Audiological Diagnosis after Newborn Screening

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Ifos World Course on Hearing Rehabilitation
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Universal Newborn Hearing Screening (UNHS): What's next?

0 –1 month **3 months** **6 months**

UNHS Diagnosis Intervention

Behavioral Audiometry: when and how

Objective measures: what is children-specific?

Diagnostic strategy

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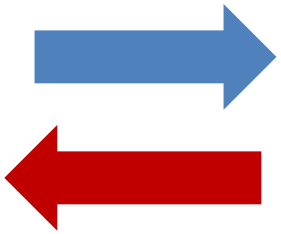
Principles of Behavioral Audiometry

- **Building a circular path between the clinician and the child**

Deliver stimuli
Take reactions



Take stimuli
Deliver reactions

- **Adapt your testing to the child age (neurodevelopmental, not chronological)**

- **Always use the parents as partners when testing**

Before 6 months: Behavioral Observation Audiometry (BOA)

- **Take your time and look for the infant reflexive behaviors to auditory stimuli:** i.e., eye blink/widening, modification of cardiac rhythm, startle responses (Moro reflex)…
- **Bias 1**: can be elicited by a wide range of intensity levels
- **Bias 2**: babies can get bored very quickly
- **Bias 3**: observer experience-dependent

Behavioral Audiometry: when and how

Objective measures: what is child specific?

Diagnostic strategy

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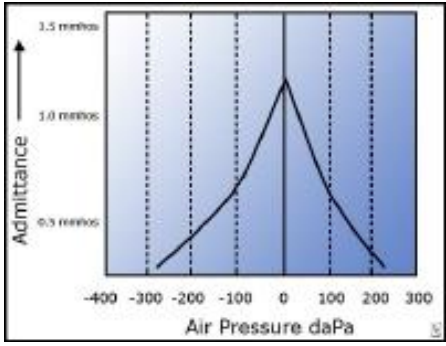
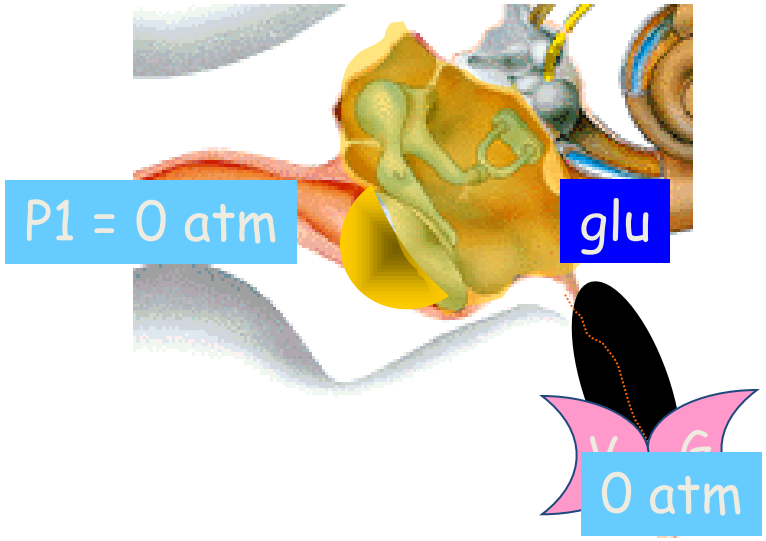
TARGETTING…

- **Middle Ear**
- Inner Ear
- Afferent pathway & beyond

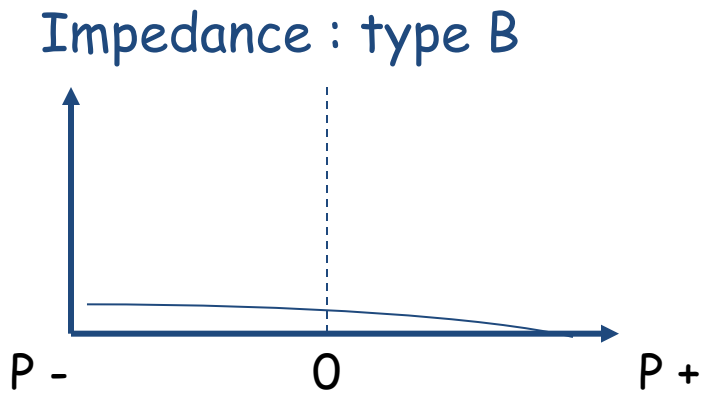


Otitis with middle ear effusion



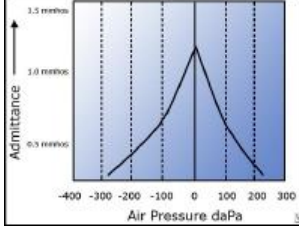
Tympanometry

(Otto Metz, 1946; Jerger, 1970)



Adapted from Van Den Abbeele et al.

