiologist
- Otolaryngologist
- Psychologist
- Psychiatrist
- Neurologist
- Pharmacologist
- Nutritionist
- TMJ Specialist
- Physical Therapist
- Biofeedback Specialist

Tinnitus patient management procedures

- Medication
- Perfusions
- Surgery
- Stress Management
- Biofeedback (mirrored?)
- Nutritional Counseling
- rTMS

Alternative Approaches

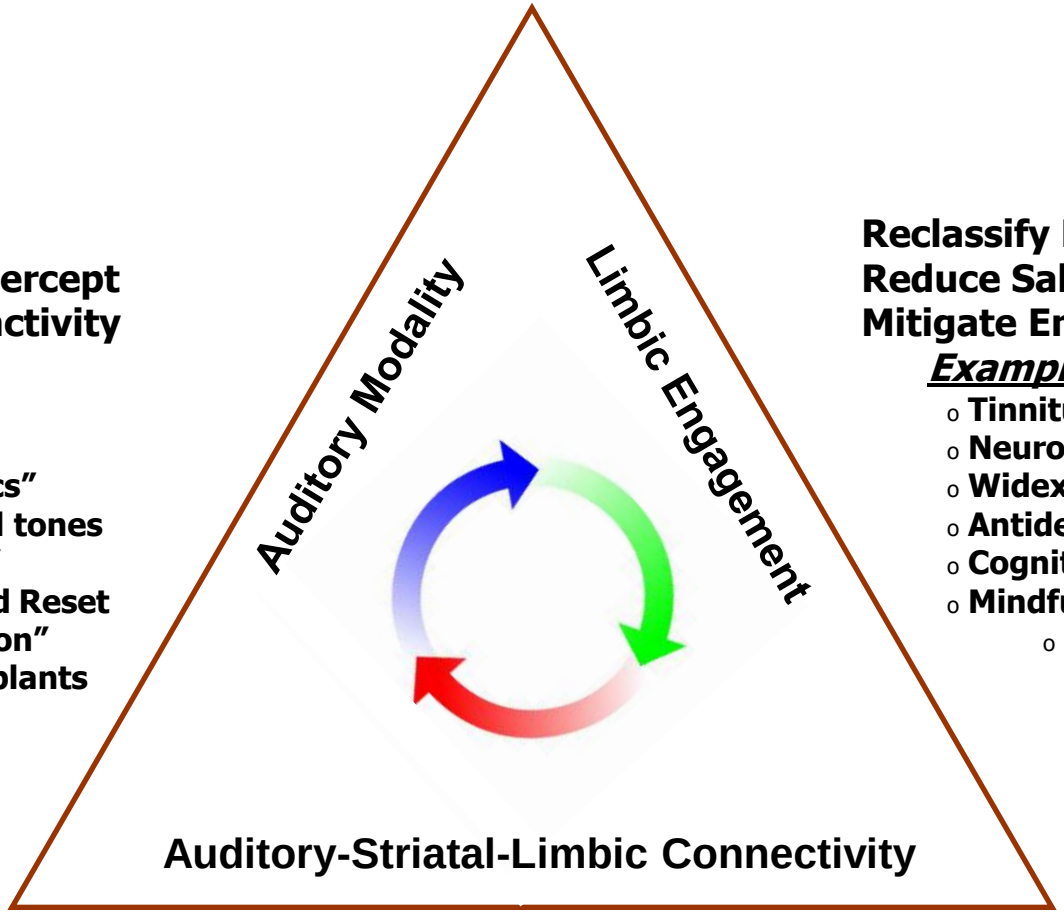
- ginkgo biloba
- fish oil omega fatty acids
- acupuncture
- hyperbaric treatment
- magnetotherapy
- lasertherapy
- homeopathy
- naturopathy (like cures like)
- osteopathy
- DMSO
- anticholinergic drugs (glutamic acid)
- vaso-active drugs and carbogen inhalation
- baclofen injections
- electrostimulation

Tinnitus Therapies

Reduce Contrast
Mask Phantom Percept
Suppress Hyperactivity

Examples

- **Maskers**
- **Hearing Aids**
- **"Neuromonics"**
- **"Zen" Fractal tones**
- **"Sound Cure"**
- **"Co-ordinated Reset Stimulation"**
- **Cochlear Implants**



Reclassify Phantom Percept
Reduce Saliency
Mitigate Emotional Distress

Examples

- **Tinnitus Retraining**
- **Neuromonics**
- **Widex Zen Therapy**
- **Antidepressants**
- **Cognitive-behavioral therapy**
- **Mindfulness Based Stress Reduction**

Disrupt Information Conveyance
Avoid Interference with Audition

Examples

- **Striatal Neuromodulation**
- **Vagal nerve stimulation**
- **Cortical Stimulation (rTMS)**

Reversing pathological neural activity using targeted plasticity

- Several studies have reported that the severity of chronic pain and tinnitus is correlated with the degree of map reorganization in somatosensory and auditory cortex, respectively.

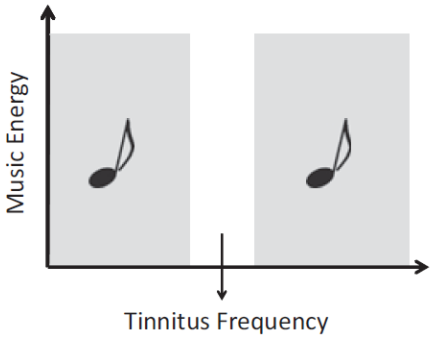
- Repeatedly pairing tones with brief pulses of vagus nerve stimulation completely eliminated the physiological and behavioral correlates of tinnitus in noise-exposed rats. Improvements persisted for weeks after the end of therapy.

- Pairing release of neuromodulators (such as acetylcholine and norepinephrine) with tones that are distant from the tinnitus frequency reverse the frequency map distortion and the pathological activity patterns associated with tinnitus.

Engineer ND, Riley JR, Seale JD, Vrana WA, Shetake JA, Sudanagunta SP, Borland MS, Kilgard MP. Nature. 2011 Feb 3;470(7332):101-4. Epub 2011 Jan 12.

