

Prescribing adjusting and evaluating hearing aid performance in children

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Outline

- 
- Objective assessment of hearing in children

- 
- Auditory Neuropathy Spectrum Disorders
 - Audiological Follow-up

- 
- Conventional hearing aid fitting
 - Cochlear implant indications

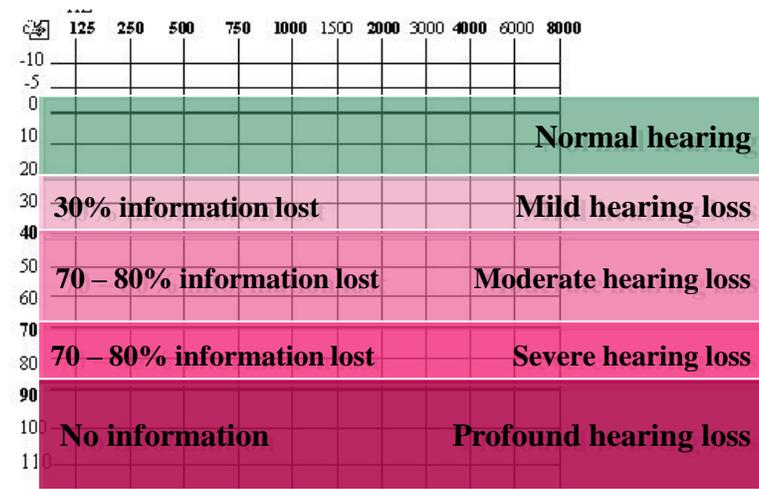
Objective assessment of hearing in children

Diagnosis Process – Hearing loss degrees

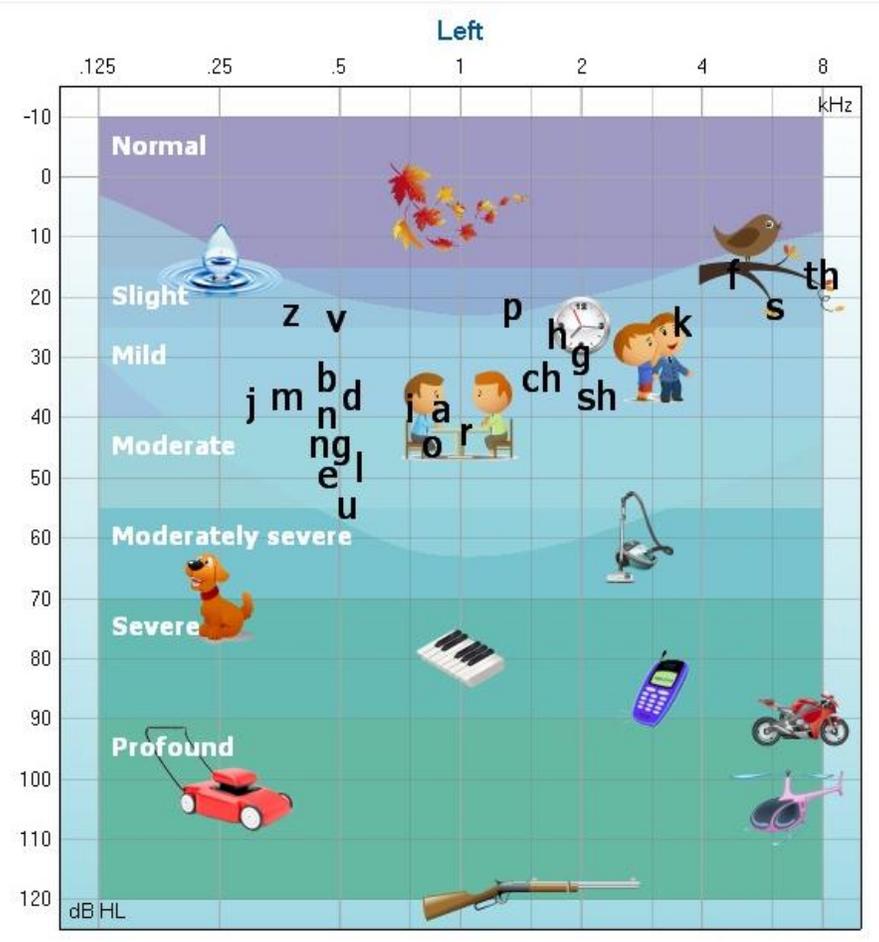
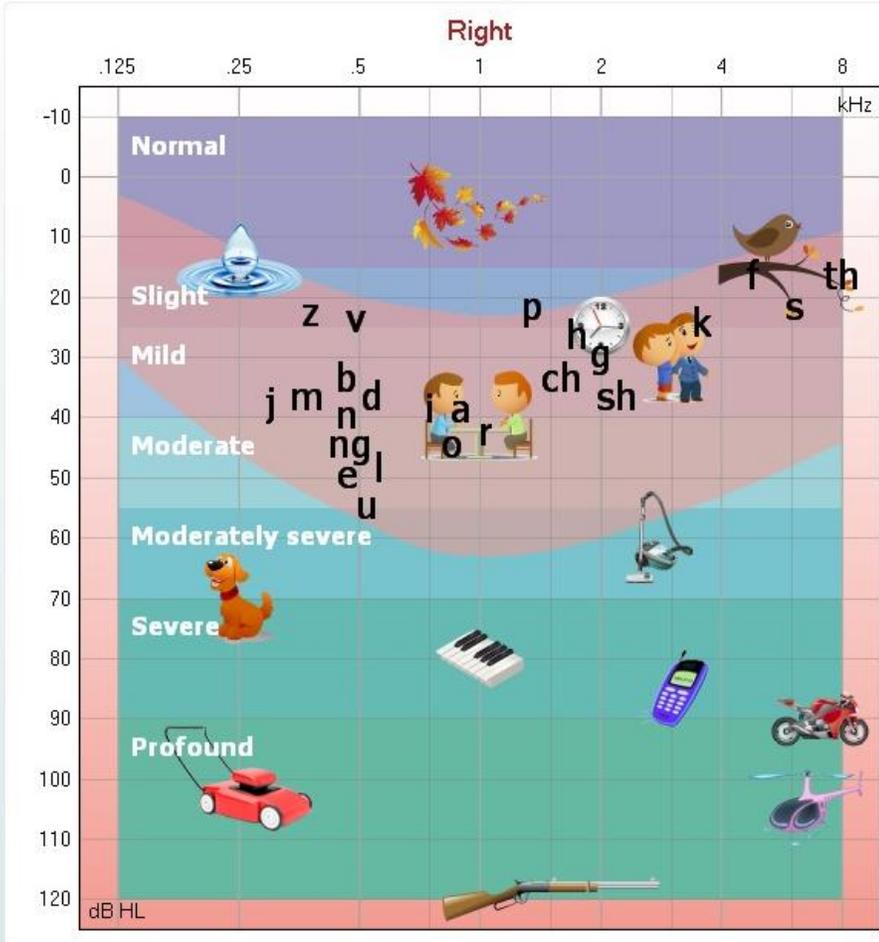
- Hearing loss / Conventional and Implantable hearing aids

Hearing loss	Degree	PTA mean
Normal hearing		< 20 dB HL
Mild hearing loss		21 - 40 dB HL
Moderate hearing loss	I st degree	41 - 55 dB HL
	II nd degree	56 - 70 dB HL
Severe hearing loss	I st degree	71 - 80 dB HL
	II nd degree	81 - 90 dB HL
Profound hearing loss	I st degree	91 - 100 dB HL
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Total deafness	III rd degree	111 - 119 dB HL
		> 120 dB HL

