

Sound Therapies: Basis, implementation and outcomes

Current Trends in the Evaluation and Treatment of Tinnitus
AudiologyNOW! 2011, Academy Research Conference (ARC)

G D Searchfield PhD

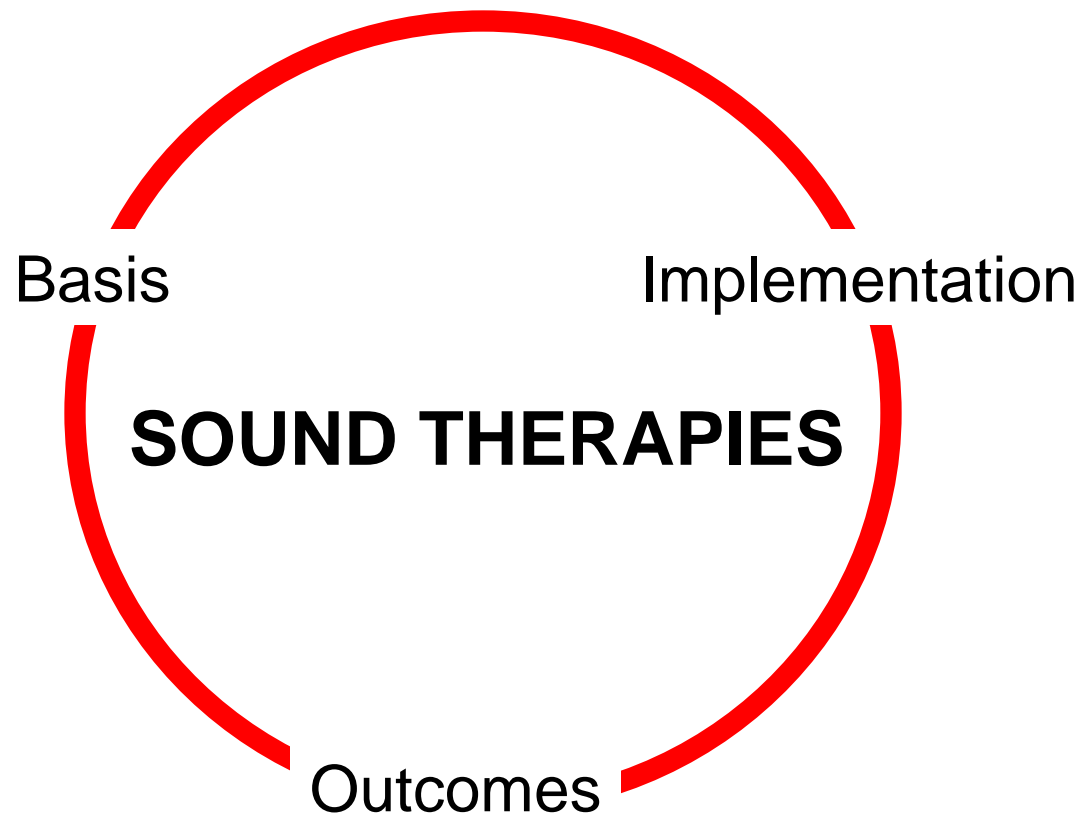
g.searchfield@auckland.ac.nz

I advise that I have no financial interests with any commercial products mentioned in this presentation.

At the end of this talk you should be able to...

1. Describe the underlying basis of several sound therapy types.
2. Identify the different psycho-acoustical features of sound reported as being beneficial for sound therapy.
3. Identify ways in which an individual's listening preferences and hearing can influence the choice of sound therapy.

Over the next 40 or so mins...

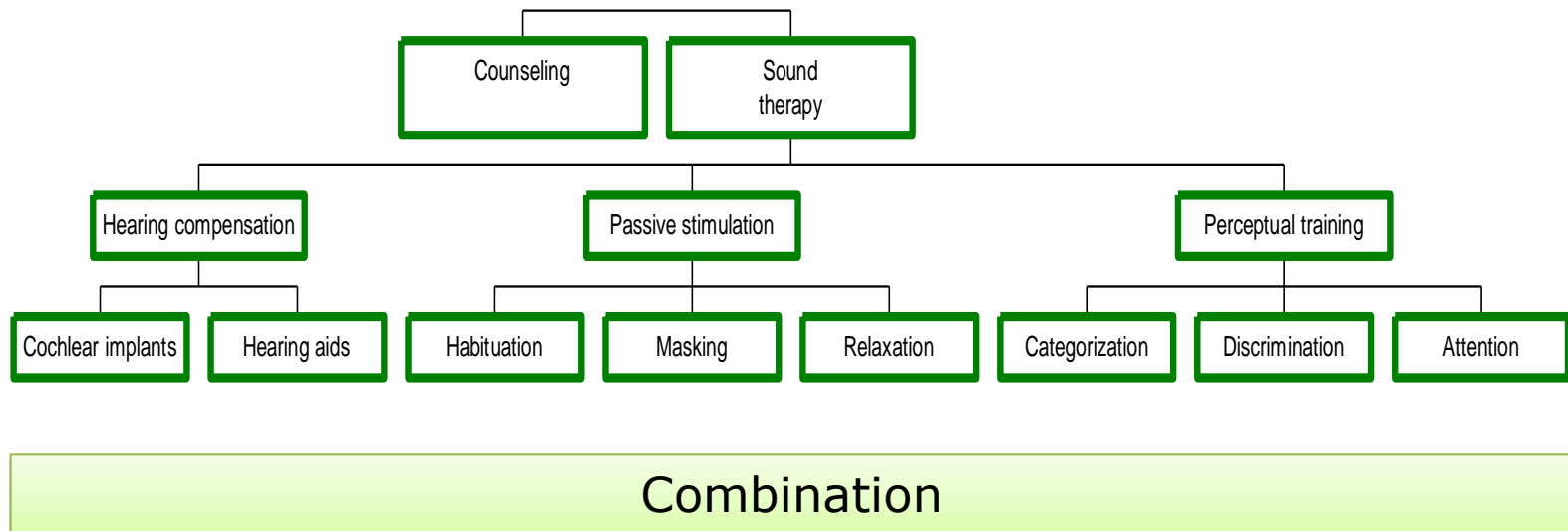


Sound Therapies: Basis

"You're head is humming and it won't go in case you don't know..."

Robert Plant – Led Zeppelin
Stairway to Heaven

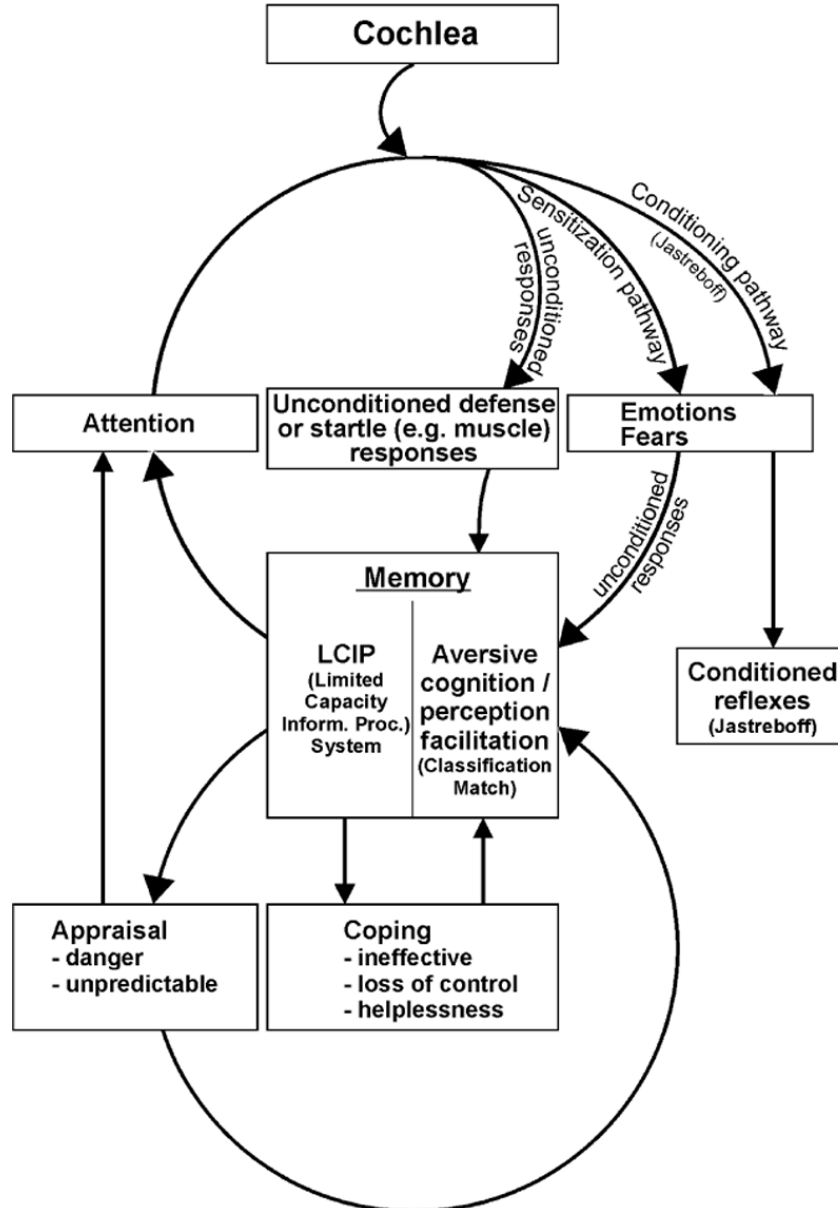
- Sound (or Acoustic) therapy is a generic term used to describe the use of sound to have a positive effect on tinnitus, either to directly or indirectly reduce tinnitus perception and negative effects on quality of life.



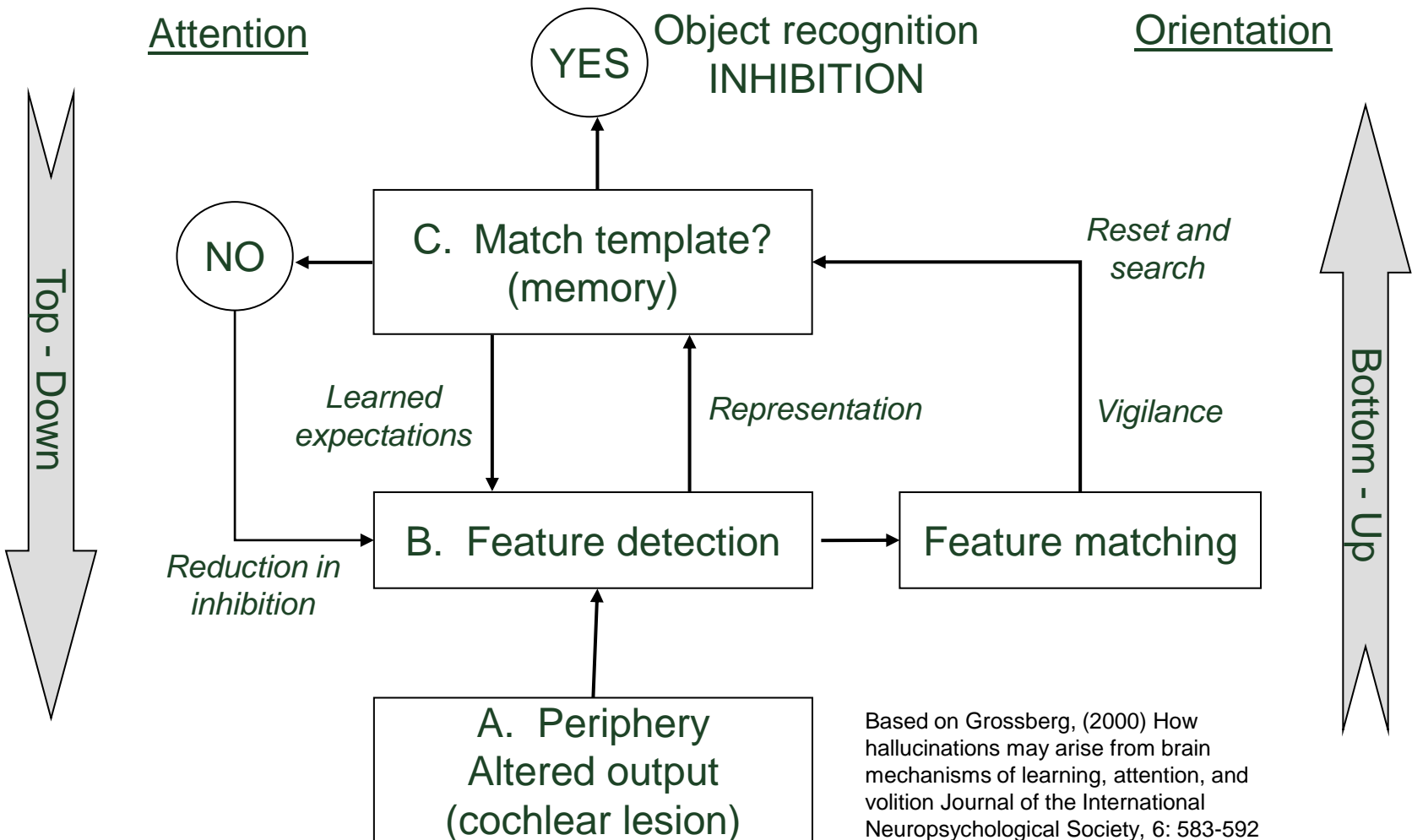
Sound therapy could lead to psychological benefits or alter the underlying physiological generators.

- Masking (excitatory and informational/central)
- Gain adaptation
- Attention
- Habituation
- Lateral inhibition
- Residual inhibition
- Relaxation
- Other plastic processes

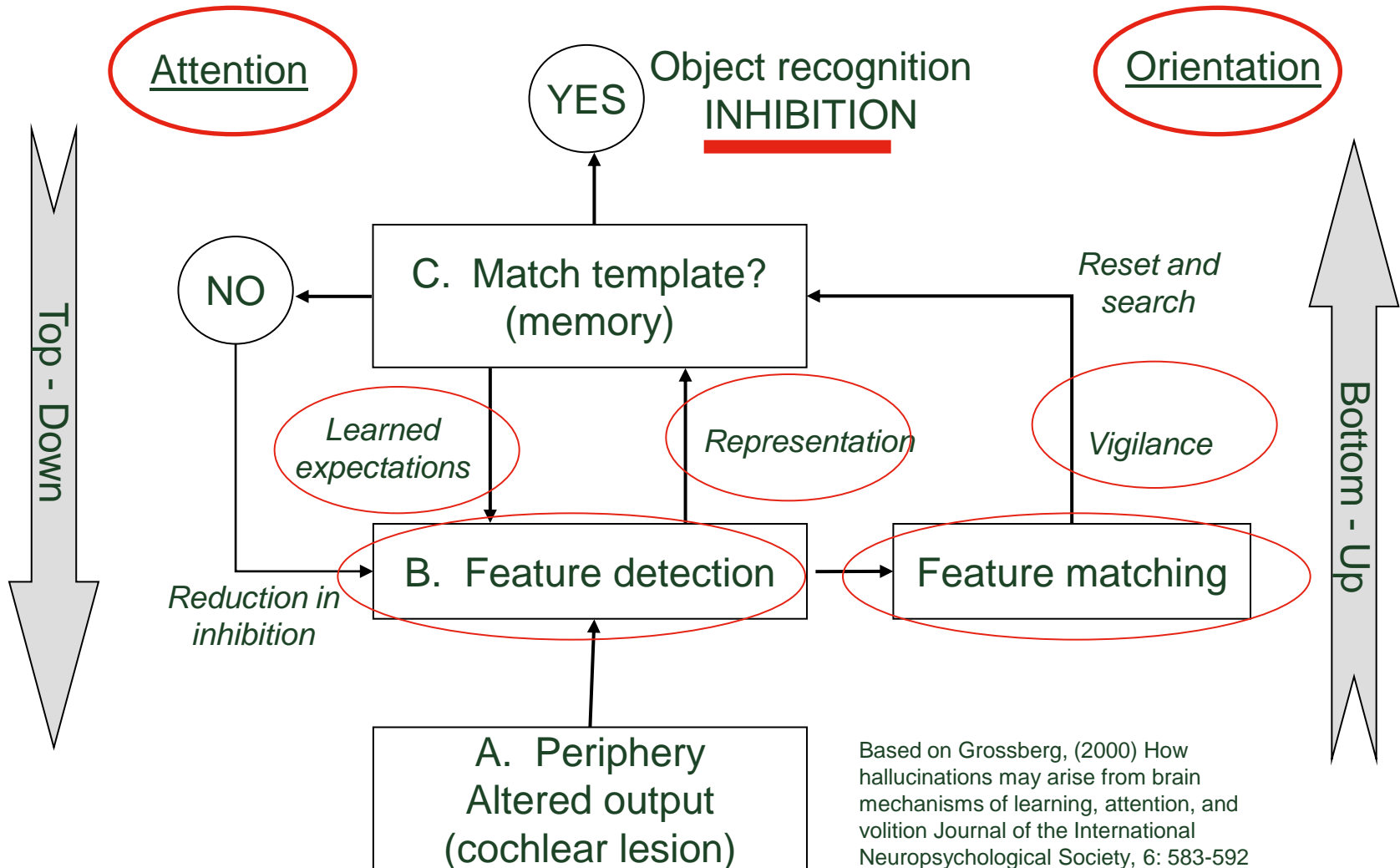
A model of tinnitus perception



Zenner HP, Pfister M, Birbaumer N.(2006) Tinnitus sensitization: Sensory and psychophysiological aspects of a new pathway of acquired centralization of chronic tinnitus. *Otol Neurotol.* 27(8):1054-63. Fig 4 p 1057

