

Indication and Verification of Hearing Implants for Conductive and Mixed Hearing Loss

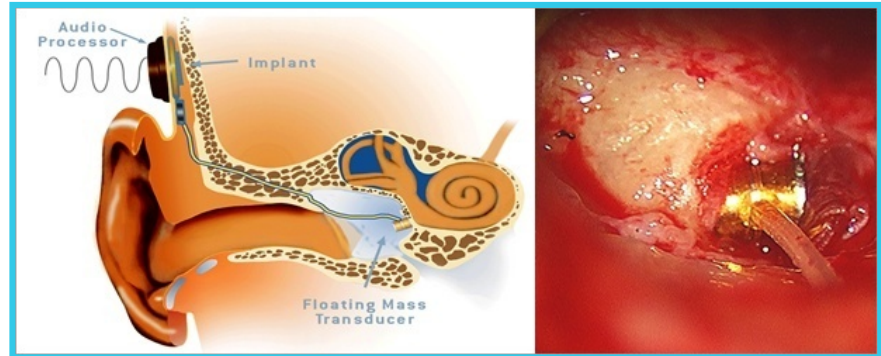
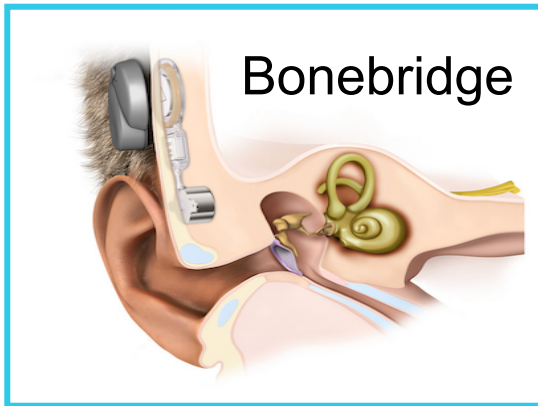
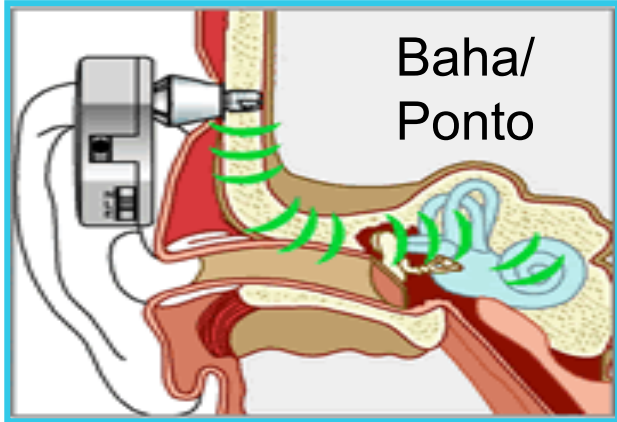


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Auditory implants in conductive/mixed hearing loss

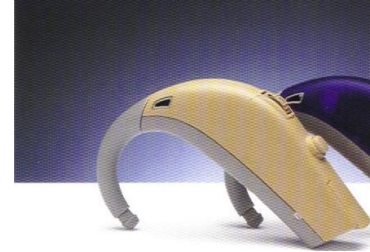
- If reconstructive surgery is not an option or (sub)total closure of the air-bone gap cannot be guaranteed
 - If conventional hearing devices cannot be used or should not be used (aural atresia/chronic running ear) or a poor result is expected
 - Then, implantable hearing device, bypassing the impaired outer/middle ear, can be applied
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Bone conduction devices (BCD)



