RECENT ADVANCEMENT OF AUDIOLOGICAL ASSESSMENT AND MANAGEMENT OF TINNITUS

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TINNITUS

- PERCEPTION OF SOUND OR BUZZING NOISE , IN ABSENCE OF XTERNAL NOISE
- ANNOYING AND BOTHERSOME
- PERIPHERAL & CENTRAL
- HYPERACUSIS AND PSEUDO-TINNITUS
- ACUTE AND CHRONIC
- SUBJECTIVE AND OBJECTIVE TINNITUS
- NORMAL AND ABNORMAL TINNITUS
- ABNORMAL : CAUSE SPECIFIC OR IDEOPATHIC

ASSESSMENT

- ASSESSMENT OF HEARING & NEURODIAGNOSTICS

SUBJECTIVE : PURE TONE AUDIOMETRY

(EXTENDED HIGH FREQUENCY AUDIOMETRY)

OBJECTIVE : IMPEDANCE AUDIOMETRY , ABR , OAE

- SPECIFIC ASSESSMENT :

P-300 , MMN

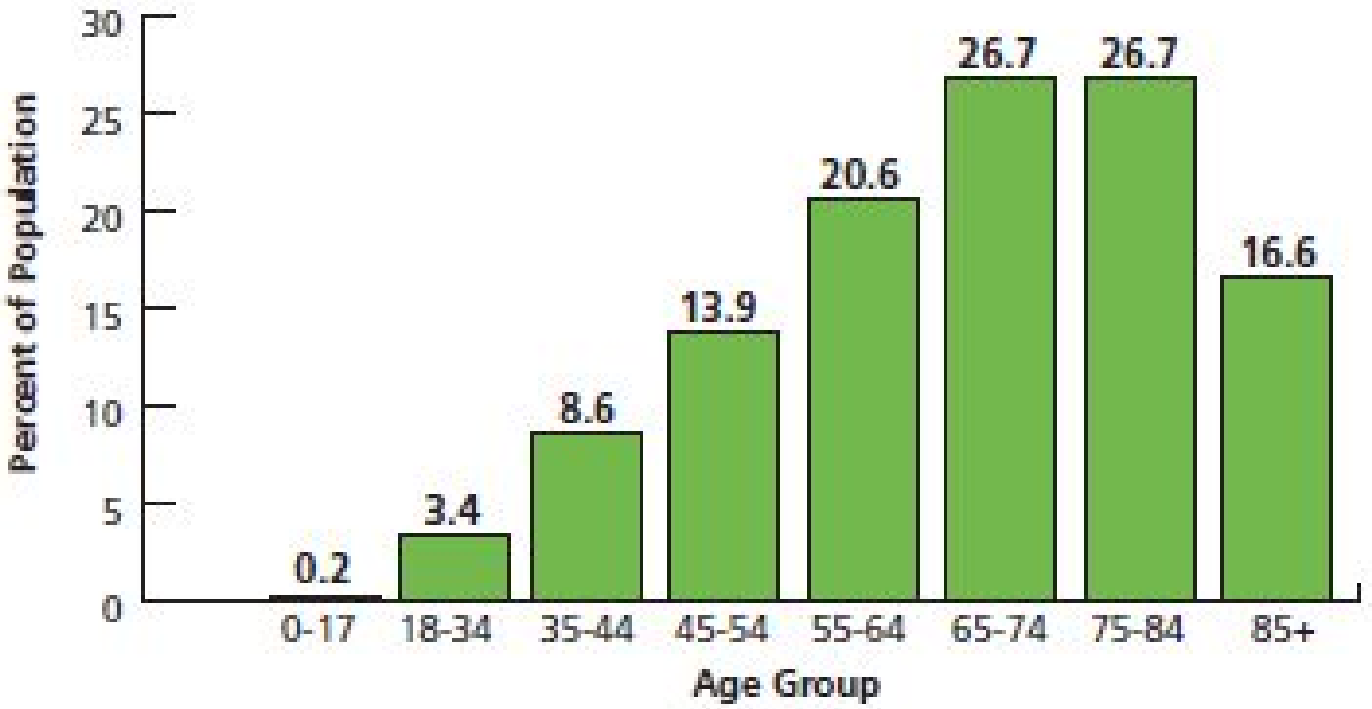
ASSESSMENT (CONTD.)

- PSYCHOACOUSTIC ASSESSMENT OF TINNITUS (PITCH AND LOUDNESS MATCHING , OCTAVE CONFUSION , RESIDUAL INHIBITION , LDL)
- TINNITUS HANDICAP INVENTORIES AND OTHER ASSOCIATED QUESTIONNAIRES LIKE : TCQ,TRQ
- TINNITUS MASKEBILITY DETECTION (FELDMAN MASKING CURVE)
- ANNOYANCE MEASURES
- PSYCHOLOGICAL MEASURES (STAI,BDI)

Tinnitus Facts

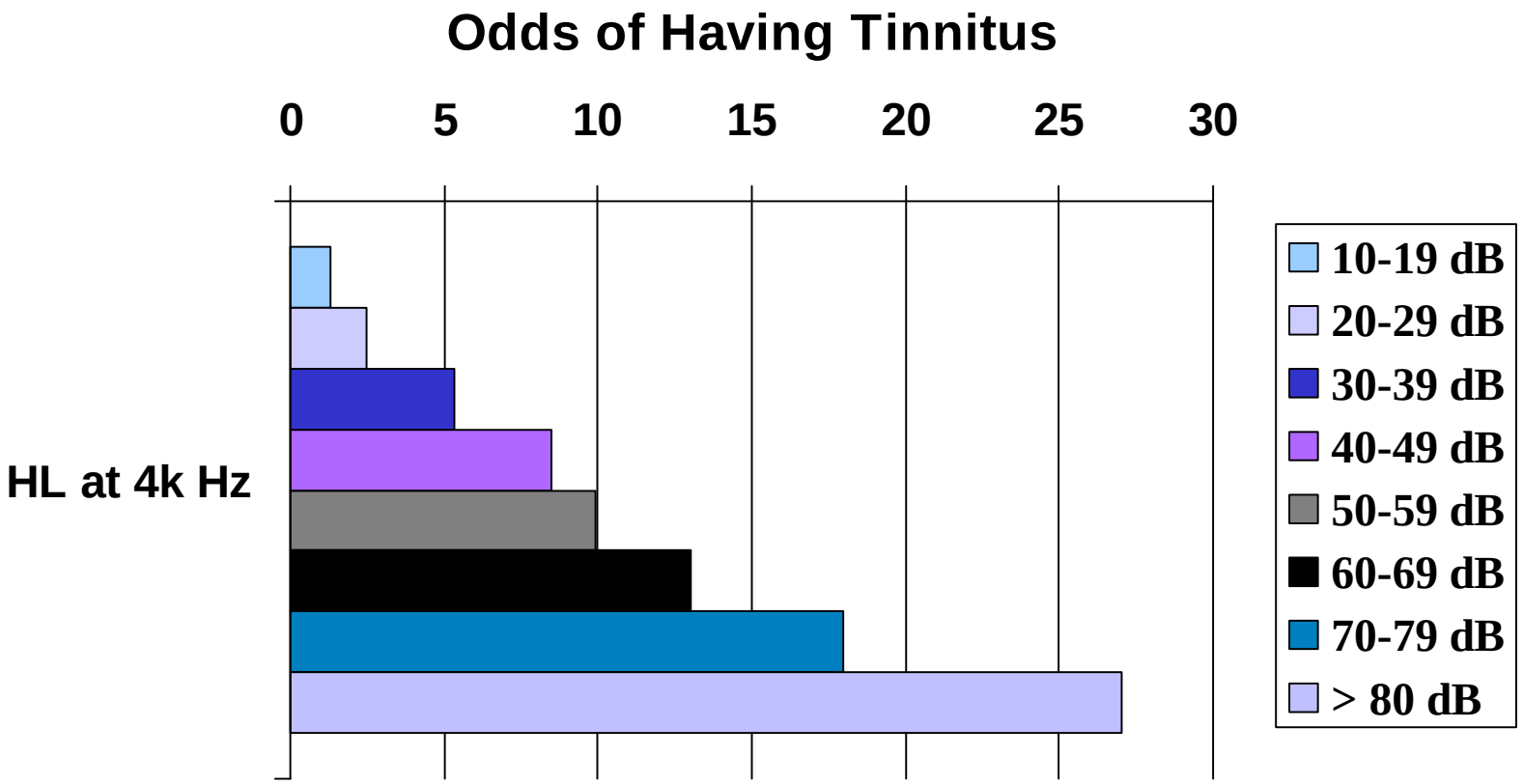
- Approximately 15% of the world's population has tinnitus.
- More than 70% of hearing impaired individuals have had tinnitus at some point
- 80-90% of tinnitus patients have some evidence of hearing loss
- 10 - 20% of tinnitus sufferers seek medical attention