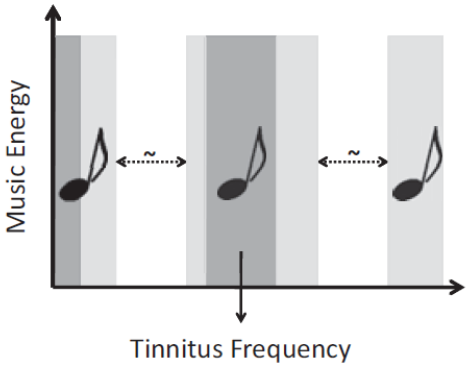
Target processing

1 octave notch around Tinnitus frequency.
Same processing on both ears



Placebo processing

1 octave notch elsewhere
No notch at tinnitus frequency



Okamoto H et al. PNAS 2010;107:1207-1210

“Reasonable” tinnitus patient management procedures

- Counseling
  - Reassurance (including placebo)
  - Education
  - Cognitive-Behavioral Therapy

- Sound enrichment
  - Masking or mixing
  - Amplification

- Combination
  - Desensitization / Habituation (TRT)
  - Neuromonics acoustic desensitization protocol
  - Fractal tones

Big difference between “no cure” and “no help”

Objectives

- initiate and facilitate tinnitus habituation
- remove perception from patient’s consciousness

Tinnitus Retraining Therapy

- directive counseling
- auditory (low level noise) therapy

Habituation

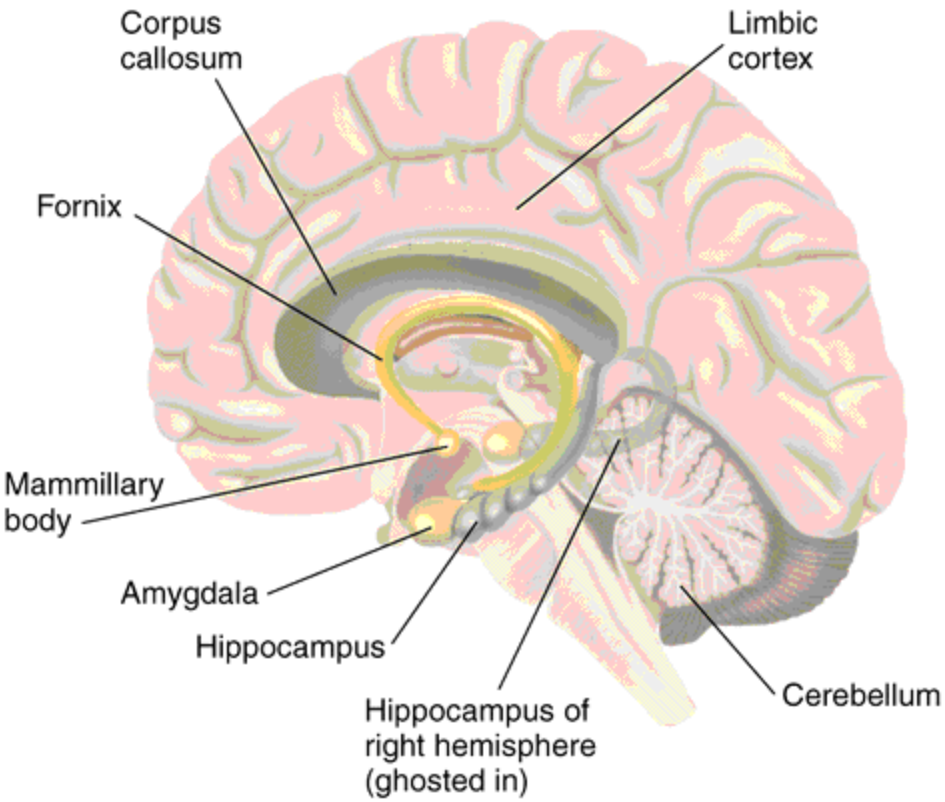
- **the process of "ignoring" (or becoming accustomed to) a stimulus without exerting any conscious effort.**
- **from a psychological perspective, it is defined as the adaptation, or decline of a conditioned response, to a stimulus following repeated exposure to that stimulus.**

Basic assumptions

- The brain can sort out meaningful stimuli from those which are not
- Attention is directed toward "salient" or information-bearing stimuli

The Limbic System

▶ **Major Components of the Limbic System**



Examples of normal habituation

- Ring on your finger
- Clothing
- Refrigerator humming
- Rear end (buttocks) in your chair

How sensory systems suppress stimuli

- Somatosensory
- Auditory

- How brain (limbic system) determines importance of external stimuli
  - Thunder versus soft, unexpected sound

Sound enrichment for desensitization / habituation

- low level noise interferes with pattern recognition by increasing neuronal activity
- this makes tinnitus more difficult to detect
- gradually increasing input could decrease gain over an extended time
- Some (Jastreboff) suggests 24 hours a day, 7 days a week
- Others (Neuromonics) claim 2-4 hours adequate

Current sound treatments

- Noise generators
- Maskers
- Music
- Hearing aids (effective in over 60% of cases)
- Combination instruments
- Home based
- CDs (e.g. Personal Growth Tinnitus Relief, Petroff DTM)

Terminology

- Masking
- Partial Masking
- Mixing
- Music (unfiltered, filtered, dynamically altered, fractal tones)

The three enemies of tinnitus

- Excessive noise
- Silence
- Fear

Essential attributes for inducing tinnitus sensitization (opposite of habituation)

- Tinnitus is considered noxious
- Tinnitus may induce fear
- Tinnitus progression is unpredictable
- Patient feels helpless (loss of control) and can’t cope
- Patient is anxious

- If present, engagement; if not present, disengagement

Definition of Cognitive-Behavior Therapy

The therapeutic effort to modify maladaptive thoughts and behaviors by applying systematic, measurable implementation of strategies designed to alter unproductive actions

Similarities of tinnitus with pain

- subjective
- invisible
- affected by extraneous events

Differences between TRT and Cognitive Therapies

- CT is intensive and collaborative designed for 8-12 weekly sessions and direct testing of hypotheses
- Tinnitus remains, but coping skills improve
- TRT uses directive counseling with 6 – 8 sessions over 18 month period