Active middle ear implant (MEI) with actuator coupled directly to the cochlea

Some basics: fitting hearing devices

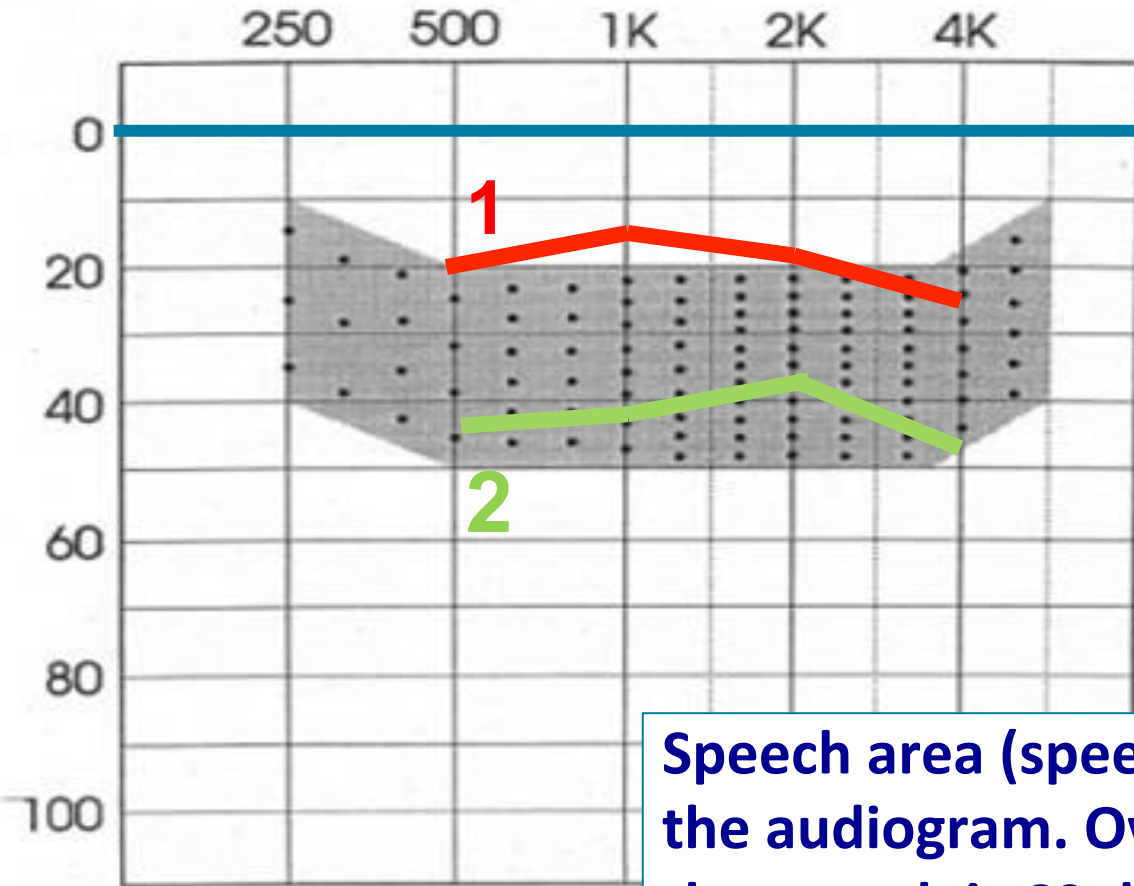


Aim of hearing aid fitting: optimize **audibility of speech**, while environmental sounds are at acceptable levels and loud sounds are not uncomfortable (irrespective of the type of hearing loss and type of device used)

- *The ‘audibility of normal speech’, an example taken from the literature*

Post-intervention thresholds, dB HL

Frequency (kHz)



Audibility index

0.91

98%

0.21

17%

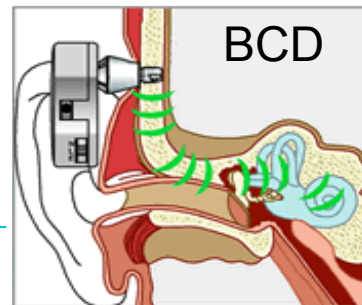
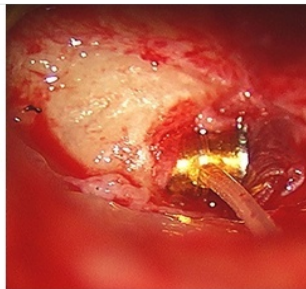
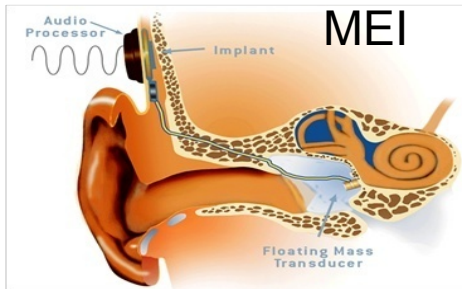
word
scores

Speech area (speech banana) in the audiogram. Overall level of the speech is 60 dB SPL

How are we doing; fitting implantable hearing devices in conductive-mixed hearing loss

BCD and MEI with actuator coupled to the cochlea **stimulate directly the cochlea, bypassing the impaired middle ear**

- *So, concerning the fitting, we are dealing with the cochlear loss not the mixed loss. Consequence: we can build on our experience in fitting BTE in SNHL*



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- Consequence: to fit hearing devices in conductive/mixed hearing loss, use the same procedures and fitting rules* as those to fit BTEs in SNHL, with the cochlear thresholds (bone-conduction) as input. Such procedures/fitting rules are based on optimizing the audibility of speech
 - However, BCDs and MEI have limitations, e.g. limited gain and output, audible internal noise... in contrast to BTEs. **Although great, impressive technology, thanks to the industry**; in audiological terms: poor hearing devices

* Like half-gain rule, NAL or DSL

Capacity of auditory implants for conductive/ mixed hearing loss; source of variance

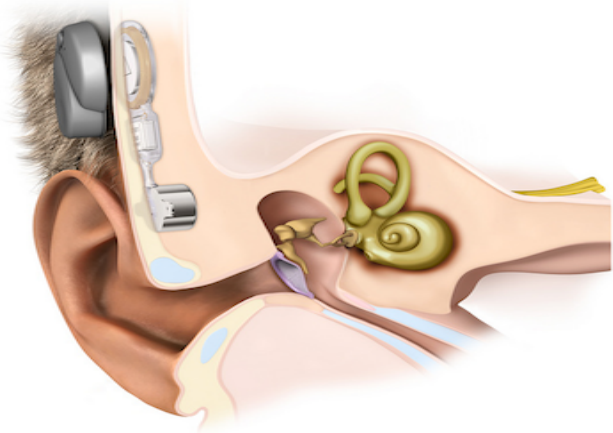
Categorization based on **(objective)** MPO measurements