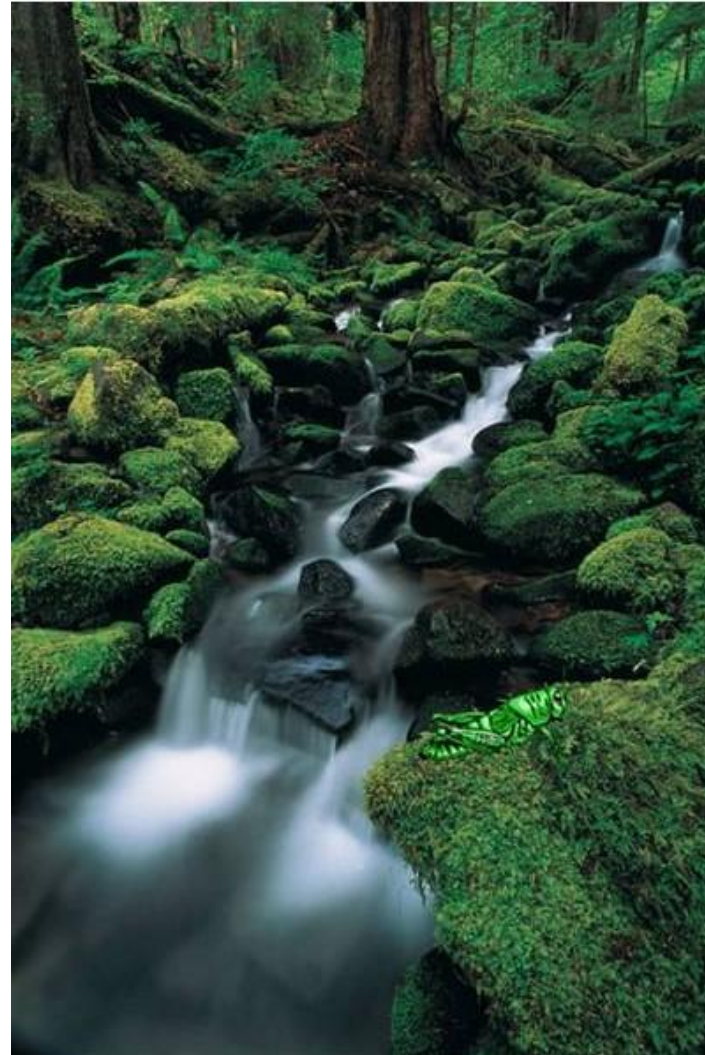


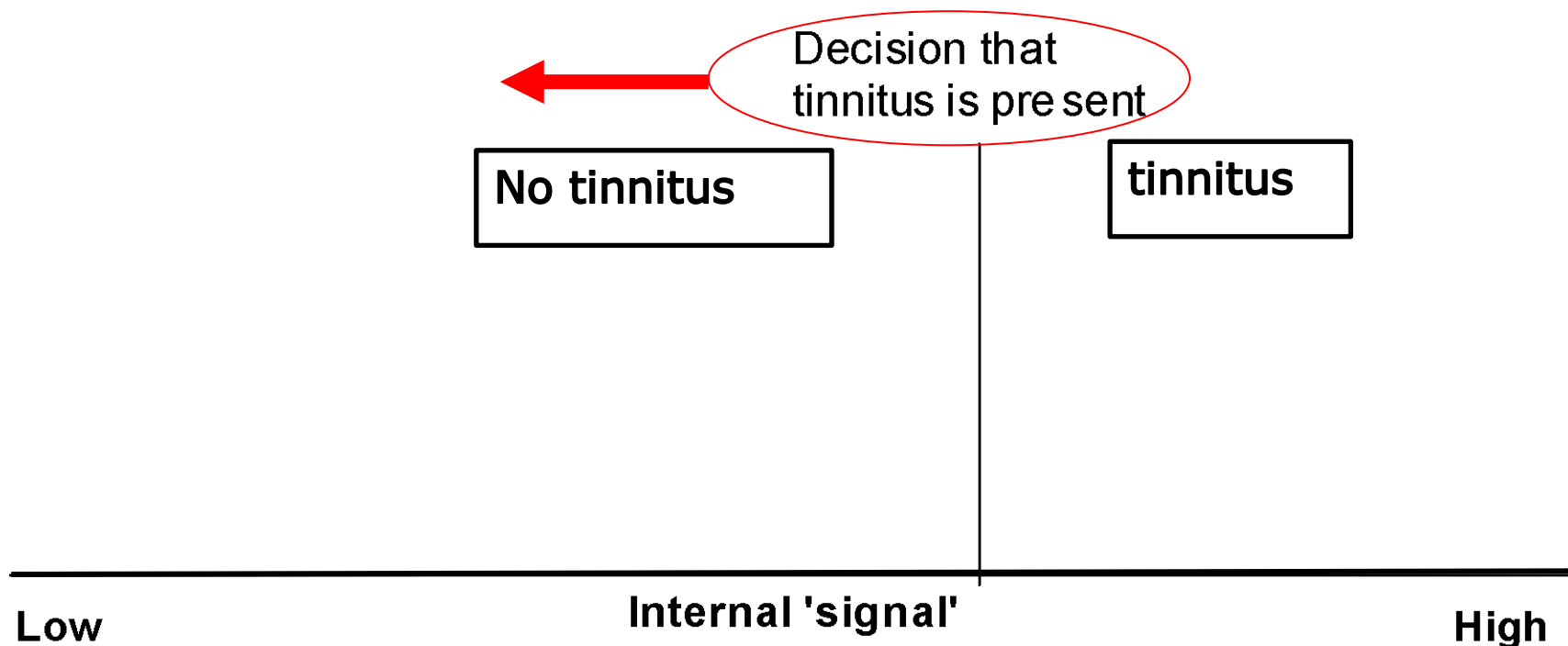
Based on Grossberg, (2000) How hallucinations may arise from brain mechanisms of learning, attention, and volition Journal of the International Neuropsychological Society, 6: 583-592



Based on Grossberg, (2000) How hallucinations may arise from brain mechanisms of learning, attention, and volition Journal of the International Neuropsychological Society, 6: 583-592



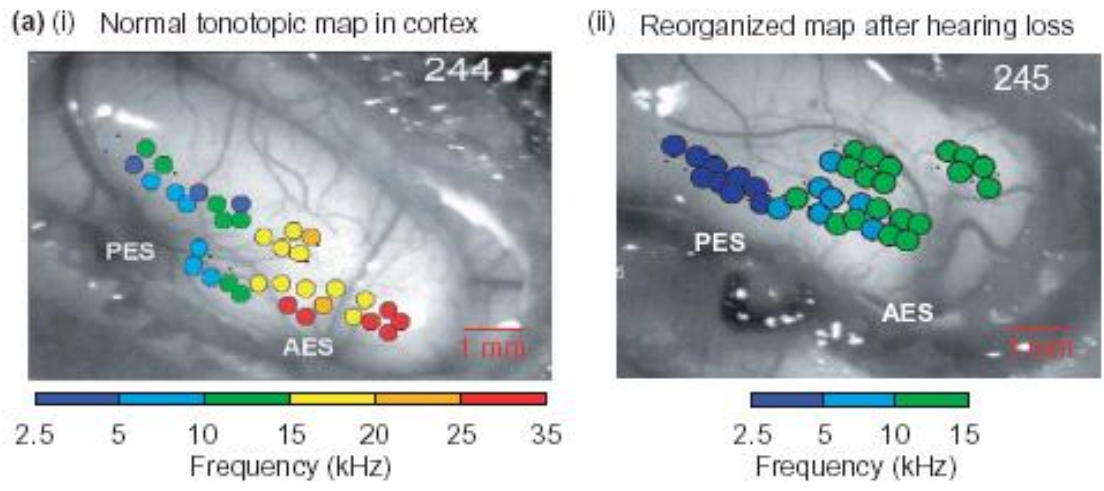




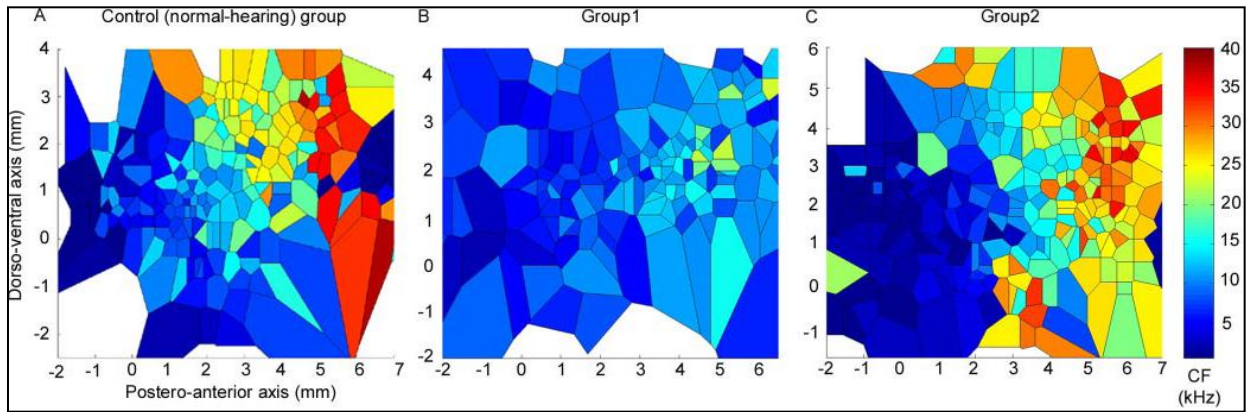
Ignition → *Promotion* → *Awareness*

Based on Welch D. & Dawes P. 2008. Personality and perception of tinnitus. *Ear. Hear.*, 29, 684 - 692.

Reorganization



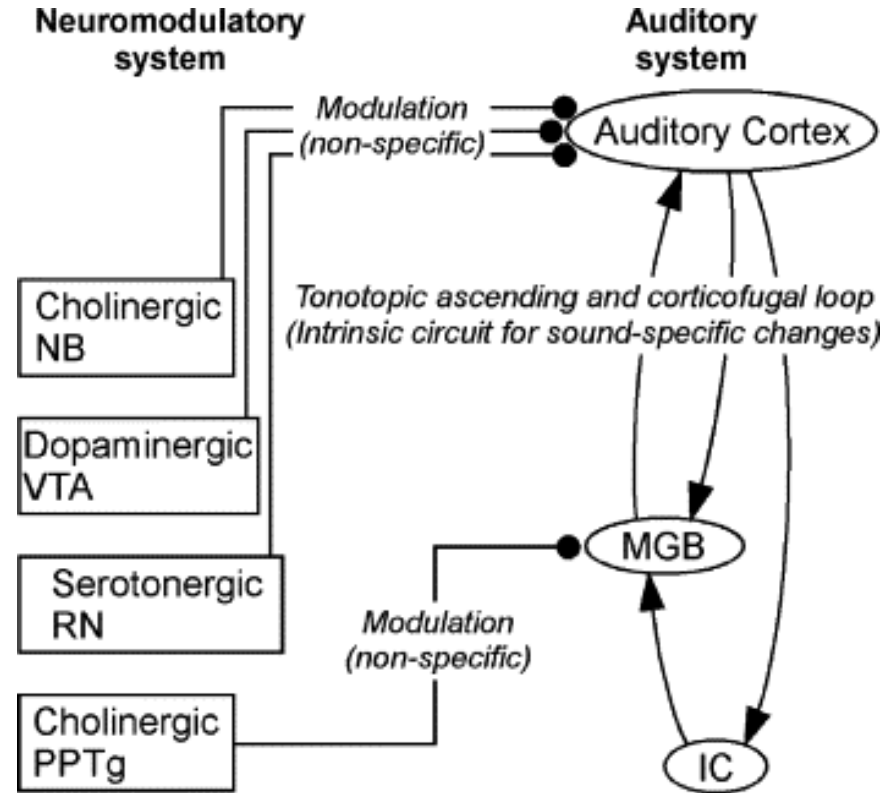
Eggermont JJ and Roberts L. (2004). "The neuroscience of tinnitus." Trends Neurosci 27(11): 676-82.



Noreña, A & Eggermont, J (2005) The Journal of Neuroscience, 2005, 25(3):699-705.

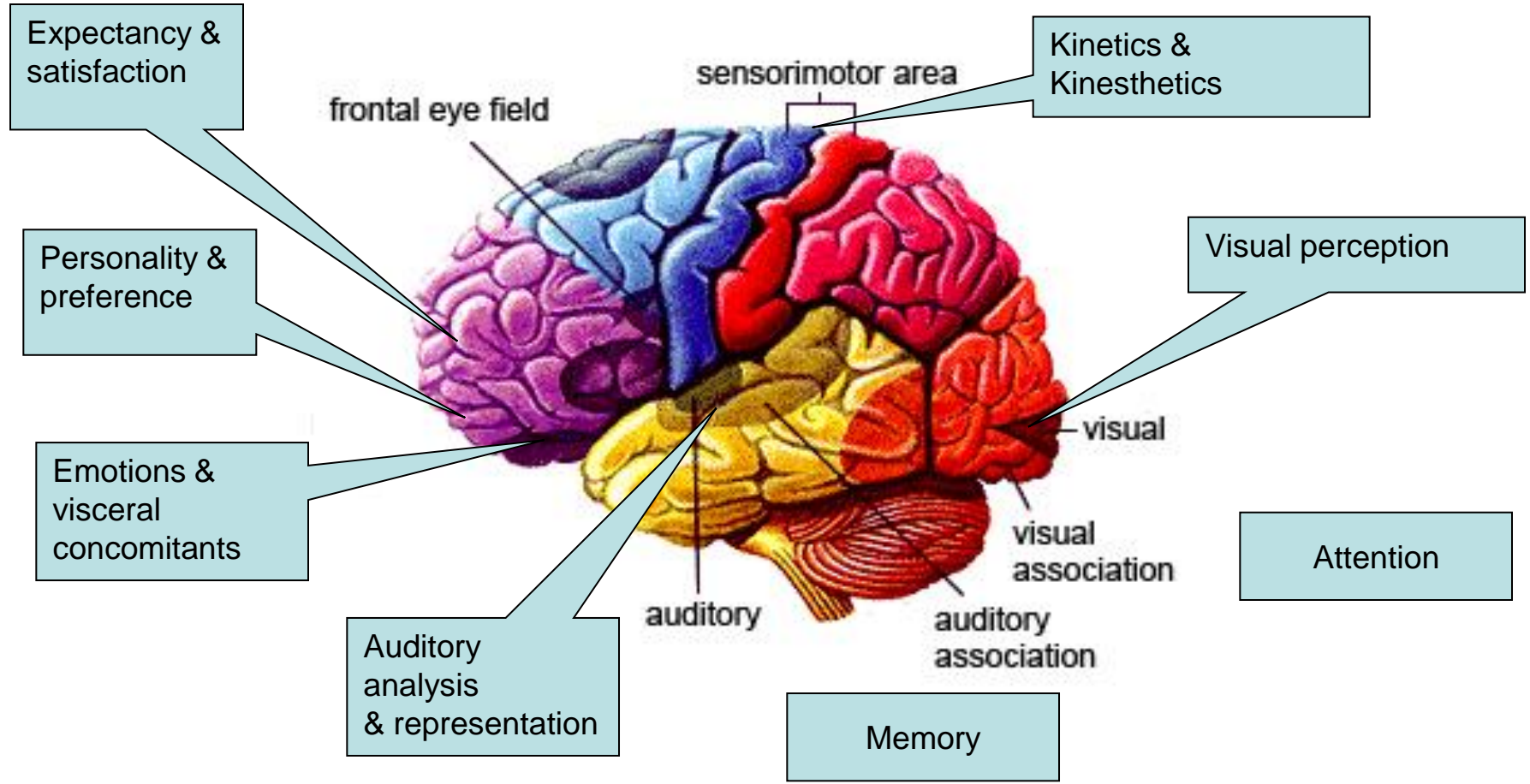
Sound guides plasticity.