Why hearing aids may help tinnitus patients

- Greater neural activity allows brain to correct for abnormal reduced inhibition
- Enriched sound environment may prevent maladaptive cortical reorganization
- Alter production peripherally and/or centrally
- Reduce contrast to quiet
- Partially mask tinnitus
- Fatigue and stress is reduced allowing more resources to be allocated to tinnitus fight
- All of the above may facilitate habituation

and

- The majority of tinnitus sufferers have at least some degree of hearing loss

A perfect example of an auditory disorder closely related to stress:

Tinnitus

Influence of noise and stress on probability of having tinnitus

- N = 12, 166 ; N with tinnitus) = 2,024 (16%)
- Each year of age increased the odds ratio of tinnitus by about 3%.
- Men generally showed a higher risk for tinnitus compared with women.
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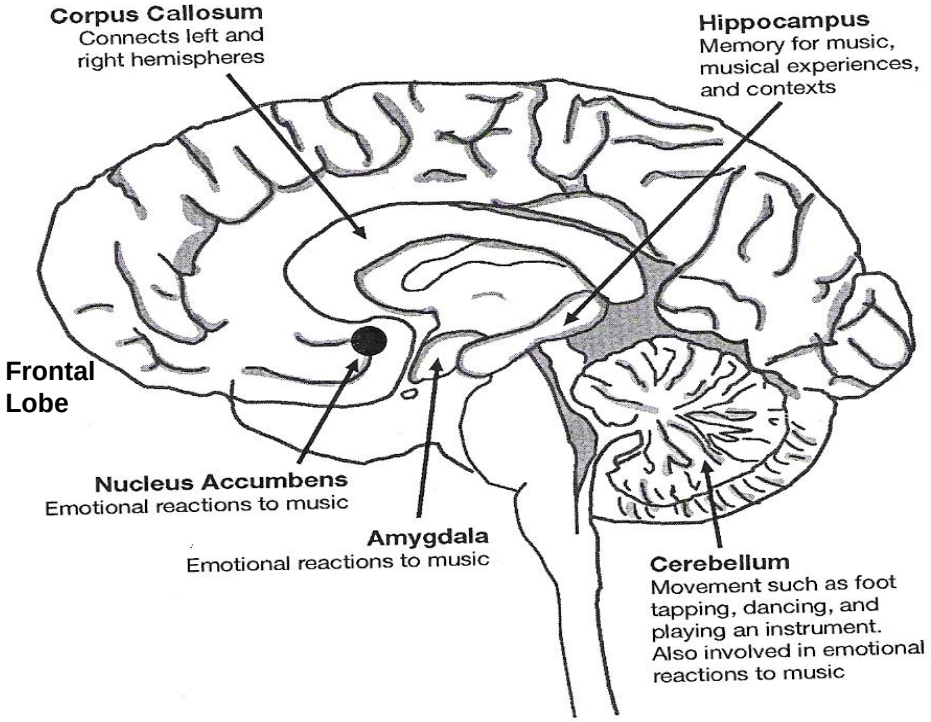
- Conclusions: Stress management strategies should be included in hearing conservation programs, especially for individuals with mild tinnitus who report a high stress load.
  - Baigi, et al; Ear and Hearing 2011. 32, 6:787-789

- Music has been shown to activate the limbic system and other brain structures (including the frontal lobe and cerebellum) and has been shown to produce physiologic changes associated with relaxation and stress relief.

Where is music processed?



How is music used?

- Home
- Work
- Celebrations
- Advertising
- Romance
- Movies
- Athletic locker rooms
- Shopping malls
- Hospitals
- Therapies
- Relaxation

Modes of Delivery

- Home stereo
- iPod
- Neuromonics
- Hearing aids

“Rules” of music and emotions

- Slow onset, long, quiet sounds – calming
- Music with a slow tempo (i.e. near natural heart rate (60 – 72 beats per minute) - relaxing
- Repetition - emotionally satisfying

Neuromonics

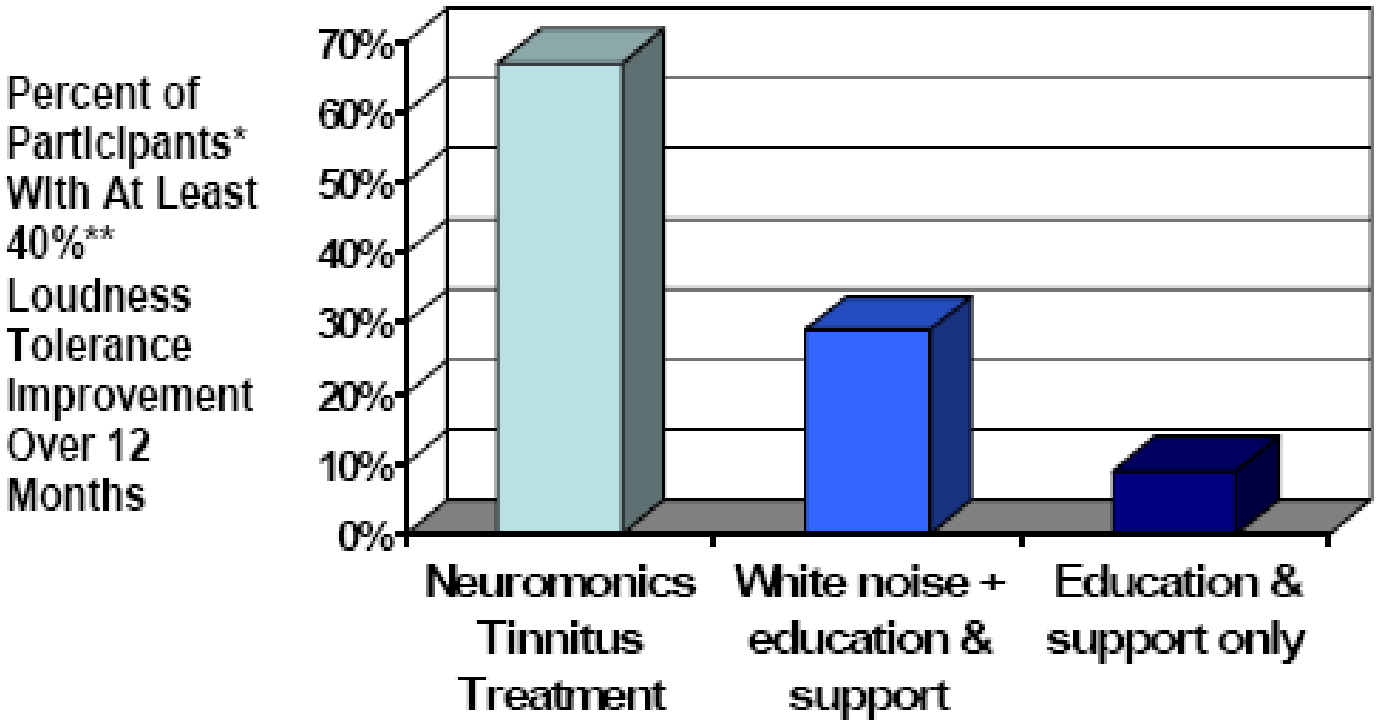
- a bit of cognitive therapy
- A bit of TRT
- Music therapy (for affect and relaxation) and wide band stimulation using a iPod-like processor with Bang and Olufsen earphones
- Rhythm
- Hearing instrument algorithm (equal sensation level) for hearing loss compensation
- 2 stage program
- expensive