BCDs:

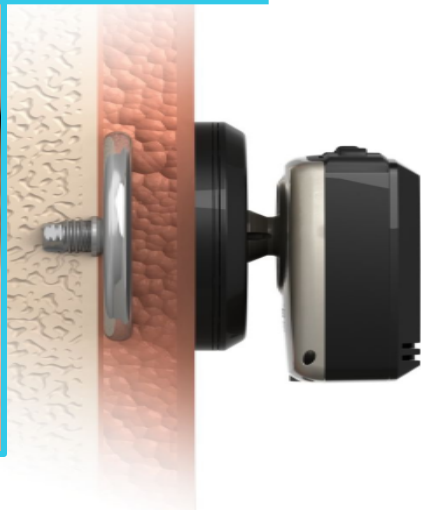
- Transcutaneous devices (Sophono, Baha Attract)
- Active transcutaneous device (Bonebridge)
- Percutaneous devices (Baha/Ponto)

MEI

- Middle ear implants with actuator coupled to a cochlear window
-



4 kHz,



Transcutaneous device	MPO dB HL
Sophono 1-2	53
Bonebridge	67
Baha Attract BP110	63

Summary

Percutaneous device	MPO: 0,5-4 kHz, dB HL
Baha Divino	69
BP110	74
Baha 5 super power	85

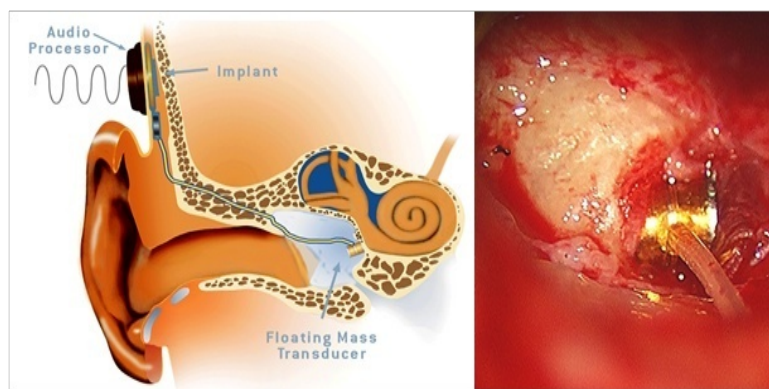


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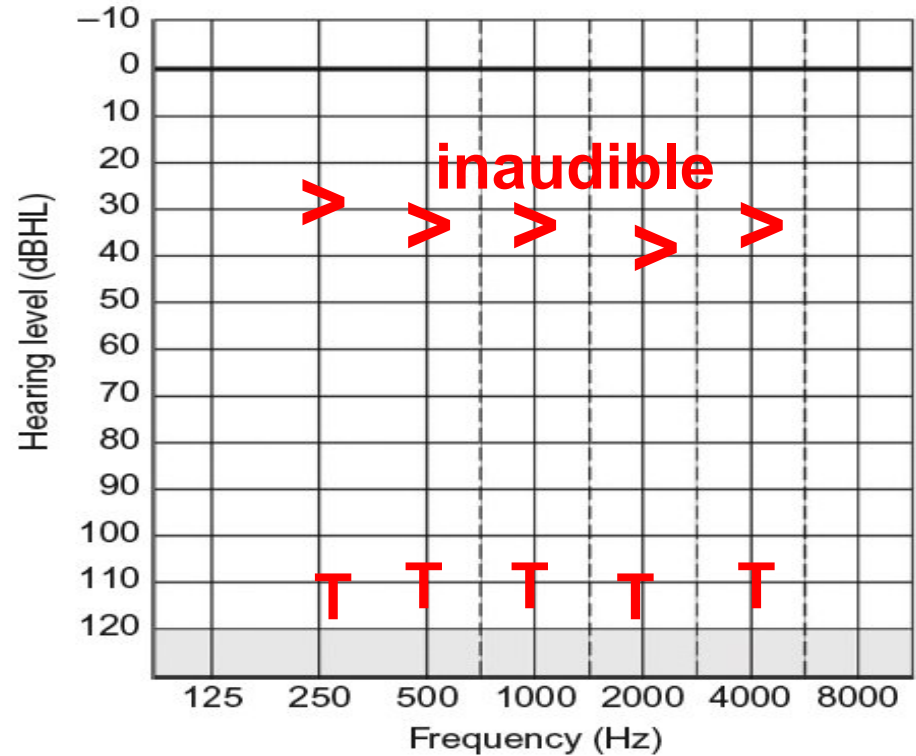
Baha
power



Transcutaneous device	MPO dB HL
Sophono 1-2	53
Bonebridge	67
Baha Attract BP110	63