Conventional hearing aids

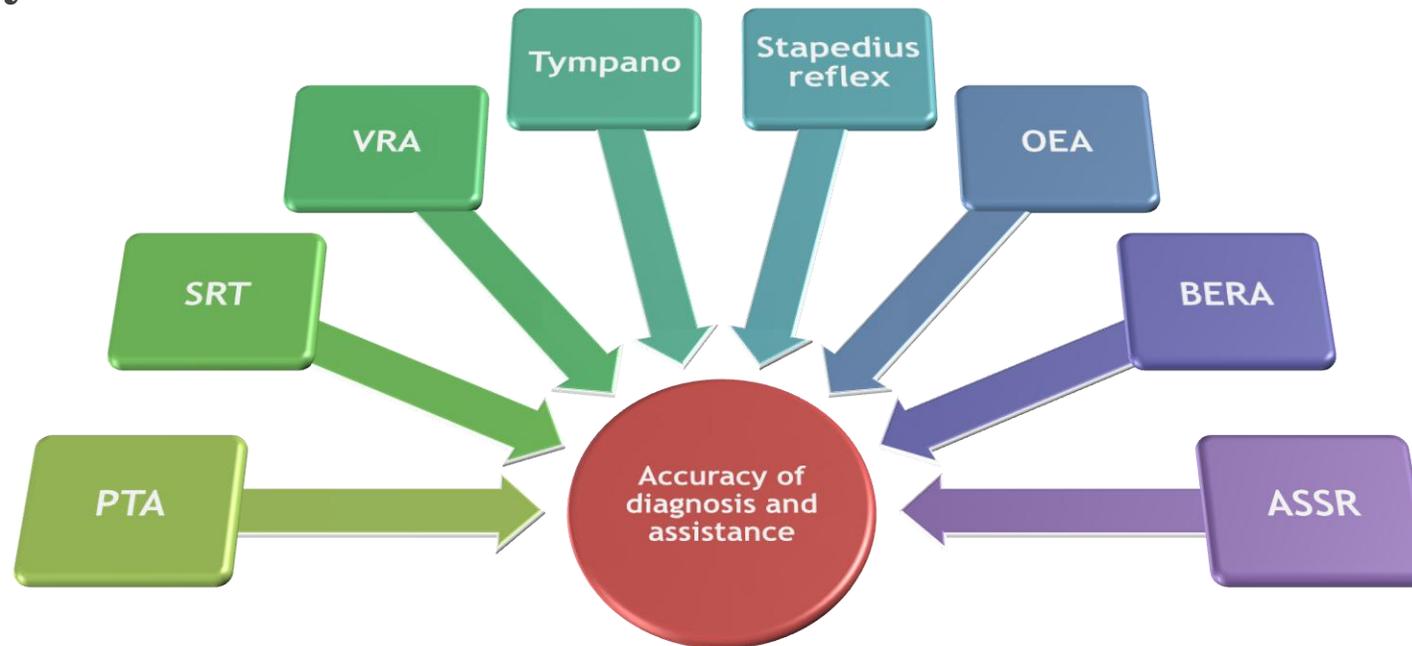


Classification of hearing loss – PTA
 (BIAP recommendations /may 2005 - no. 02/1 bis)



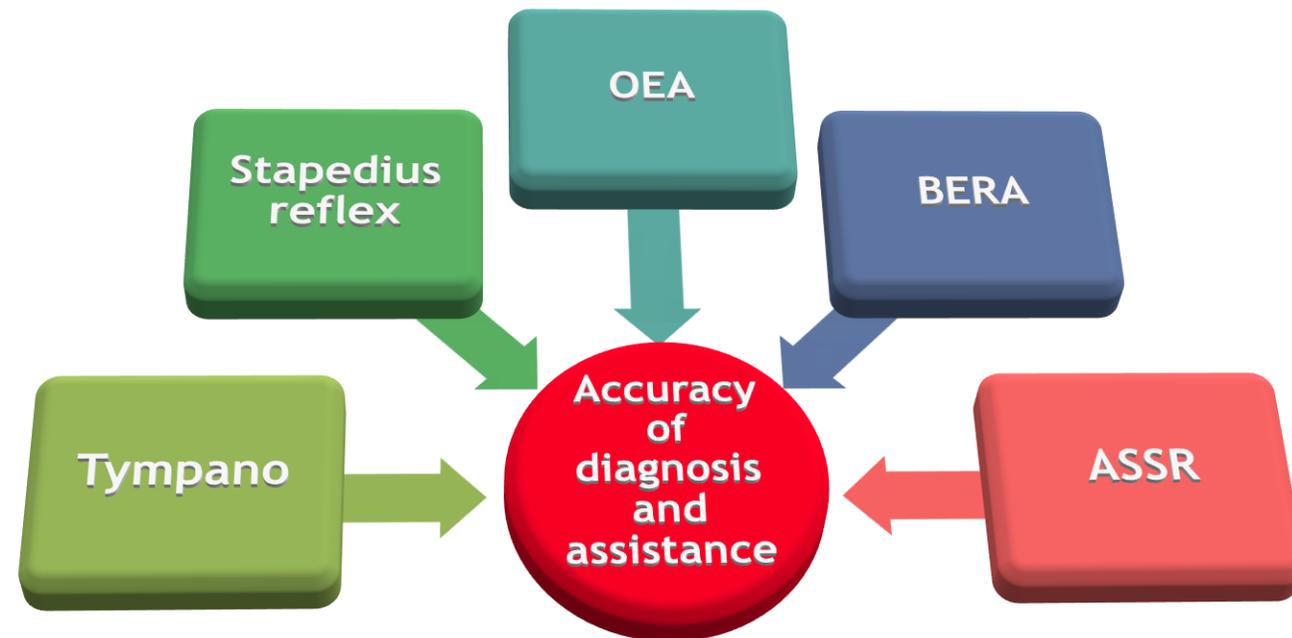
Audiological Assessment

- Many audiological tests
 - None of them fully describes the hearing status
 - A battery of tests is needed