Neuromonics

Why can’t we just use an iPod?

- Frequency shaping
- Loudness balance
- Compression

Loudness Tolerance Improvements (%)



* Participants with pre-treatment TRQ>16
** Measured with Visual Analogue Scale

Categorical Expectations

- We don’t like the unexpected
- But certain rules have to be followed
- Active listening may arouse, passive listening may soothe
- For tinnitus patients, active listening may draw attention to the tinnitus, passive listening may facilitate habituation

Selecting the right sounds

Sounds (including music) affects people in different ways, due to inherent, learned (and cultural) preferences

Thus it is appropriate to use relaxing background sounds (that activate the parasympathetic division of the autonomic nervous system) and minimize exposure to alerting, negative, or annoying sounds (that activate the sympathetic division)

Cultural preferences (Bolero)

Earworms?

Considerations

- For relaxation
  - Music with a rhythm slower than your natural heart rate (72 beats per minute) is useful to many people
  - Lower pitches are more calming than higher pitches, generally speaking
- For focus and concentration
  - No distraction
  - Personal preference
  - Few emotional tags
- For tinnitus
  - Active listening (distraction)
  - Masking (covering up)
  - Passive listening (habituation, desensitization)

Definition of fractal

- "a rough or fragmented geometric shape that can be split into parts, each of which is (at least approximately) a reduced-size copy of the whole”
- Properties include self-similarity and a simple and recursive definition

Fractals in nature

- Examples include:
  - clouds, rivers, fault lines, mountain ranges, craters, snow flakes, crystals, lightning, cauliflower, broccoli, blood vessels, ocean waves and DNA

- Fractal tones create a melodic chain of tones that repeat enough to sound familiar and follow appropriate rules, but vary enough to not be predictable.

- Fractal technology ensures that no sudden changes appear in tonality or tempo

Conclusions of Kochkin, et al; 2011

- Of the nine tinnitus treatment methods assessed, none were tried by more than 7% of the subjects.
- **Treatment methods rated with substantial tinnitus amelioration were hearing aids (34%) and music (30%).**
- Subjects who had their hearing aids fit by professionals using comprehensive hearing aid fitting protocols are nearly twice as likely to experience tinnitus relief than respondents fit by hearing care professionals using minimalist hearing aid fitting protocols.
- **This study confirms that the provision of hearing aids offers substantial benefit to a significant number of people suffering from tinnitus. This fact should be more widely acknowledged in both the audiological and medical communities.**

– Kochkin S., Tyler R., Born J. MarkeTrak VIII: The Prevalence of Tinnitus in the United States and the Self-reported Efficacy of Various Treatments *Hearing Review*. 2011;18(12):10-27.

Disclosure

Zen

- An optional listening program in certain (Passion, Mind, and Clear) Widex hearing aids that plays adjustable, continuous, chime-like tone complexes using fractal algorithms.
- The chimes are generated based on an understanding of the properties of music that would be most relaxing (Robb et al., 1995):
    - Ability to self select music.
    - Tempo near or below resting heart rate (60-72 bpm).
    - Fluid melodic movement.
    - Variety of pitches
    - No rapid amplitude changes
    - Element of uncertainty (Beauvous 2007)
    - Passive listening

- Each Zen program can be individually adjusted to loudness, pitch and tempo preferences
- The fractal tones (or the noise) should be audible, but relatively soft
- It should never interfere with conversational speech
- The annoyance level of the tinnitus should just begin to decrease (i.e., tinnitus can still be audible)

	Default pitch				Tonality		Dynamic Range		Default tempo		
Fractal styles	Low	Medium low	Medium high	High & reverberant	Major	Minor	Restricted	Broad	Slow	Medium	Fast
Aqua	■				■		■		■		
Coral			■			■		■	■		
Lavender			■		■			■			■
Green				■	■		■			■	
Sand			■		■			■			■

Frequency response and amplitude settings are based on in-situ audiogram.

A filtered broad band noise can be used as a separate program or in combination with the fractal tones.