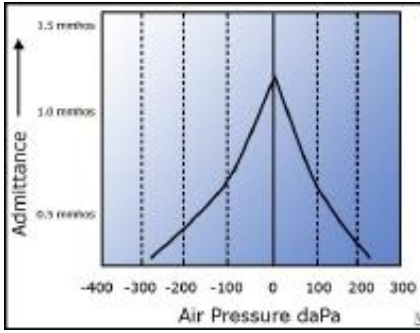
Effect of ear canal volume

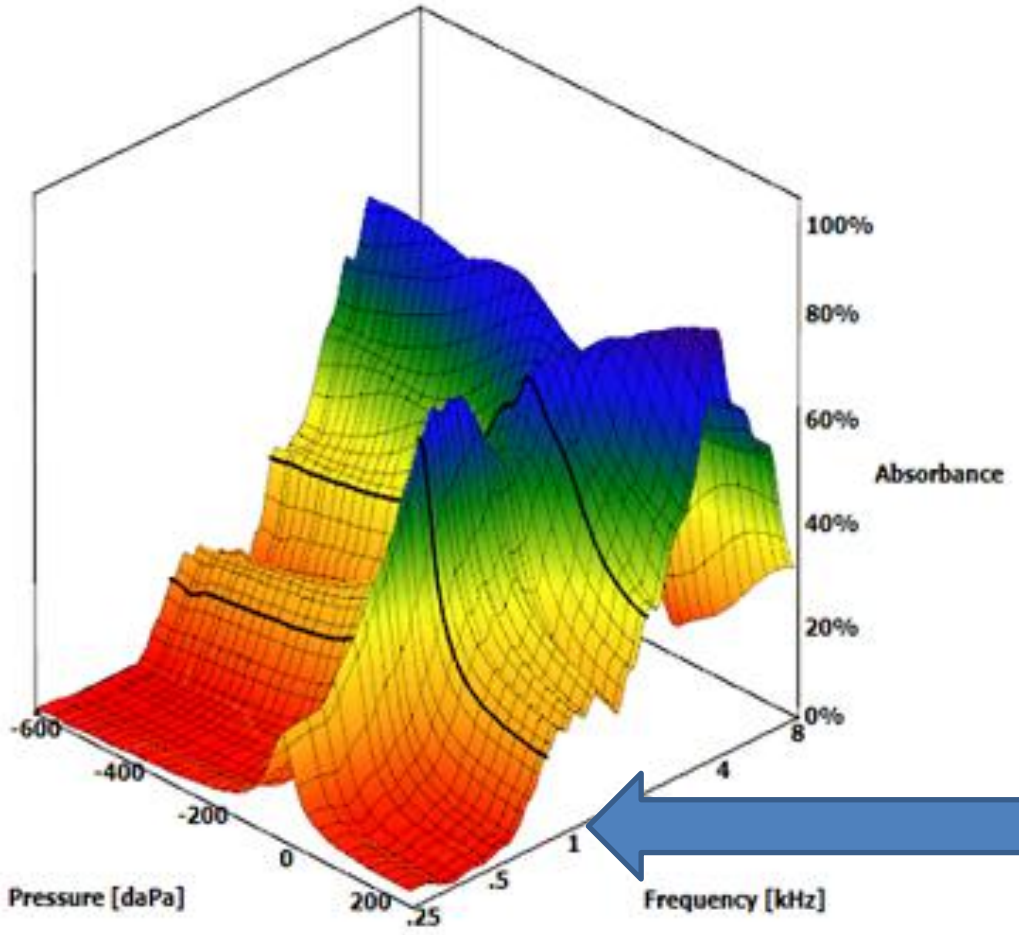


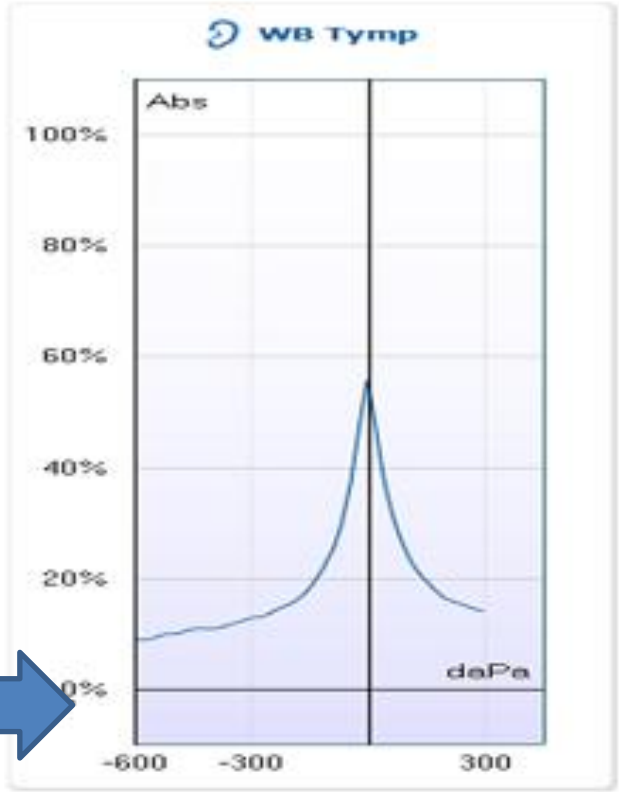
Age Group	Equivalent ear canal volume (V_{ec})	Static compensated admittance (Y_{tm})	Tympanometric width (TW)	Tympanometric peak pressure (TPP)
Newborns and Infants <6 months (1000 Hz probe)	0.2 – 0.8 cc	>=0.6 mmho for negative compensation >= 4 mmho for positive compensation	<150 daPa	NA
6-18 months - (226 Hz probe)	0.5 – 1.0 cc	>=0.2 mmho	<250 daPa	+25 to -75 daPa
>18 months to 10 years (226 Hz probe)	0.6 – 1.2 cc	>=0.3 mmho	<200 daPa	+25 to -75 daPa
>10 years and Adults (226 Hz probe)	1.0 – 2.2 cc (males) 0.8-1.9 cc (females)	>=0.3 mmho	<125 daPa	+5 to -105 daPa

Consensus statement: Eriksholm workshop on wideband absorbance measures of the middle ear. Feeney MP et al., Ear Hear. 2013