Figure 2. In

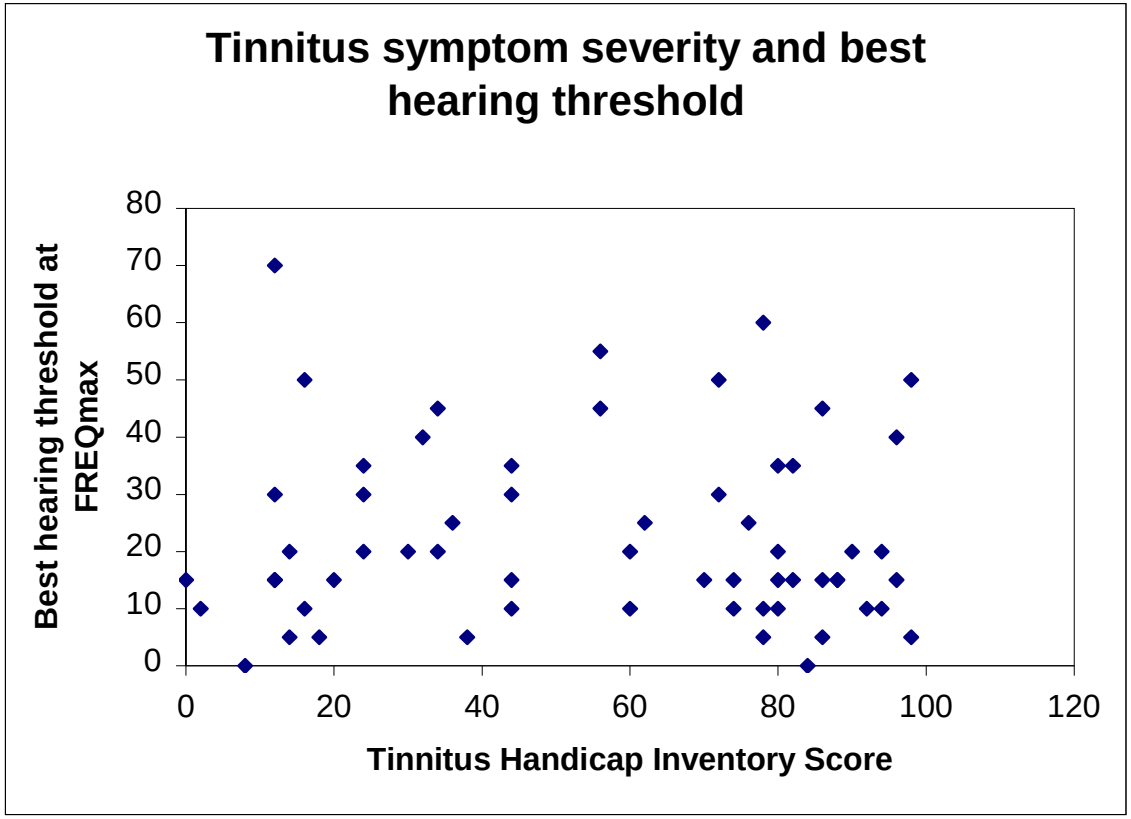


Kochkin et al, 2012

Tinnitus and Hearing Loss



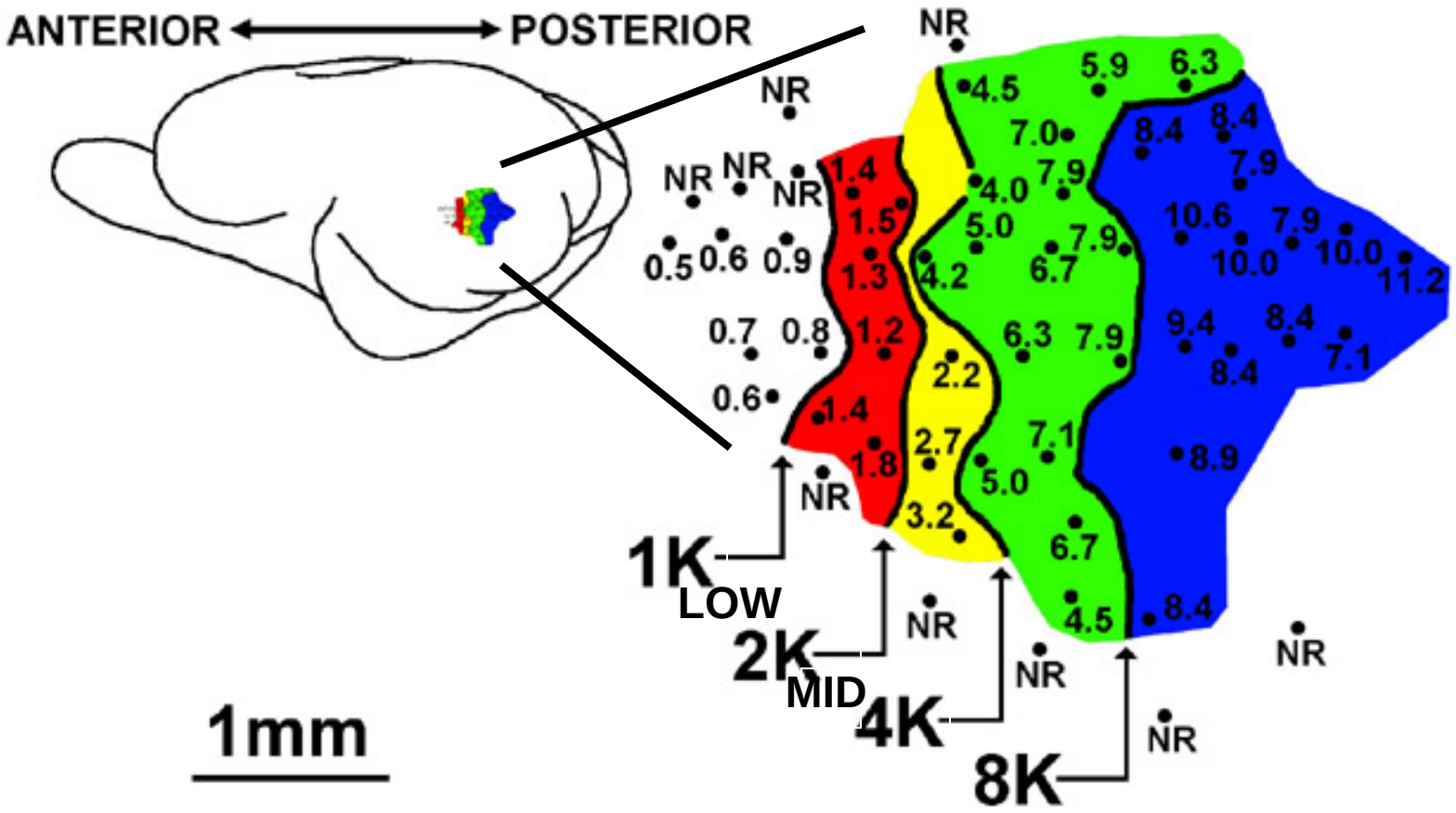
Correlation between tinnitus severity and auditory threshold



Tsai, Cheung, and Sweetow, 2007

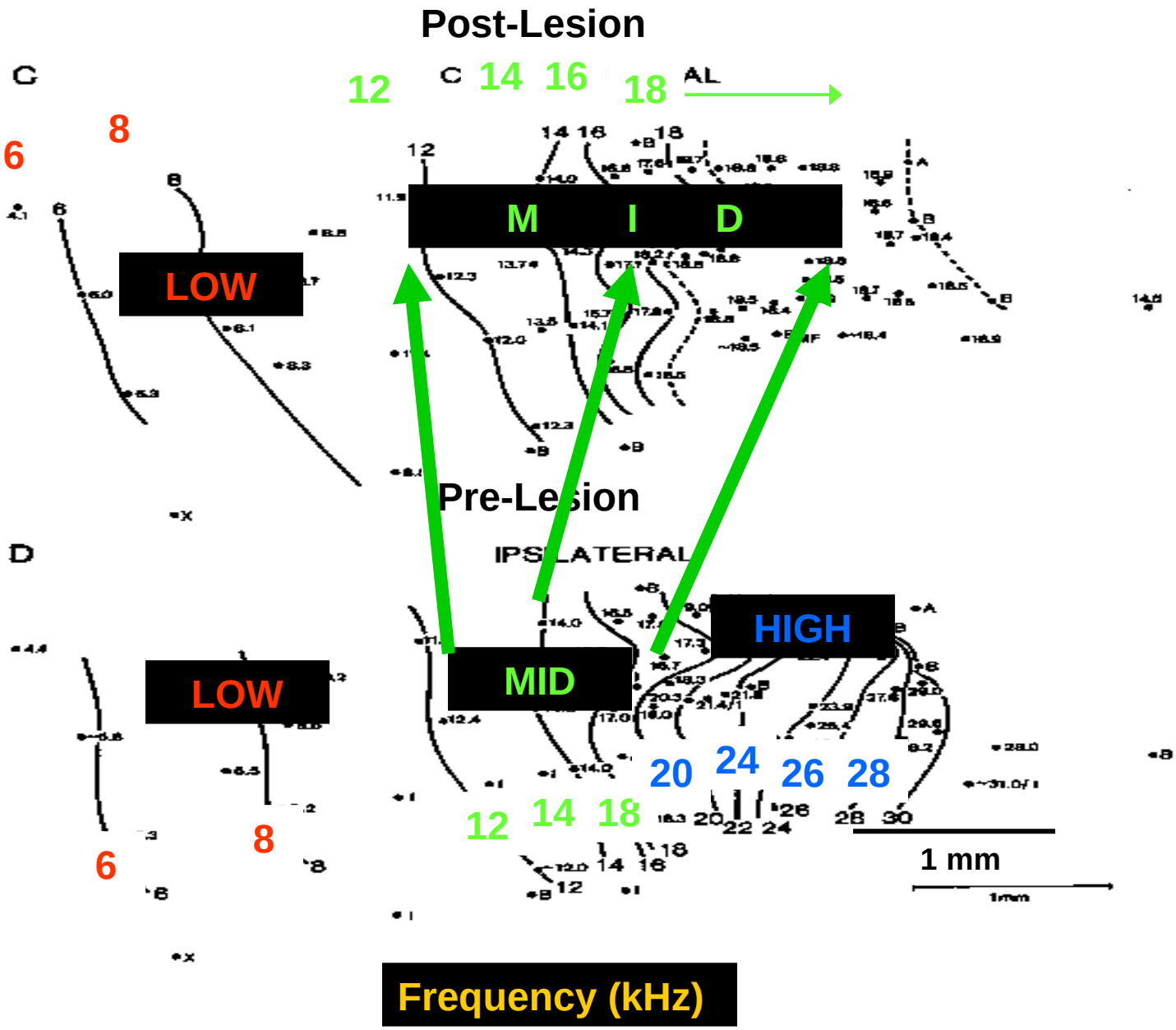
Restricted cochlear lesions in adult animals produce a dynamic reorganization of the representation, or map, of the cochlea in the primary auditory cortex

AUDITORY CORTEX



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

Cat Auditory Cortex



Irvine and Rajan (1995)

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

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, stress turned out to be more important.
- 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

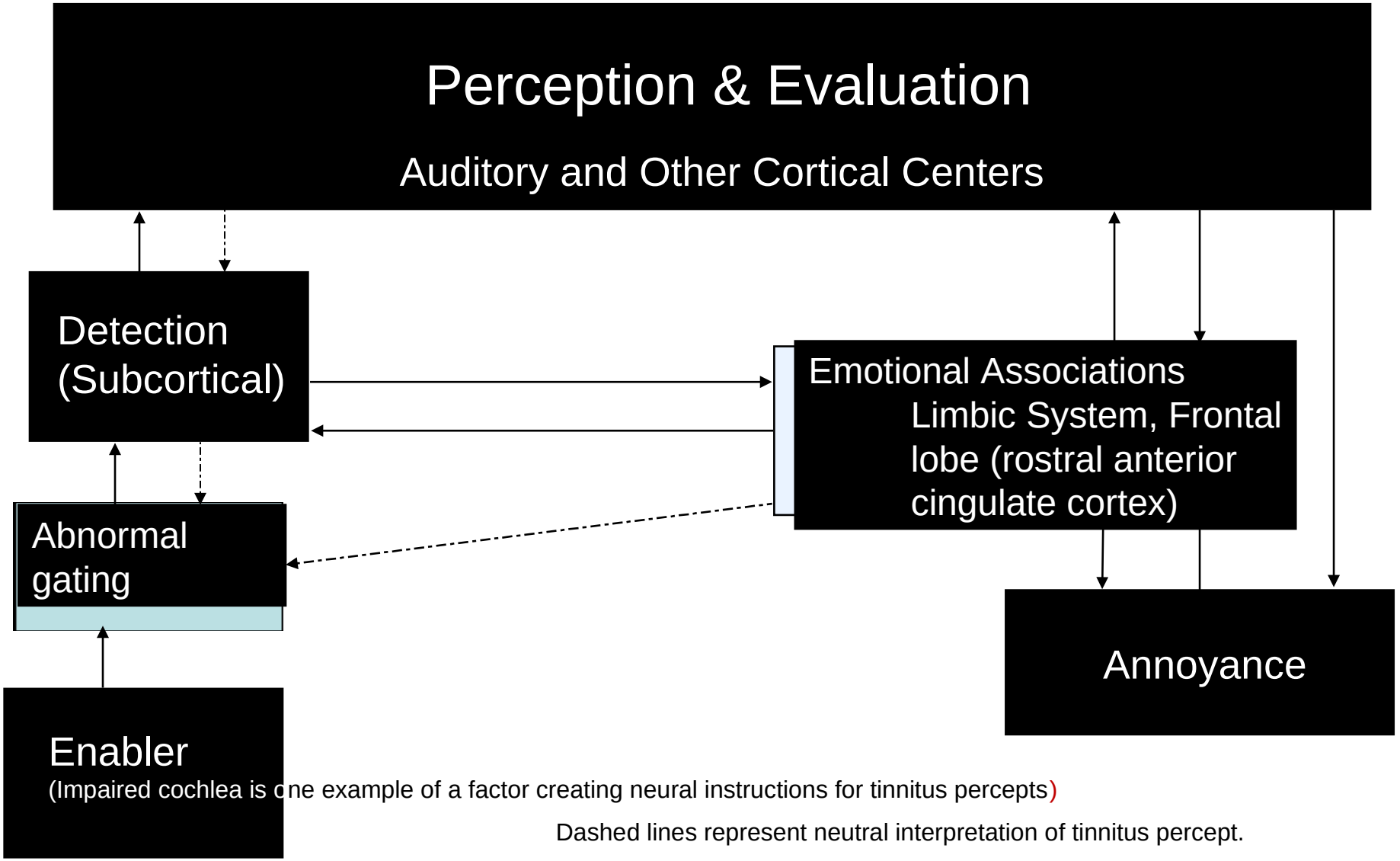
- Disruption of auditory input (e.g., hearing loss) and resultant increased gain (activity) within the central auditory system (including the dorsal cochlear nucleus and auditory cortex)
- Decrease in inhibitory (efferent) function
- Over-representation of edge-frequencies (cortical plasticity)
- Dysfunctional 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)