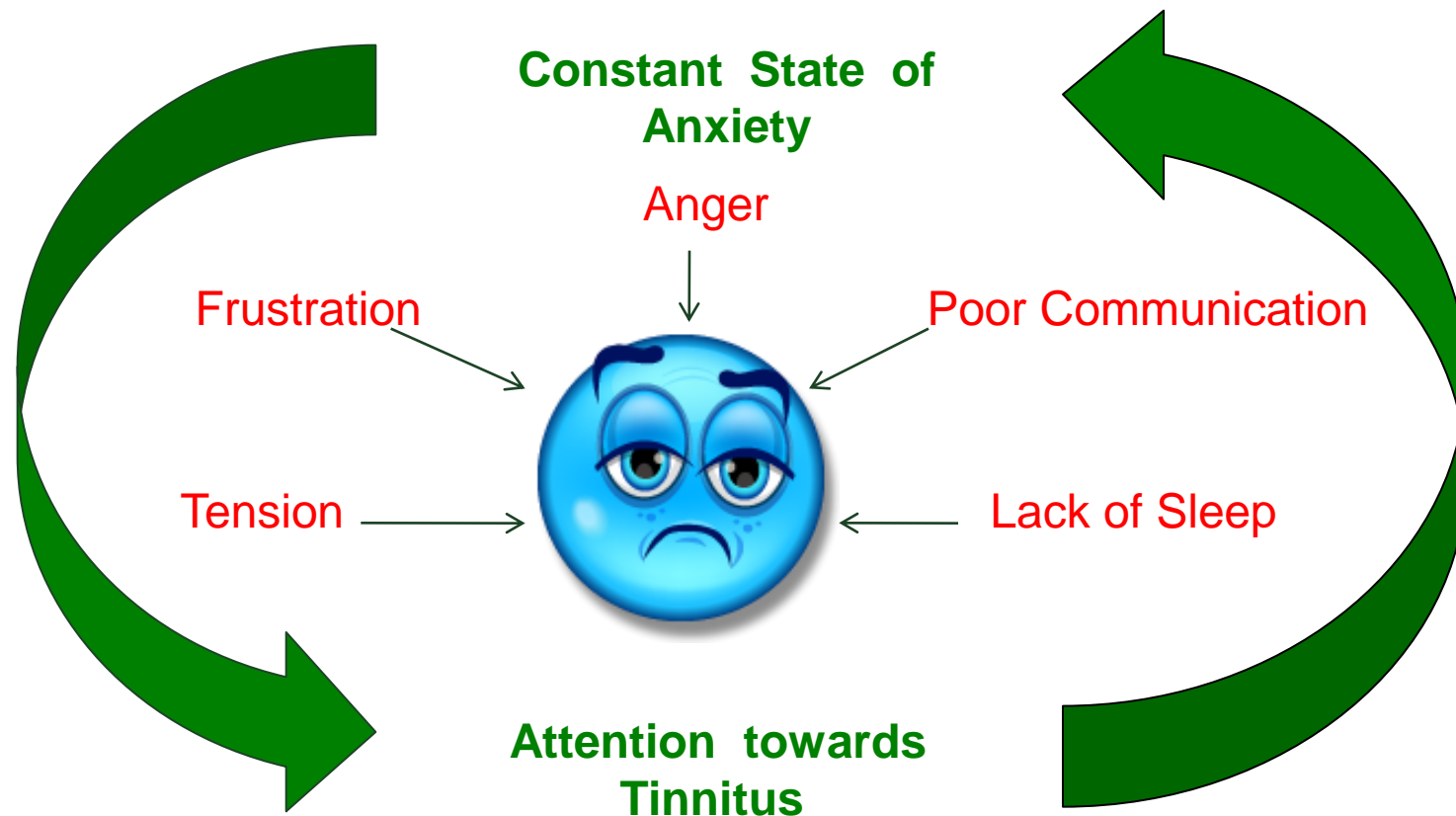
Communication between the cortex, thalamus & midbrain co-ordinates and adjusts circuits.



XIONG, Y. ZHANG, Y. YAN, J. The neurobiology of sound-specific auditory plasticity: A core neural circuit. *Neuroscience and Biobehavioral Reviews* 33 (2009) 1178–1184.

Hearing - more than the ear



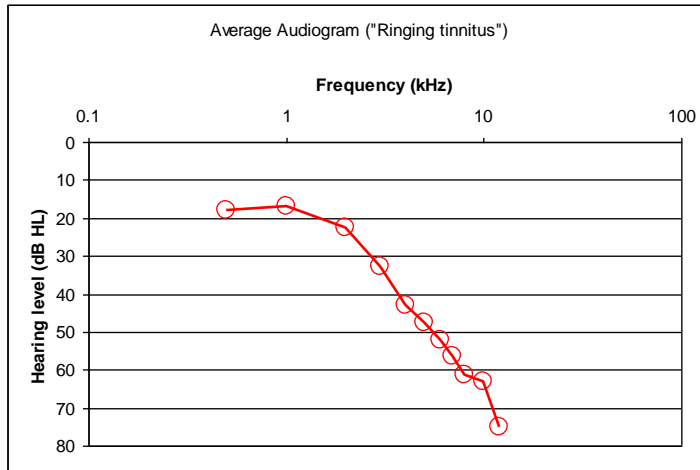


Lockwood et al.2002, Andersson et al. 2005,Appelqvist et al. 2001

Sound Therapies: Implementation

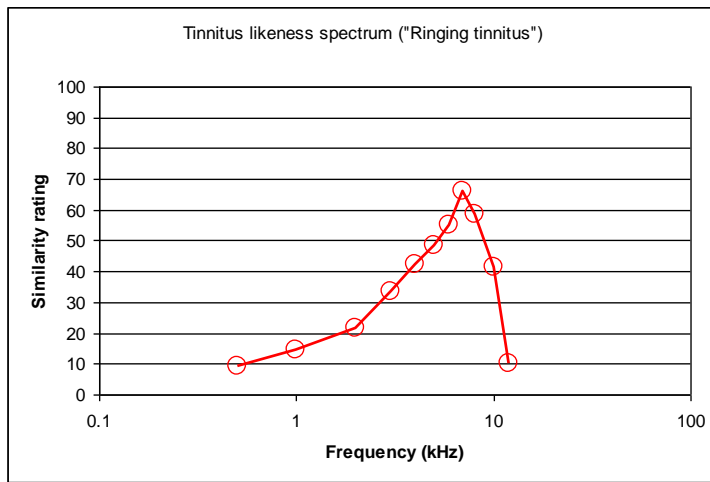
Psychoacoustical Considerations

Signal spectrum



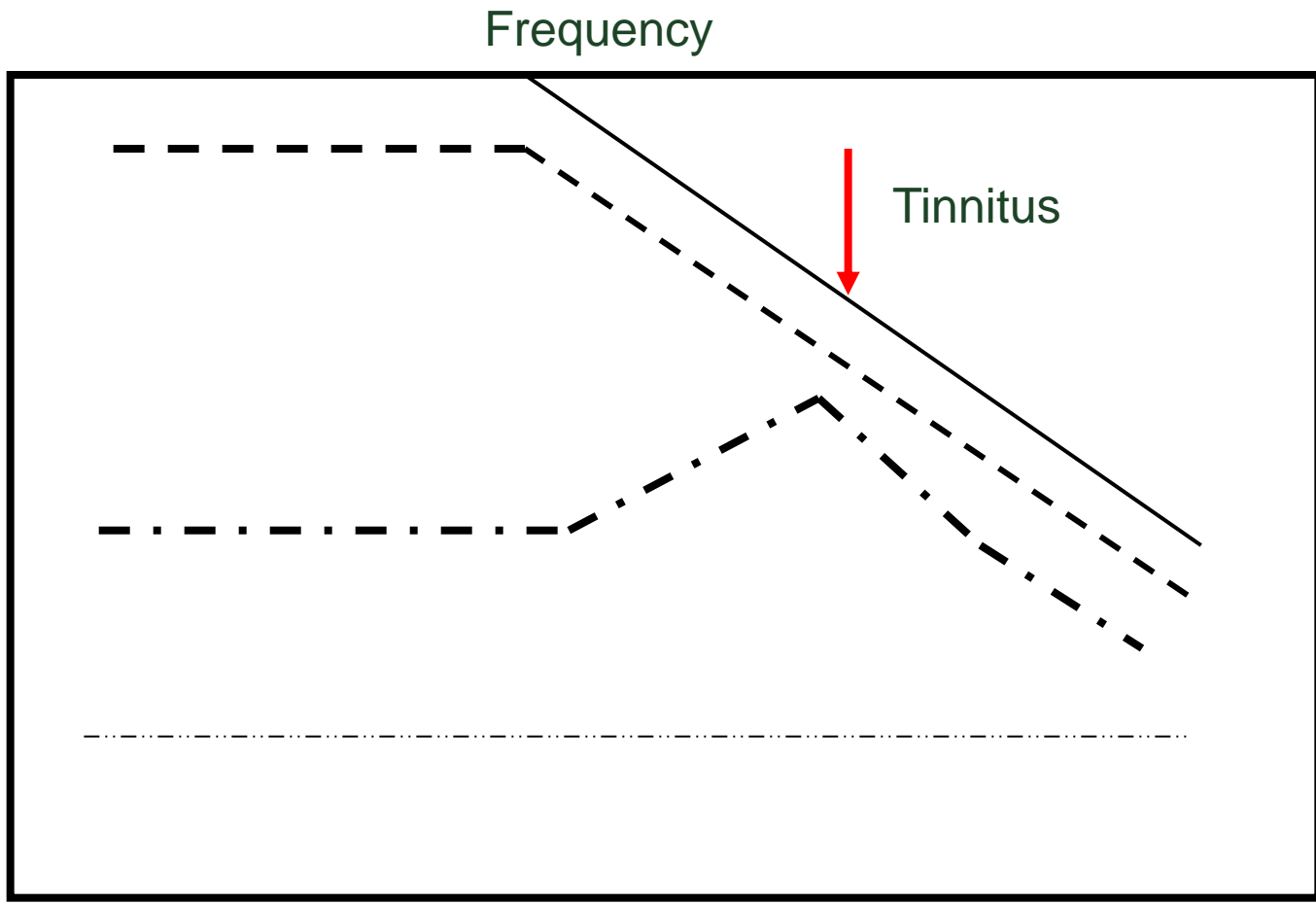
At least 2 important considerations

1. Hearing loss



2. Associated tinnitus spectrum

Frequency specific masking



Feldman (1971), Tyler and Conrad-Armes (1984)

Hearing aids

'The empty vessel makes the greatest sound.'

William Shakespeare

The Life of King Henry the Fifth (Boy at IV, v)

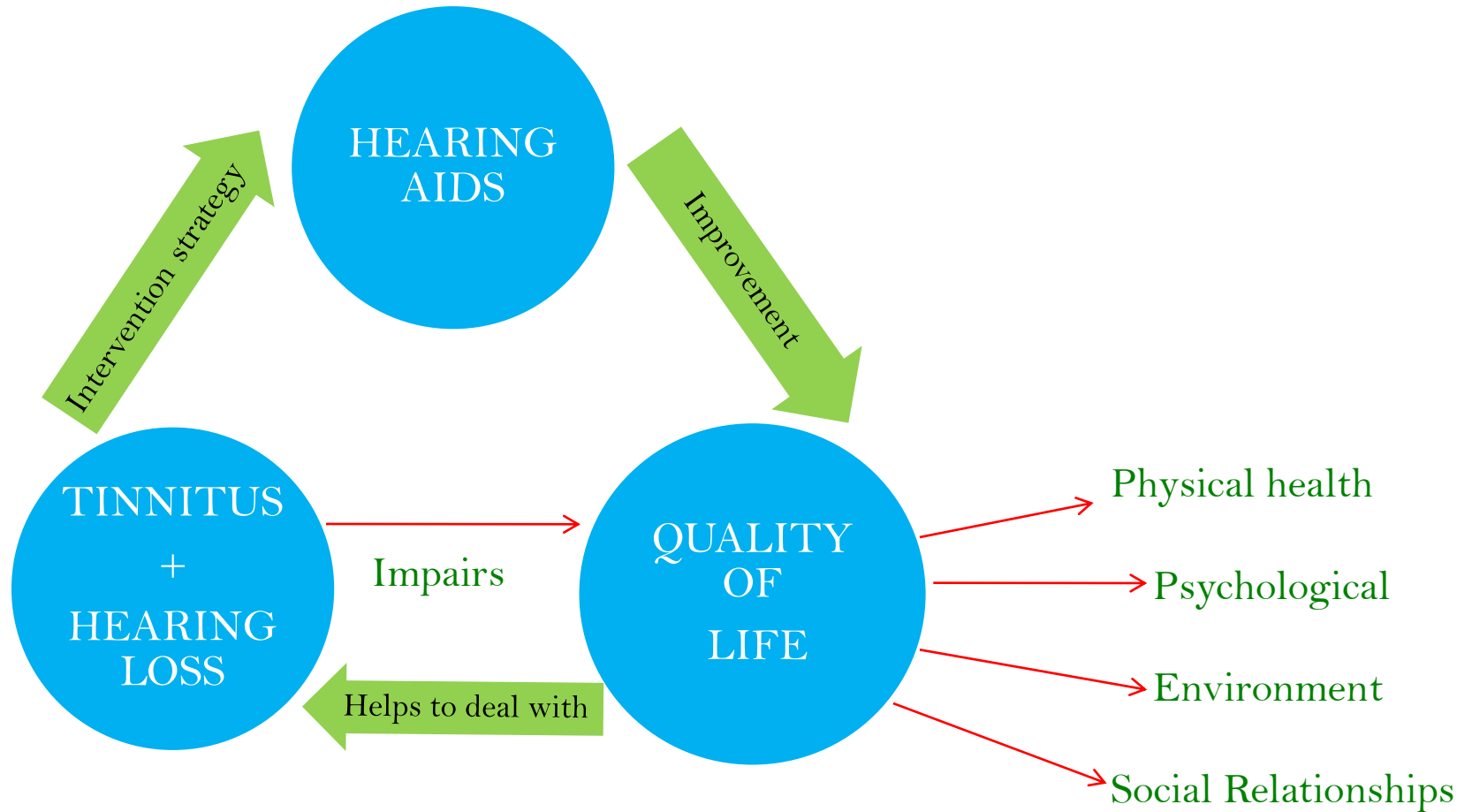
- Saltzman and Ersner (1947) A hearing aid for the relief of tinnitus aurium
- Surr et al. (1985) 50% of hearing aid users benefit with tinnitus relief
- Melin et al. (1987) no benefit
- Surr et al. (1999) 10% reduction in tinnitus handicap over 6 weeks.