3D wideband tympanometry





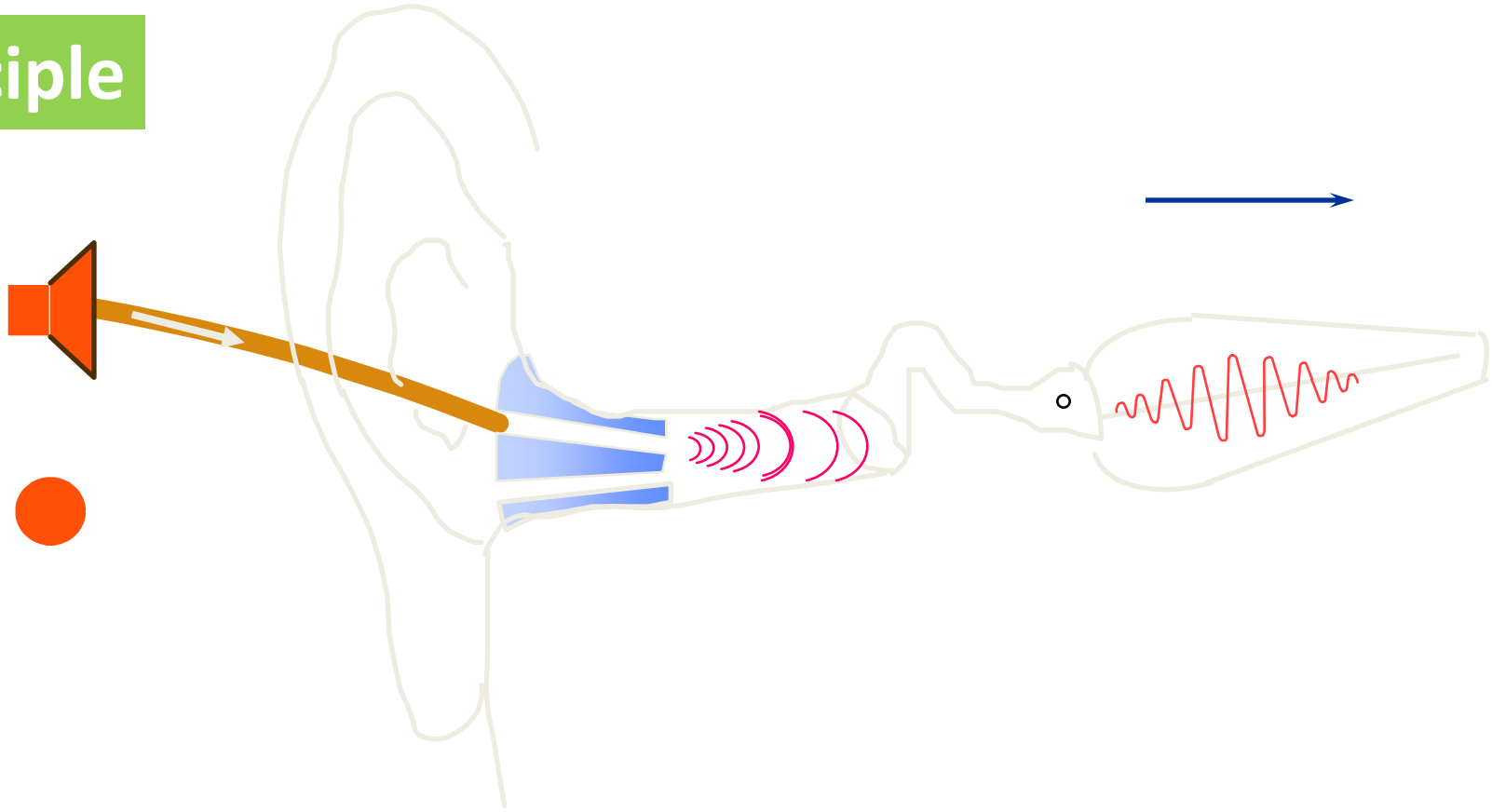


TARGETTING…

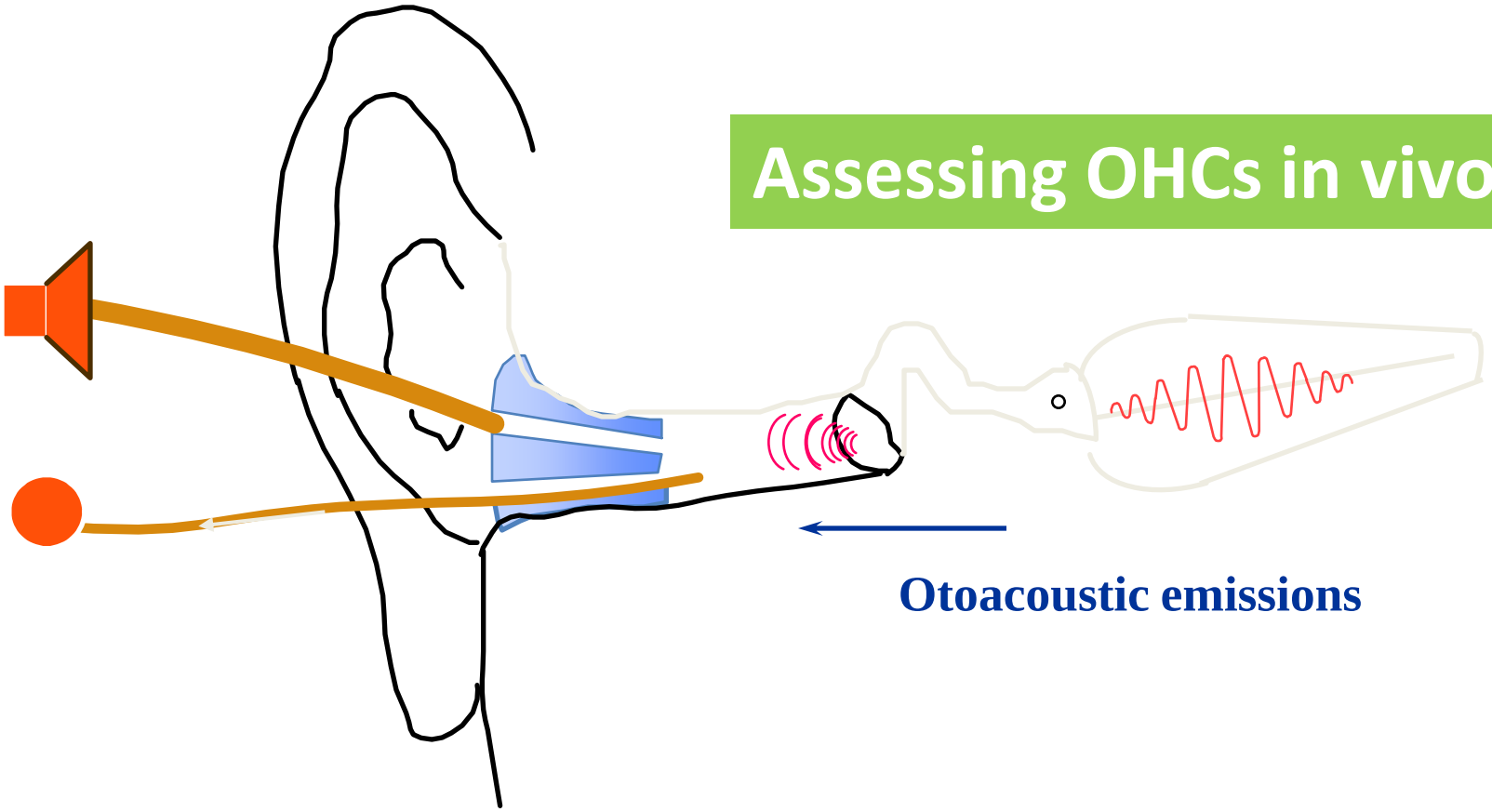
- Middle Ear
- **Inner Ear**
- Afferent pathway & beyond

Transient evoked otoacoustic emissions

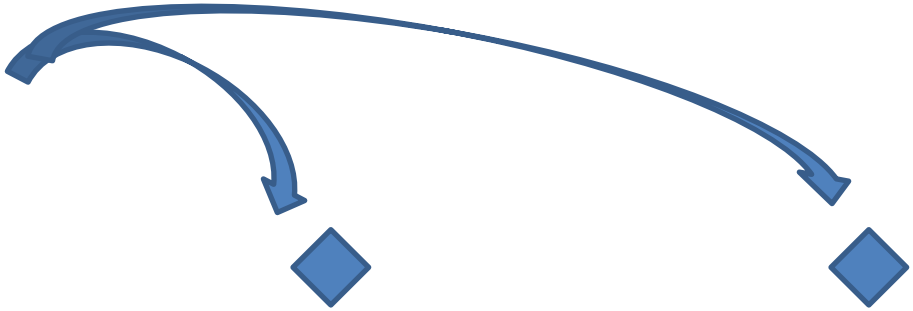
Principle



Transient evoked otoacoustic emissions

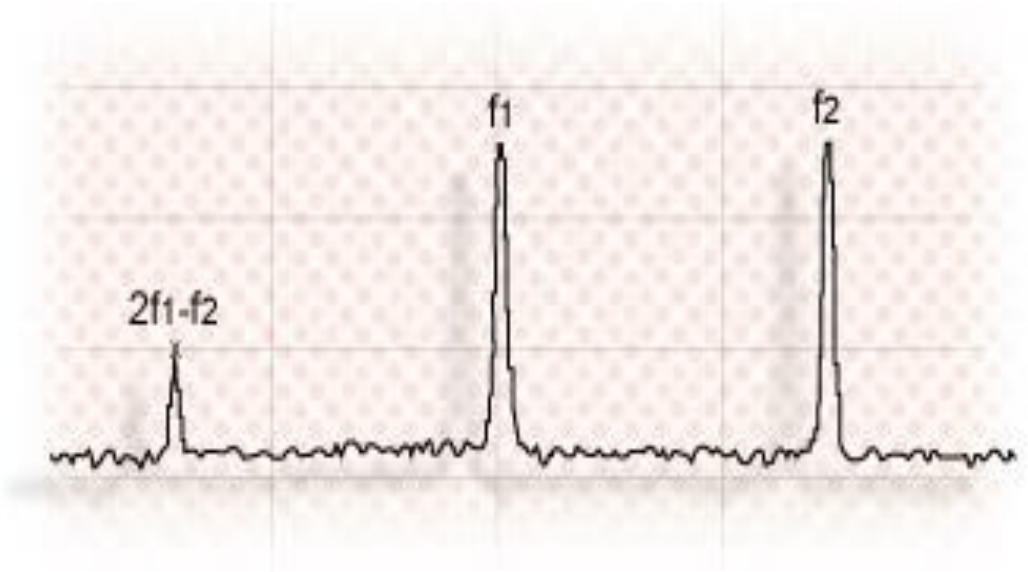


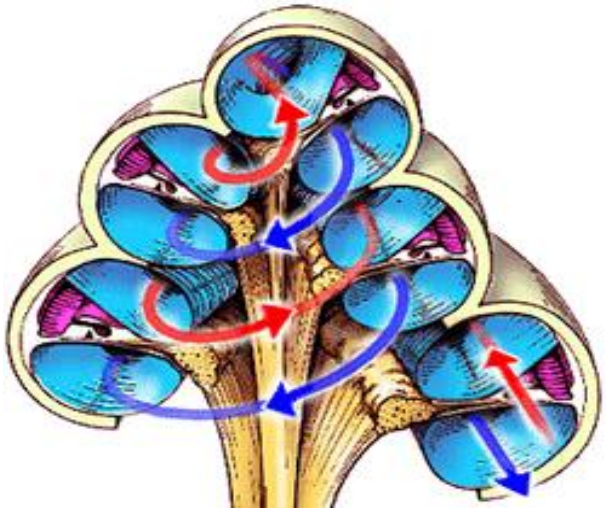
Distorsion Product 0toacoustic emissions



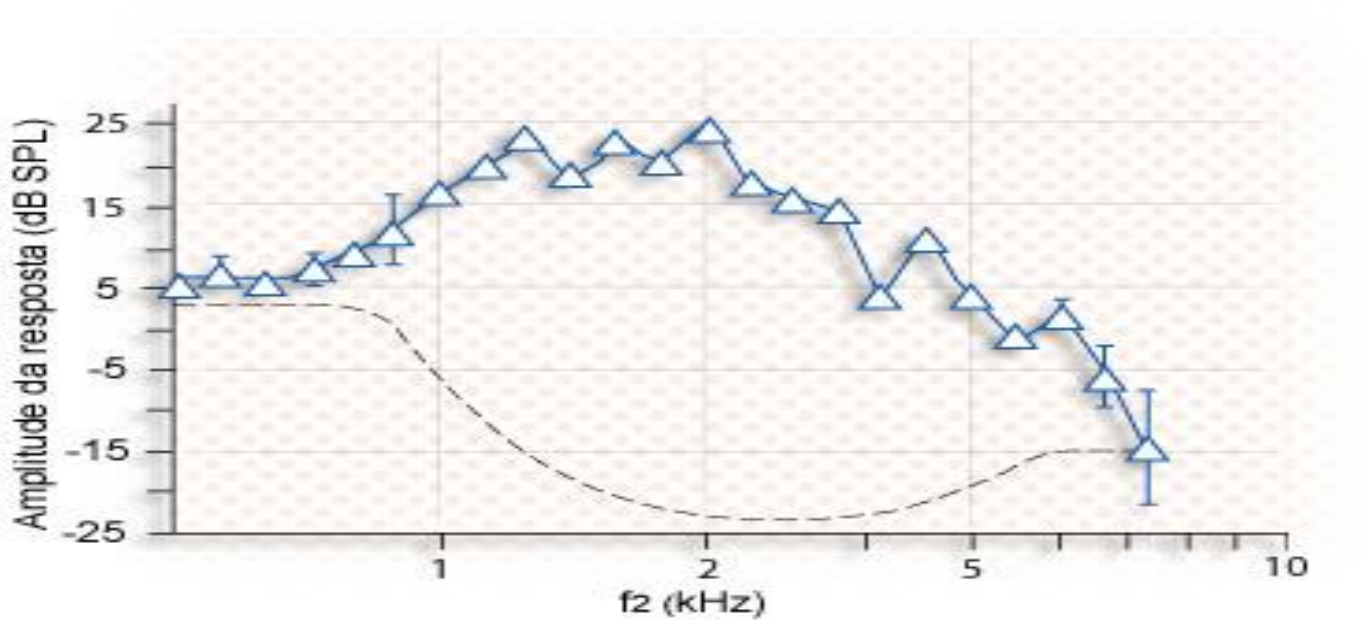
Objective Audiometry: DPOAEs are back!