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



Three aspects of tinnitus that should be addressed

- auditory
- attentional
- emotional

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

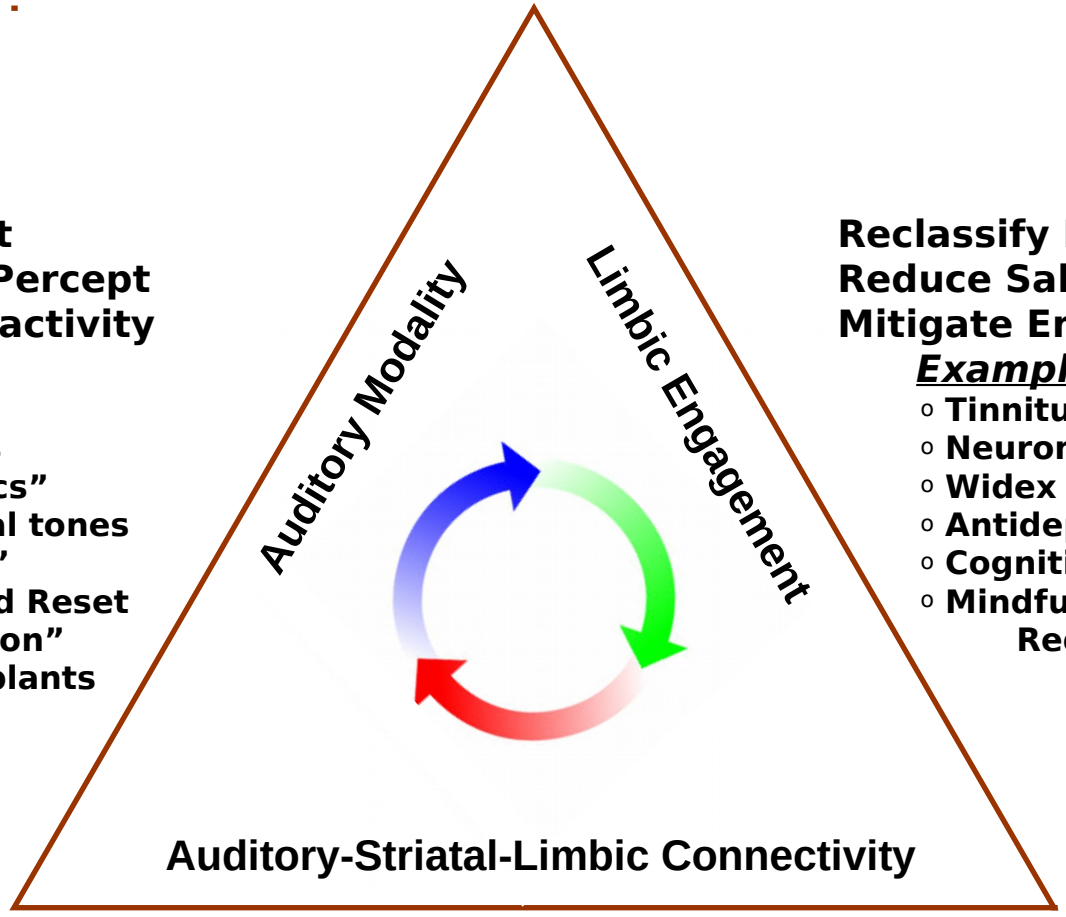
Defining the tinnitus problem

- 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

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)**

“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

Current sound treatments

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

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.

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

What are the objectives of sound therapy?

- Complete masking
- Partial masking
- Mix
- Habituate
- Distract
- Suppress

Habituation

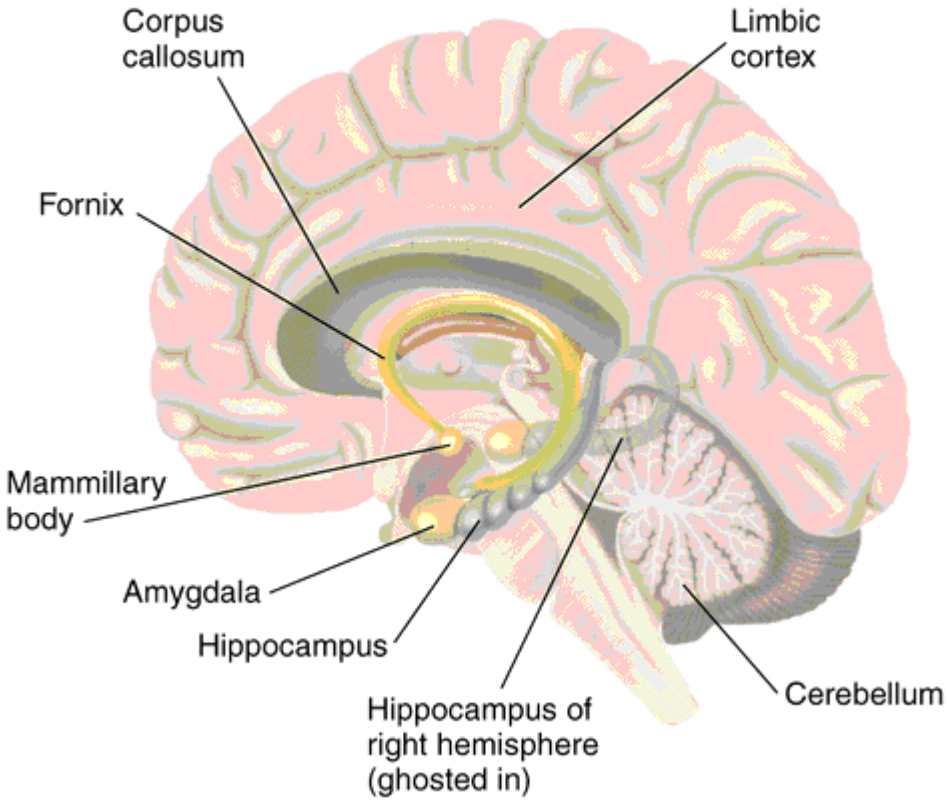
- **the process of "ignoring" (or becoming accustomed to) a stimulus without exerting any conscious effort.**
- **from a psychological perspective, it is defined as the adaptation, or decline of a conditioned response, to a stimulus following repeated exposure to that stimulus.**

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

Arguments against masking

- Jastreboff(2005) – ear phenomena & dopamine through MGB

- Tyler (2010) – cognitive & emotional content / not excluded

Transient form of suppression is residual inhibition

- 1 mint (HENRY ,2005)
- 2 mint (VERNON , 2010)
- 15 MINT & 30 MINT (Chatterjee et al. 2015)

Differences between masking and suppression

- the signal used to facilitate suppression is softer than the tinnitus perception
- time course …..Masking of tinnitus is instantaneous, while suppression of tinnitus requires from several seconds to several minutes to both occur and then decay.
  - this suggests different neural mechanisms for the two methods.
- maskers typically have similar spectral and temporal properties to the tinnitus, whereas the most effective suppressor may have distinctly different spectral and temporal properties than the perceived tinnitus.
- suppression is a physiologic process in which sounds may modulate the activity of the auditory cortex and interrupt tinnitus generation.

TINNITUS SUPPRESSION BY LOW-RATE MODULATED SOUNDS

Vanessa S. Rothholtz, Qing Tang, Kelly M. Reavis, Jeff Carroll, Edward C. Wu, Esther Fine, Hamid R. Djalilian, Fan-Gang Zeng

How does suppression differ from masking?

- Effective tinnitus suppressors are often softer and have different temporal and spectral properties than the perceived tinnitus, whereas maskers are often presented at an equal level and share similar temporal and spectral properties as the perceived tinnitus.
- It has been hypothesized that tinnitus may reflect abnormal, most likely overly synchronized, neural activity in the auditory cortex.
- Liang and Lu report that low-rate amplitude- or frequency-modulated acoustic sounds produce sustained and highly synchronized cortical responses.
- External stimulus, particularly an amplitude- or frequency-modulated stimulus, can produce cortical activity that will compete with the tinnitus-induced neuronal activity by introducing synchronization of the population of neurons generating tinnitus.

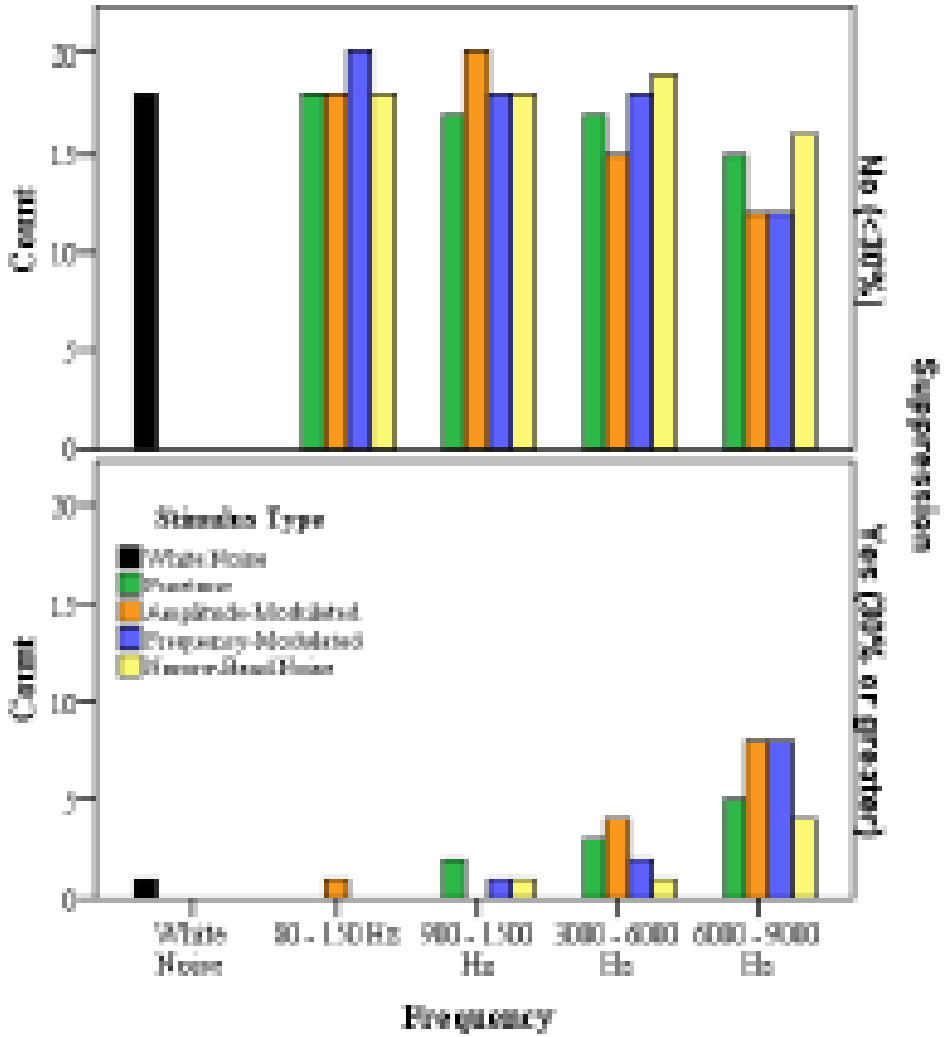


Figure 4. External tone parameters by suppression effectiveness.