- Sanchez & Stephens (2000) Survey of tinnitus patients over 1/3 of respondents reported that the primary benefit of attending a specialised tinnitus clinic was the fitting of hearing aids
- Trotter & Donaldson (2008) 25-years experience using hearing aids for tinnitus therapy - significant improvement in tinnitus perception, comparing analogue aids with digital hearing aids

- Older, often linear amplification hearing aids
 - Underamplification of soft sounds
 - Overamplification of loud sounds
 - Distortion
 - Limited bandwidth
- Fitted with the primary goal of assisting hearing
 - Limited consideration of electroacoustical characteristics ideal for tinnitus

In selecting hearing aids for tinnitus therapy aims are:

1. Reduce tinnitus audibility/enriched sound environment
2. Improve hearing
3. Long term plastic changes in brain

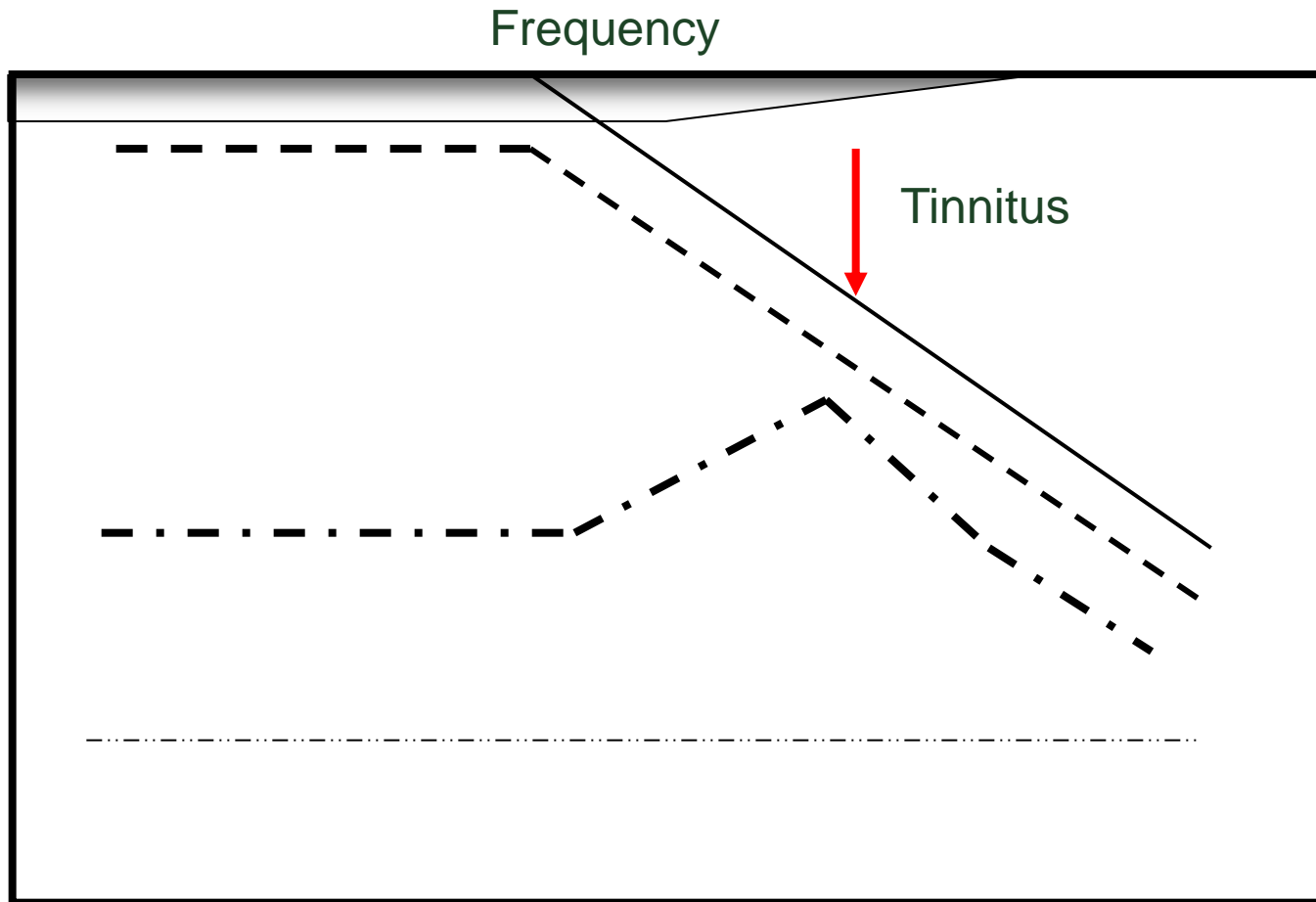


- Not simply a case of increasing gain for all sounds
- Effects of sound on arousal, attention and emotional state
- Avoid drawing attention to hearing, draw attention away from tinnitus

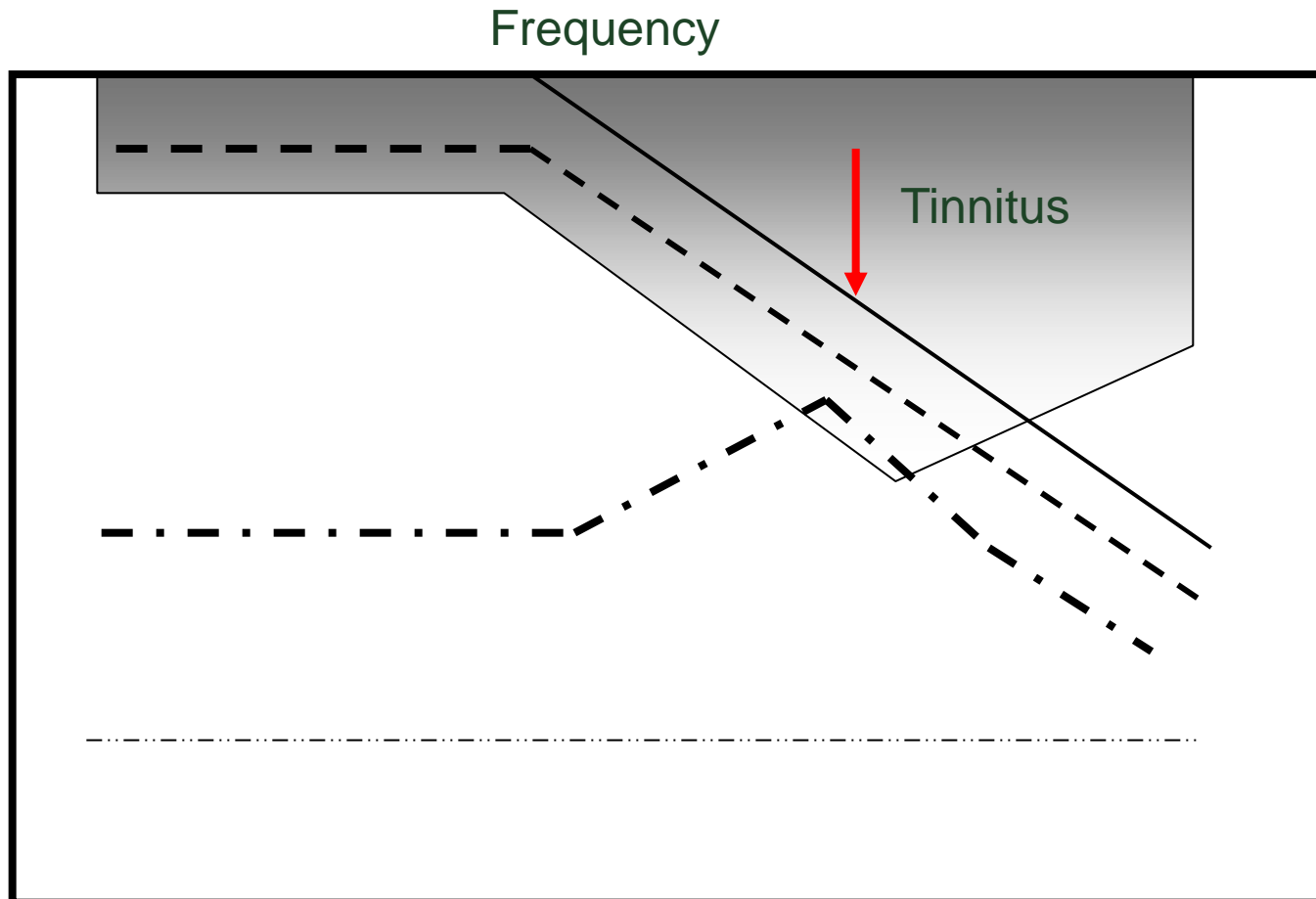
How to achieve reduced tinnitus audibility?

- What frequency response and how much compression?
 - Background noise spectrum
 - Hearing aid response
 - Tinnitus pitch
- What prescription of amplification?
 - Broad frequency response
 - Amplification of soft sounds
 - Avoid loudness discomfort

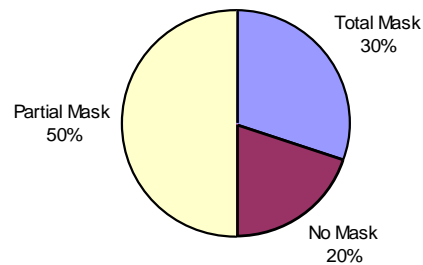
Background noise



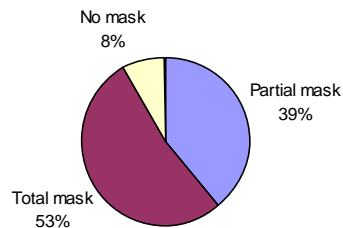
Amplification of Background noise



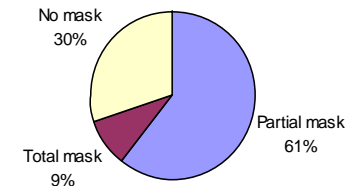
**Overall masking effect of hearing aids
N.102 ears**



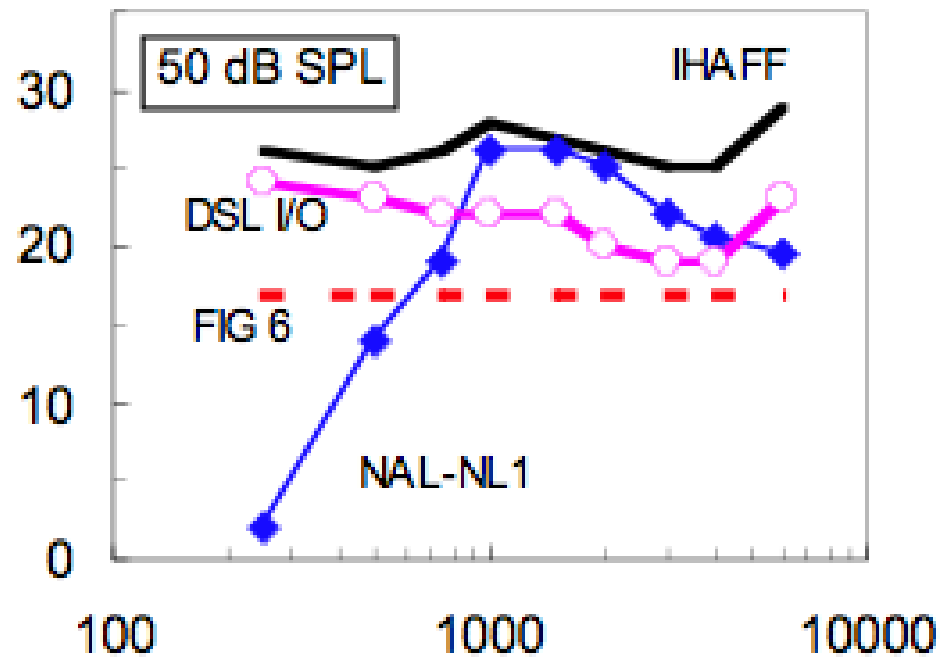
**Masking effect on tinnitus pitch within hearing aid frequency range
(N 49 ears)**