MEI	MPO
VSB	85 dB HL

Example: mixed loss, cochlear thresholds of 31 dB HL

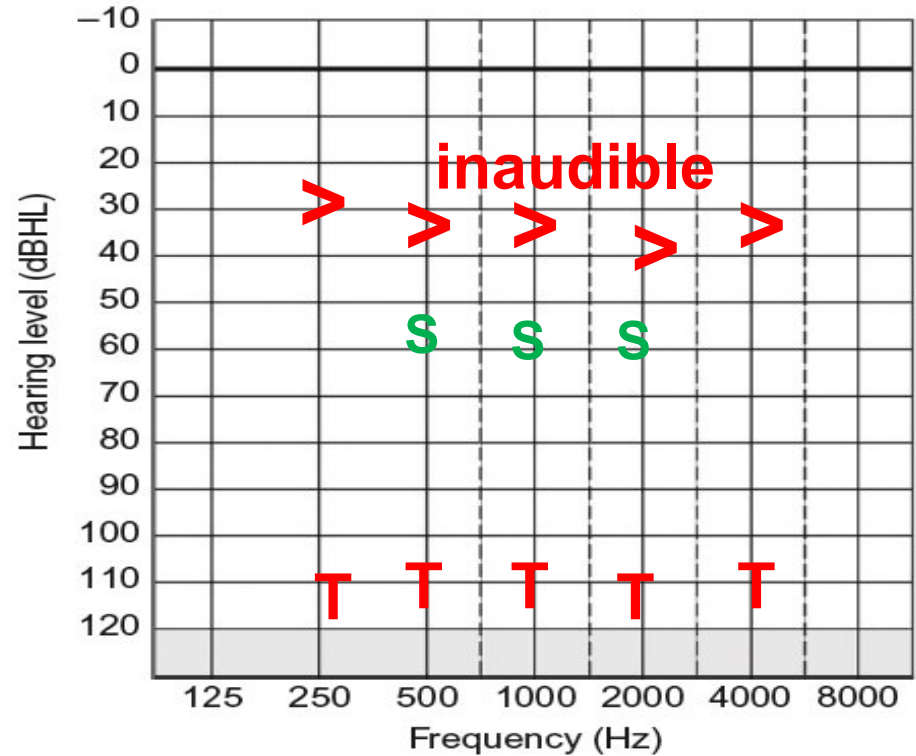


T: discomfort levels
Storey & Dillon 1998

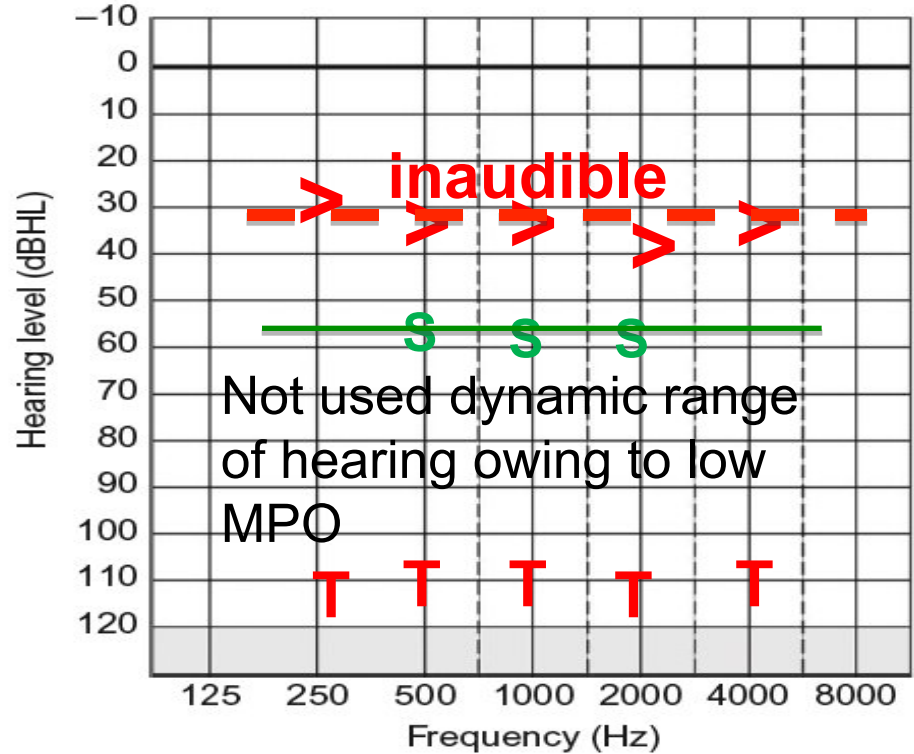
Example: mixed loss, cochlear thresholds of 31 dB HL