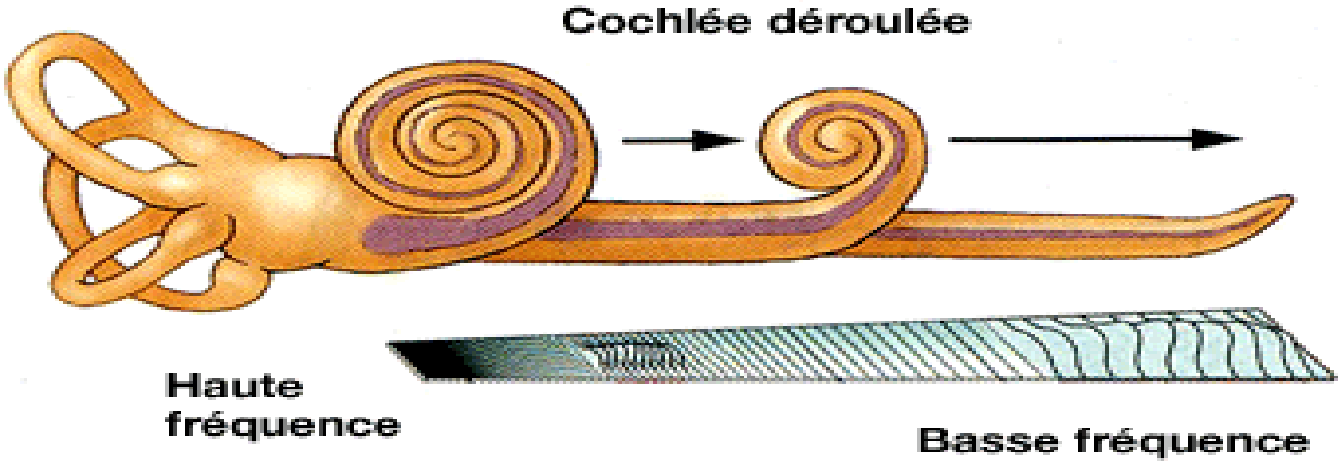
Distorsion Products



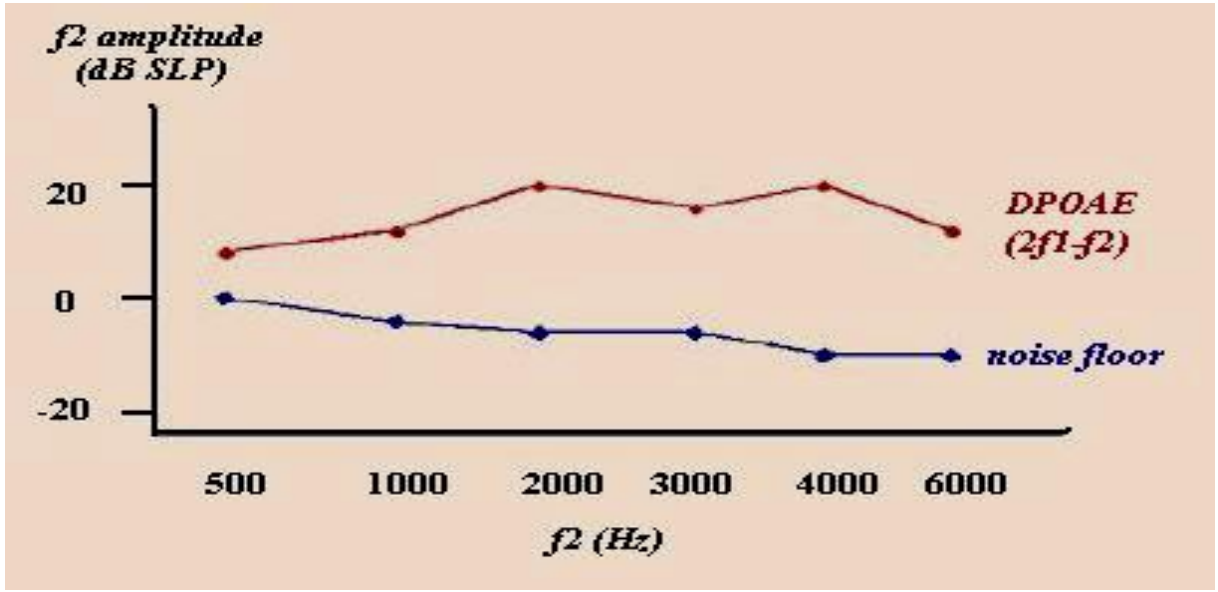


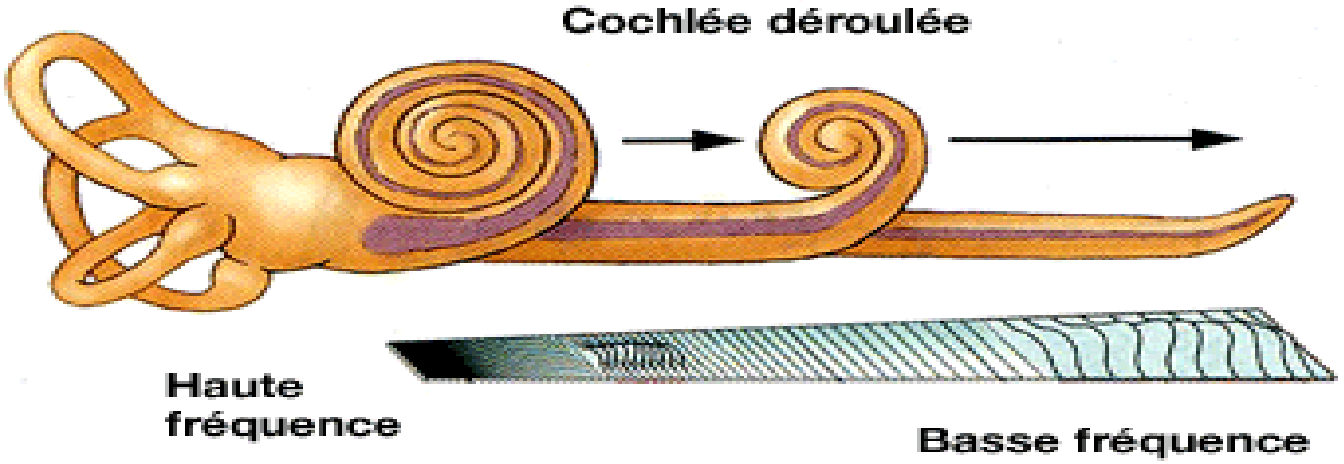
Distorsion Products





Distorsion Products

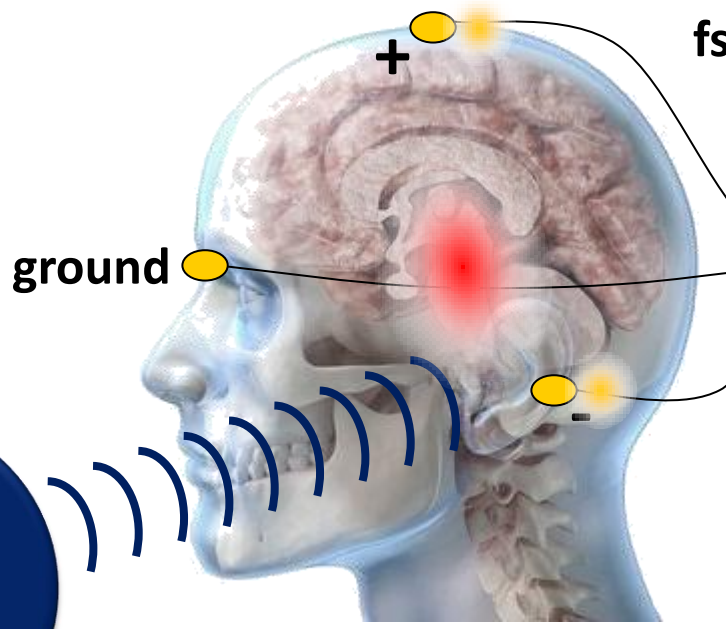




TARGETTING…

- Middle Ear
- Inner Ear
- **Afferent pathway & beyond**

AUDITORY BRAINSTEM RESPONSES



fs = 7 à 50 kHz

3000 trials

> 80 Hz

ABR

Auditory Brainstem Response

Click, Chirp, Tone Burst

Why « brainstem » ?