**Masking effect on tinnitus pitch outside hearing aid frequency range
(N 53 ears)**

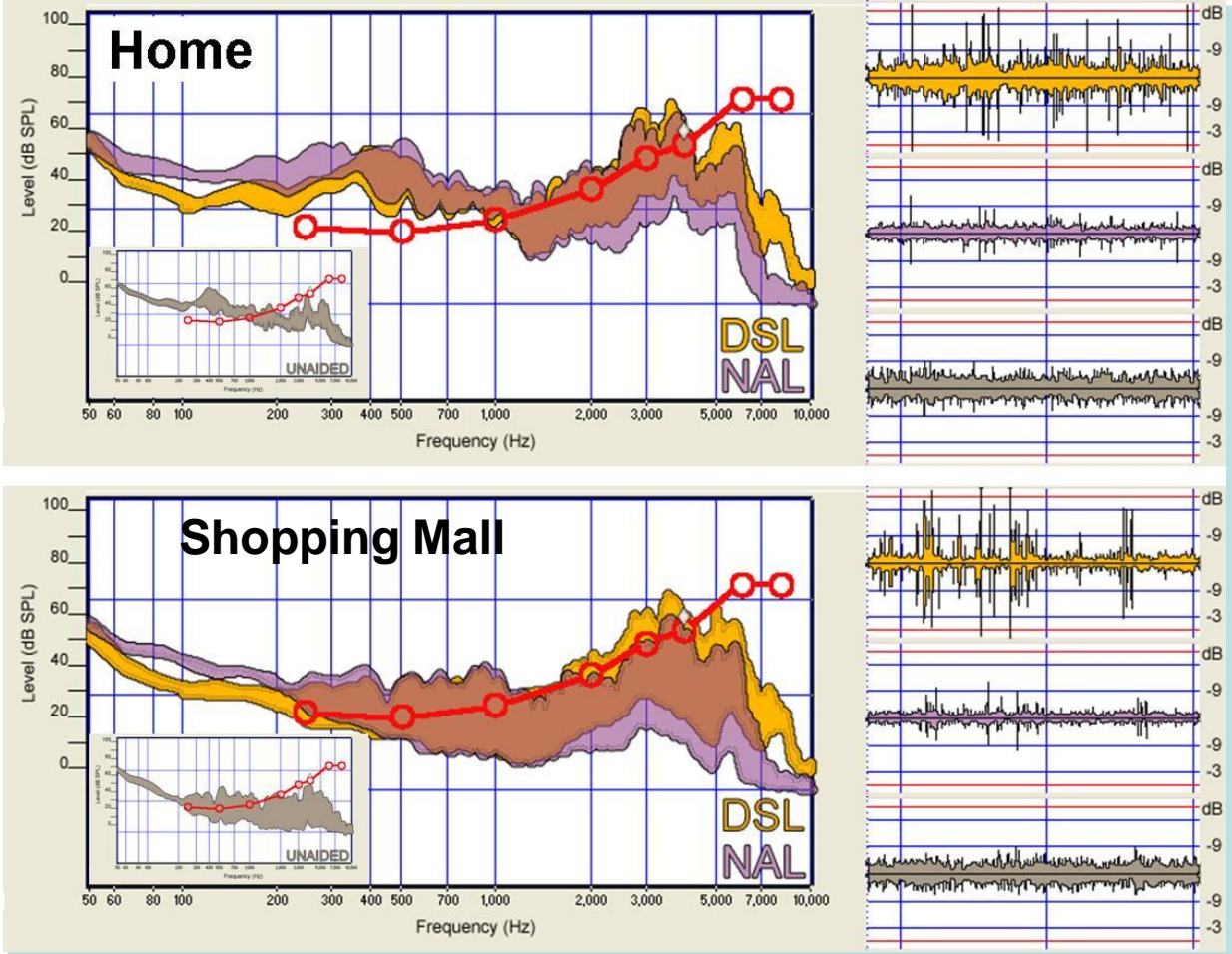


Frequency response

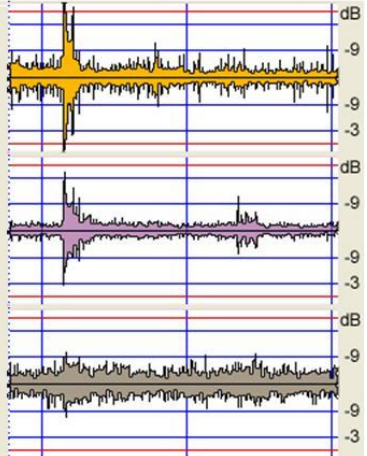
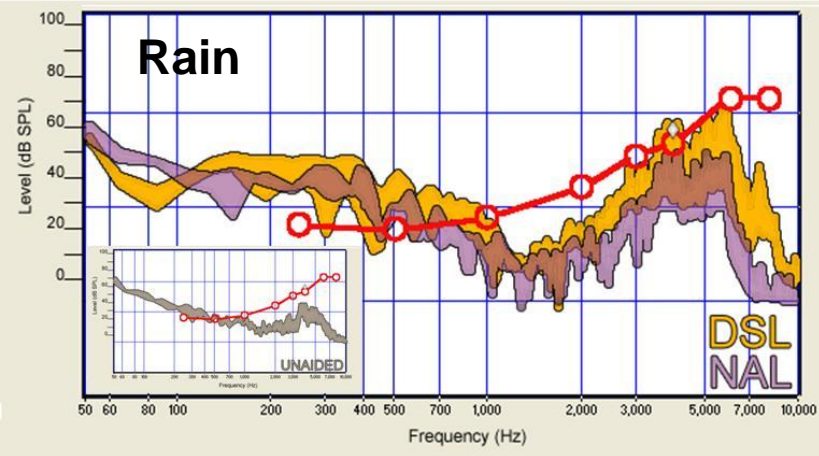
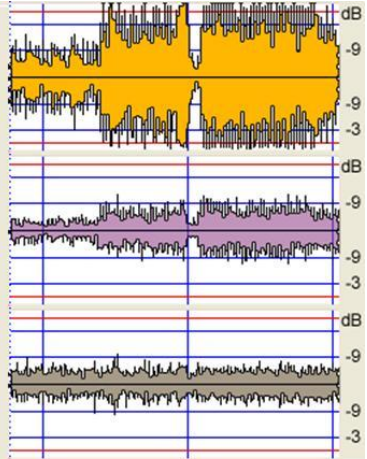
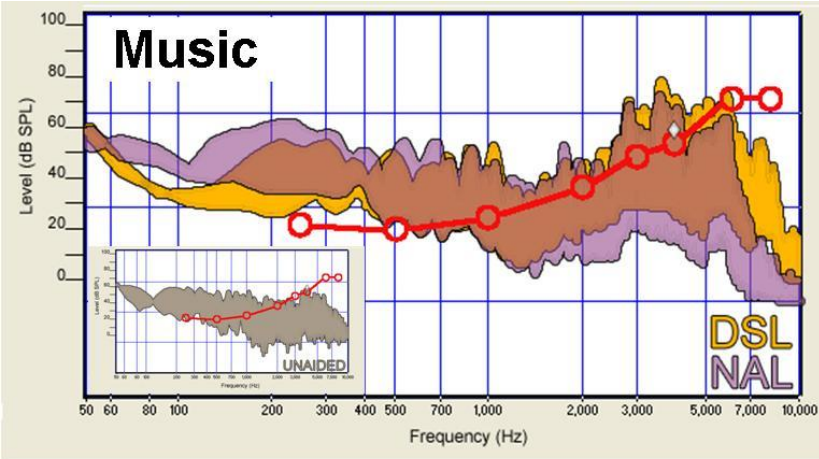


Dillon (2001): *Hearing Aids*. Thieme. ISBN 1-58890-052-5

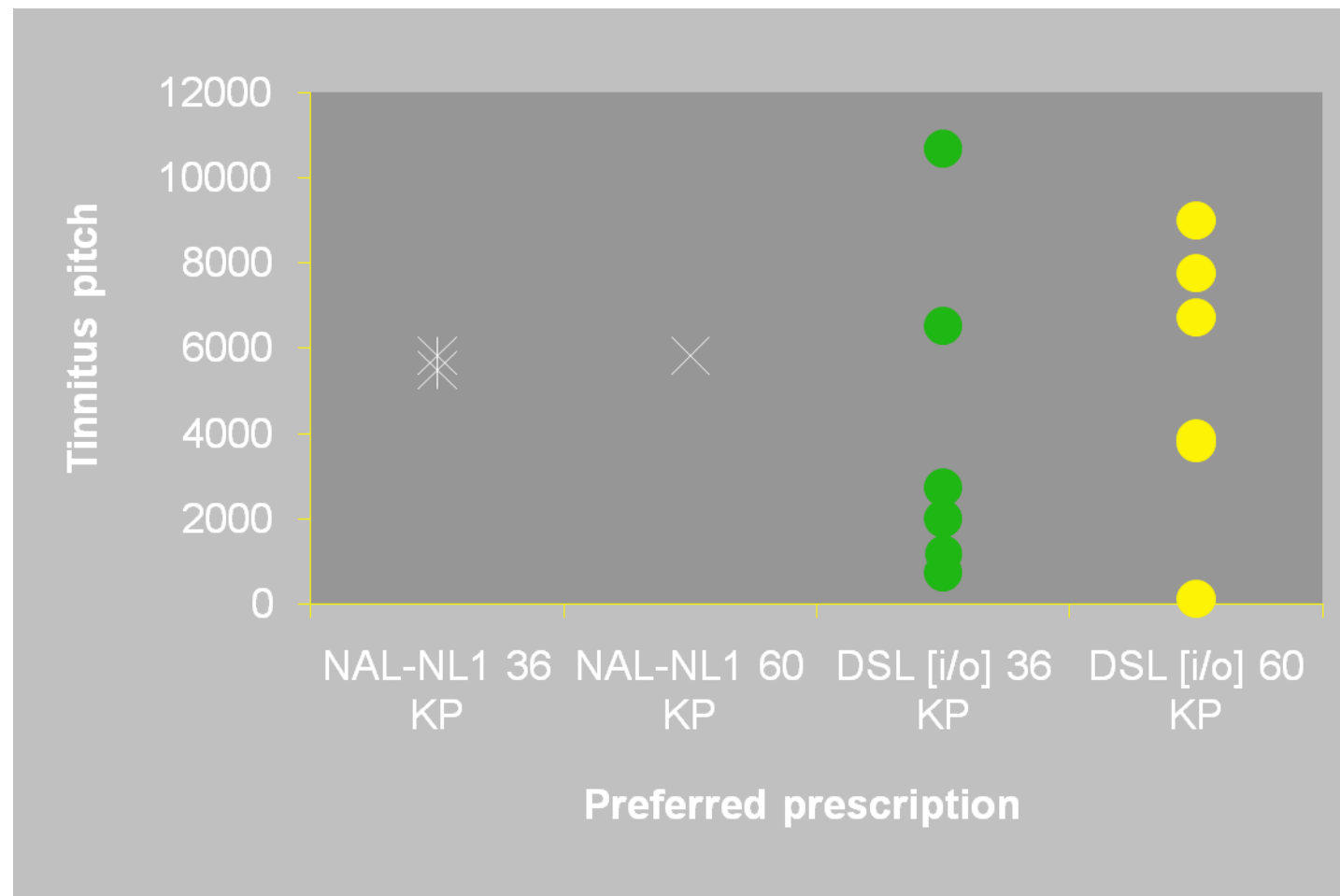
Comparisons



Comparisons



Tinnitus pitch



Wise (2003)