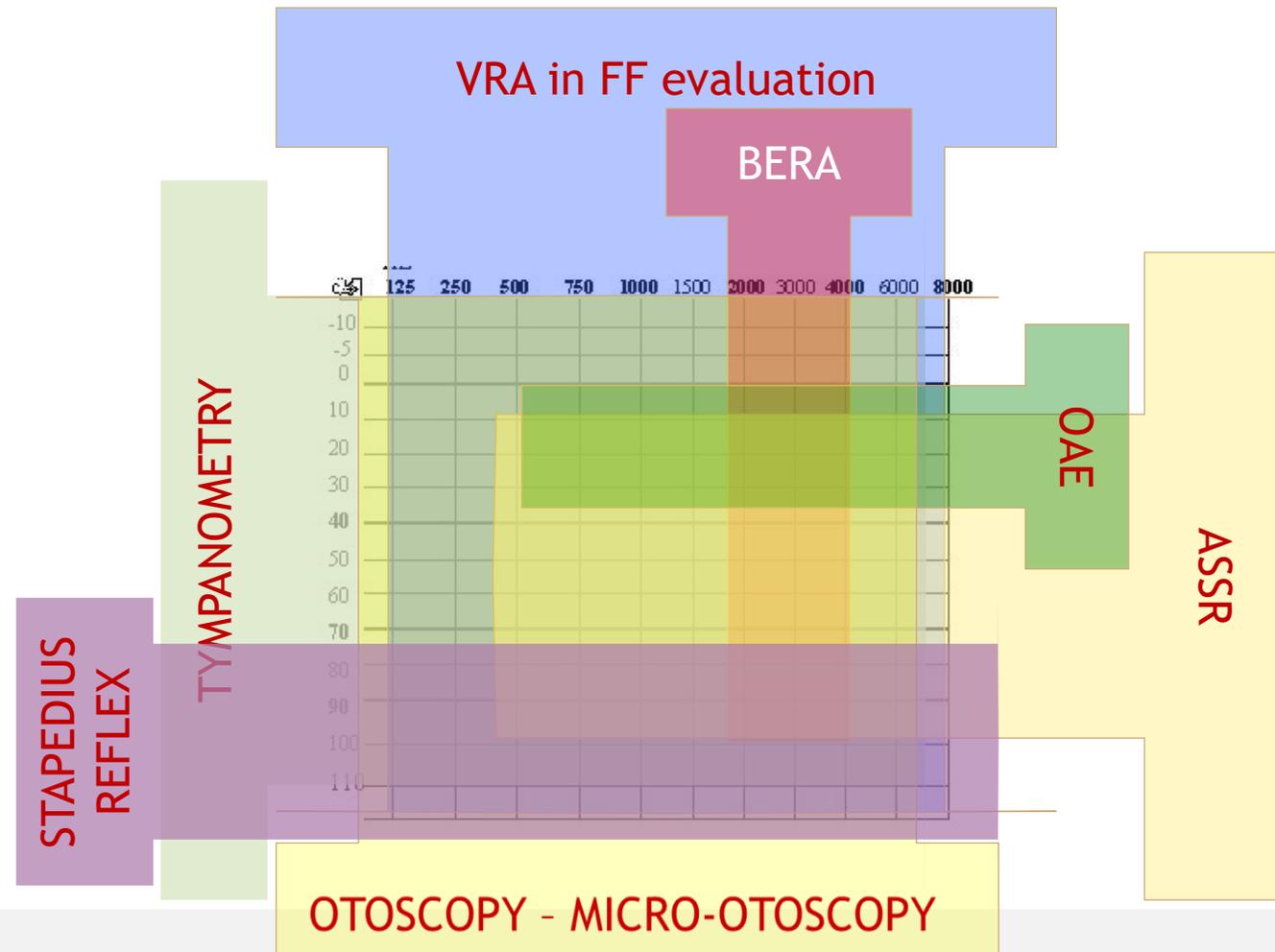
Objective diagnosis of hearing loss

- Objective assessment of hearing in **small children**



Objective diagnosis of hearing loss

- **THE AUDIOLOGICAL PUZZLE**



Reasons for cross-check diagnosis algorithm

Test	IDEAL	REAL
OAE	If presents (pass) - Normal hearing thresholds, or mild HL (< 30-35 dB)	- ? Auditory neuropathy spectrum disorder
	If absents (refer, Timp A) - At least mild hearing loss	- < 5% of normal hearing population
BERA	Wave V - absent at 100 dB - Profound deafness	- Partial deafness - Neural dyssynchrony
AABR	Pass - Normal hearing or mild hear loss	- Moderate - severe hearing loss on low frequencies
		Etc.

Objective diagnosis of hearing loss

- NO SINGLE PROTOCOL -

Usual situations



No middle ear pathology

No malformations

Special patients



Malformations of external or/and middle ear

Complex malformations, including inner ear

Fluctuating hearing

Maturation problems

Standard protocol



Adaptative protocol



But be careful !!!

- **THE MOVING HEARING !!!**
- **Evolutivity** of hearing loss – increases the thresholds (progressive hearing loss)
- Auditory system **maturation** – decreases the thresholds
- **Fluctuating** hearing loss – unstable thresholds

Auditory Neuropathy Spectrum Disorders

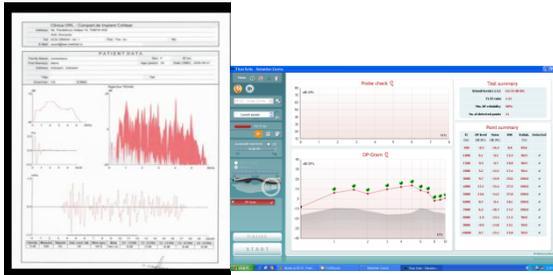
- ANSD -

- Auditory neuropathy
- Neural dyssynchrony
- **AUDITORY NEUROPATHY SPECTRUM DISORDERS**
 - First description
 - Starr et al. – 1996 : ”auditory neuropathy”

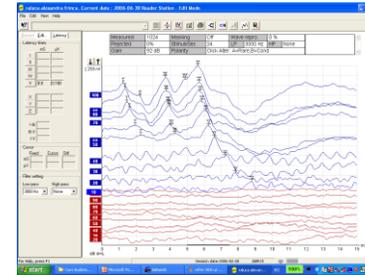
Auditory Neuropathy Spectrum Disorders

- Audiologic assessment characteristics -

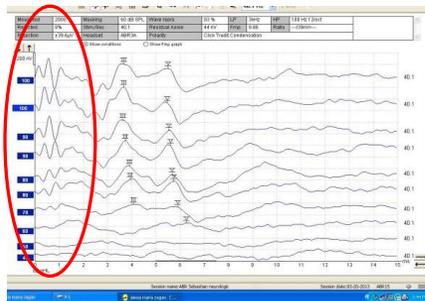
- OAE present (at least for some time)



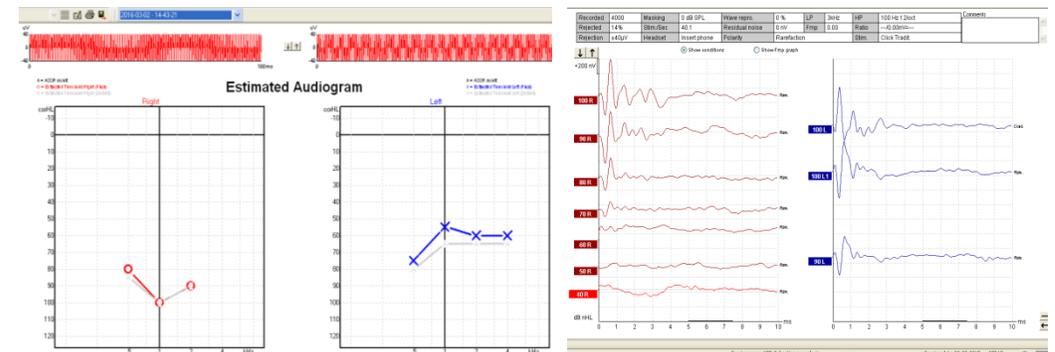
- Abnormal or absent BERA responses



- Cochlear microphonics - present

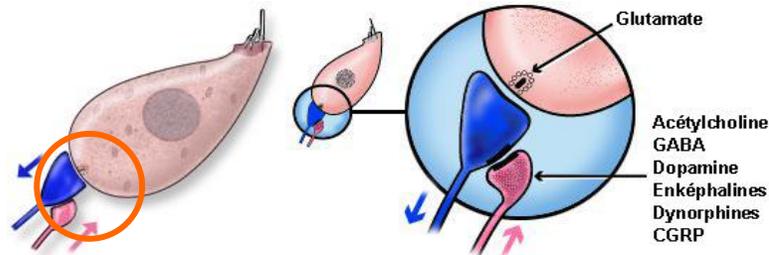
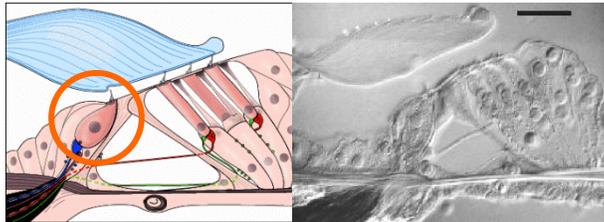
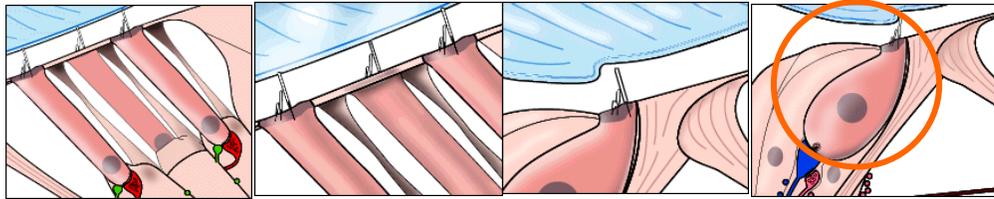