Early activity (< 20 ms) > 80 Hz

Auditory Evoked Potentials (AEP)

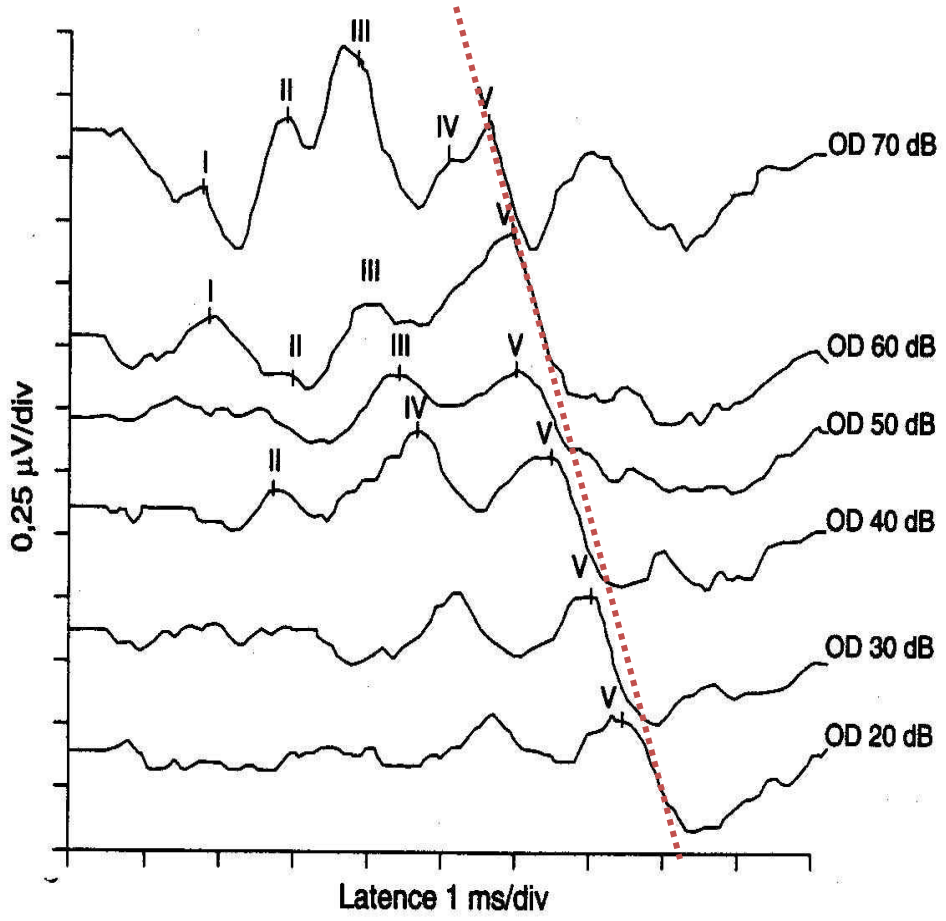
I) **CLICK ABRs**

II) FREQUENCY-SPECIFIC DIAGNOSIS

III) HOW TO GET RID OF CONDUCTIVE HL

ABR RECIPE
IN YOUNG CHILDREN

Looking for objective hearing threshold

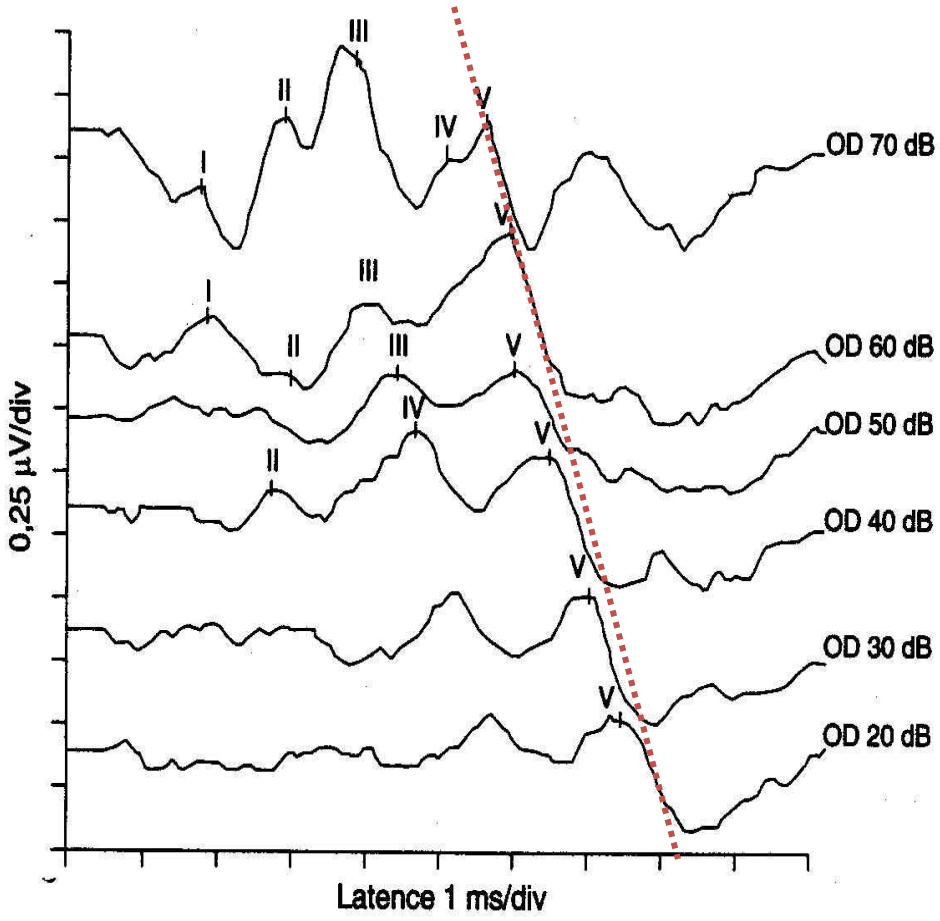


Normal ABRs (20 dB-threshold)

Start at 70 dB
then diminish stim level
(10-20 dB steps)

ABR information

What does it tell you?

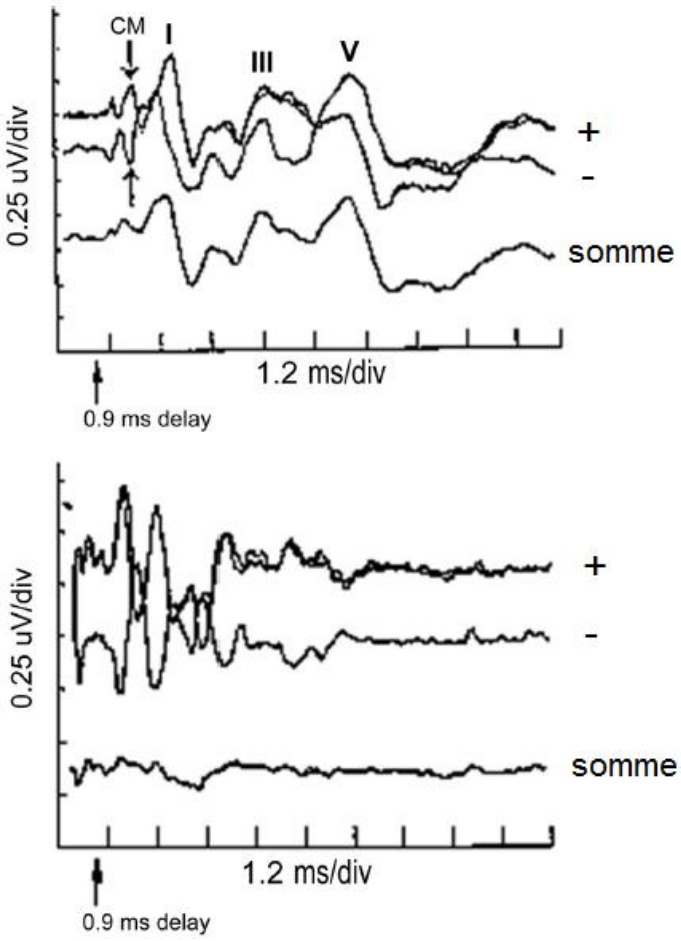


- ✓**Well-defined waveforms**
- ✓**CNS maturity**
- ✓**Topodiagnosis in conjunction with TEOAEs**
- ✓**Auditory neuropathy diagnosis**