Sound Therapies: Implementation

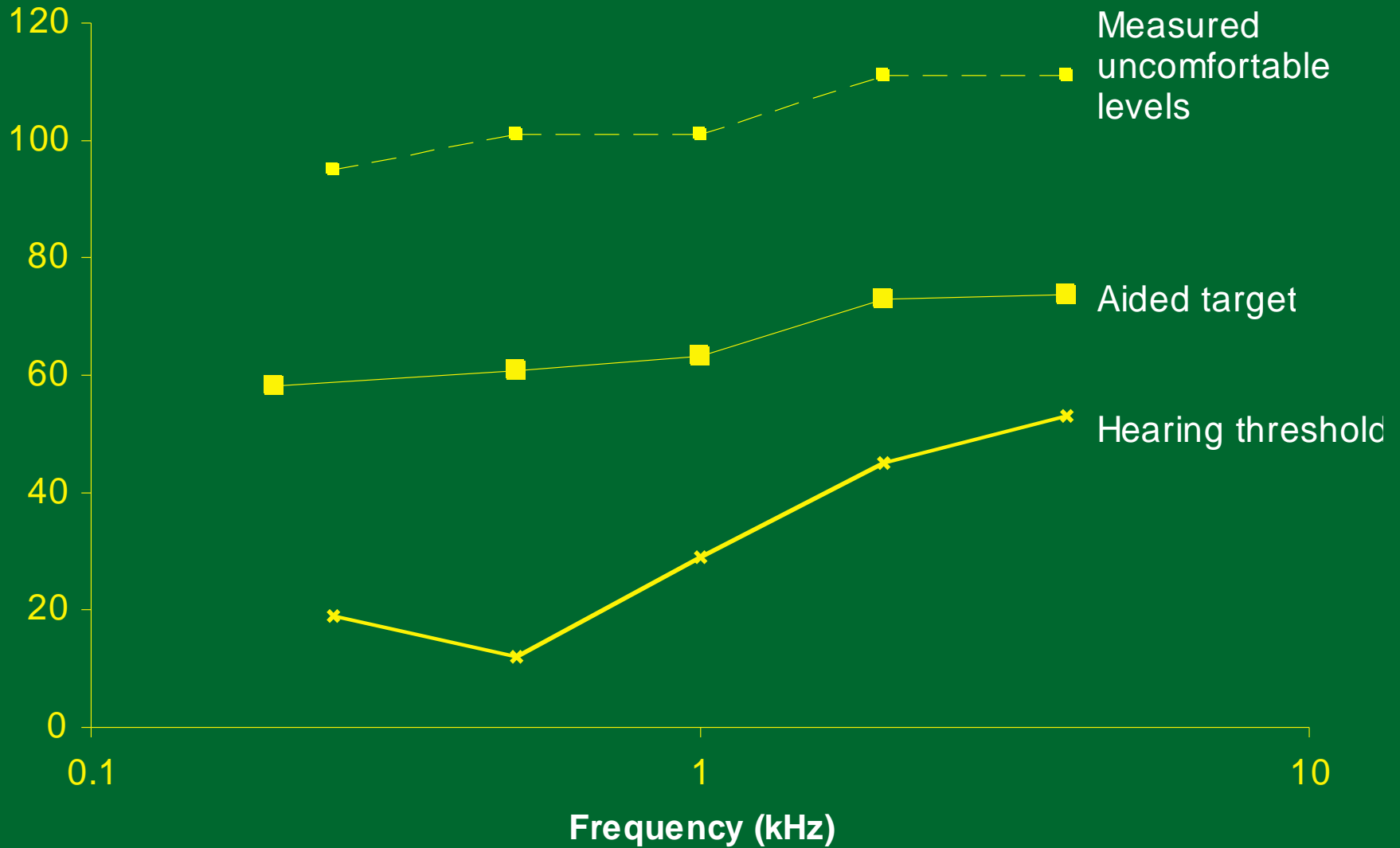
Hearing aids - how we do it

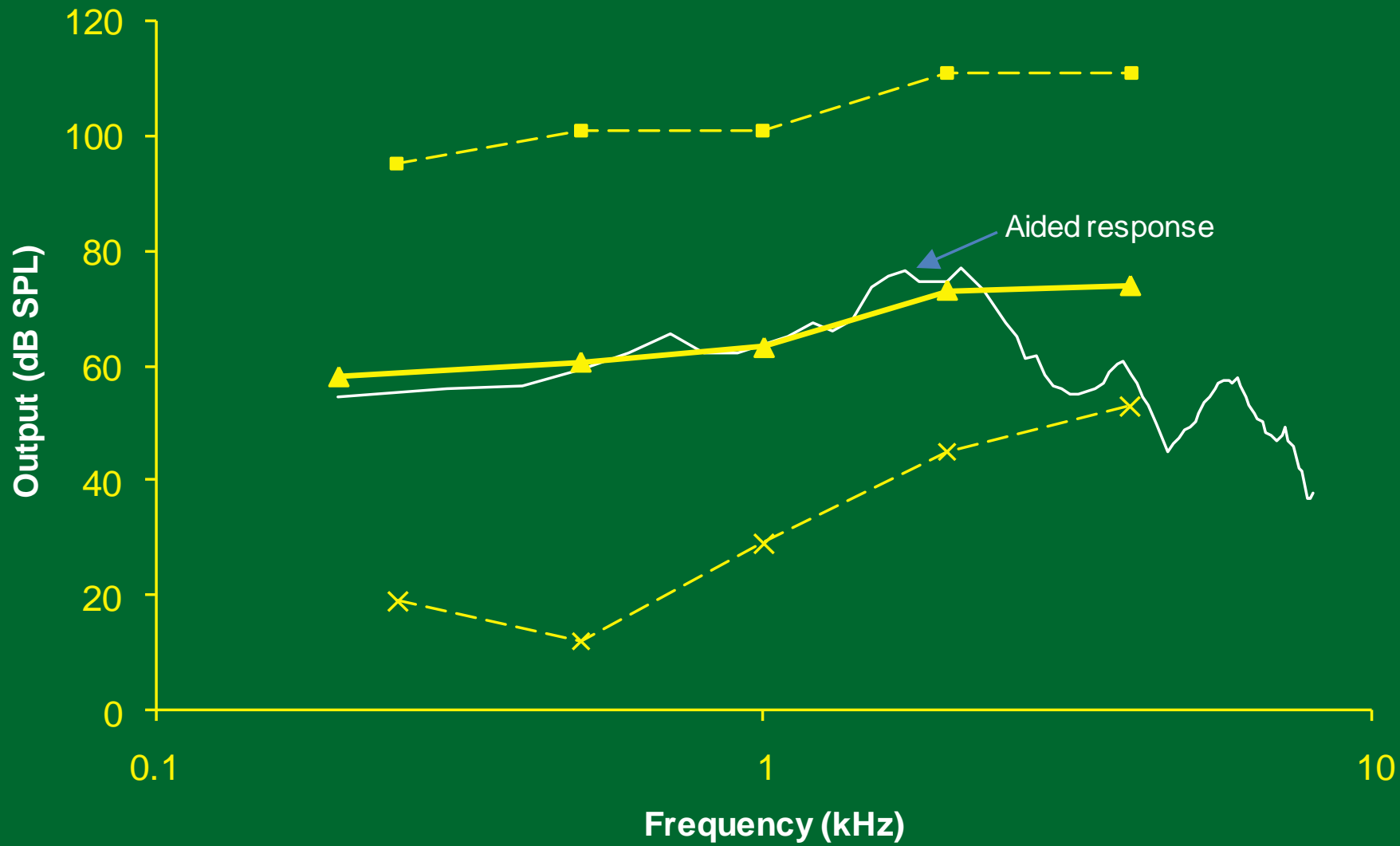
Key fitting parameters

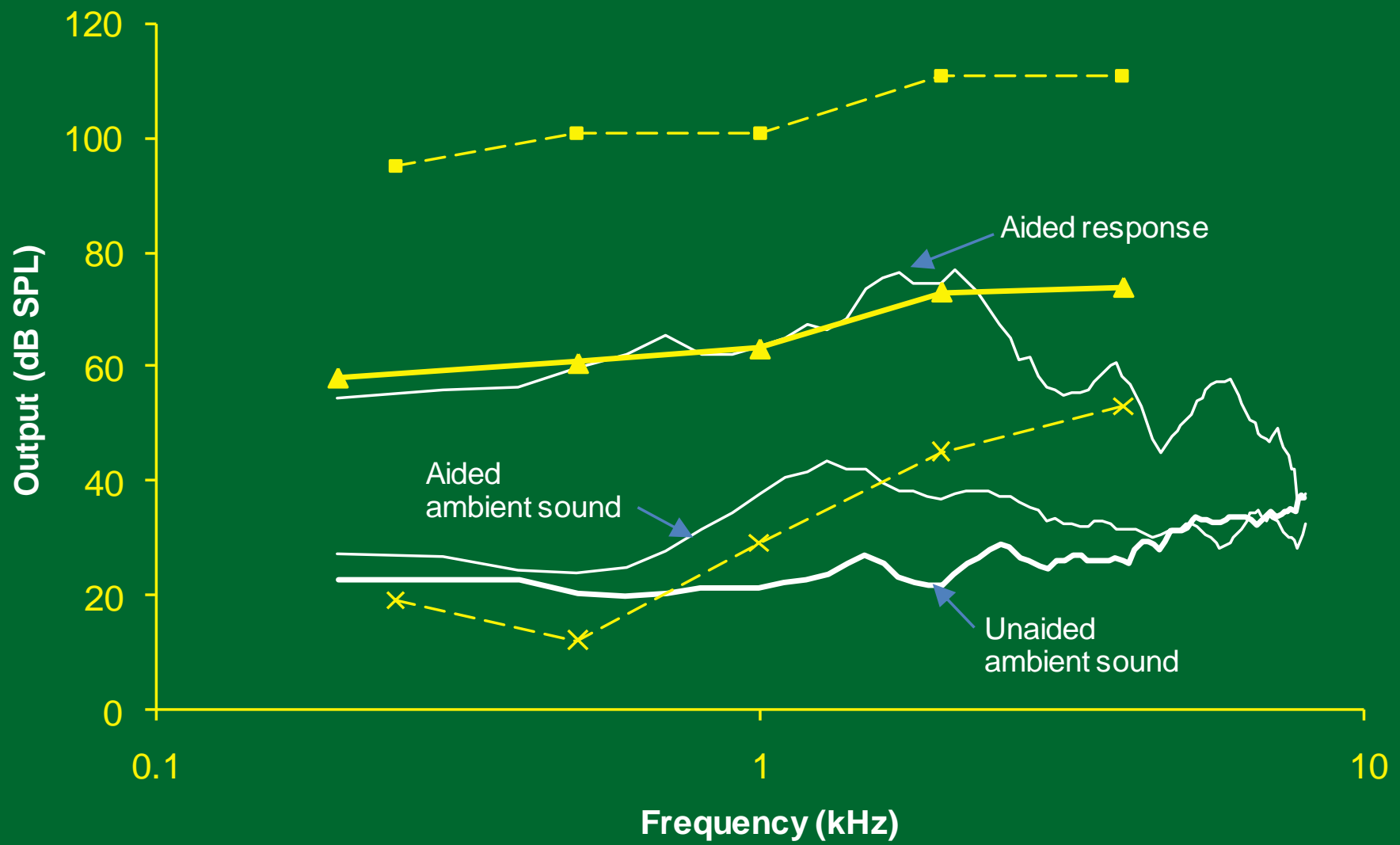
- Amplify soft environmental sounds
 - Turn off features recommended for noise reduction
 - Expansion off
 - Low compression threshold

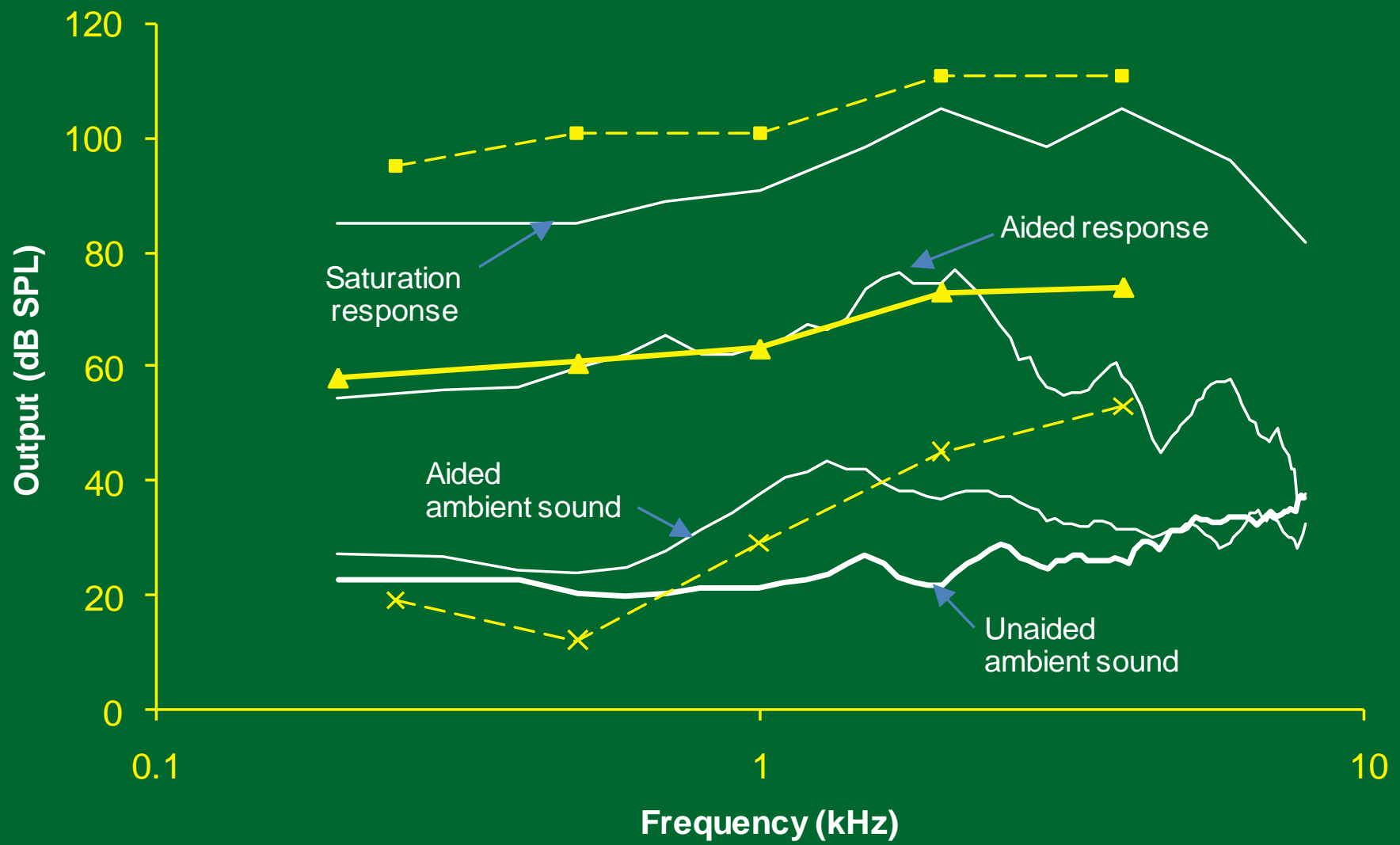
- Optimize listening comfort

Fitting procedure

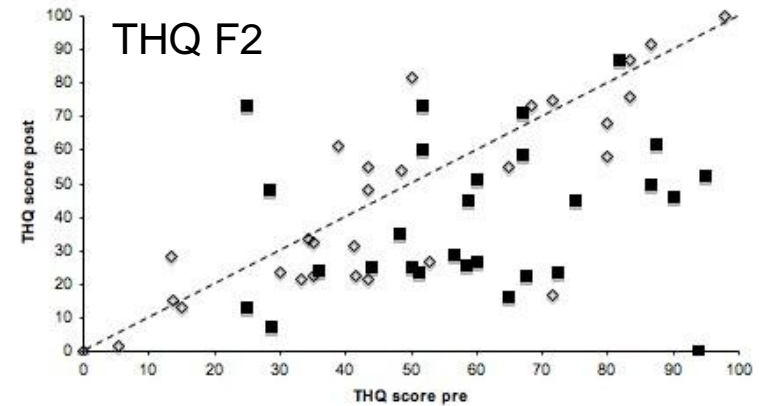
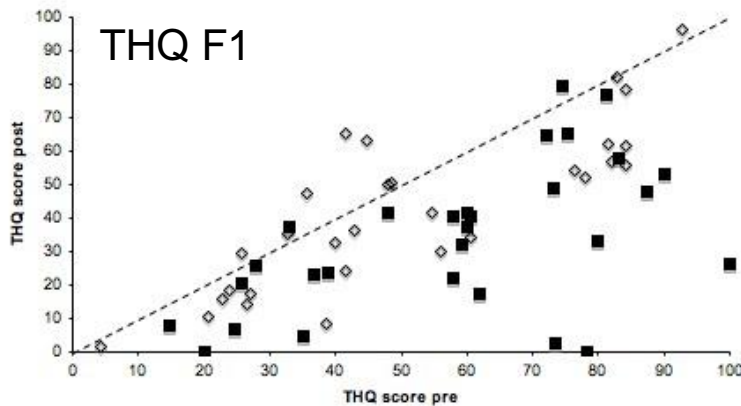
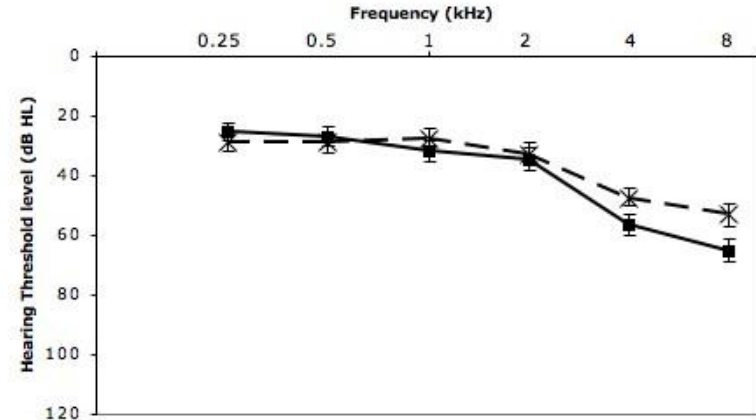
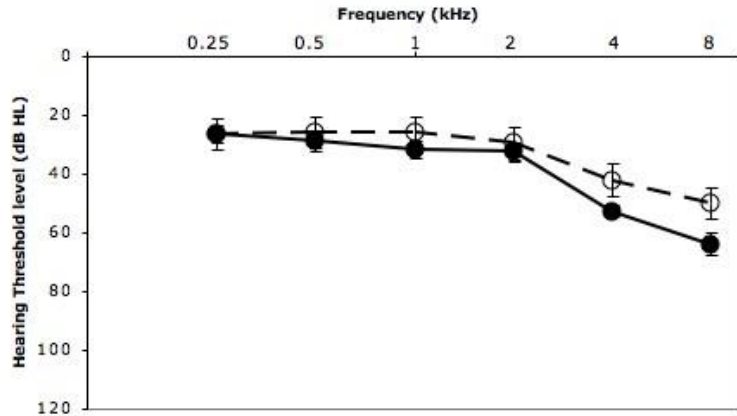








Hearing aids vs. counseling alone



SEARCHFIELD, G.D; KAUR, M; MARTIN, W.H. 'Hearing aids as an adjunct to counseling: Tinnitus patients who choose amplification do better than those that don't', *INT J AUDIOL*, 49, (8), p574-579, 2010.

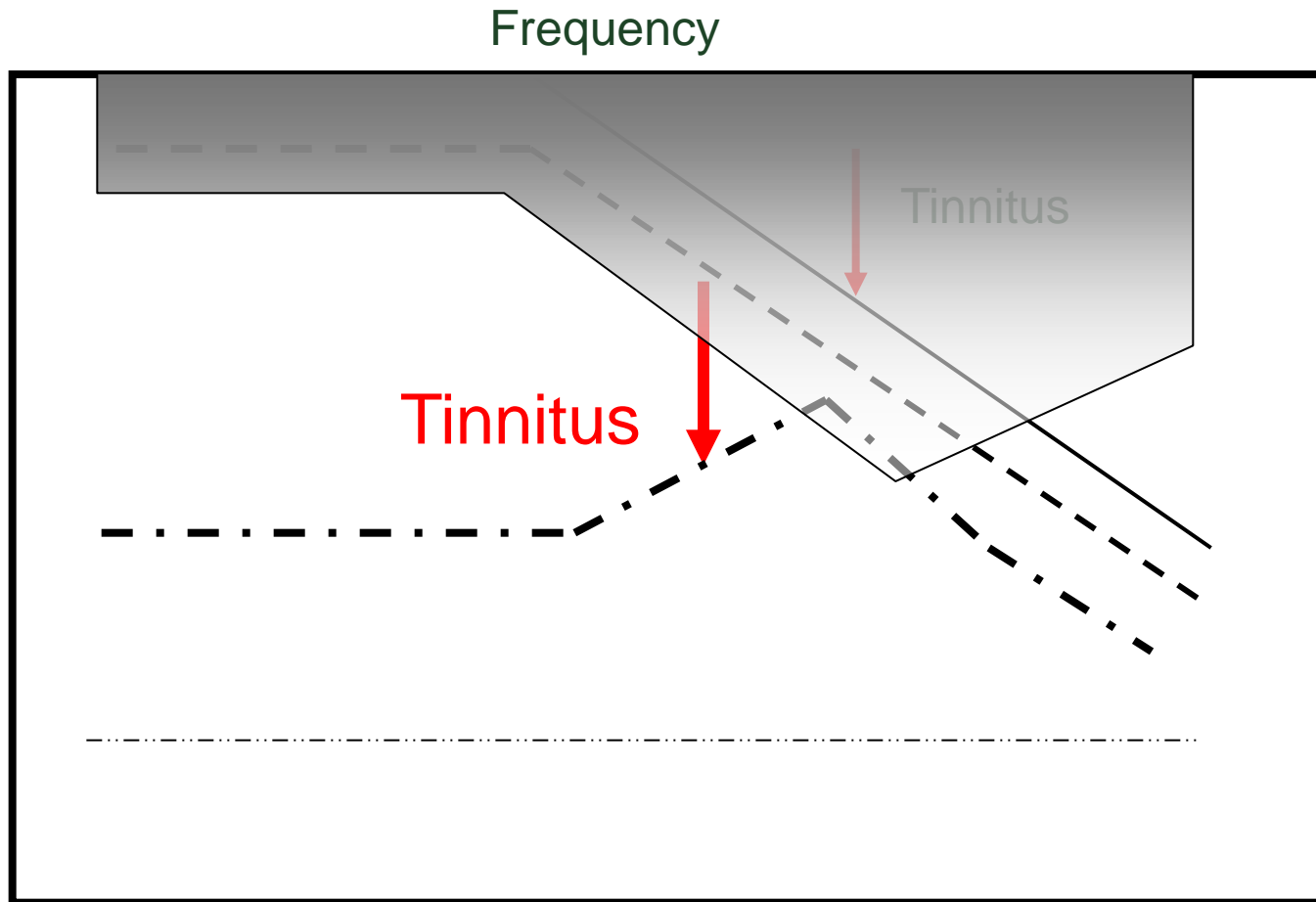
Sound therapies

“Why is it that buzzing in the ears cease if one makes a sound? Is it because a greater sound drives out the less?”