- Mismatch BERA-ASSR-VRA



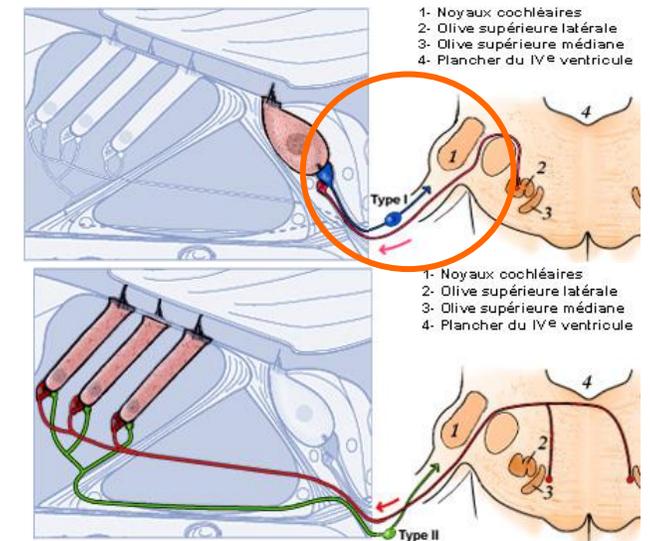
Auditory Neuropathy Spectrum Disorders

- Different origins -



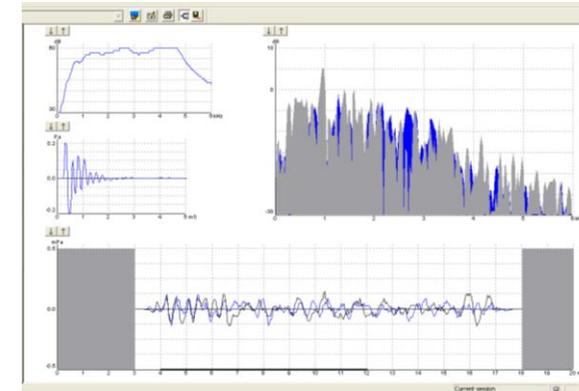
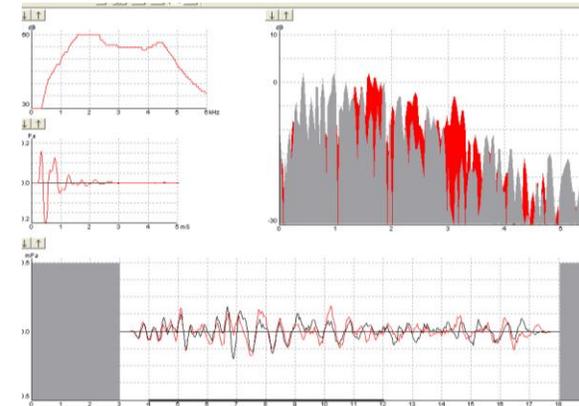
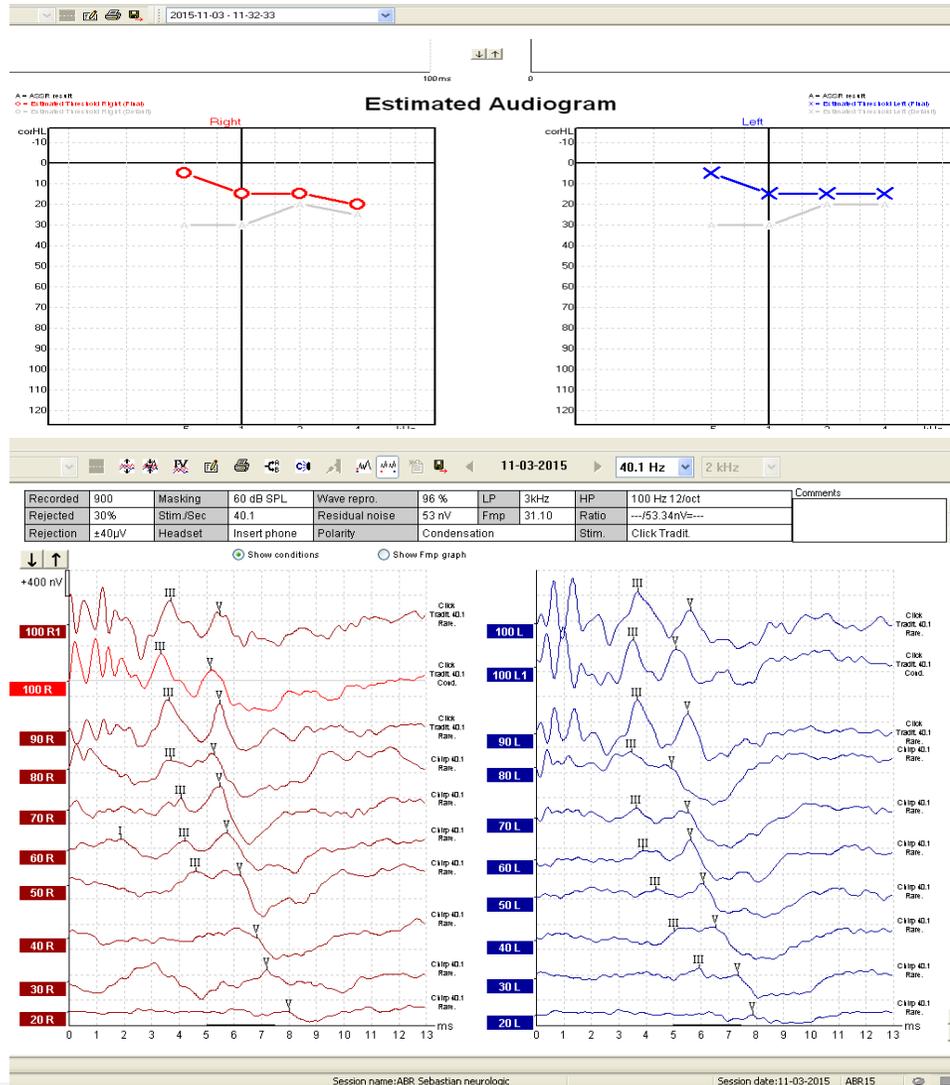
- 2008 – International Newborn Hearing Screening Conference
 - Auditory Neuropathy Spectrum Disorder - ANSD

- Dysfunction can be determined by :
 - Corti's dysfunctions - internal ciliated cells
 - Synaptic dysfunctions - neural sensory junction pathology
 - Dysfunction of the auditory nerve