Auditory Neuropathy Diagnosis

- TOAEs are present
- ABRs are absent
- Cochlear microphonic potential (CMP) must be looked for

Cochlear Microphonic Potential (CMP)

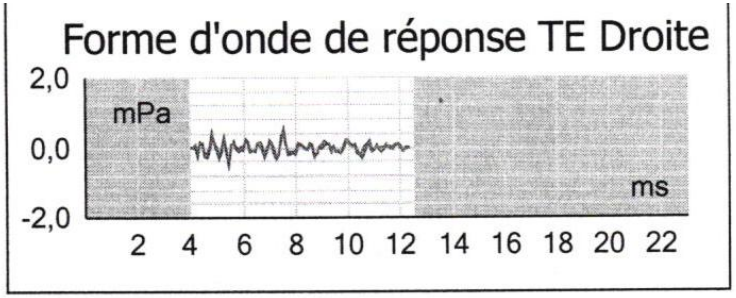


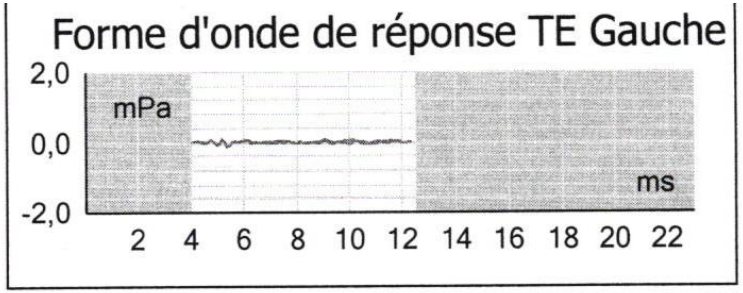
From Hood, 2015

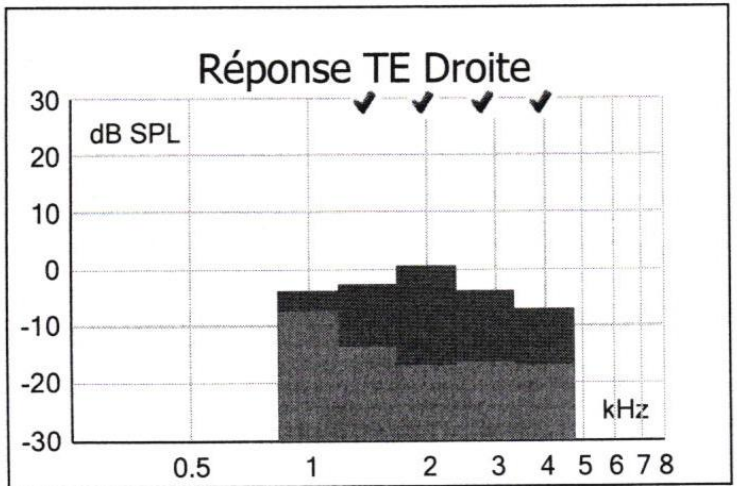
- Low amplitude response just a few msec after the click
- Latency does not change with intensity level
- Receptor potential of hair cells
- Follow stimulus polarity (either rarefaction or condensation click)

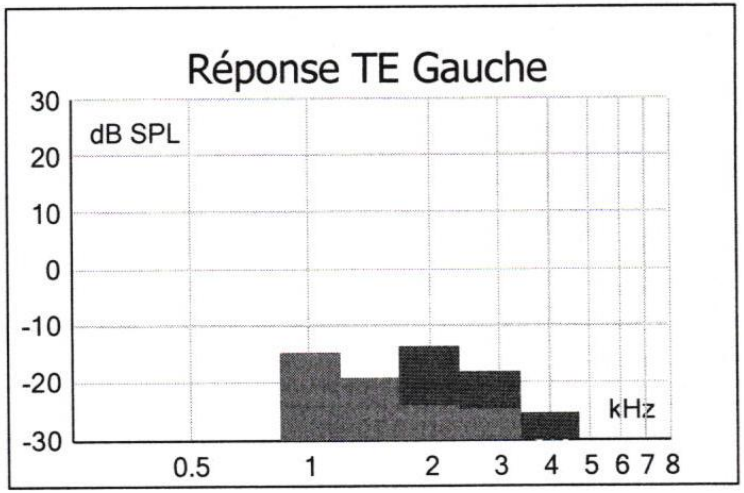
(**Starr et al., 1996 ; Starr et al., 2001 ; Buchman et al, 2006 ; Berlin et al., 2010**)

Case Report – 2 month-old preterm birth (36 weeks)