Attributed to Aristotle 384-322 BC

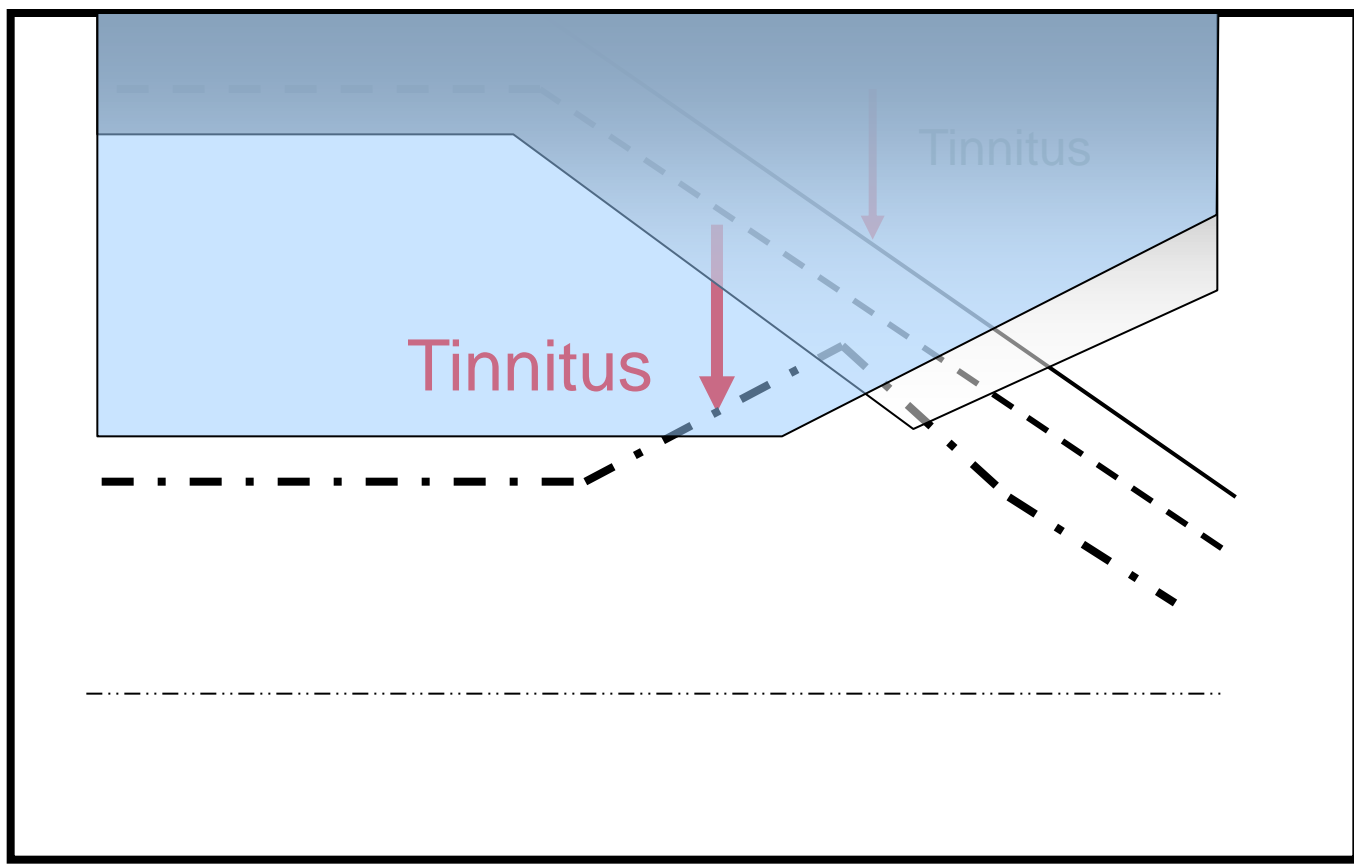
Stephens, S. D. G. (1984). "The treatment of tinnitus - a historical perspective." *The Journal of Laryngology and Otology* **98**: 963 - 972.

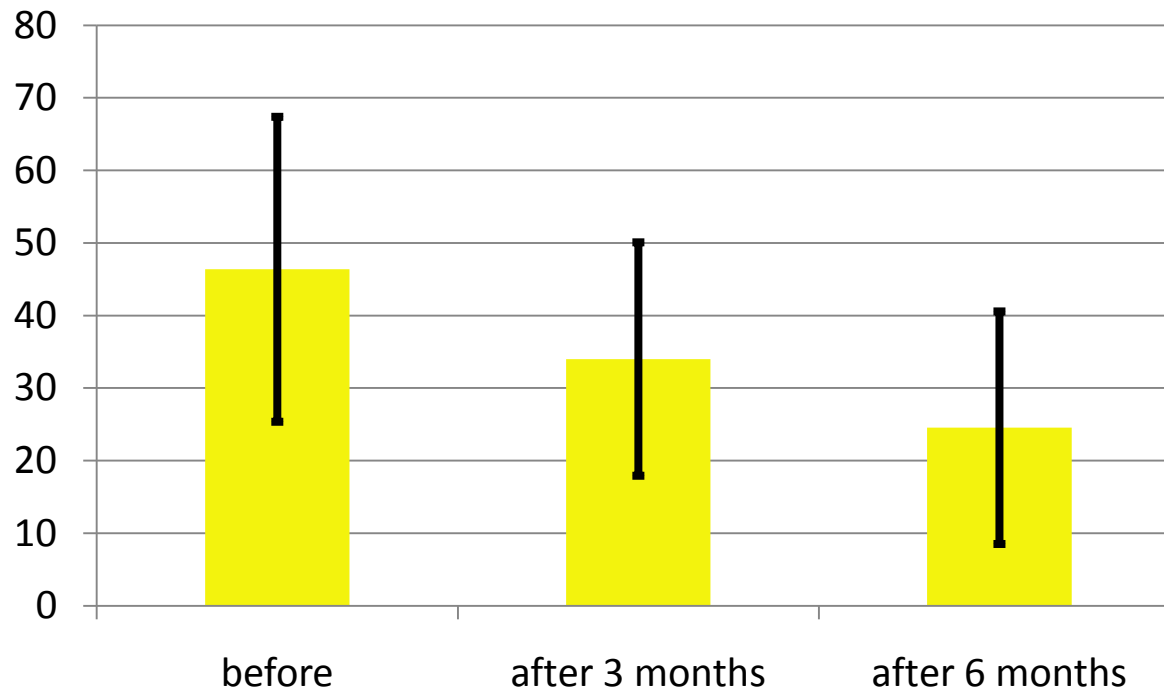
Hearing aids alone



Extra sound

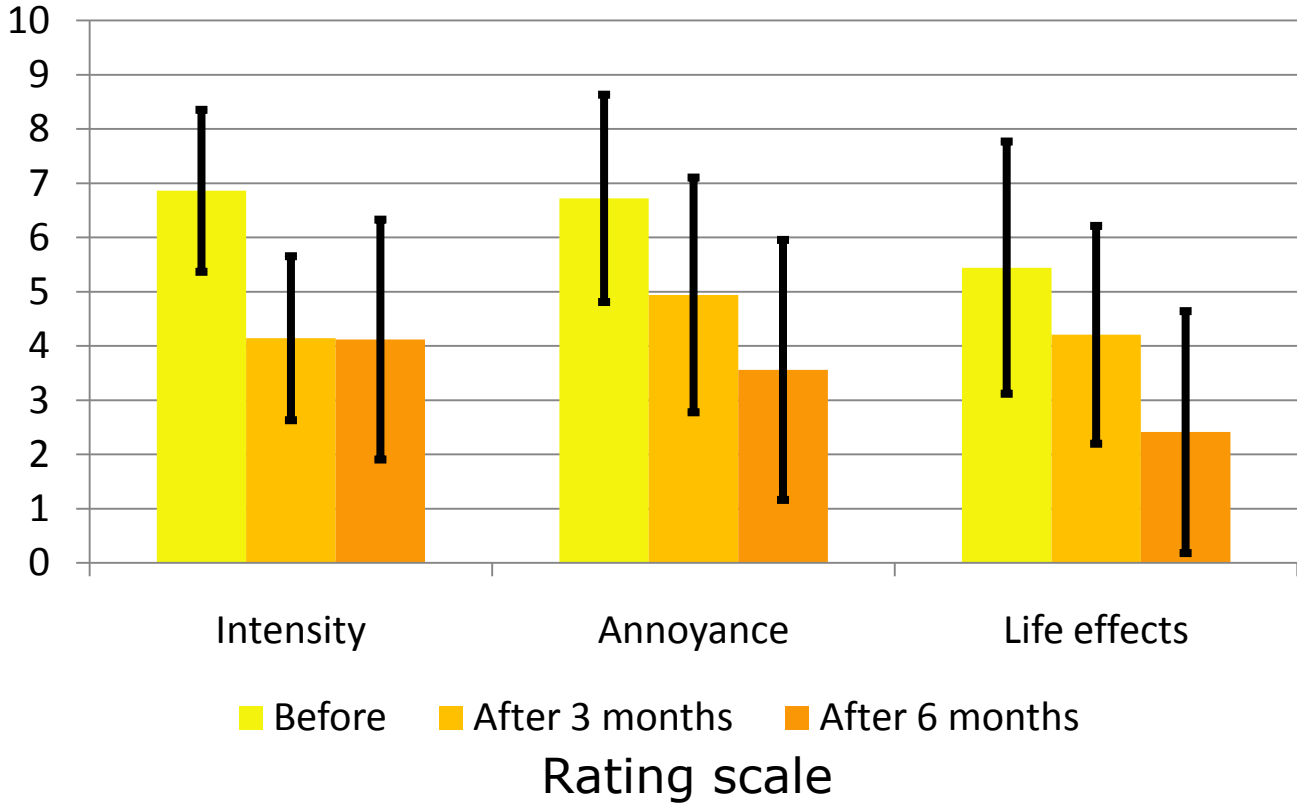
Frequency





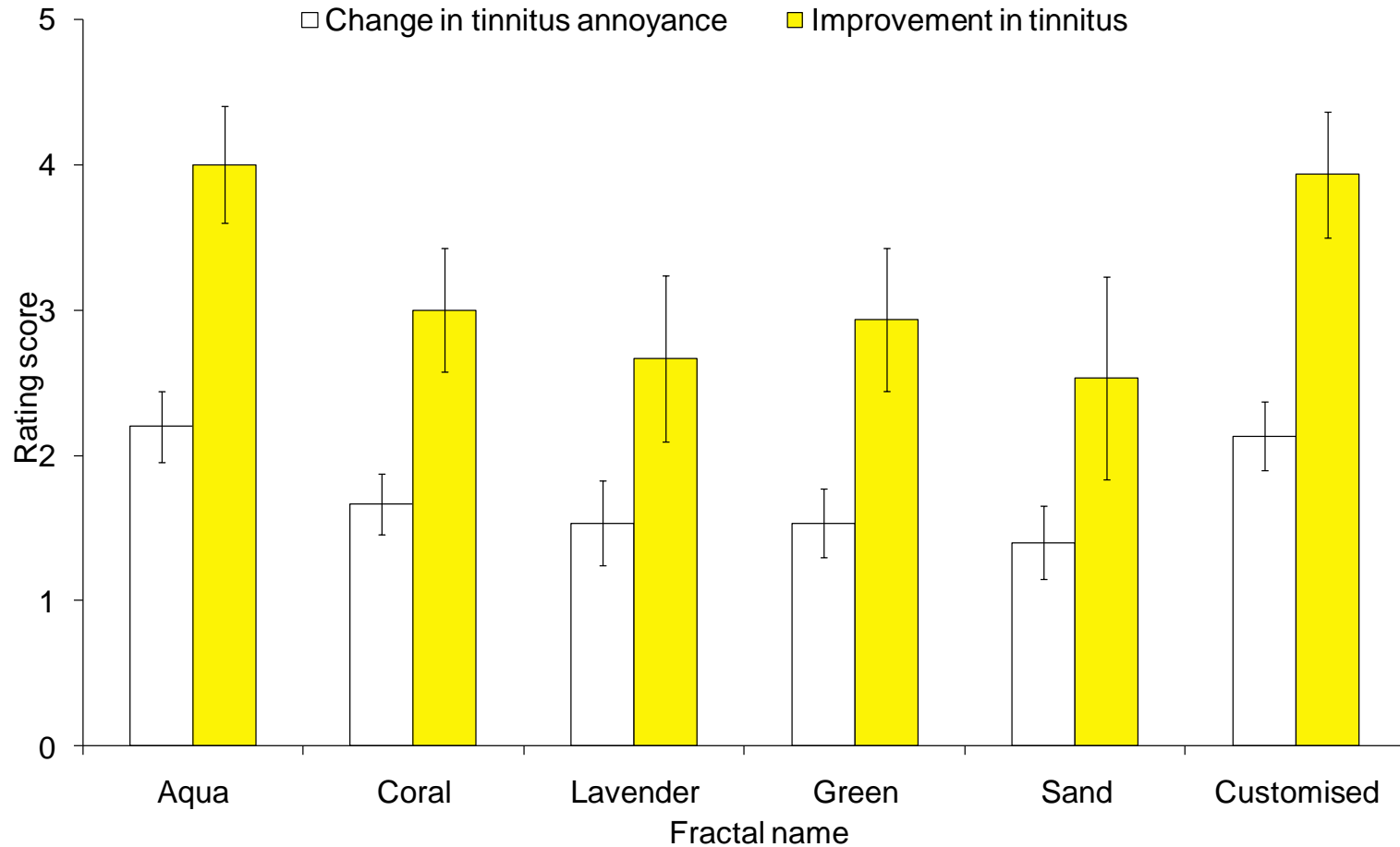
THI

Passive Auditory Stimulation by a prototype of combi aid that implements the high-pitch auditory stimulation. Luca Del Bo, Valentina Berto, Laura Carrabba, Marco Costantini, Stella Forti, Mani Kaur, Kei Kobayashi, Alessia Paglialonga, Grant Searchfield, Kim Wise, Ole Dyrlund

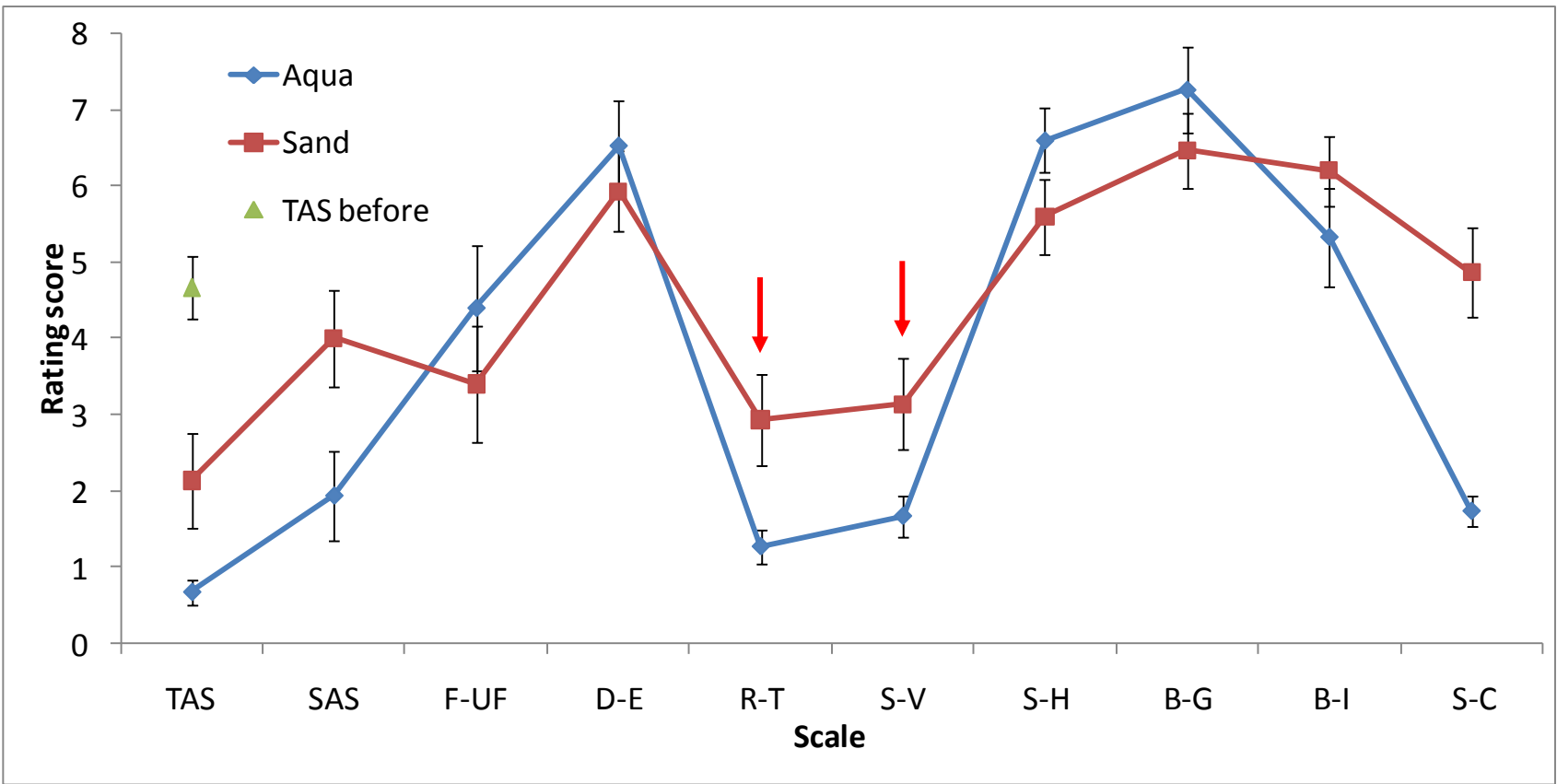


Passive Auditory Stimulation by a prototype of combi aid that implements the high-pitch auditory stimulation. Luca Del Bo, Valentina Berto, Laura Carrabba, Marco Costantini, Stella Forti, Mani Kaur, Kei Kobayashi, Alessia Paglialonga, Grant Searchfield, Kim Wise, Ole Dyrlund