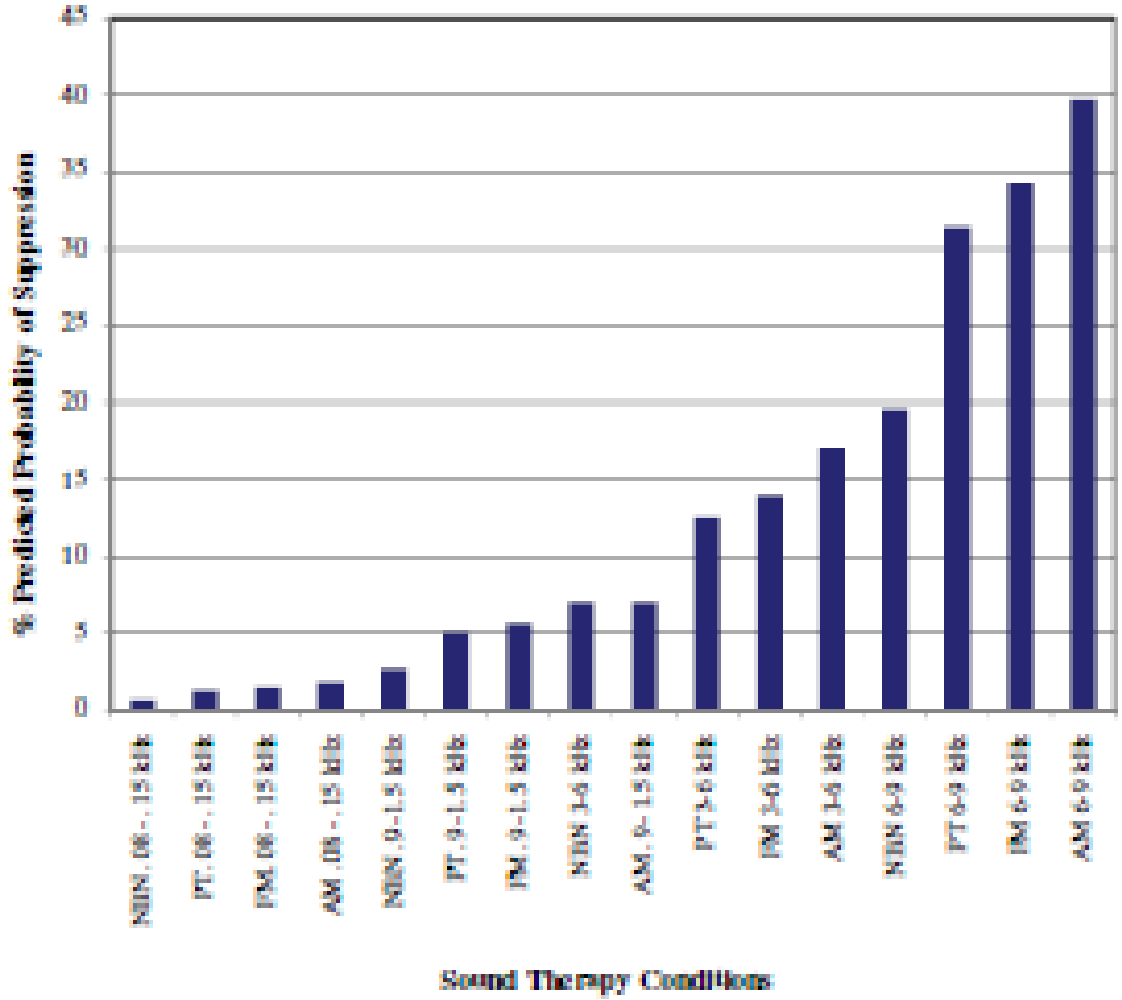


Figure 5. Modeled rank order of the 17 sound therapy conditions evaluated.

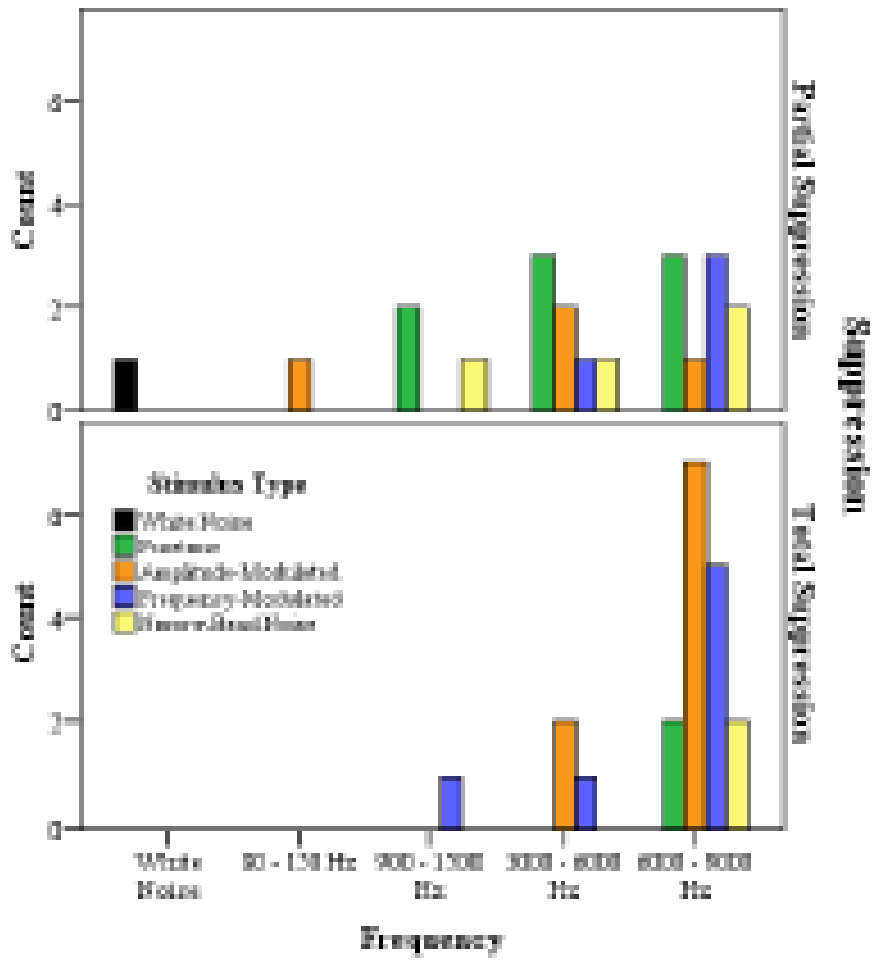


Figure 6. External tone parameters by suppression effectiveness.

Conclusions

- Subjects who experienced suppression reported louder tinnitus (db SL) at baseline
- Best stimuli were amplitude modulated pure tones with carrier frequencies between 6K and 9K
- White noise is ineffective as a suppressor
- For subjects with any suppression, AM and FM pure tones were more likely to yield total suppression compared to un-modulated pure tones

“Comparison of Custom Sounds for Achieving Tinnitus Relief”

Henry, et al. Journal of the American Academy of Audiology; 15,8, 2004

CDs used

- Moses/Lang CD7, (1993)
  - noise bands covering seven different frequency ranges —user selects most effective band
  - (Johnson,1998; Vernon and Meikle, 2000)
- Dynamic Tinnitus Mitigation (DTM-6a)
  - Petroff Audio Technologies, Inc. (Marina Del Rey,CA; petroffml@aol.com)

Sample sounds

- E- water (dynamic)
- E- air
- E- nature (dynamic)
- White noise
- Personal Growth high frequency relief

DTM

- DTM sounds use proprietary “dynamic” (changing) sound formats that are intended to enhance masking and distract attention away from tinnitus.
- “Dynamic” acoustic technology refers to proprietary semi-random, short-term amplitude and frequency domain modulation signal processing
- E-Nature and E-Water, have been “dynamically” processed to provide expanded amplitude peaks on the order of 5 to 15 dB, over corresponding time durations on the order of 10 to 500 msec.

Table 4. Mean Output Levels, Annoyance Ratings, and Rankings of Tinnitus Annoyance for the Various Sound Stimuli

Sound	Mean Output (dB Level on Audiometer)	Adjusted Mean Output (dB SPL)	Mean Annoyance (0–6 Scale)	Mean Rank	Squared Sum
DTM E-Nature	39	56	1.1	4.00	80
DTM E-Water	36	57	1.3	4.65	93
Moses/Lang 4–14k	62	69	1.9	5.68	114
Moses/Lang 6–14k	65	70	1.8	6.03	121
DTM E-Air	39	55	1.8	6.08	122
Moses/Lang 8–14k	71	74	2.0	6.58	132
White noise (audiometer)	28	48	1.9	6.63	133
Moses/Lang .1–4k	32	54	2.0	6.70	134
Moses/Lang pink noise	33	51	2.0	6.83	137
Moses/Lang 10–14k	75	78	2.0	6.93	139
Moses/Lang 2–14k	57	64	2.1	7.05	141
Tinnitus alone	-	-	3.2	10.88	218
SUM					1564

Differences between E-Nature, E-Water , and E-Air

- E-Air = E-Nature when measured in 2 dimensions (amplitude/frequency)
- When measured in 3 dimensions E-Nature is dynamic
- E-Water is significantly rolled-off in high-frequency amplitude relative to E-Air, so we would expect E-Air to provide better masking.
- E-Air should have performed at least as well if not better but this didn’t happen; perhaps because E-air was dynamic????

Problems with this study

- Presentations lasted from 3-30 seconds
- Study was done in a sound booth
- Hearing loss amongst subjects varied
- TDH 50s, which have significantly reduced amplitude from ~ 7-13KHz, were used

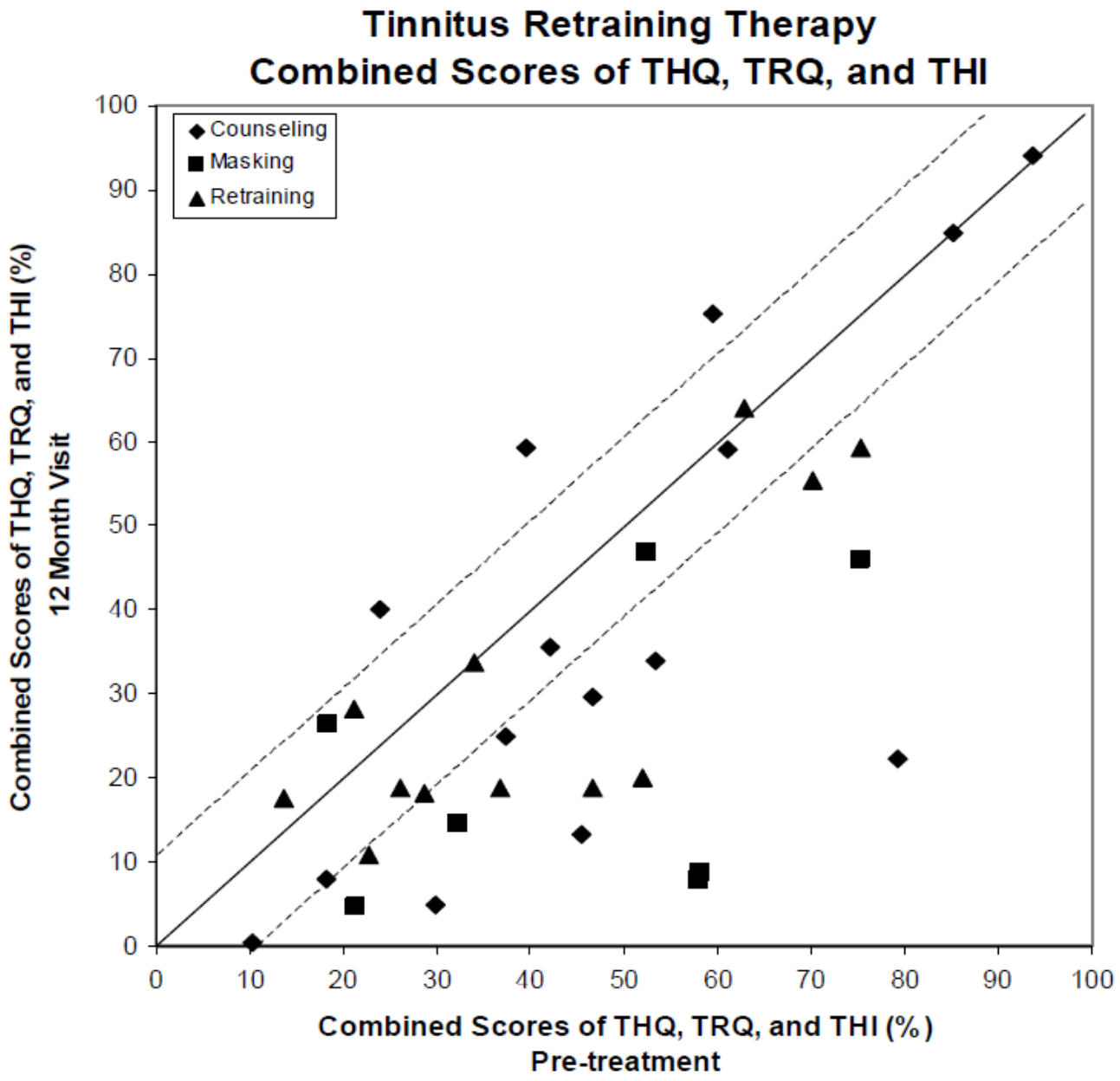
Does acoustic therapy help?