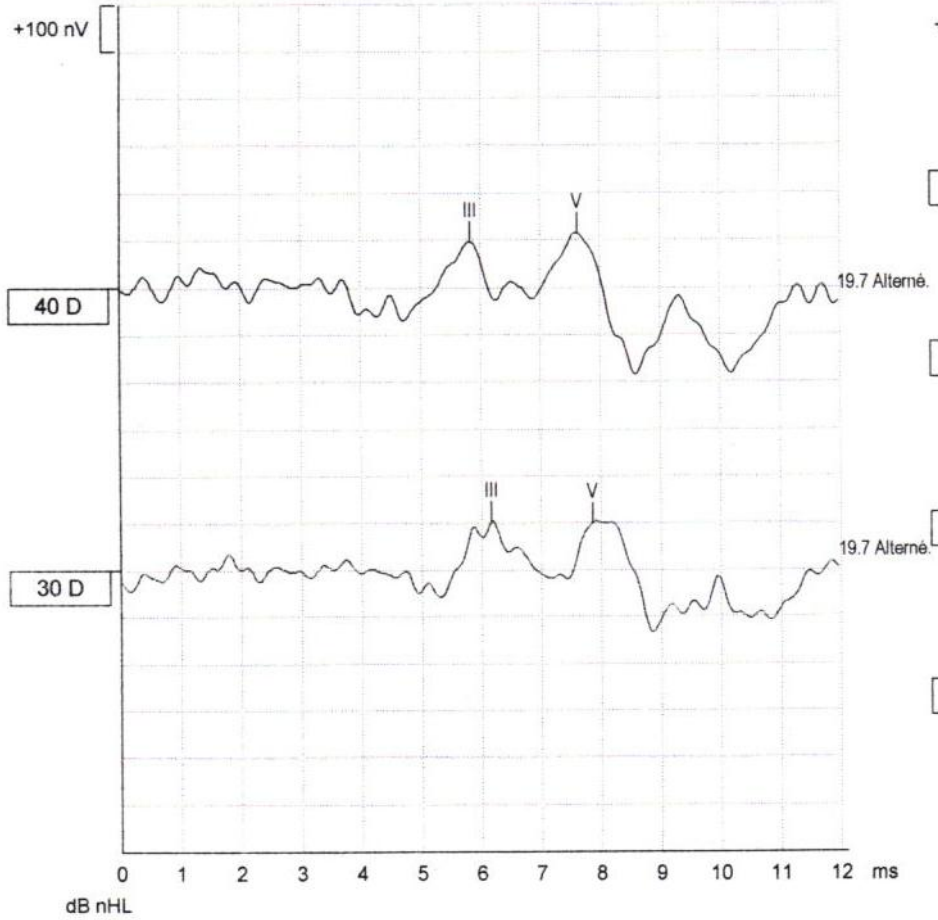


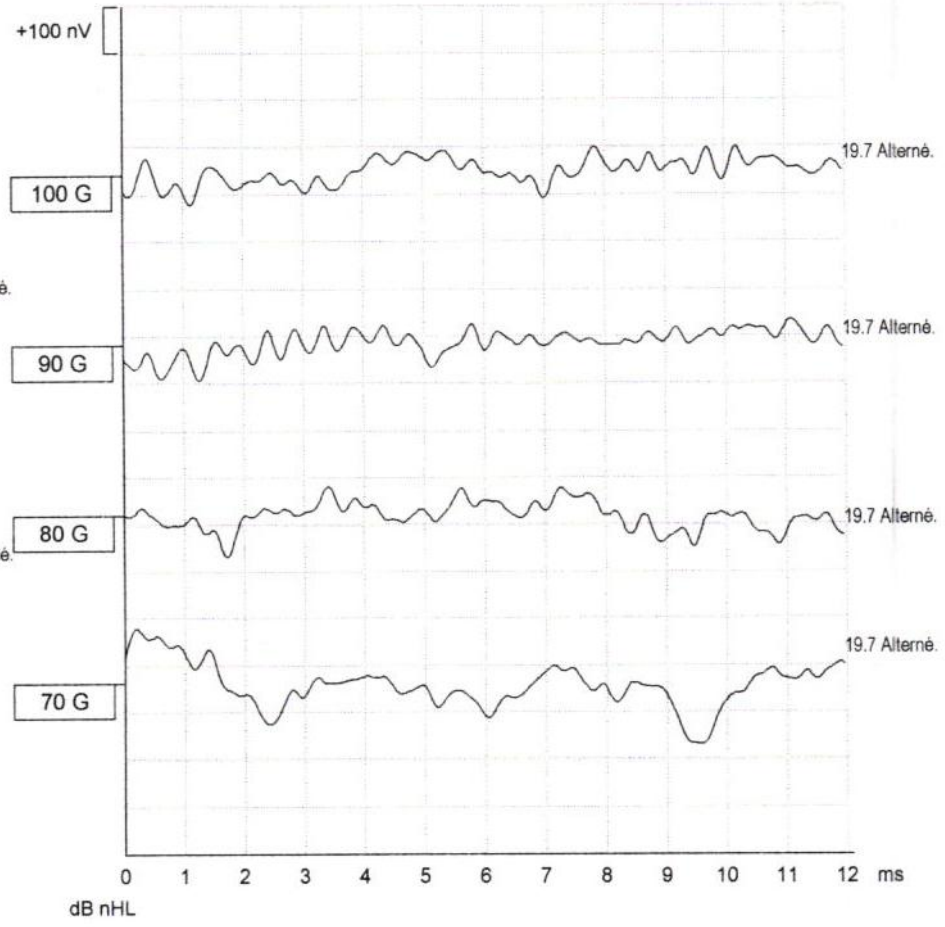


OEA present

OEA absent

Case Report – 2 month-old preterm birth (36 weeks)

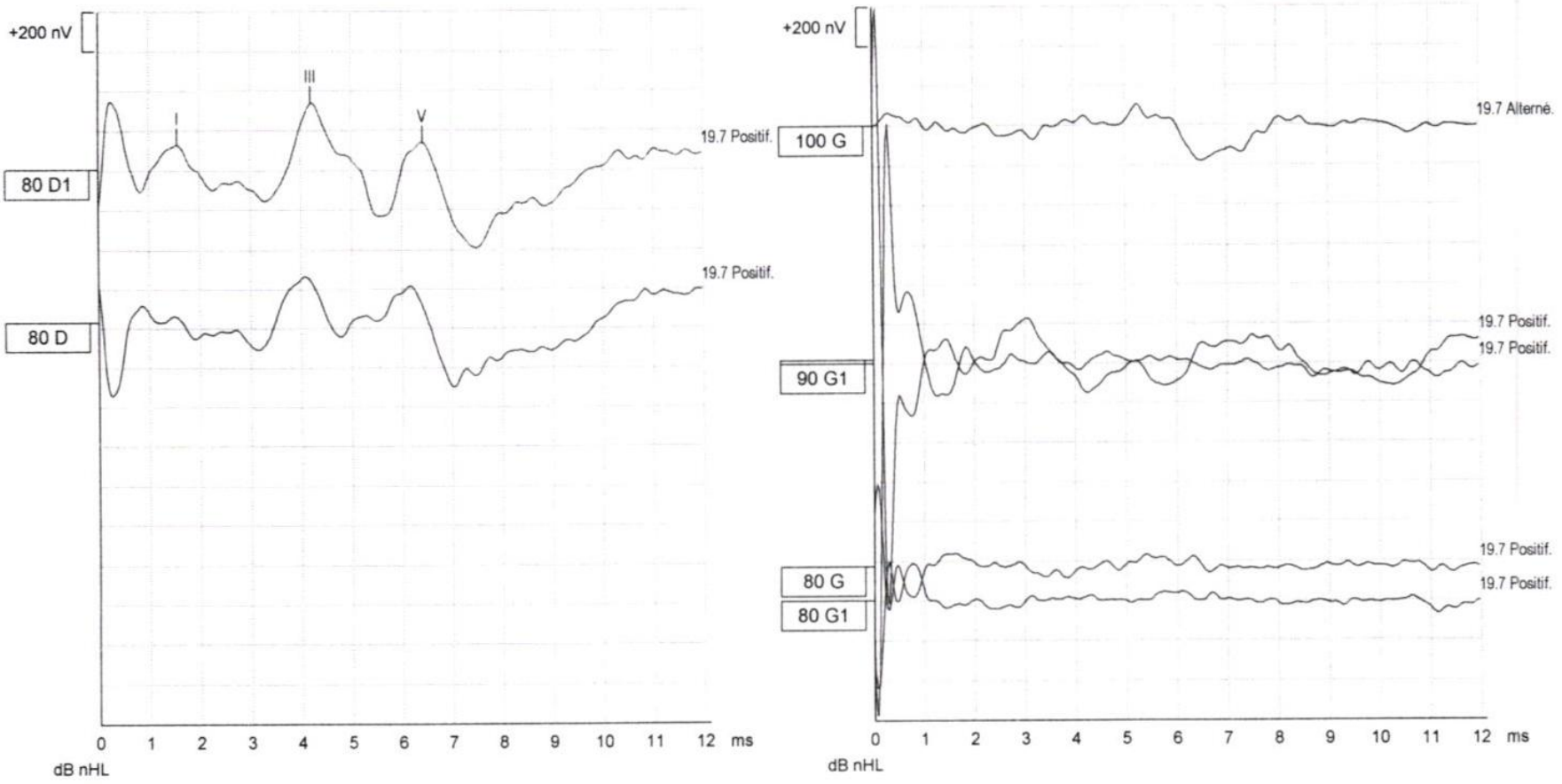




ABR present
Alternating Polarity click

ABR absent
Alternating Polarity click

Case Report – 2 month-old preterm birth (36 weeks)



CMP present

Rarefaction / Condensation clicks

Auditory Evoked Potentials (AEP)

I) CLICK ABRs

II) **FREQUENCY-SPECIFIC DIAGNOSIS**

III) HOW TO GET RID OF CONDUCTIVE HL

Tone-Burst ABRs

informa
healthcare

Original Article

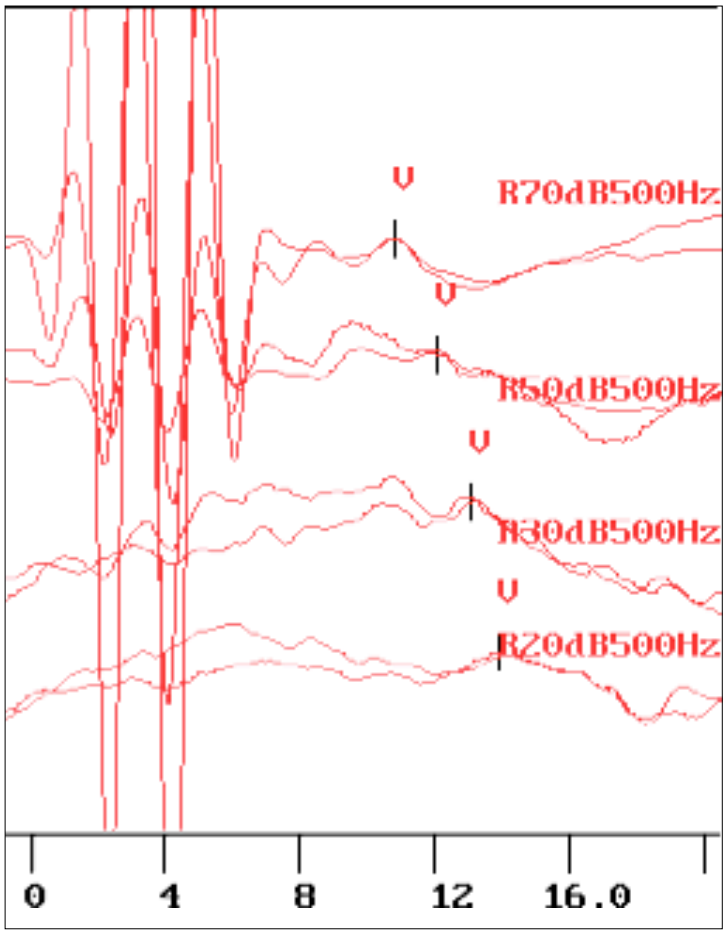
International Journal of Audiology 2007; 00:1–9