Auditory Neuropathy Spectrum Disorders

- With normal hearing -



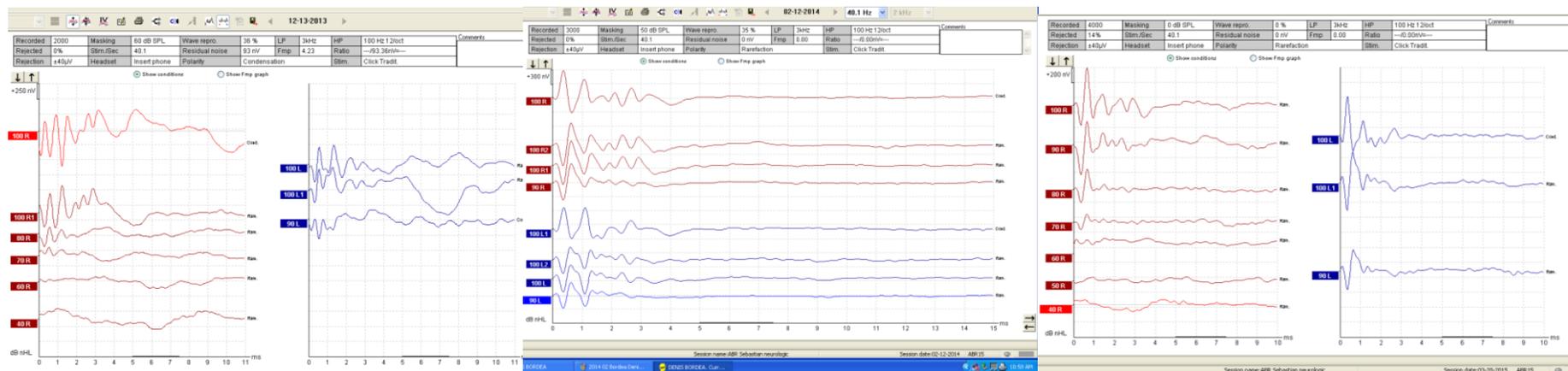
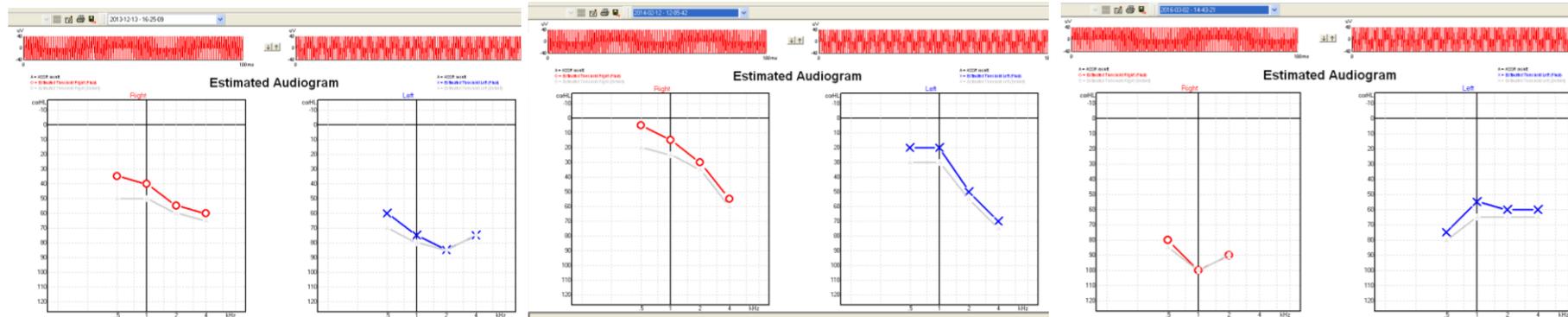
Auditory Neuropathy Spectrum Disorders

- With fluctuation/progressive hearing loss -

2013

2014

2015



Audiological Follow-up

Periodically hearing assessment - 1/6 months to 3 yo, later 1 session per year



- TONAL AUDIOMETRY IN FREE FIELD
- VISUAL REINFORCED AUDIOMETRY
- VOCAL AUDIOMETRY – using simple messages

Audiological Follow-up

Periodically hearing assessment - 1/6 months to 3 yo, later 1 session per year



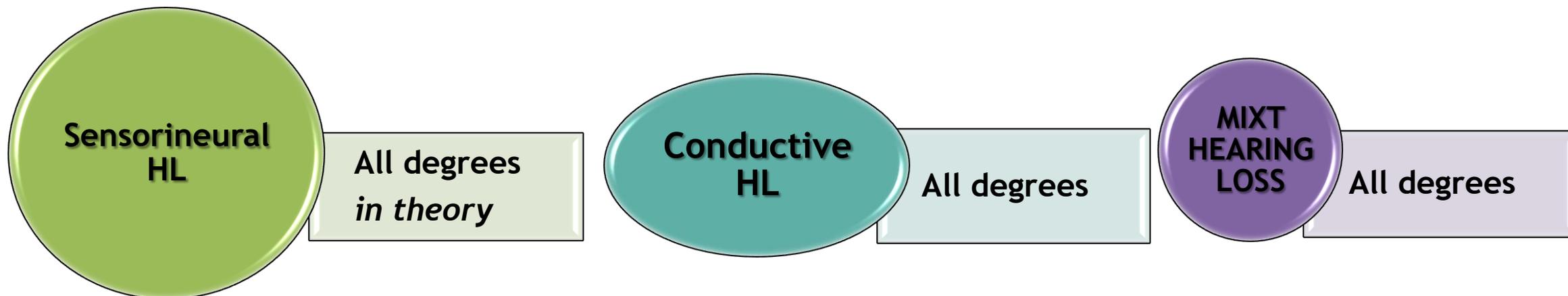
- The role of parents and educators !!!
- SPEECH AUDIOMETRY - the use of simple messages
- Perceiving Simple Sounds / MESSAGE UNDERSTANDING



Audiological Follow-up

- Auditory neuropathy
 - PTA/ speech audiometry: **audiological follow up +++**
 - Limited efficacy of conventional hearing instruments for language development: **speech therapist' follow-up +++**
 - Consider cochlear implant indication

Which child is eligible for hearing aid fitting ?

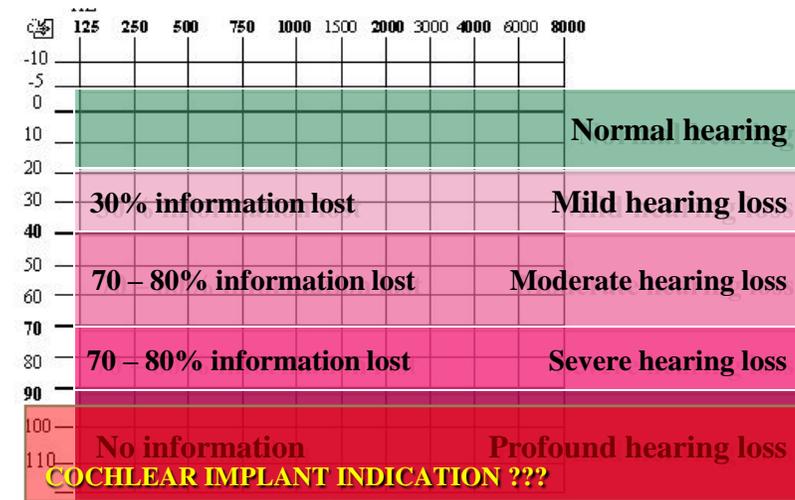


Objective assessment of hearing in children

Diagnosis process – Hearing loss degree

- Hearing loss / Conventional and Implantable hearing aids indication

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Classification of hearing loss – PTA
(BIAP recommendations /may 2005 - no. 02/1 bis)

- Determining hearing loss in dB HL is done according to ISO standards
- The average of tonal loss in dB HL on 500 Hz, 1000 Hz, 2000 Hz and 4000 Hz
- The loss is calculated **for each individual ear**
- It is also possible **to calculate a global loss** (for both ears)

Conventional hearing aid

- WHO IS ADDRESSED?