- McKinney, et al; 1999
  - Counseling only; 72% showed “improvement” (N=54)
  - Counseling with sound generators at just audible level; 75% showed “improvement” (N=72)
  - Counseling with hearing aids; 61% showed “improvement” (N=56)
  - Counseling with sound generators at mixing level; 83% showed “improvement” (N = only 36)

Does acoustic therapy help?

- Herraiz, et al, 1999
  - Counseling only; 94% showed “improvement” (N ~ 30)
  - Counseling with hearing aids; 85% showed “improvement” (N ~ 35)
  - Counseling with sound generators; 83% showed “improvement” (N ~ 30)

My conclusion….not definitive proof….yet 70% of TRT users get them! But, these were done with white noise.

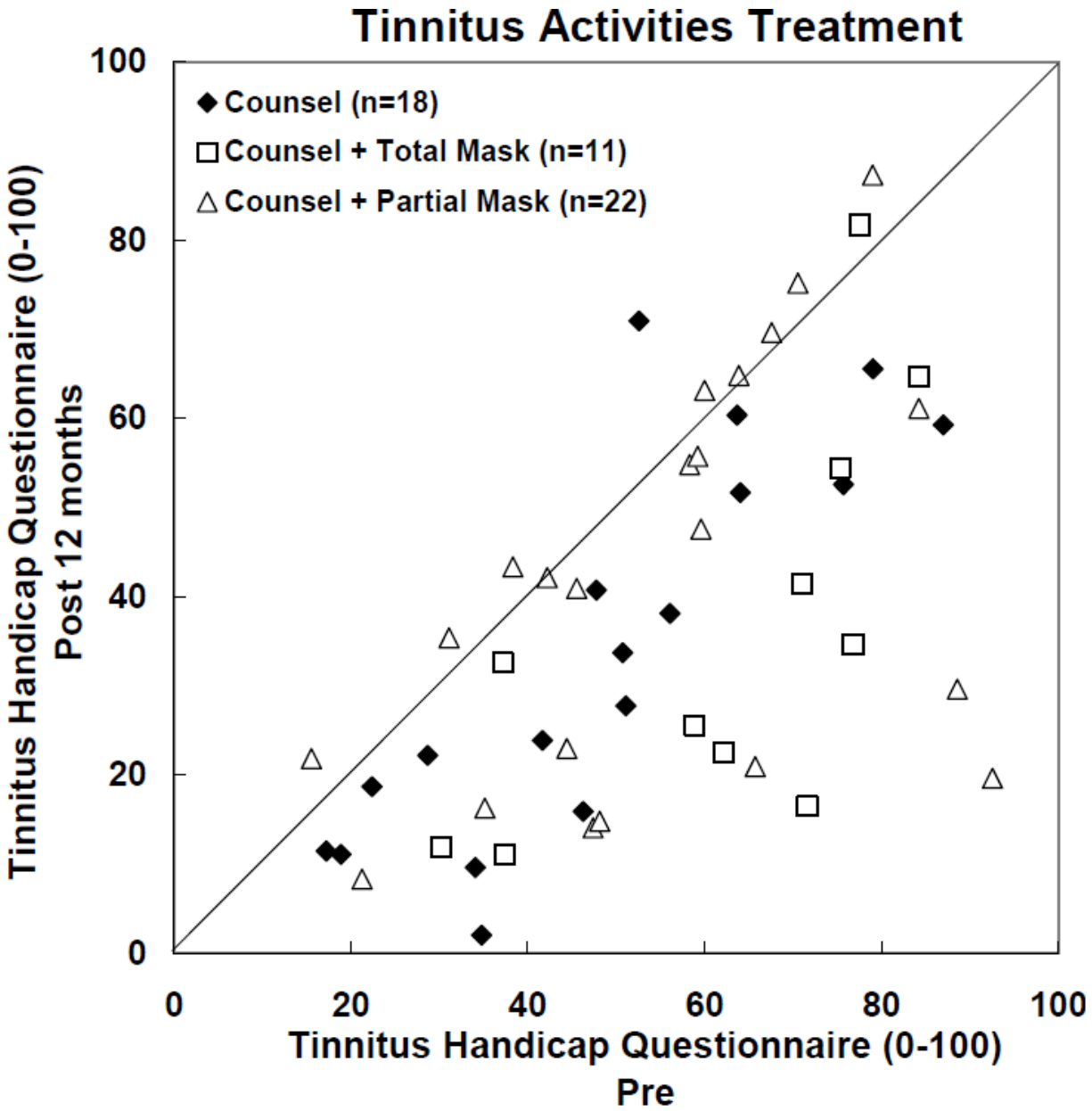


Counseling only = 3 worse, 6 same, 6 better (50%)

Masking = 2 same, 4 better (66%)

Retraining = 5 same, 6 better (54%)

Tyler, 2010



Counsel only = 8 same; 10 better (55%)

Counsel + total mask = 2 same; 9 better (81%)

Counsel + partial mask = 12 same; 10 better (45%)

Tyler, 2010

- Both TRT and general counseling without additional sound therapy are effective in reducing the annoyance and impact of tinnitus.
- The largest effect on overall tinnitus handicap was observed in the TRT participants, with an effect size of 1.13. However, a clinically significant effect was also observed in the control group, with an effect size of 0.78.

Effect of Tinnitus Retraining Therapy on the Loudness and Annoyance of Tinnitus: A Controlled Trial; Bauer, Carol A.; Brozoski, Thomas J. Ear & Hearing: March/April 2011 - Volume 32 - Issue 2 - pp 145-155

Weakness of group data and randomization

- Group analysis assumes all are the same
- Some individuals show large changes, but these are diluted in group analysis
- There is not likely a single treatment which confers universal benefit
- Subjects who do not want a device, but who are randomized to a device group are less likely to show benefit
    - Tyler, 2010

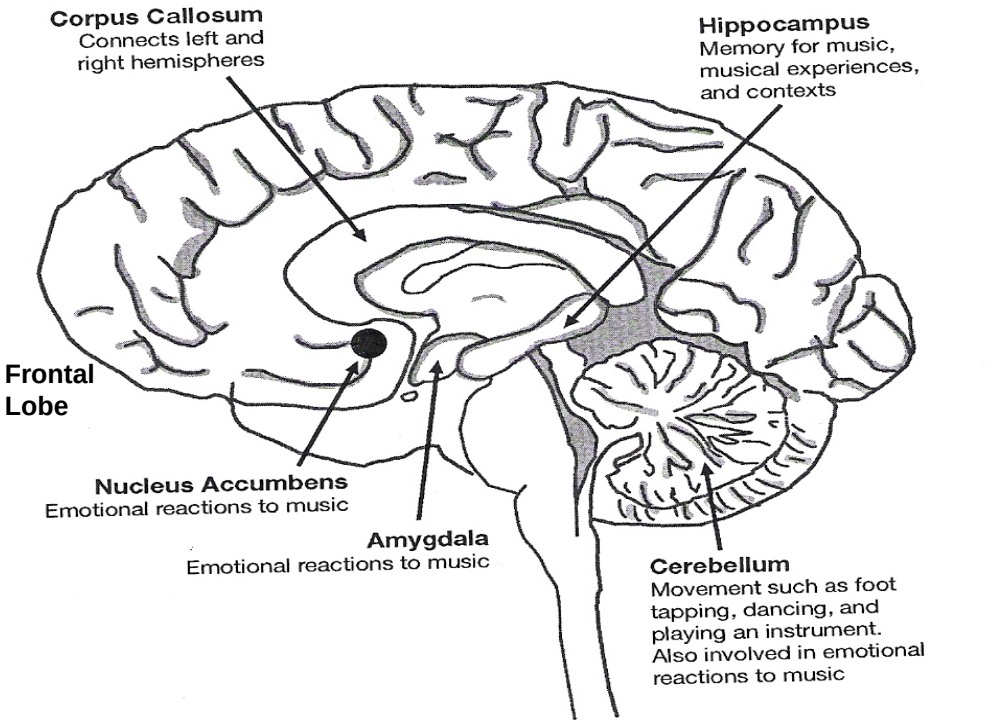
Goal ... **Stimuli**	**Active listening (Distraction)**	**Masking**	**Desensitization (Habituation)**
Music	iPoD Radio	Neuromonics, phase 1 Radio or iPod (filtered or unfiltered) Amplisound combo	Neuromonics, phase 2 iPoD Fractal
Speech	Books on tape	Spouse (just joking)	Hearing aids
Misc	TV Meditation DTM Personal Growth	DTM Shower	TRT, sound enrichment

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

Tinnitus

- 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

Categorical Expectations

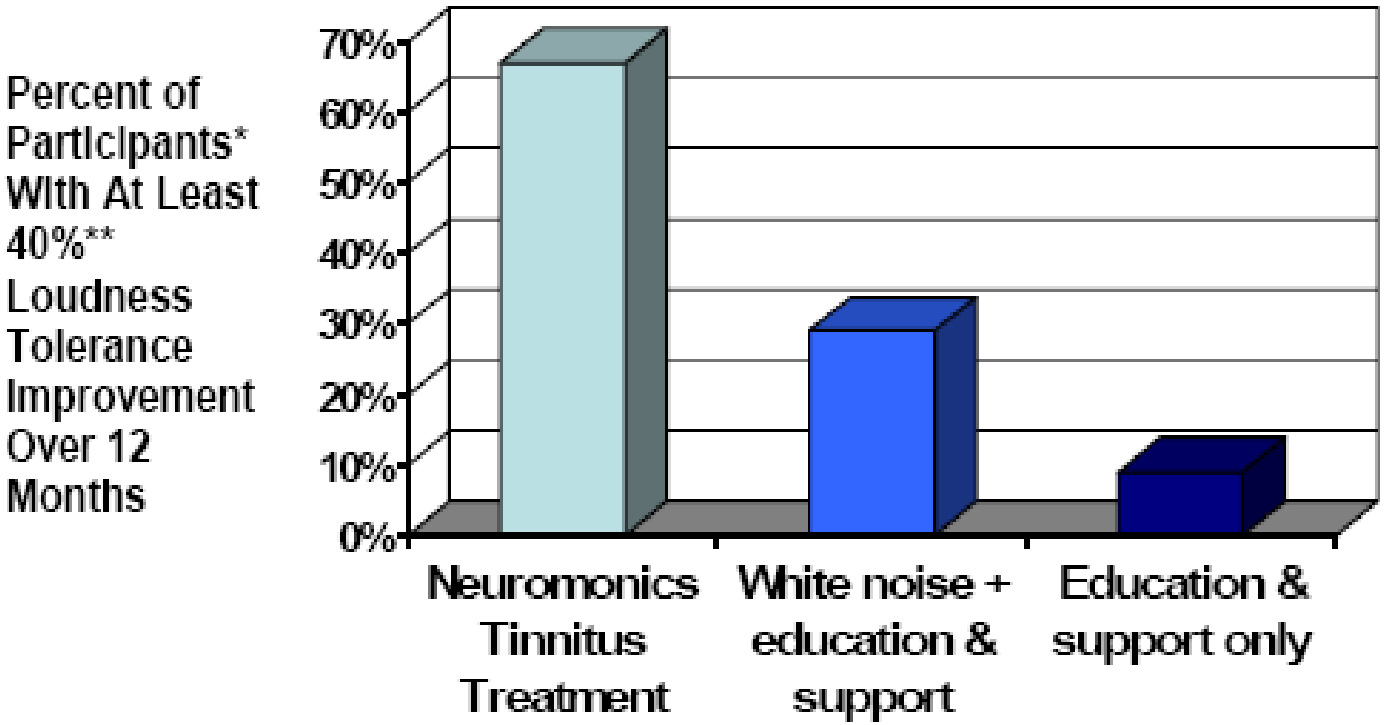
- We don’t like the unexpected
- But certain rules have to be followed
- Active listening may arouse, passive listening may soothe
- For tinnitus patients, active listening may draw attention to the tinnitus, passive listening may facilitate habituation

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

Loudness Tolerance Improvements (%)



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

Comparison of sound generators (SGs) vs Neuromonics tinnitus treatment (NTT)

- N= 56; 6 month trial

- Both groups (SG and NTT) demonstrated a significant reduction in tinnitus for SG and NTTs. However, there were no differences in the SG or NTT treatment groups.