S: MPO transcutaneous
BCD

T: discomfort levels

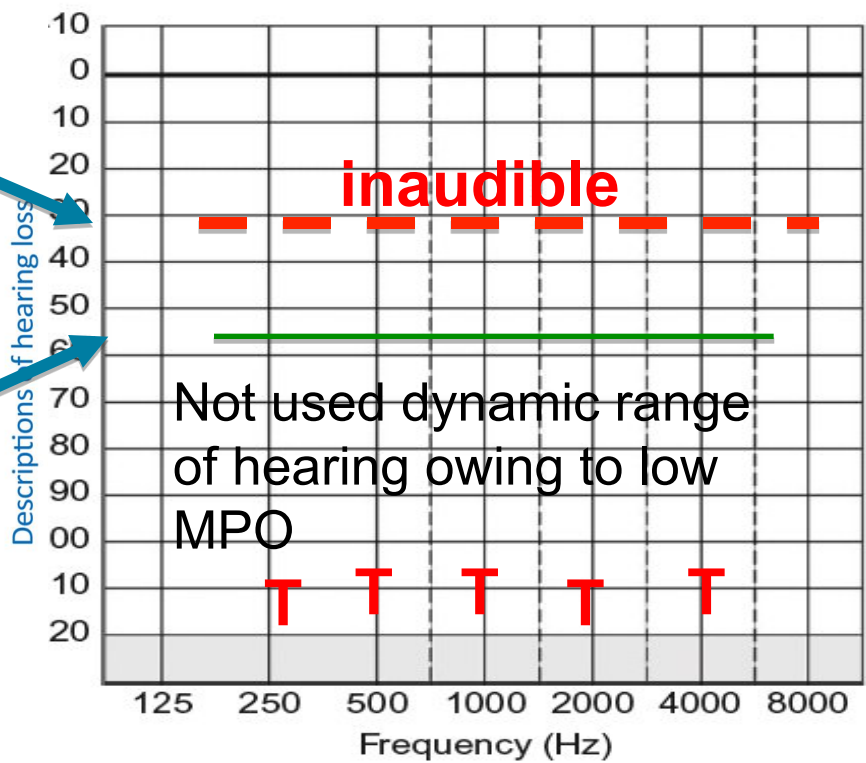
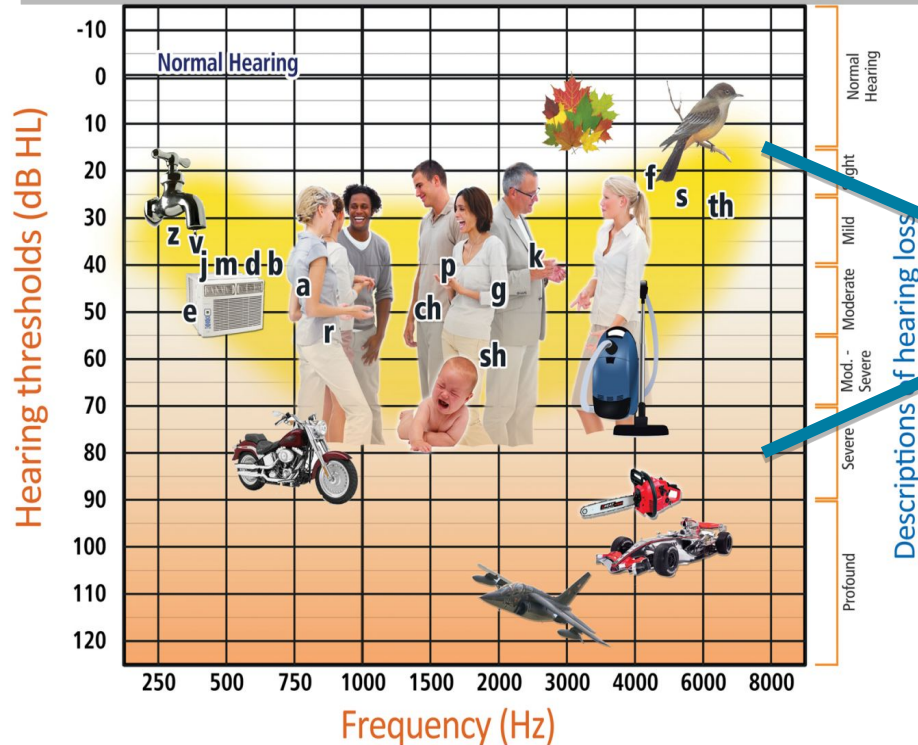