- Patients with unilateral or bilateral auditory loss without any other medical or surgical options
- AIDABLE with acceptable results
- !!! PROFOUND HEARING LOSS

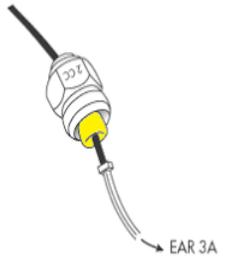
- WHAT SHOULD BE TAKEN INTO ACCOUNT?

- Degree of deficiency
- The type of hearing loss
- The shape of the tonal audiometric curve
- The shape of the voice audiometric curve (masking)
- Local aspect of the ear, anatomy and pathology

Conventional hearing aid

- Follow-up/control

- Verification of hearing aid fitting quality in the clinical phase (using measuring chain)
- Questionnaires for parents - observational study at home
- Logopedic evaluation
- Profound neurosensory hearing loss
 - Mandatory hearing aid trial before cochlear implant recommendation ?
 - How long should we wait ?



Type of conventional hearing aid

- Conventional hearing aids
 - Air conduction hearing aids

- Retro-auricular :
 - Behind the Ear (BTE)
 - Receiver in canal (RIC)
- Intra-auricular



- Bone conduction hearing aids



Which type of hearing aid ?

CONVENTIONAL HEARING AIDS

DIGITAL

- Retro-auricular
- Intra-auricular
 - In ear
 - CIC
 - microcanal
- Bone vibrators (BC - contact)

IMPLANTABLE HEARING AIDS

PASSIVE

- Middle ear/ossicular prostheses

DIGITAL ACTIVE HA

- Middle ear implants
- Cochlear implants
- Bone conduction implants
- Retrocochlear implants

Type of hearing aid depends on age

- From 0 to 6 year-old:
 - BTE with soft earmold (skull fracture might happen with rigid earmold in case of head trauma!)
 - RIC if enough room in the ear canal for the receiver
 - No intra-auricular devices which are too rigid !
 - BAHA with headband
- From 6 to 12 year-old :
 - BTE
 - RIC
 - Still no intra-auricular devices
 - BAHA with headband

Conventional BC hearing aids

- **Bone conduction hearing aid**

- Mastoidian vibrator :

- Glasses
- Hearband BAHA
- Ad Hear
- Crown and sound arch

- **DEPEND ALSO ON THE AGE**
(bone density)



Which kind of earmold ?



Soft Silicon
(Shore hardness of maximum 30 to 40) is mandatory

Which kind of earmold ?

Earmolds must be adapted to the type and degree of hearing loss

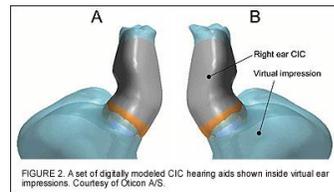
Standard

- Classic
- Open-fit

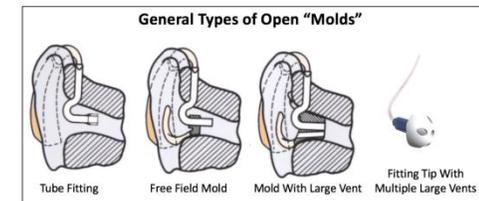
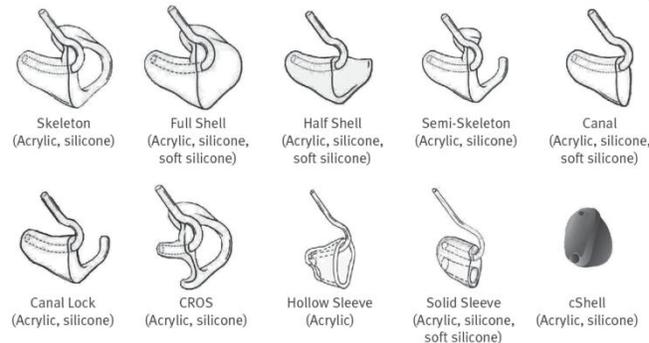


Customized

- In ear – full shell
- Skeleton
- Intracanal
- Adaptable with RIC (receiver in canal)
- With vent
 - comfort
 - acoustic



Earmold styles

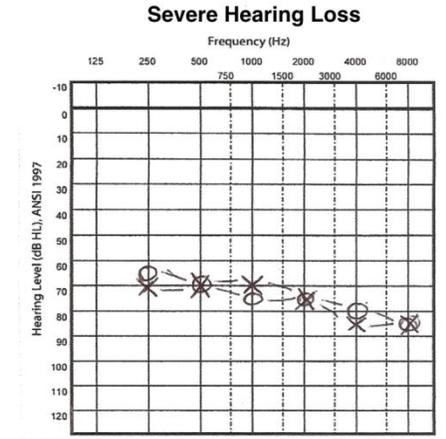
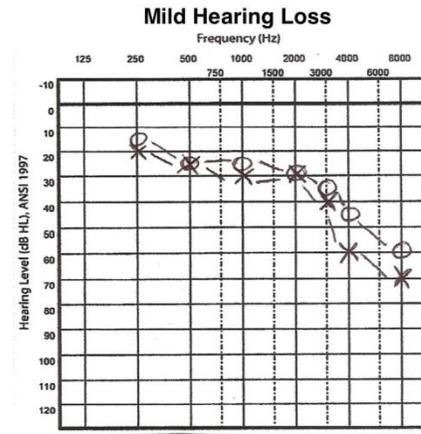
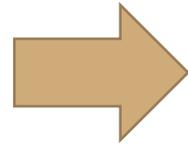
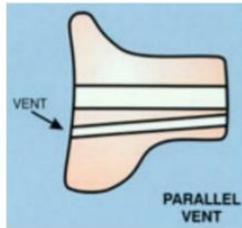


Which kind of earmold ?

- Importance of venting -

Venting

- A vent is often an intentional component of an earmold/earshell
- simply a column of air which provides a channel between the air within the ear canal and the air external to the ear canal



Open fitting



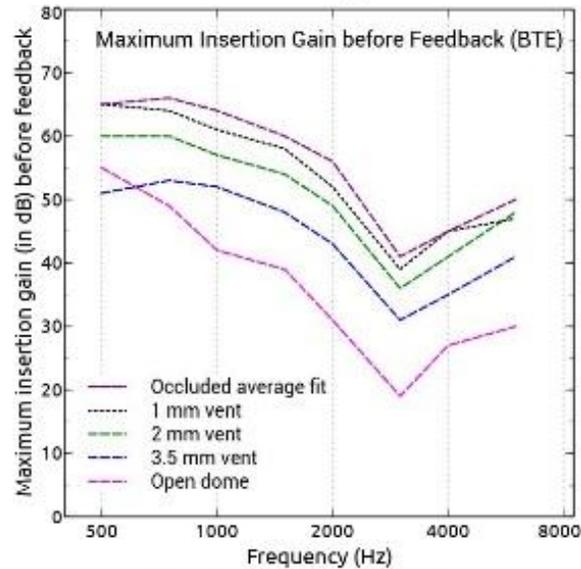
Closed fitting

Which kind of earmold ?