Signals are dichotic

Evidence of effectiveness

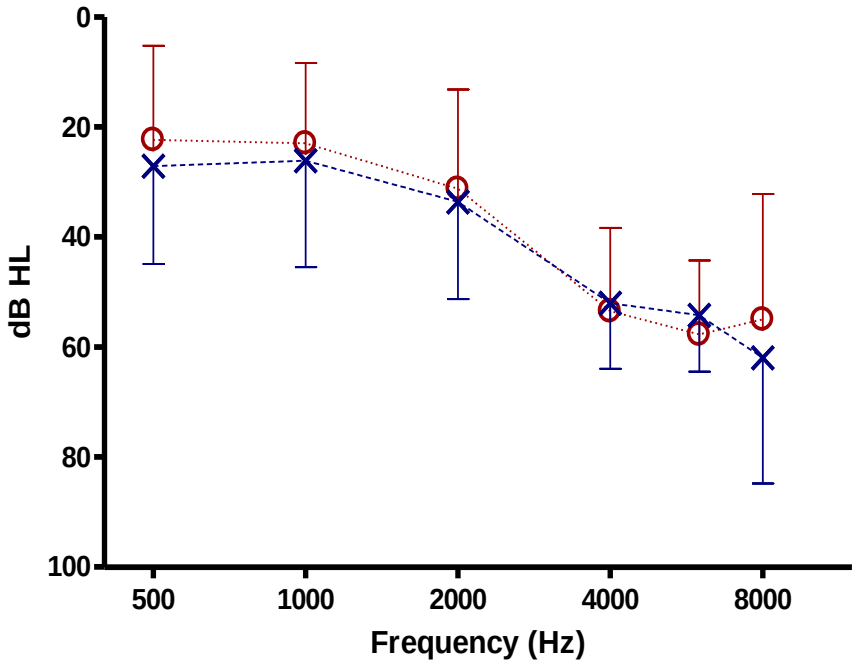
- Sweetow & Henderson-Sabes, The use of acoustic stimuli in tinnitus management. JAAA 21,7, 461-473, 2010
- Kuk F, Peeters H, Lau CL. The efficacy of fractal music employed in hearing aids for tinnitus management. *Hearing Review*. 2010;17(10):32-42.
- Herzfeld and Kuk, Hearing Review, 2011; 18,(11), 50-55.

•14 subjects with severe, uncompensated tinnitus, 6 non-tinnitus subjects. 2 subjects dropped out.

• All tinnitus subjects had been seen at UCSF for tinnitus treatment at least 3 mos. prior to the study – completed tinnitus counseling and other therapies but were still significantly bothered (average THI entering study = 58.7).

• All subjects had tinnitus for at least one year and had received no active treatments (including counseling) for at least three months prior to the start of the experiment.

• Battery of questionnaires = THI, TRQ, stress, annoyance, and relaxation measures.