Example: mixed loss, cochlear thresholds of 31 dB HL



Outside world

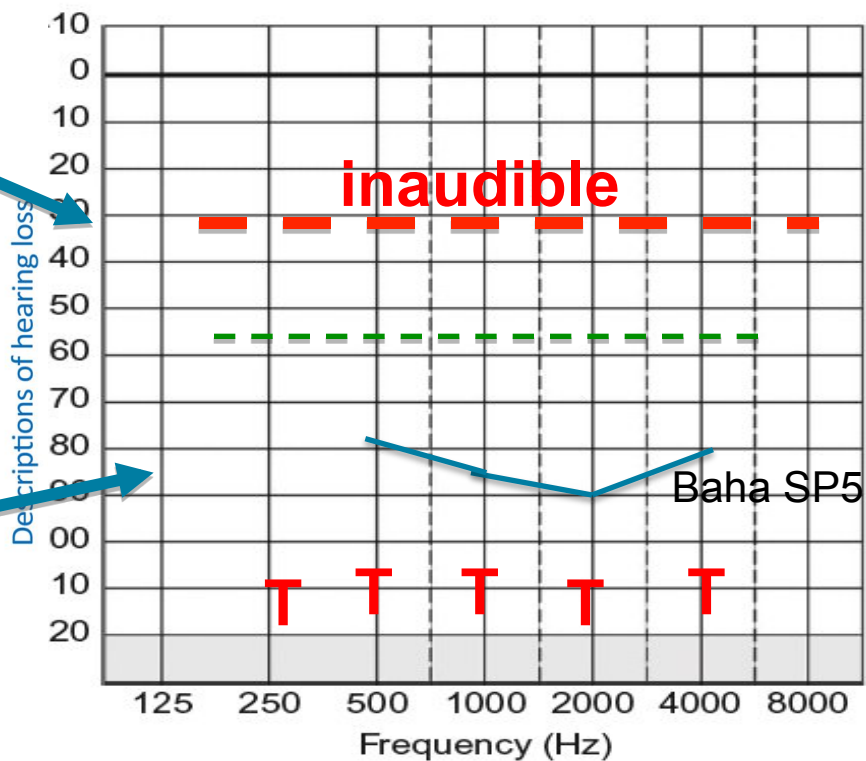
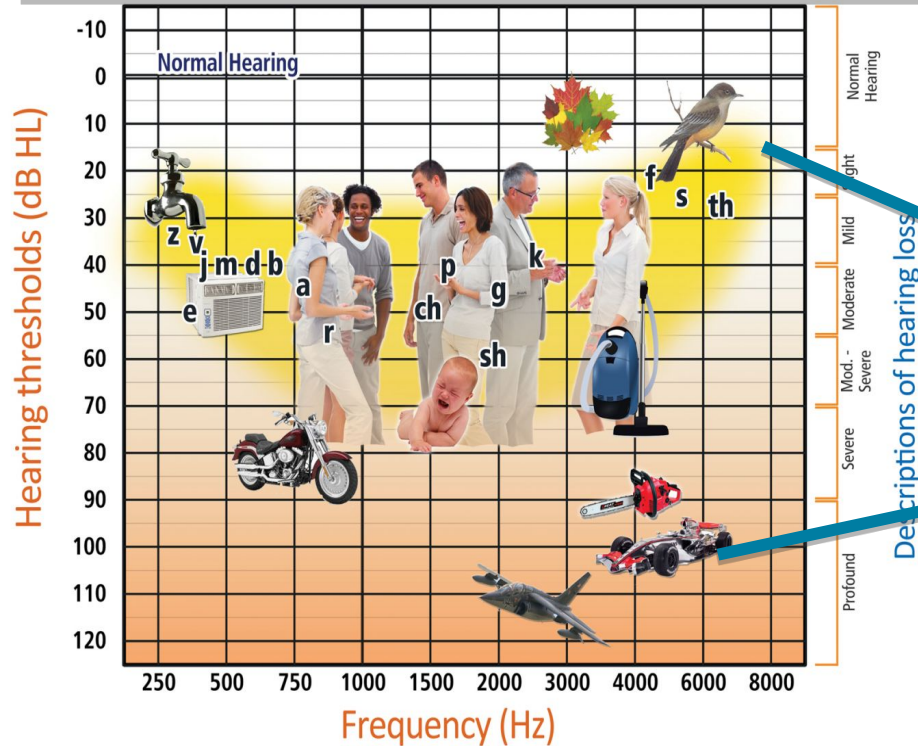
Patient's auditory window to the world