- Conclusions: Both protocols (SG and NTT) yielded significant improvements with regard to quality of life (HRQoL) issues, based on the THI improvements

- SG appears to be more cost efficient than NTT. “The cost per unit of improvement (treatment utility) on the THI (scale from 1–100 points) measured in “quality-adjusted life years” was $604 per point for the sound generator treatment compared to $1,771 per point for the neuromonics treatment. The implication here is that equivalent gains might be obtained at a lesser cost to the patient.”

Newman CW, Sandridge SA. (2012) A Comparison of benefit and Economic Value Between Two Sound Therapy Tinnitus Management Options. *Journal of the American Academy of Audiology* 23:126–138.

Independent results for Neuromonics tinnitus treatment protocol

- Forty-seven patients initiated treatment with the Neuromonics device during the 2 year study period.
- Fourteen patients completed treatment, and another 18 were actively undergoing treatment at the end of the study period.
- The mean pure-tone average (N 47) = 23.4 dB for the involved ear.
- Of those who completed the treatment, the mean posttreatment TRQ score was significantly lower than the pretreatment score (p ~ .001).
- Fifteen patients (31.9%) returned the device or did not complete treatment.
- Across all 47 patients, 48.9% achieved a successful reduction of 40% or greater in TRQ score.
- No correlation among pure-tone average, initial TRQ score or duration of use, and percentage change in TRQ score for those with at least one follow-up test.

Goddard JC, Berliner K, Luxford WM. Recent Experience with the Neuromonics Tinnitus Treatment. Int Tinnitus J. 2009;15(2):168-173

Why can’t we just use an iPod?

- Frequency shaping
- Loudness balance
- Compression

Studies (citation) have shown that baroque music at 60 beats per minute causes your brain to produce more alpha brainwaves. Some specific examples of good relaxation music.

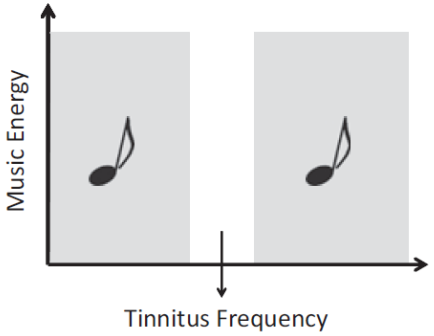
- "Harpsichord Concerto in F Minor," by J.S. Bach
- "Concerto No.10 in F Major from Twelve Concerti Grossi," by A. Corelli
- "Winter" from "The Four Seasons," by A. Vivaldi
- "Canon in D," by Pachelbel
- "Adagio in G Minor for Strings," by Albinoni

Read more: http://www.articlesbase.com/stress-management-articles/the-best-relaxation-music-541489.html#ixzz1TLaTSXjT

- http://www.healingcombattrauma.com/2008/06/using-sound-healing-for-ptsd.html

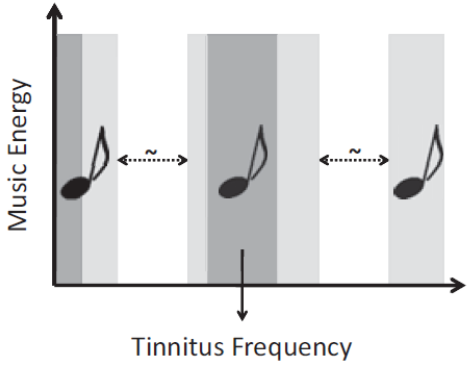
Target processing

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

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

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

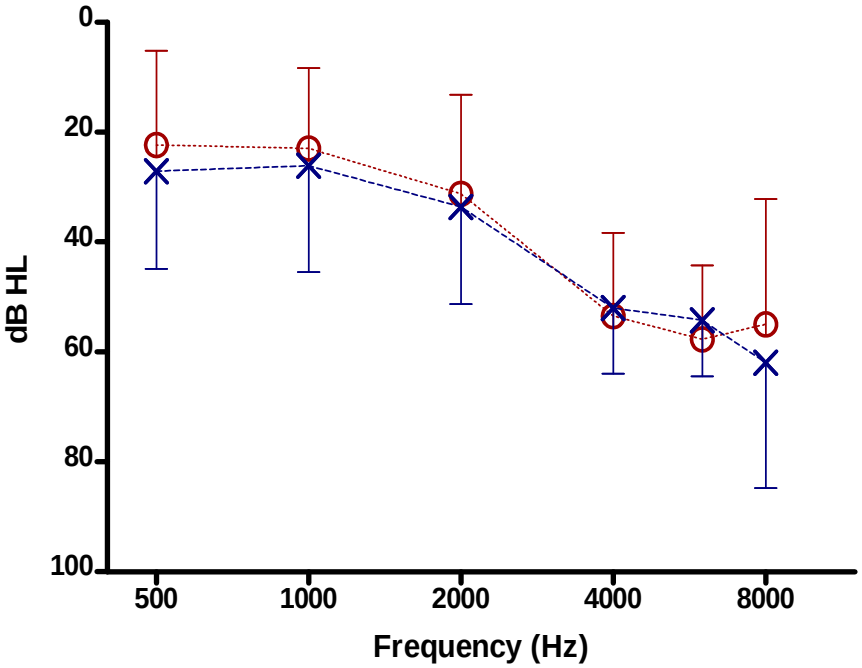
Evidence of effectiveness

- 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).

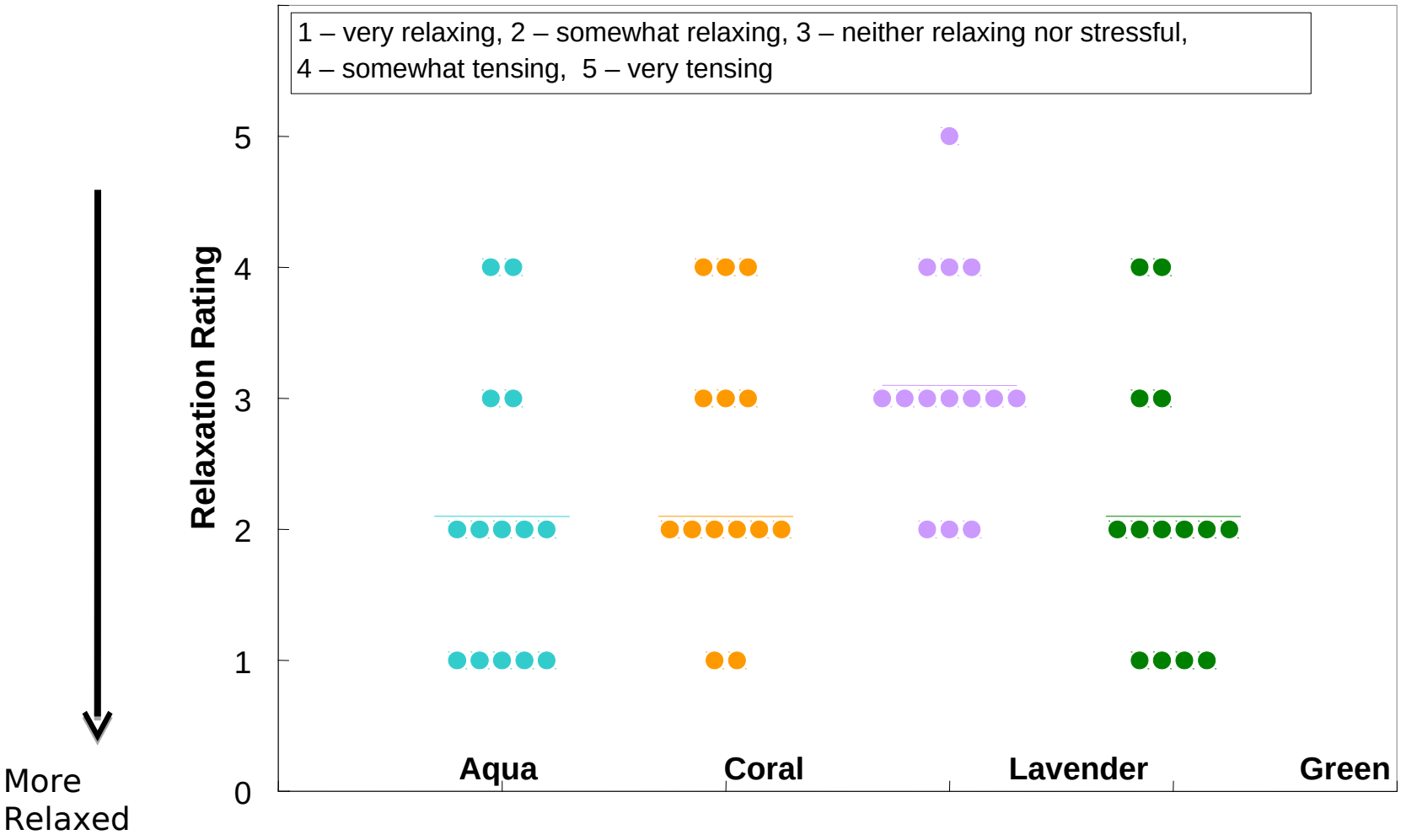
• All subjects had tinnitus for at least one year and had received no active treatments (including counseling) for at least three months prior to the start of the experiment.



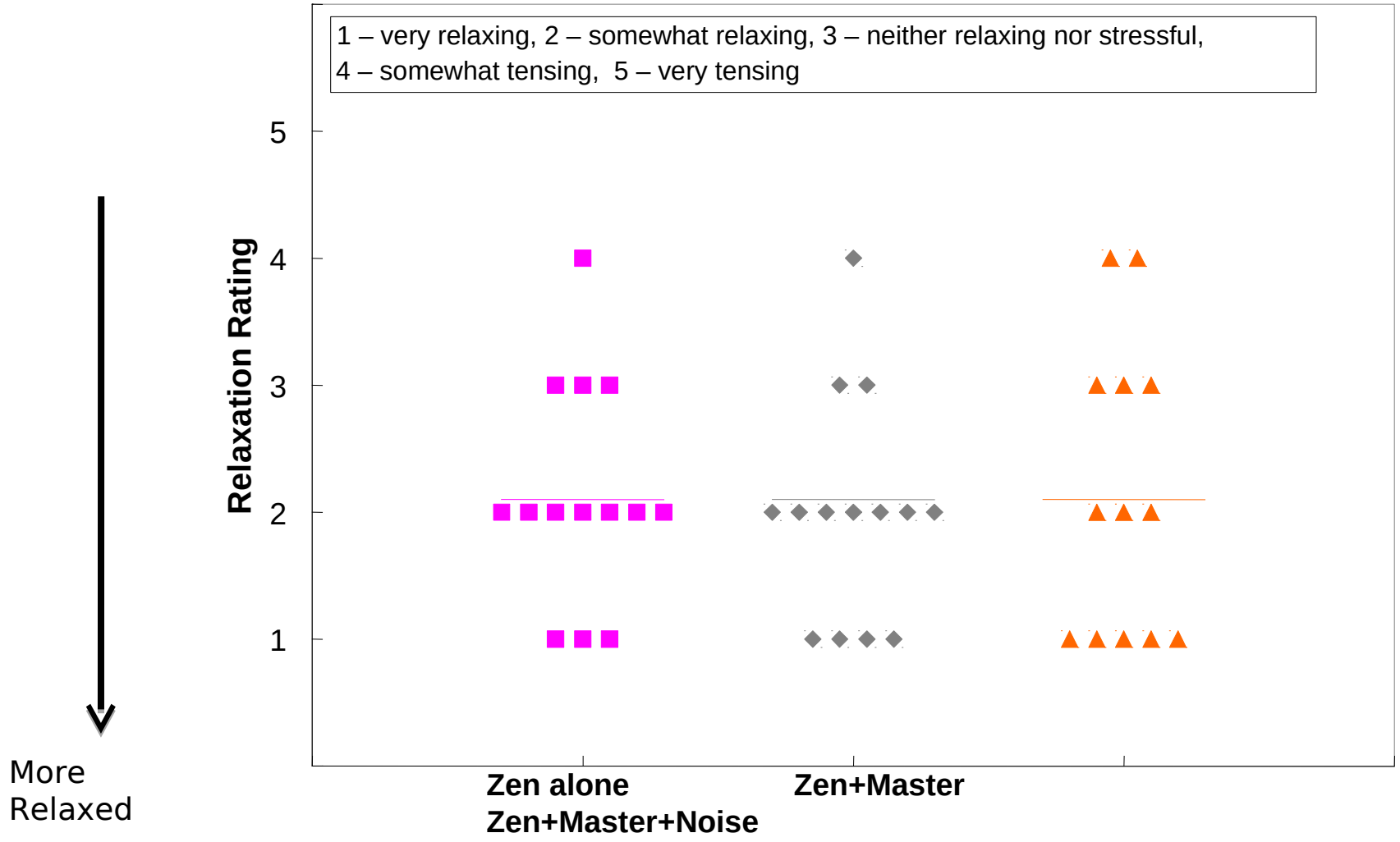
Study Questions

- 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?