- Importance of venting -

Venting

-Effects on venting on feedback-



Venting

-Effects on HA gain and MPO-

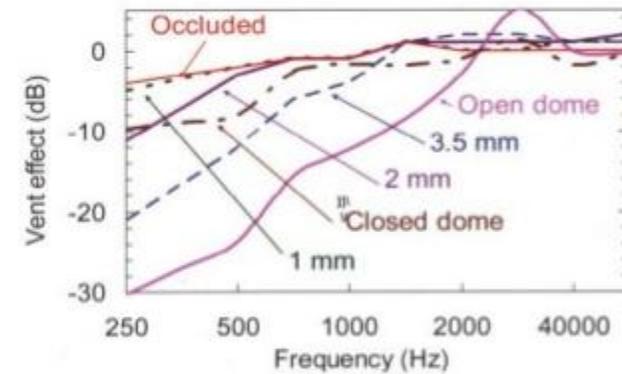


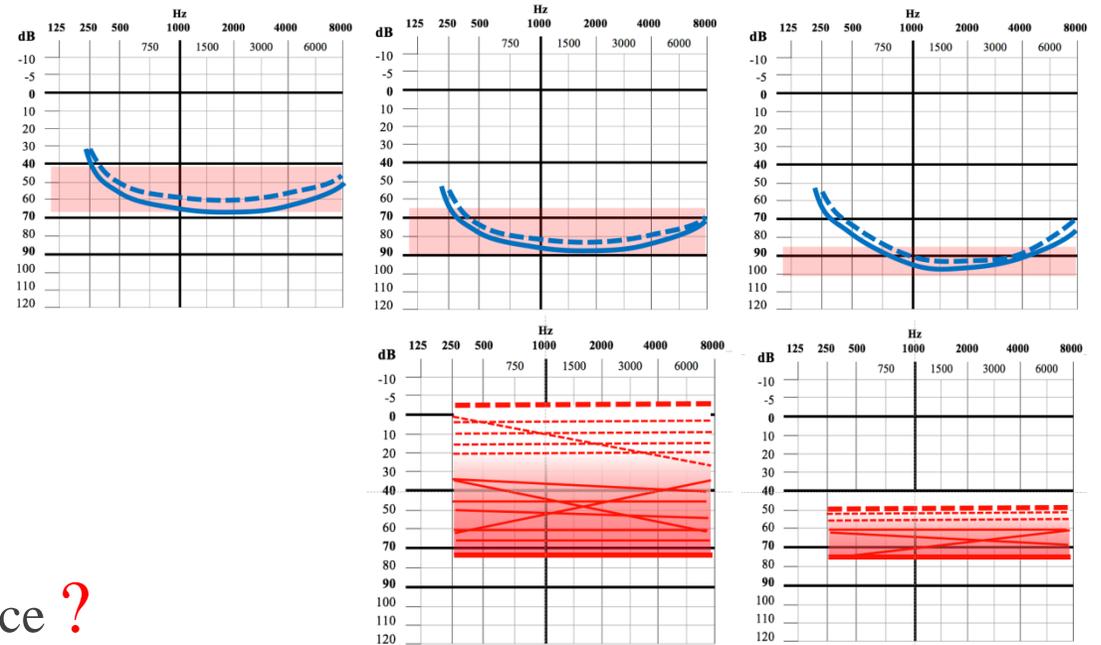
Figure 5.11 Effect of different sized vents on the frequency response of amplified sound, relative to the response with a tightly fitting earmold or earshell. 430, 431, 1355

Hearing aids can help

- Medium, severe and profound 1st degree neurosensory hearing loss
- Medium and severe transmission hearing loss
- Moderate, severe and profound 1st degree mixed hearing loss
 - (>41 < 90 dB HL)
 - Conventional hearing aid
 - Retroauricular – earmolds adaptation



- Medium and severe HL – good results
- Severe and profound HL – limited performance ?



Conventional Hearing Aids

- Efficacy of hearing aid fitting
 - Anamnesis
 - Free field tonal audiometry – for each fitted ear!!!!
 - Free field speech audiometry – adapted to the age – sometimes impossible
 - Behavioral audiometry / Visual reinforced audiometry – age related
 - Function of the speech development - exercises to indicate shapes, objects ...
- In some patients – **just hearing sounds can be considered as a success**

Conventional Hearing Aids

- **ONE OR TWO ???**
- Calculation of global hearing aid performance

$$\begin{aligned} & \mathbf{7 \times PTA \text{ mean (0.5, 1, 2, 4 KHz) on better ear}} \\ & \quad + \\ & \mathbf{3 \times PTA \text{ mean (0.5, 1, 2, 4 KHz) on worse ear}} \\ & \quad / \\ & \mathbf{10} \end{aligned}$$

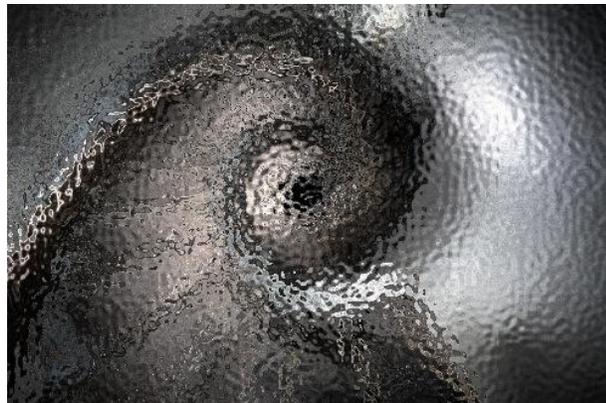
No sound perception –120 dB lost

Conventional Hearing Aids

- Conditions:
- The hearing aid fitting
 - For each ear which needs it
- Only if potential development of speech production and comprehension fits conventional Hearing Aid recommendation
 - Speech audiometry– more than 60 – 70% intelligibility
 - In children – HA trial for a period with speech therapy and follow-up
 - EXCEPTIONS

Conventional Hearing Aids

- The conventional hearing aid offers the amplified sounds to the INTERNAL EAR
 - **Damaged organ - possible source of distortion.**



Sebastian Cozma

TAKE HOME MESSAGES

- Less than 50% of speech discrimination at 60 dB in free field with appropriate hearing aid fitting = cochlear implant indication
- Pay attention to ANSD (Neural dissynchrony)
- Conventional hearing aid indications in borderline cases must be discussed by a multidisciplinary team

Conventional Hearing Aids

- Specials fittings -

- Bimodal hearing aids

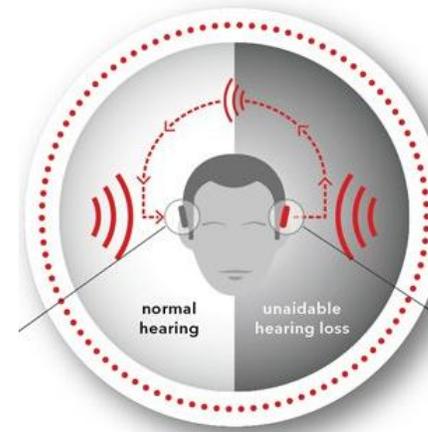


**Cochlear
implant**



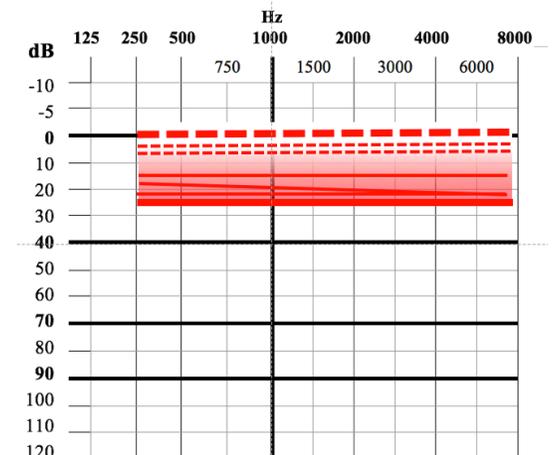
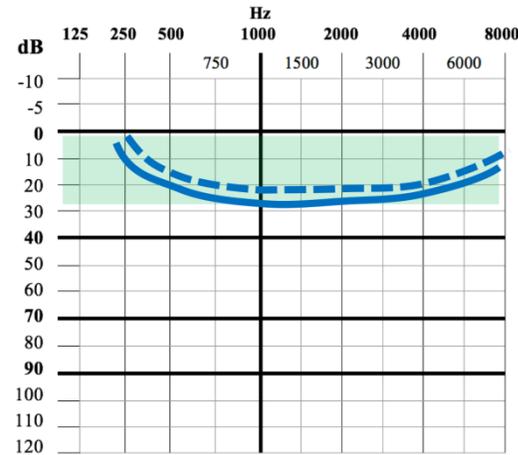
**conventional
hearing aid**