From: *Acoustic Hearing, Clinics*

Outside world

Patient's auditory window to the world



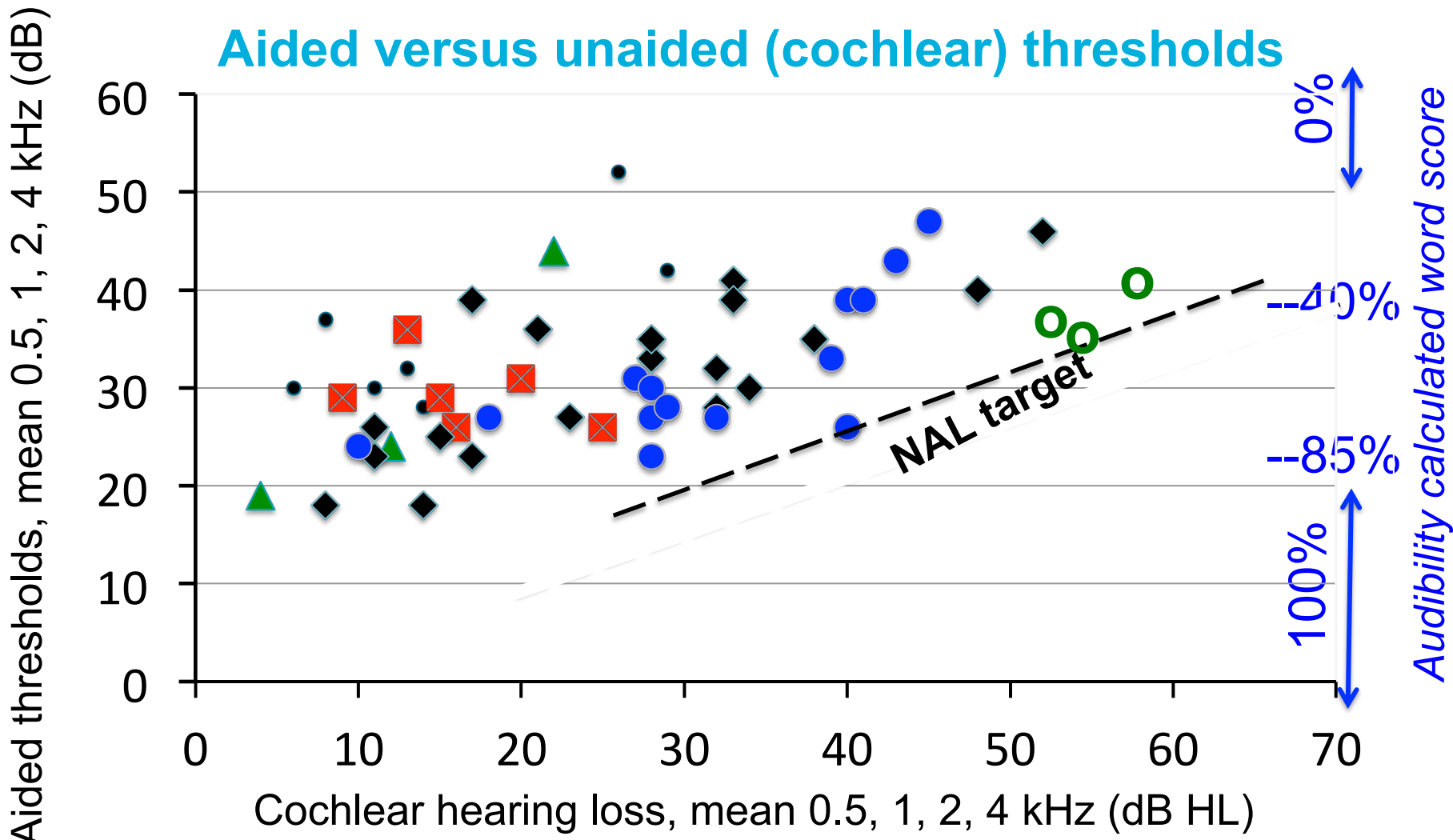
How 'wide' should the aided dynamic range of hearing be?

- Best option: 100% of the patient's dynamic range of hearing is utilized: thus MPO equals loudness discomfort level (*only possible with Codacs*)
 - Milder criterion (compromise): 2/3 of the dynamic range of hearing should be available, with a minimum of 35 dB (www.snikimplants.nl)
-

Device	MPO dB HL	Cochlear loss (SNHL component)*
Sophono Alpha 1-2	53	<5 dB HL
Baha Attract with BP110	63	<15
Bonebridge	67	<20
Baha/Ponto standard	67-69	<25
BP110, Ponto power	74-76	<35
Baha 5 SP	85	<50
VSB	85	<50