Fractal sounds



Fractal sounds - relaxation



Physiological evidence for sound therapy

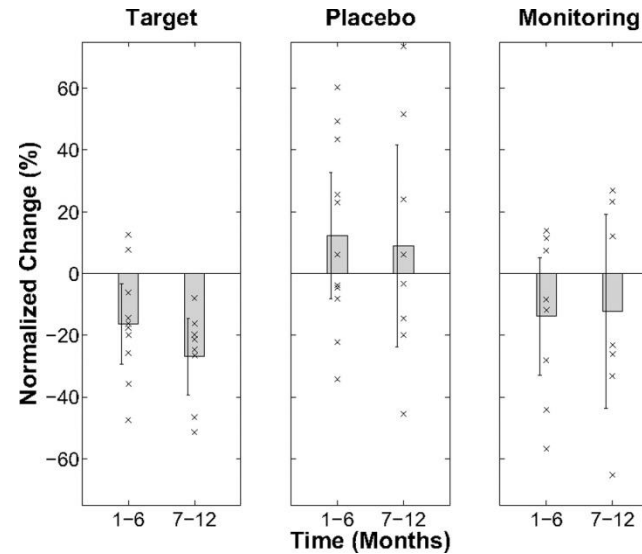
By magic numbers and persuasive sound.

William Congreve,
Mourning Bride (act I, sc. 1)

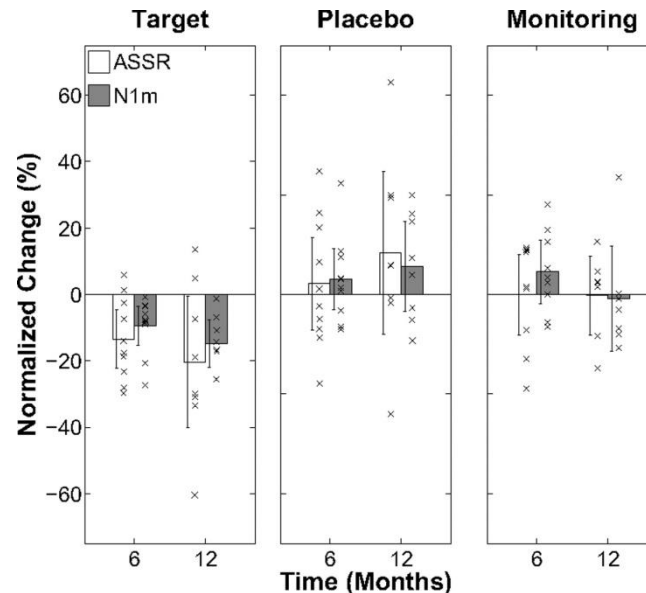
Subjective & objective: notched music

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

Normalized tinnitus loudness change after 6 and 12 months of treatment (or monitoring) relative to baseline (0) for the three patient groups (target, placebo, and monitoring).



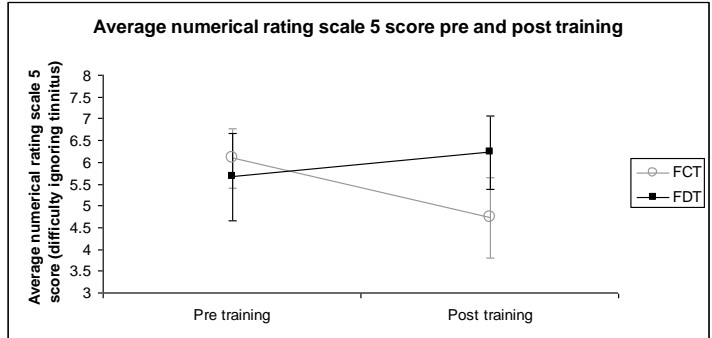
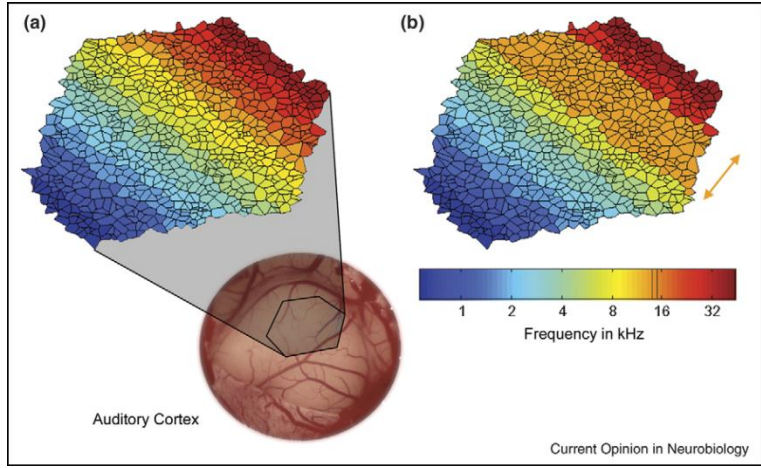
Normalized tinnitus-related auditory cortex evoked activity change after 6 and 12 months of treatment (or monitoring) relative to baseline (0) for the three patient groups (target, placebo, and monitoring).



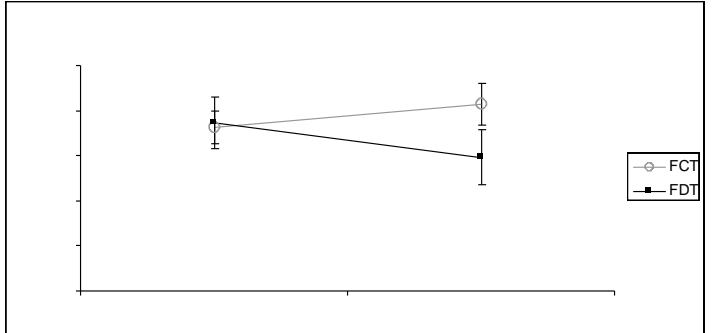
Subjective & objective: Categorization and discrimination

DAHMEN, J.C. & KING, A.J. 'Learning to hear: plasticity of auditory cortical processing' *Current Opinion in Neurobiology* 2007, 17:456-464

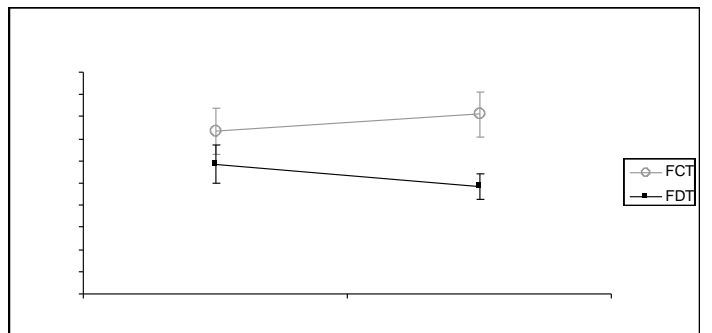
JEPSEN, K; SANDERS, M.P; SEARCHFIELD, G.D; KOBAYASHI, K. 'Perceptual Training for Tinnitus', *Proceedings of 'Tinnitus Discovery': Asia-pacific Tinnitus Symposium*, 11-12 Sept 2009. *New Zealand Medical Journal*, p141-153, 2010.



Scale difficulty ignoring Tinnitus



N1 Cortical potential



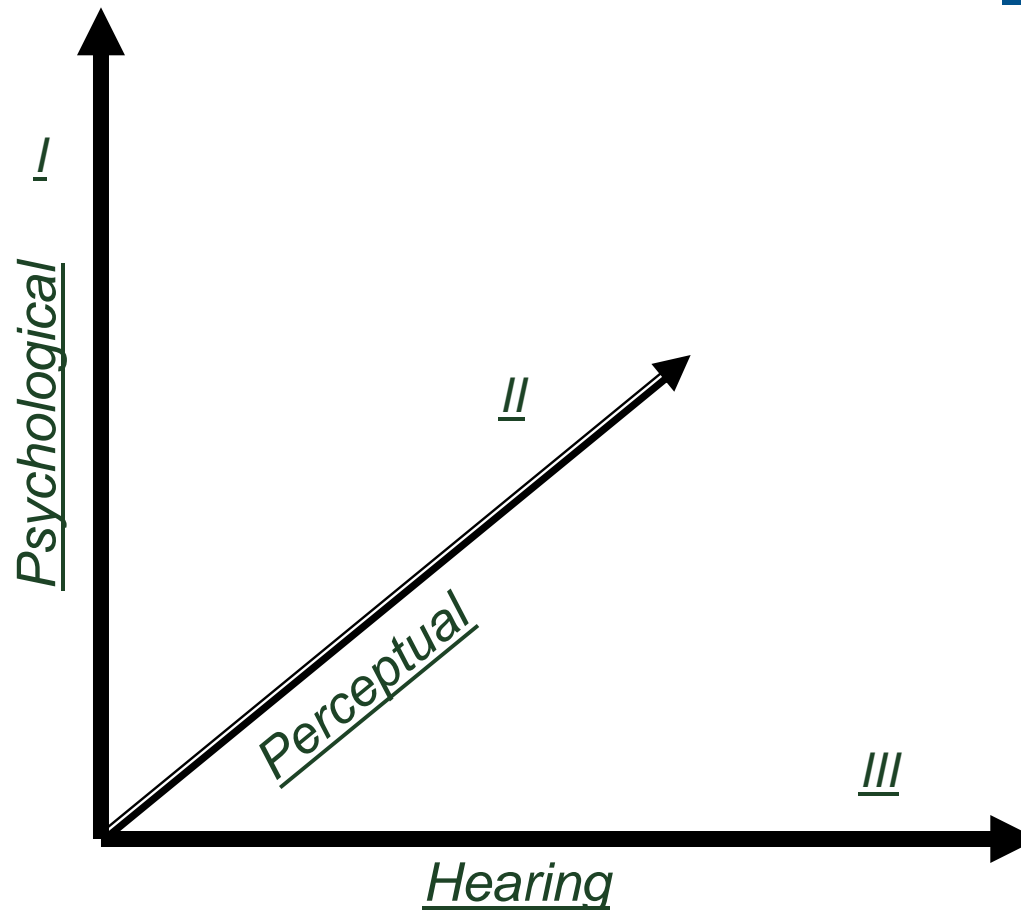
P2 Cortical potential

Summary

“Everybody has their taste in noises as well as in other matters.”

Jane Austen (1775 - 1817)

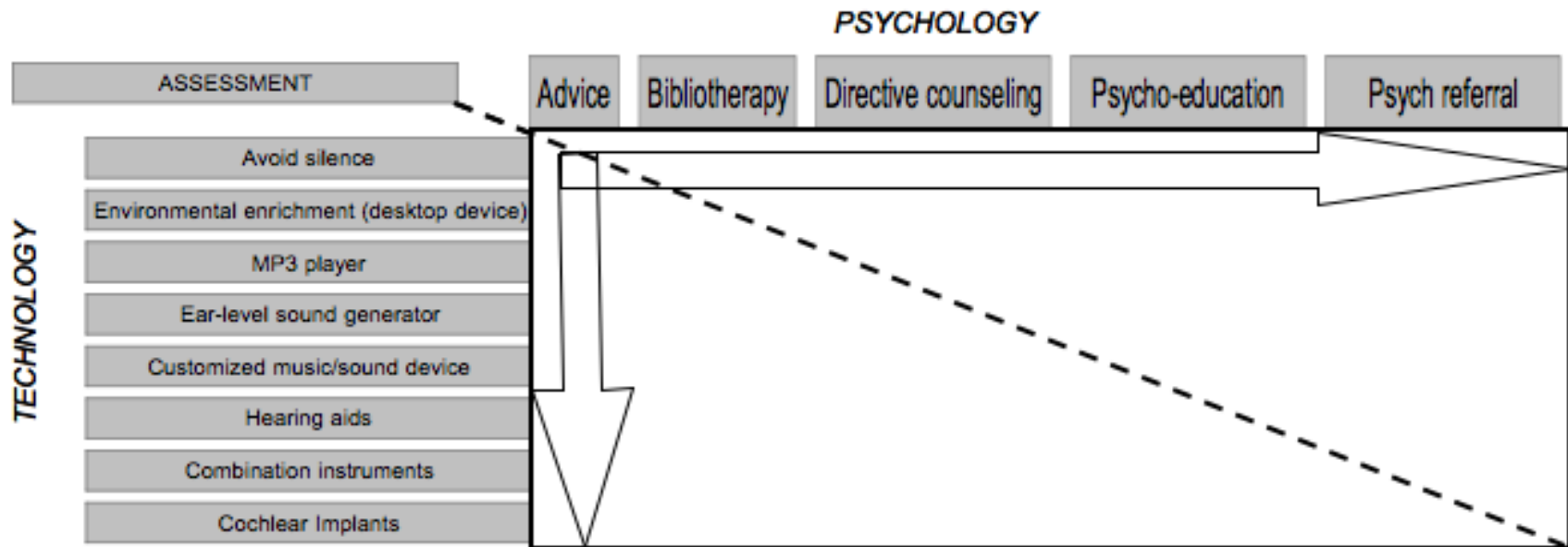
Suggested model based on 3 axes



SEARCHFIELD, G.D; JERRAM, C. 'Tinnitus assessment', Proceedings of 'Tinnitus Discovery': Asia-pacific Tinnitus Symposium, 11-12 Sept 2009, Auckland, New Zealand New Zealand Medical Journal, Auckland, 11 September - 12 September 2010, p112-125.

Inform treatment (e.g. low - high score)

- Axis I
 - Counseling to Psychological referral.
- Axis II
 - Avoid silence to Sound therapy.
- Axis III
 - Communication training to Hearing aids/Cochlear implants.



SEARCHFIELD, G.D; BAGULEY, D. 'The Role of the Audiologist', In: Moller, A; Kleinjung, T; Langguth, B; Ridder, D.D. (ed.) *Textbook of Tinnitus*, New York, Springer, p215-222, 2010.

- Evidence for the effects of sound on potential generation mechanisms of tinnitus are emerging
- There is an ever increasing volume of research supporting use of sound therapy
- Still a need for carefully controlled clinical trials
- We encourage inclusion of objective measures (physiological) in clinical studies to assist in determining tinnitus mechanisms

Acknowledgements

Many thanks to the organizing committee for inviting me. This AAA conference is supported, in part, by a conference grant (R13 DC011728) from the National Institute on Deafness and Other Communication Disorders.

**Preliminary announcement:
2nd Asia & Pacific Tinnitus Symposium
Cook Islands
September 2012**