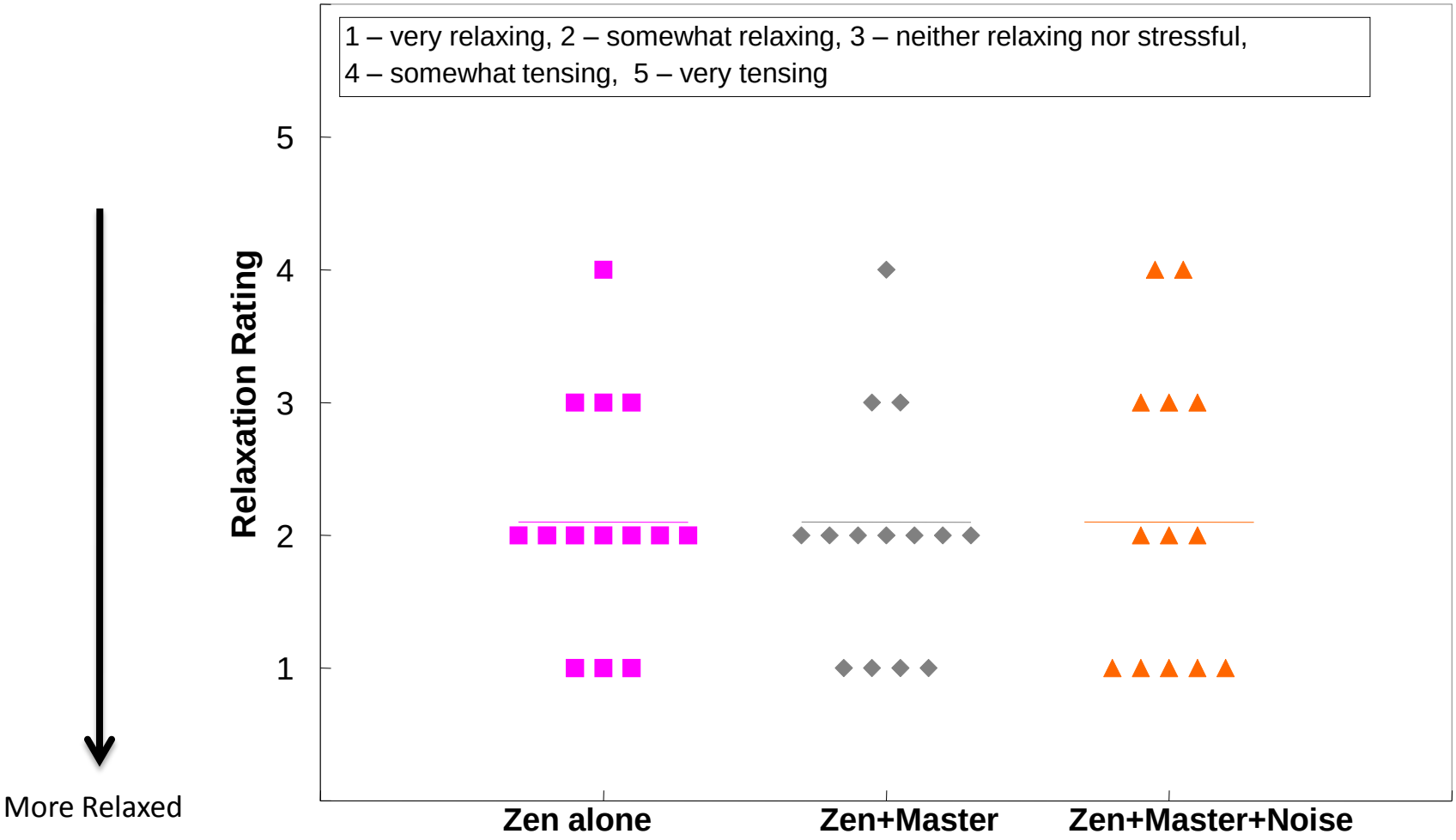


Study Questions

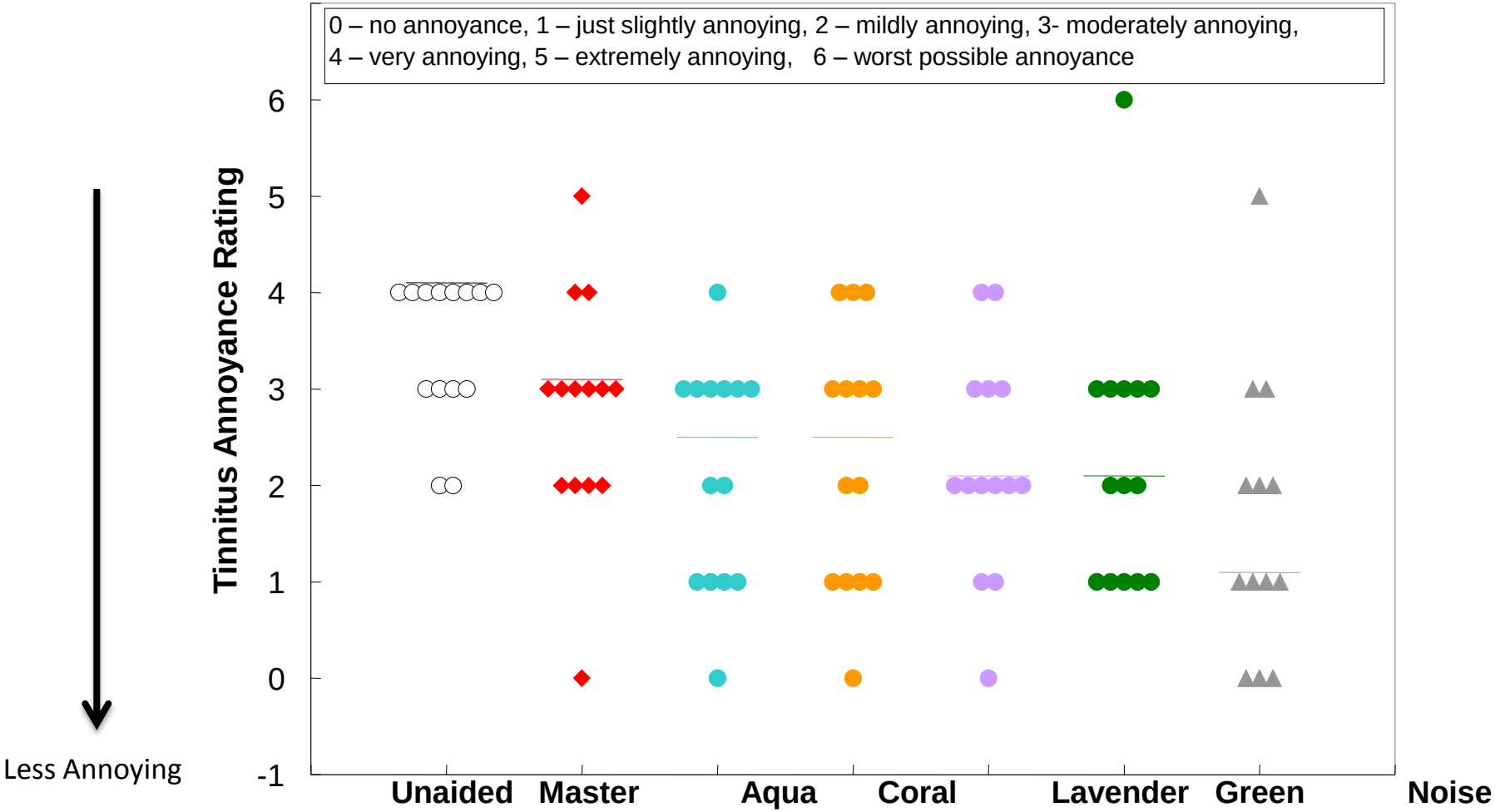
- Would fractal tones (and/or noise) delivered through hearing aids be:
  - Perceived as relaxing to tinnitus patients?
  - Reduce short term tinnitus annoyance in the lab?
  - Lower subjective tinnitus handicap and reaction scores in a 6 month field trial?