- CROS – transcranial hearing

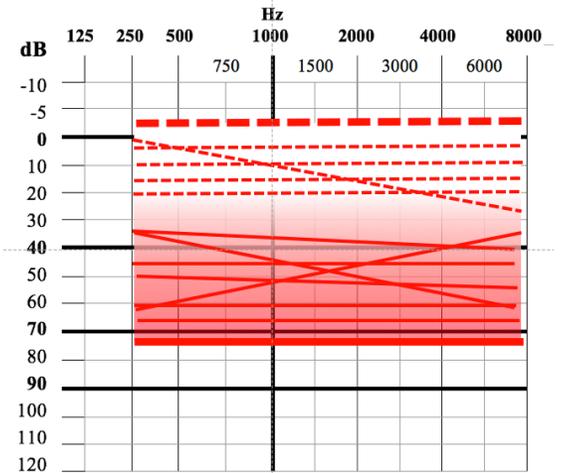
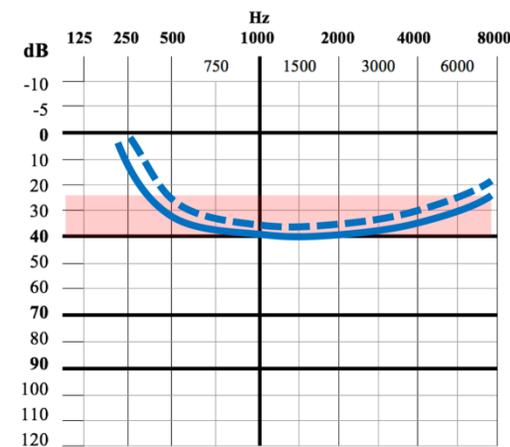


Hearing aids limits

- The mild neurosensory hearing loss at the limit with normal
- The mild conduction hearing loss at the limit with normal
 - Not indication for hearing aids



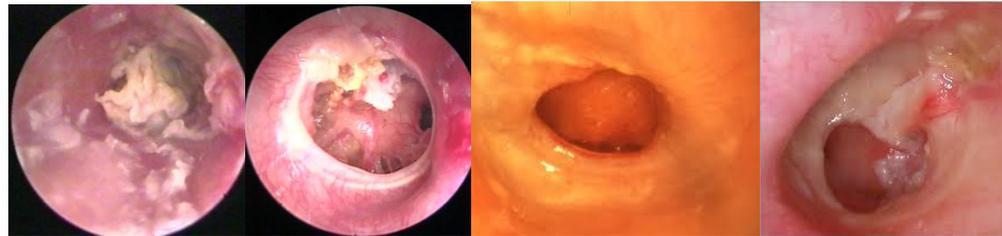
- Mild neurosensory hearing loss
- Mild conduction hearing loss
 - (>30 dB HL)
- Conventional hearing aid
 - Retroauricular – earmolds adaptation



Contraindications

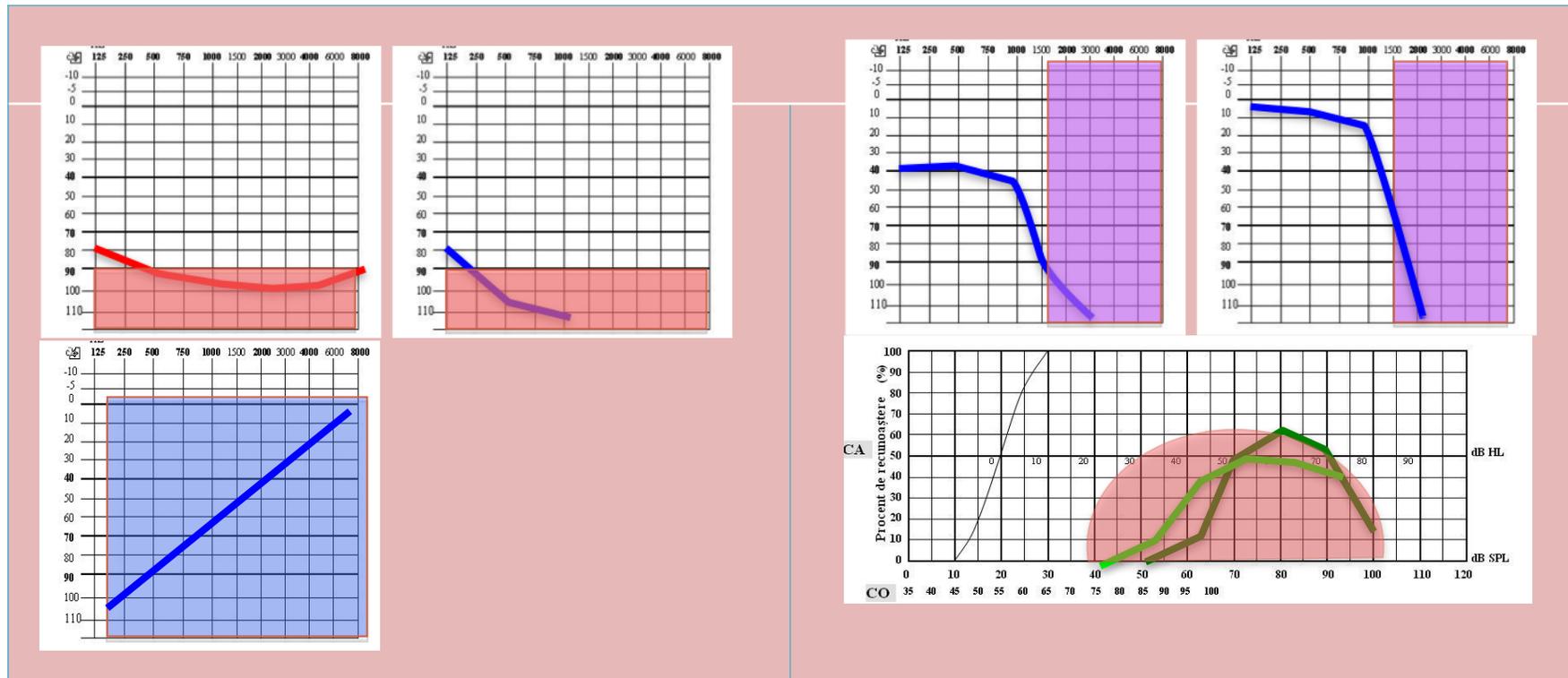
- Contraindications
 - Local chronic infections
 - Intolerance to earmold material / allergies
- Active / relapsing suppurative infectious disease
- PRESENCE of allergies / intolerances
- External ear malformations - agenesis

- Audiological criteria / medical criteria



Implantable Hearing Aids

- Conventional hearing aids ARE NOT INDICATED
 - Cochlear implant OR electro-acoustical stimulation?



THANK YOU !