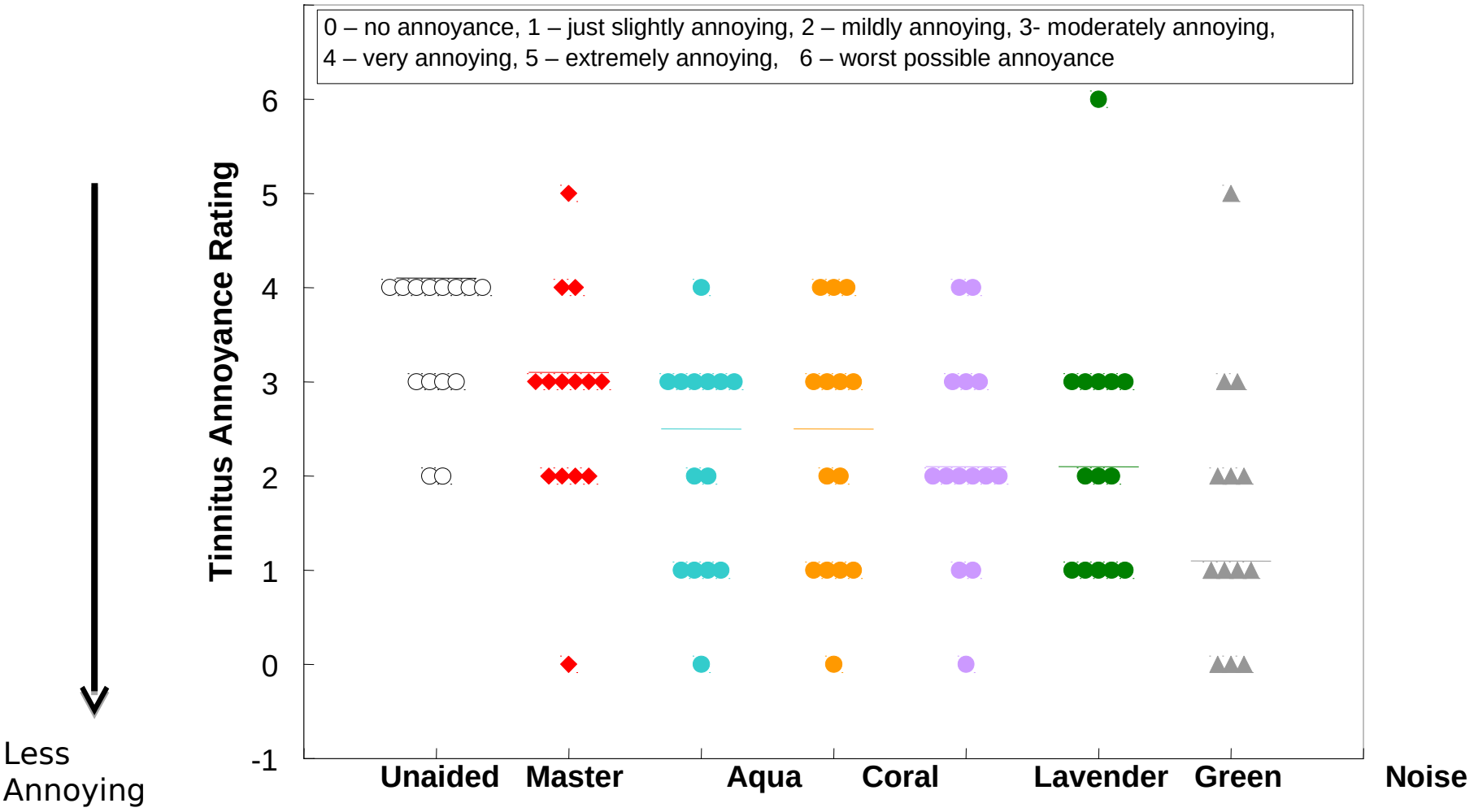
Relaxation ratings



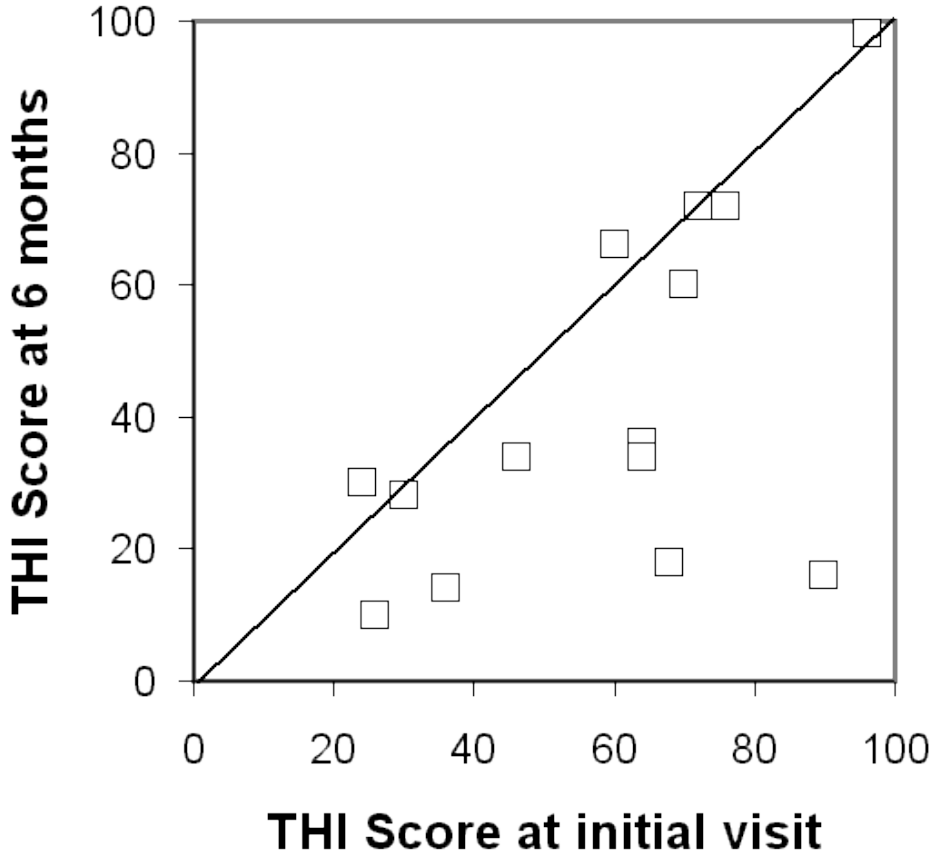
Relaxation ratings

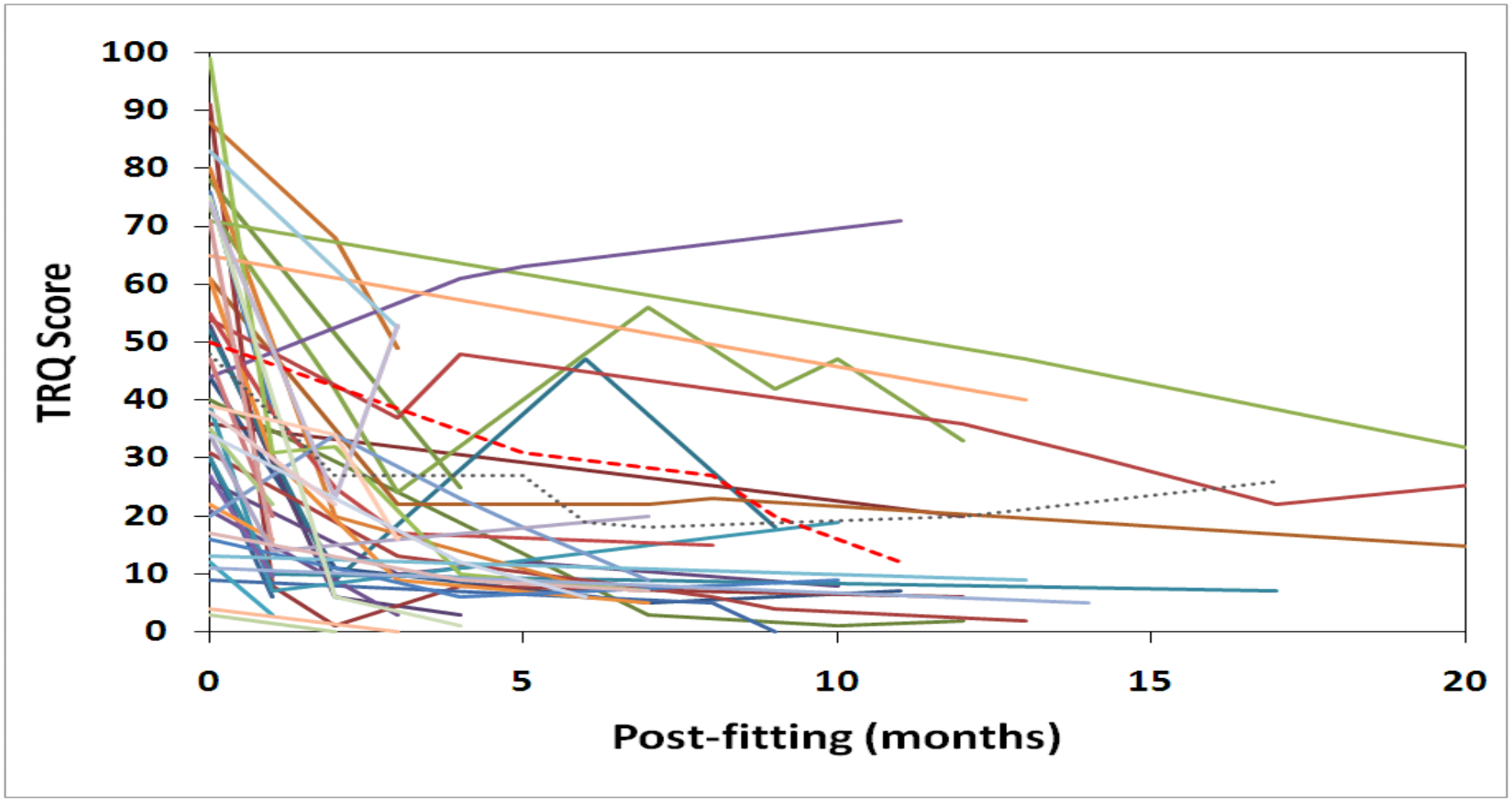


Tinnitus annoyance



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**

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

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!