**according to the 2/3 rule*

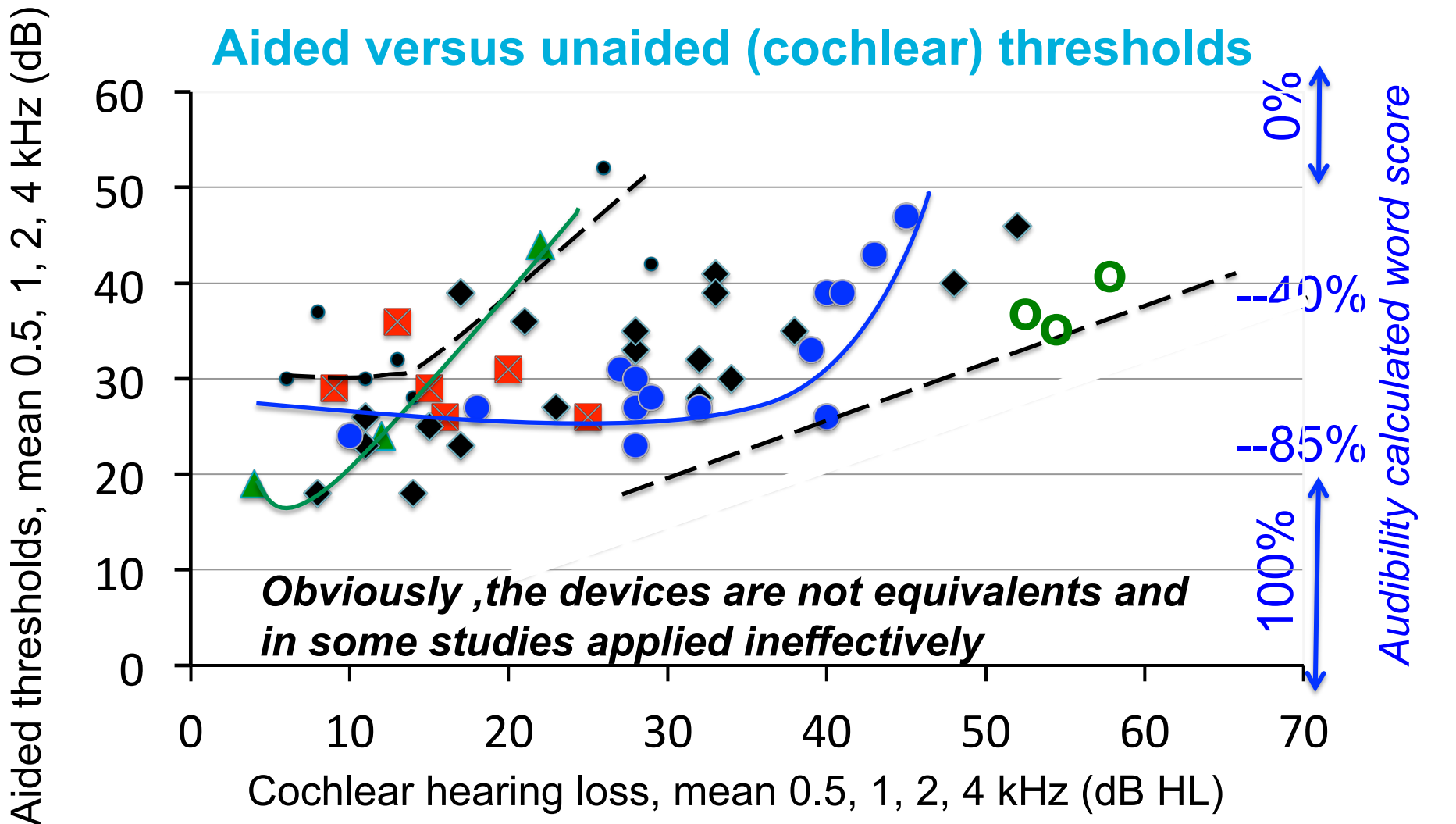
Aided versus unaided (cochlear) thresholds



Why such a large spread

- Use of devices/processor with insufficient capacity; application information provided by the companies is often not well-documented and over-enthusiastic
 - Variability in fitting procedures: each company has its own fitting software that tries to optimize the outcome while minimizing/masking the limitations of the devices
 - Coupling-efficiency of the actuator of MEIs is variable
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The fitting protocol; to be revised?

- **Companies** suggest a ‘first fit’ based on (not always) NAL or DSL or ‘one-third-rule’, however, all with a ‘company flavor’
- Therefore, fine-tuning by an experienced independent audiologist
- *To help with fitting: a new pragmatic fitting procedure was developed to optimize the audibility for all types of implantable devices, based on NAL rule*

What we did next: study the frequency-specific aided thresholds (Snik et al., 2019)

- Of the 51, 33 studies presented frequency-specific aided- and cochlear (bone-conduction) thresholds
- We studied the aided thresholds as a function of cochlear loss, per octave frequency
- According to the **well-validated NAL-RP rule***, aided thresholds should be equal to approx. 0.45 times the cochlear threshold

* *first-order, conservative approach assuming linear amplification*

Tool for validation of outcomes (Snik et al., 2019)

Cochlear loss or SNHL component, dB HL at 1, 2, or 4 kHz	5	15	25	35	45	55	65
Target aided threshold, dB HL	<25	<25	<25	<25	<30	<35	<40

Conductive loss

rather severe mixed loss

Target word scores*:

Mean cochlear loss (0.5, 1, 2, 4 kHz), dB HL	5	15	25	35	45	55	65
Target word score %	>95	>95	>95	>95	>80	>45	>20

* Using the audibility index, 10 dB/octave sloping; 5 dB above target aided thresholds

Conclusions; auditory implants for conductive or mixed HL

- Great technology, however, MPO is a limiting factor (and gain)
- Transcutaneous BCDs should only be used in predominant conductive HL in contrast to percutaneous BCDs and VSB
- Many patients are under-amplified. Appropriate devices should be applied. Use fine tuning not just the manufacturer's software prescriptions
- Conclusions will change when new processors/coupling options are introduced
- For quality purposes, implant teams should comprise an otologist and audiologist working closely together during selection and evaluation phases

Important factors for decision making

- Amplification options available nowadays are not equivalents; especially for children, choose powerful devices
- To be discussed with the parents/child during selection: reimbursement issues; burden (and invasiveness) of the surgery, possible complications, aftercare, MRI compatibility, handling and cosmetics....
- Audiological results should be leading, not cosmesis

auditory implants

Where do we stand at present?

*Thank you for
listening*

www.snikimplants.nl

snikimplants.nl

Regularly updated, free website.

Info based on (as much as possible) objective facts.

Concerns implantable bone conductors, middle-ear implants and devices directly stimulating the cochlea (not CI).

Bimonthly, a recently published paper is discussed.

www.snikimplants.nl