Relaxation ratings

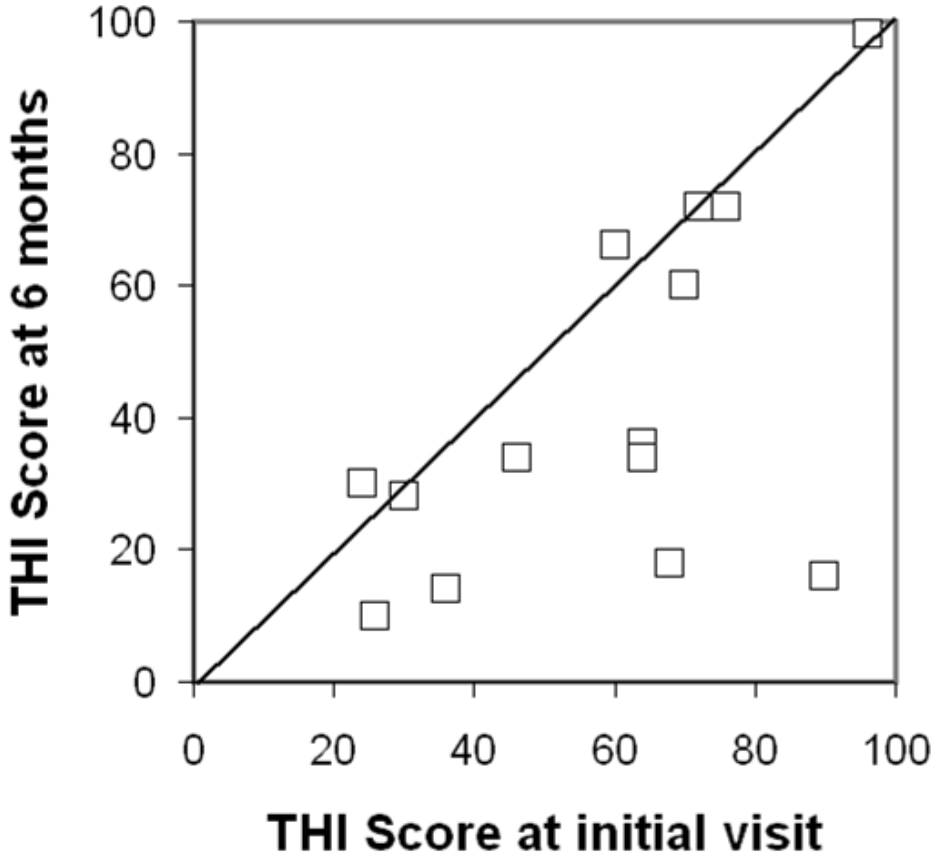
Relaxation ratings

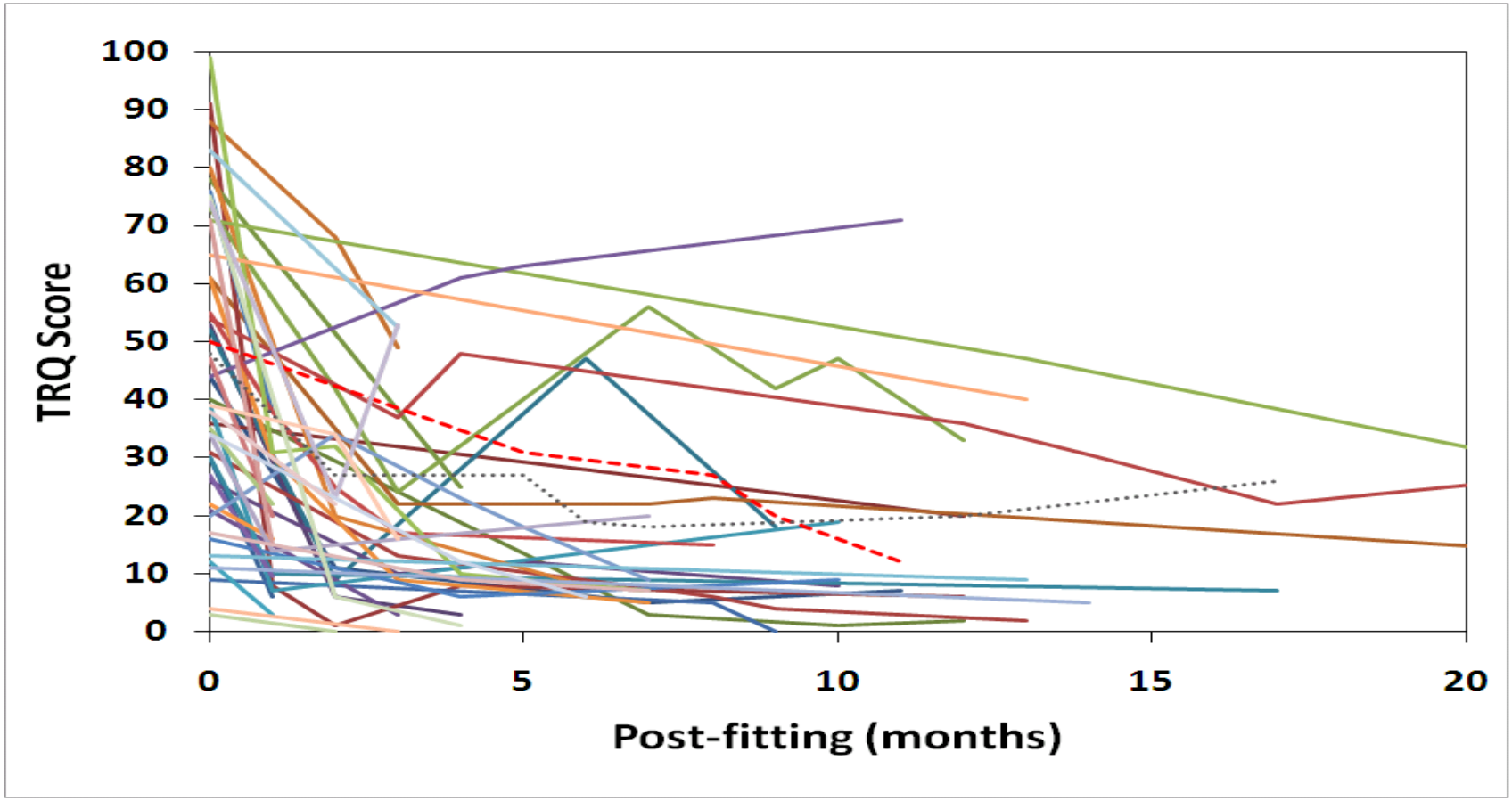


Tinnitus annoyance



Tinnitus Handicap Inventory





Herzfield and Kuk, 2011 (48 subjects receiving counseling plus

Summary of findings

- **Fractal tones were effective as a tool in promoting relaxation and reducing annoyance from tinnitus**
- **Both fractal tones and noise reduced tinnitus annoyance, but the fractal tones were preferred by subjects for longer term use**

Disclosure

Widex Zen Therapy

- ***an integrated program addressing all 3 major components of tinnitus distress; auditory, attention, and emotion.***
- ***many patients will be adequately served by counseling and sound therapy (hearing aids, fractal tones, or noise) alone***
- ***patients with nnegative reactions treated with a comprehensive program integrating cognitive-behavioral concepts and relaxation exercises along with the counseling and acoustic tools.***

The overall objective of Widex Zen Therapy…..

- *is to ensure that the tinnitus does not negatively impact the patient's quality of life!*
- *it is not designed to be a cure, or to suppress tinnitus (though it sometimes produces that effect).*

Components

1. ***Counseling*** **to educate the patient and assist the limbic system to alter its negative interpretation of the tinnitus via cognitive and behavioral intervention;**
2. ***Amplification (*****binaurally, when appropriate) to stimulate the ears and brain in order to discourage increased in central activity (overcompensation) and maladaptive cortical reorganization;**
3. ***Fractal tones*** **binaurally delivered to the patient in a discreet, inconspicuous and convenient manner, designed to both relax and provide acoustic stimulation;**
4. ***Relaxation strategy program*** **highlighted by behavioral exercises and sleep management strategies**

Counseling

- **Instructional**
- **Adjustment-based**

Counseling

- Instructional counseling helps educate the patient about aspects of the tinnitus itself. For example, it addresses……..
  - **the basic anatomy and physiology of the auditory (and central nervous) system,**
  - ***why* the tinnitus is present (particularly when it is a normal consequence of having a hearing loss),**
  - ***what* the logical course of the tinnitus might be,**
  - ***how* the limbic system affects the tinnitus perception and *how* the patient's reaction impacts the ability to cope with or habituate to the tinnitus.**

Adjustment based counseling…

- **Helps the patient recognize aspects about <u>how the tinnitus is affecting him or her</u>, and the cognitive and behavioral implications. It is designed to :**

- ***address*** **the emotional sequelae of tinnitus, including fear, anxiety and depression;**
- ***identify*** **and correct maladaptive thoughts and behaviors;**
- ***understand*** **the relationship between tinnitus, stress, fear, behaviors, thoughts, and quality of life.**

Cognitive behavioral intervention….