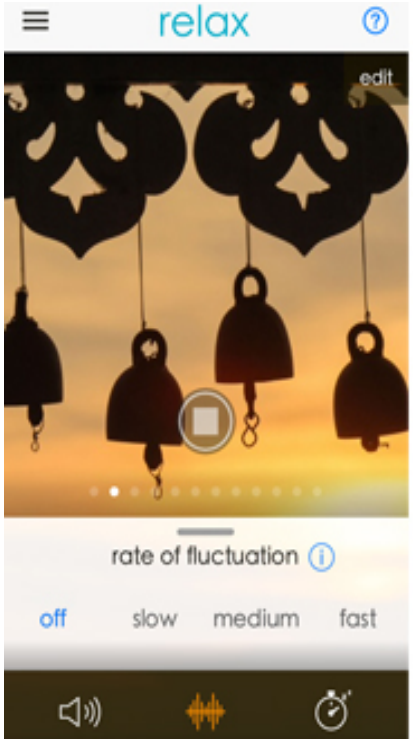
Conclusions

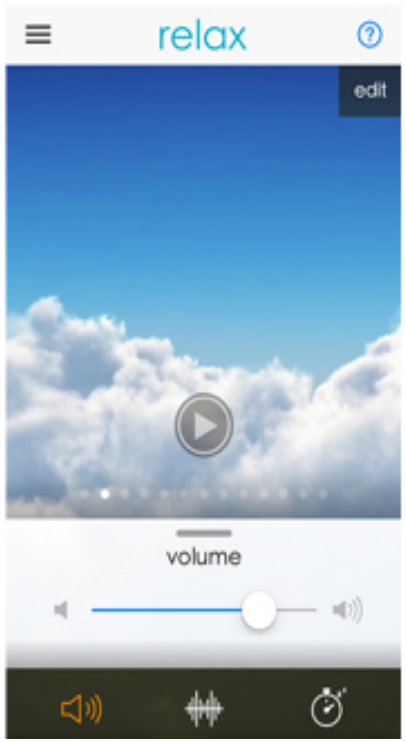
- Tinnitus patients with hearing loss may best be served by amplification that incorporates low compression thresholds, a broad frequency response, and flexible options for acoustic stimuli
- Tailor the therapy to the patient's functional and financial needs
- Sound therapy without counseling is not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

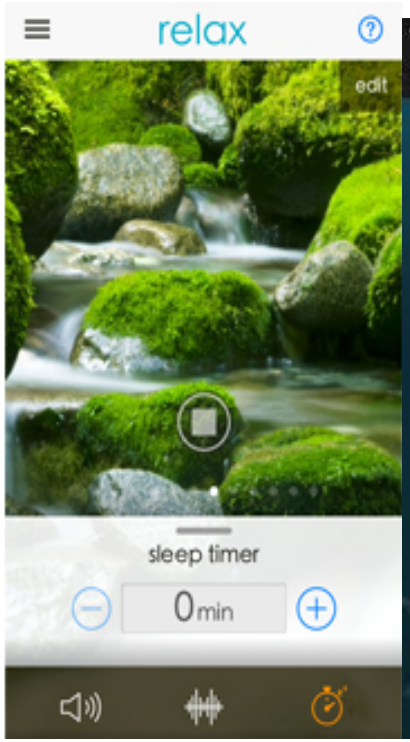
Should the preferred sound stimuli be a function of……

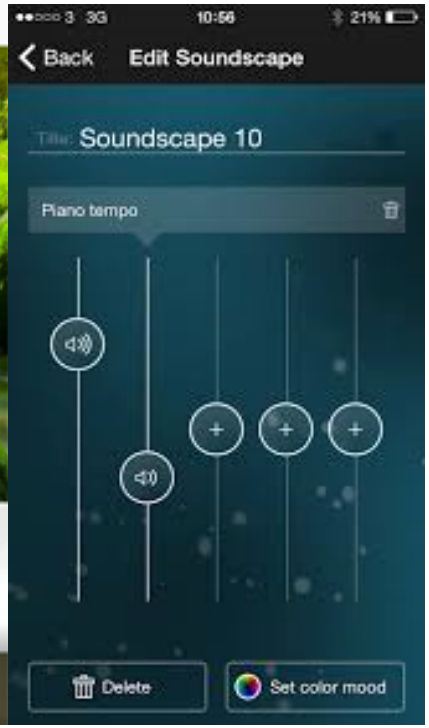
- Tinnitus theory
- Single neuron
- Cortex
- Cerebellum
- Limbic system

TINNITUS APPS









DIFFERENTIAL DIAGNOSIS

- TINNITUS (Ear noise in absence of external sounds- annoyance)
- HYPERACUSIS (sound intolerance)
- PHONOPHOBIA (fear about certain sound – avoidance)
- MISOOPHONIA (missing and adding)
- AUDITORY HALLUCINATION

  (neuropsychiatric-schizophrenia)

RECENT INDIAN STUDIES

- COMPARISON OF TRT AND TINNITUS MASKING (CHATTERJEE ET AL. 2013)

- 2. DETERMINATION OF EFFECTIVE DURATION RESIDUAL INHIBITION FOR THERAPEUTIC MASKING (CHATTERJEE ET AL. 2014)
- 3. COMBINATION OF MINDFULNESS VERSUS TINNITUS MASKING THERAPY (CHATTERJEE ET AL.2015)
- 4. COMPARATIVE EFFICACY STUDIES : COGNITIVE BEHAVIOUR THERAPY VERSUS TINNITUS MASKING (CHATTERJEE ET AL. 2016)
- 5. INCIDENCE AND PREVELANCE OF TINNITUS IN INDIA (CHATTERJEE ET AL. 2008)
- 6. STANDARDIZATION AND VALIDATION OF DIFFERENT TINNITUS QUESTIONNAIRES

International Tinnitus Journal. 2012;17(1):54-60.

Status of the tinnitus management program in India-A Survey

Sujoy Kumar Makar[1]
Suman Kumar[1]
P Shalini Narayanan[1]
Indranil Chatterjee[1]

Abstract

Objective: The aim of the study is to figure out the status of tinnitus management program (TMP) being conducted in India, to estimate the use of different tinnitus management program, to study the role of various professionals involved and document the current practices of audiologist in country. **Design:** A questionnaire on "tinnitus management survey" was developed and distributed to 150 institutions all over India. **Results and conclusion:** The return rate of the Questionnaire was 32.6%, 7 were received from Medical Colleges (MCs) and 42 from speech and hearing clinics (SHCs). Hence, the rates of TMP have not taken up appropriately in the various hospitals and clinics as yet. 71.4% SHCs have the provision of TMP, 74.28% of the institutes have less than 50% of the patients improving with the TMP, involving Audiologists in 62.85% of the institutes. 54.28% of the institutes opted for Tinnitus Masking out of the various tinnitus management programs. Outside funding for TMP was not received by 91.42% of the institutes. 60% of the institutes were provided TMP with hearing aids. 71.42% of the SHCs feel TMP is partially helpful to tinnitus sufferers thus funding should be undertaken by the Government for ensuring effectual program all over India.

Indian Institute of Psychometry, India
Vol. 27, No. 2, 2013

TINNITUS LOUDNESS MATCHING IN RELATION TO ANNOYANCE AND GRADING OF SEVERITY IN ADULTS WITH OR WITHOUT HEARING LOSS

Neha Taneja, Manisha Choudhury,
Indranil Chatterjee, Ashok Kumar Sinha

Widex India Pvt Ltd, Mumbai
AYJNIHH ,ERC, Kolkata

Tinnitus is often found associated with psychological complications which include annoyance resulting from the permanent awareness of the noise, depression, concentration problems, anxiety, sleep disturbances and intense worrying. Some authors supported that the loudness of tinnitus is not a determinant factor for the degree of distress caused by

Tinnitus, being essentially a reflection of abnormal function of the ear, has presumably occurred in man since his evolution. Approximately 14% of the adult population experiences moderate to severe tinnitus symptoms (Preece, Tyler and Noble, 2003). Twenty percent of those with such symptoms experience substantial distress

Composite Tinnitus Management

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Abstract: Tinnitus is a phenomena that is experienced by at least 25% of the population of U.S.A. Traditional treatment procedure i.e. matching & masking the tinnitus provides temporary relief. The following study was conducted on 3 patients at A.Y.J.N.I.H.H. Kolkata. In the study two cases complained of poor hearing, two complained of balance problem additional to tinnitus. An average severity rating was prepared on a 10 point rating scale. A Composite Tinnitus Management program was employed which included tinnitus matching & masking, tinnitus habituation therapy, sound enrichment & relaxation therapy for tinnitus & vestibular rehabilitation for a period of two weeks & it evidently proved to be a better management procedure than its earlier counterpart. Among the subjects two rated their tinnitus 0 (no tinnitus) on the tinnitus severity scale after a period of two weeks.

Key words Tinnitus, Composite Tinnitus Management.

Introduction

Tinnitus may be defined as the aberrant perception of sound that originates from within the head rather than from external world. Tinnitus is a consequence of altered neural activity and may result from a lesion or dysfunction at any level of the auditory system. Tinnitus is in general a buzzing or ringing sound

Eastern Journal of Medicine 19 (2014) 94-101

Original Article

Awareness of hyperacusis management among hearing health care professionals - a nationwide telephonic survey

Suman Kumar*, Indranil Chatterjee, Punam Kumari, Sujoy Kumar Makar

Ali Yavar Jung National Institute for the Hearing Handicapped, Eastern Regional Centre B.T.Road, Bon Hooghly, Kolkata

Abstract. Hyperacusis has recently attracted professional attention. Previously, this topic was not well researched or documented. In many instances, due to a lack of understanding regarding the diagnosis, the pathophysiology and treatment options, patients' complaints were ignored. Hyperacusis is defined as an abnormally strong reaction to sounds occurring within the auditory pathways. In the present study, an attempt has been made to make a telephonic survey regarding awareness of hyperacusis by asking a set of 19 questions from otorhinolaryngologists and audiologists in almost all parts of India. It is found that 36.6% of the participants report that hyperacusis is not diagnosed in their clinics, 73.4 % do not know the etiology, 33.3% manage hyperacusis and tinnitus simultaneously while others are not sure which should be managed. Decreased sound tolerance, including hyperacusis, [illegible] and phonophobia, is a challenging topic to study and treat. The etiology is not always [illegible]

Incidence of Tinnitus in Hearing Impaired Population

Indranil Chatterjee*, Subrata Mukhopadhyay**, Suman Kumar*,
Ranjana Rawat***

Abstract

This study is aimed to reveal the incidence of tinnitus in hearing impaired population. The sample surveyed consisted of 500 individuals. Among these the candidates who formed the basis of this study were 87 individuals (mean age 45.5years and standard deviation ...) reporting with hearing problem and tinnitus with other associated ear pathologies.

Among these 87 individuals, the number of male was 55 (the mean age 46 years and standard deviation .024) and the number of female candidates was 32 (mean age 44 years and standard deviation .023). According to age and gender the standardized prevalence of tinnitus in hearing impaired population was found to be 17.5%. Statistical analysis of these value were done using large sample test for binomial distribution, by applying central limit theorem in normal distribution, it was highly significant. It was observed that incidence of tinnitus seems to be quiet common in hearing impaired population with associated features like otalgia, itching, perforation of tympanic membrane and fullness of ears. Thus, tinnitus patients need to be helped through proper management techniques.

Introduction

Tinnitus is one of the chronic conditions that affect a significant proportion of population. Tinnitus is defined as any prolonged sensation of ringing, buzzing or any other sound in ears or head that is lasting for more than five minutes or longer (Davis 1995). It is usually described as

Quaranta etal (1996) studied the prevalence of self reported hearing disability and tinnitus in adult Italian. The result showed that 14.5% experience prolonged spontaneous tinnitus. Spoendline(1987) gave figures of 50% in patients with sudden sensorineural hearing loss, 70% in those with presbyacusis, 30-90% in ototoxicity patients, 50-90% in chronic acoustic trauma patients and 100% in patient

Thanks for listening

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