- is designed to identify the unwanted thoughts and behaviors hindering natural habituation, challenge their validity, and replace them with alternative and logical thoughts and behaviors.
- the objective is to remove inappropriate beliefs, anxieties and fears and to help the patient recognize that it is not the tinnitus itself that is producing these beliefs, it is the patient's reaction (and all reactions are subject to modification).

The basic processes in cognitive-behavioral intervention are :

- identify behaviors and thoughts affected by the tinnitus;
- list maladaptive strategies and cognitive distortions currently employed;
- challenge the patient to identify negative thoughts;
- identify alternate thoughts, behaviors, and strategies.

Awareness of tinnitus

↓

Cognitions (Automatic thoughts)

↓

Emotional state
(anger, depression, anxiety)

Emotional response is the result of the thoughts, not the event (awareness of the tinnitus) itself.

Challenging your thoughts

- What is the evidence that my thinking is true?
- What facts am I forgetting or ignoring?
- What are some alternative ways of thinking about this situation?
- What is the worst thing that could happen?
- How likely is it that the worst thing will happen?
- What is probably or most likely to happen?

Testing validity of NATs: common distortions in NATs

- All or nothing thinking
- Mental Filter
- Over generalisation
- Discounting the positive
- Jumping to conclusions
- Magnification
- Emotional reasoning
- Should statements
- Labelling
- Personalisation and blame

Some suggestions….

- Ask “what will make this encounter or therapy successful in your mind?”
- Remember that tinnitus patient management is a journey, remind patients of the ups and downs to be expected
- Tell patient that 1st thought upon recognizing tinnitus should be…..

Relaxation Exercises

- **Progressive Muscle Relaxation**
- **Deep breathing**
- **Guided imagery**

General suggestions for the relaxation exercises:

- **Perform the exercises while sitting in a comfortable chair in a quiet place with no distractions;**
- **Do the exercises while listening to the Zen tones, but if you are too distracted, turn off the tones;**
- **Remove your shoes and wear loose, comfortable clothing;**
- **Don't worry if you fall asleep;**
- **After finishing the exercise, close your eyes, relax for a few minutes, breathe deeply and rise up slowly.**

- **** NOTE: IF YOU HAVE MEDICAL CONDITIONS THAT MAY CAUSE YOU TO EXPERIENCE DISCOMFORT ASK YOUR PHYSICIAN BEFORE DOING THESE EXERCISES***

Progressive Muscle Relaxation (PMR):

- **PMR consists of alternating deliberately tensing muscle groups and then releasing the tension. Focus on the muscle group; for example, your right foot. Then inhale and simply tighten the muscles as hard as you can for about 8 seconds. Try to only tense the muscle group that you are concentrating on. Feel the tension. Then release by suddenly letting go. Let the tightness and pain flow out of the muscles while you slowly exhale. Focus on the difference between tension and relaxation.**

- **head (facial grimace)**
- **neck and shoulders**
- **chest**
- **stomach**
- **right upper arm**
- **right hand**
- **left upper arm**
- **left hand**
- **buttocks**
- **right upper leg**
- **right foot**
- **left upper leg**
- **left foot**
- **Relax for about 10-15 seconds and repeat the progression. The entire exercise should take about 5 minutes.**
- **DO NOT DO IF YOU HAVE HIGH BLOOD PRESSURE**

Deep breathing:

- **This is the simplest of the relaxation procedures. It simply requires you to follow the five suggestions above and to add deep, rhythmic breathing. Specifically, you should complete the following cycle 20 times:**
- **Exhale completely through your mouth;**
- **Inhale through your nose for four seconds (count "one thousand one, one thousand two, one thousand three, one thousand four");**
- **Hold your breath for seven seconds;**
- **Exhale through your mouth for eight seconds;**
- **Repeat the cycle 20 times**
- **The entire process will take approximately 7 minutes.**

Sleep suggestions (partial list)

- Maintain a standard bedtime for each day.
- Set your alarm for the same time each day.
- Walk or exercise for ten minutes a day, but not right before going to sleep.
- Set thermostat for a comfortable bedroom temperature.
- Use a fan or white noise machine to interfere with your tinnitus.
- Close your curtains/drapes and maintain a bedroom dark enough to sleep.
- Change the number of pillows you use. This also may impact somatic contributors to tinnitus.
- Don't watch TV, eat or read in bed. Use your bed for sleep and sex.
- Sleep on your back or on your side, try to avoid sleeping on your stomach.
- Take prescription medicines as directed, but only if required.

The manual…….

…..helps establish realistic, time-based expectations, provides methods of assessing progress, and creates a follow up schedule.

In addition, the information is demonstrated with the use of case examples.

Improvement

- Reduction in the number of episodes of awareness
- Increase in the intervals between episodes of awareness
- Increase in quality of life
- Not necessarily a reduction in perceived loudness
- Effect may NOT be immediate
- Establish realistic, time-based expectations

Counsel about the following:

- Tinnitus is not unique to that one patient.
- Tinnitus is not a sign of insanity or grave illness.
- Tinnitus may be a “normal” consequence of hearing loss
- Tinnitus probably is not a sign of impending deafness.
- There is no evidence to suggest the tinnitus will get worse.
- Tinnitus does not have to result in a lack of control.
- Patients who can sleep can best manage their tinnitus.

Counsel about the following:

- Tinnitus is real, and not imagined.
- Tinnitus may be permanent.
- Reaction to the tinnitus is the source of the problem.
- Reaction to the symptom is manageable and subject to modification.
- If significance and threat is removed, habituation or "gating" of attention can be achieved.
- Stay off the internet!

Conclusions

- Tinnitus patients with hearing loss may best be served by amplification that incorporates low compression thresholds, a broad frequency response, and flexible options for acoustic stimuli
- Tailor the therapy to the patient’s functional and financial needs
- Sound therapy without counseling is not likely to work

Thanks for listening

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