Flávia Martins Ribeiro[*]
Renata Mamede Carvallo[†]

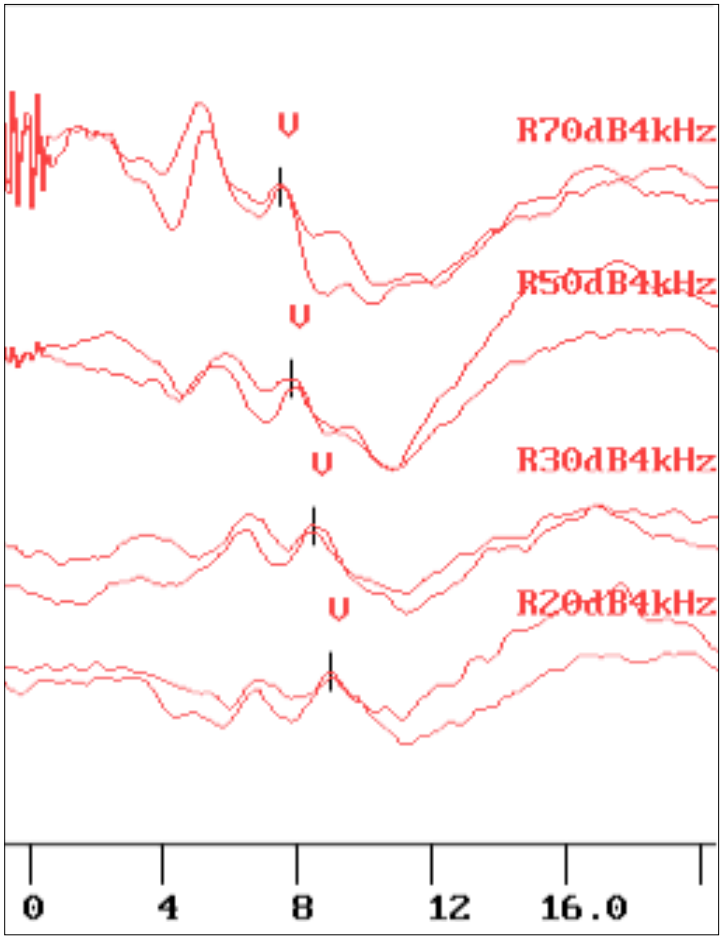
[*]Hospital São Luiz, São Paulo, Brazil
[†]School of Medicine, São Paulo University, Brazil

Tone-evoked ABR in full-term and preterm neonates with normal hearing

Tone-Burst ABR



500 Hz



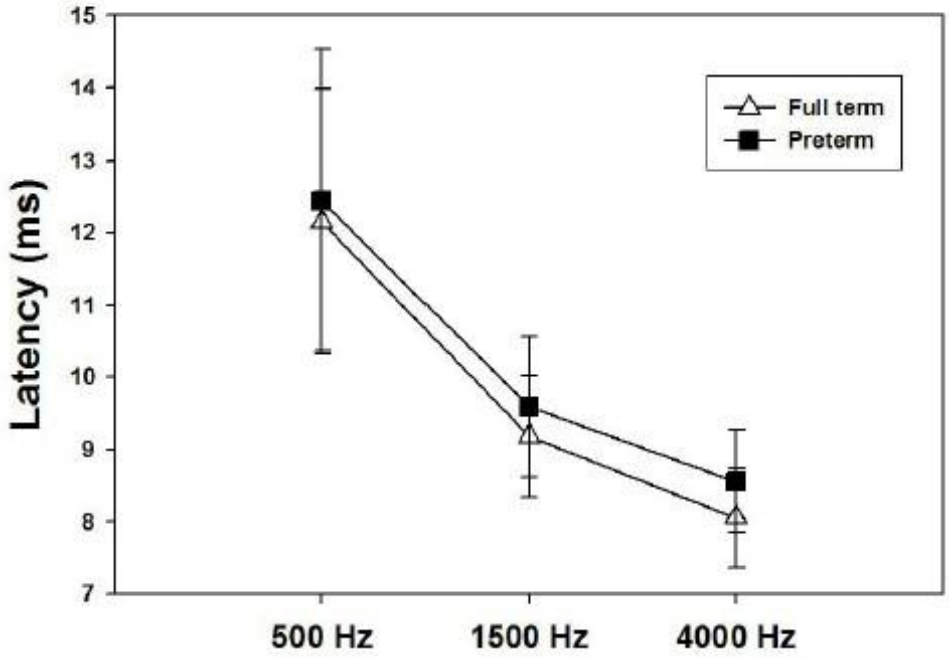
4000 Hz

Ribeiro, 2003

Tone-Burst ABR

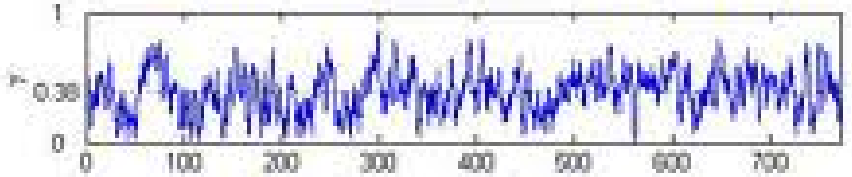
Ribeiro FM, Carvallo, RM; 2007

Figure 2: Wave V latency for three frequencies across groups.

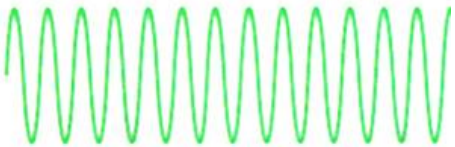


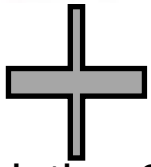
- ✓**Global neurodevelopment delay**
- ✓**No collaboration at behavioral audiometry**
- ✓**Need for frequency specific diagnosis**

Auditory steady state response (ASSR)

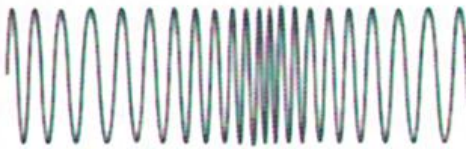


Carrier: e.g. 2000 Hz

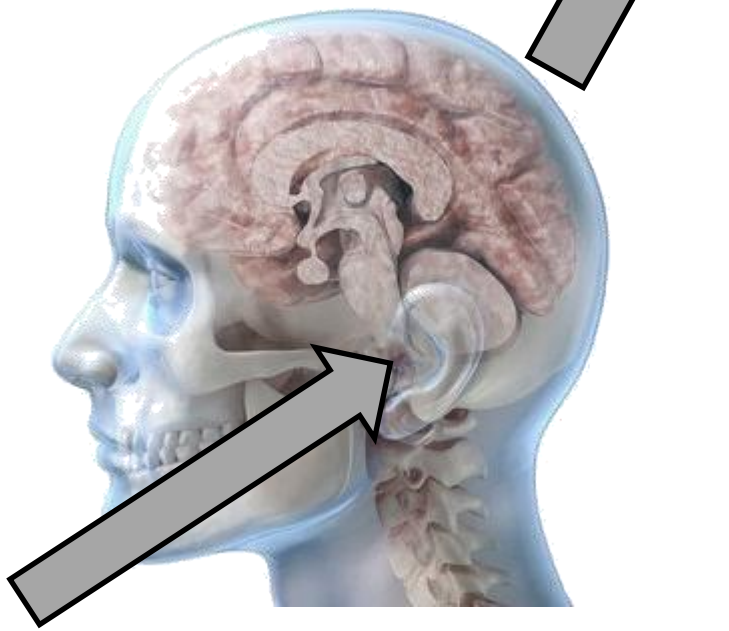




Modulation 90 Hz

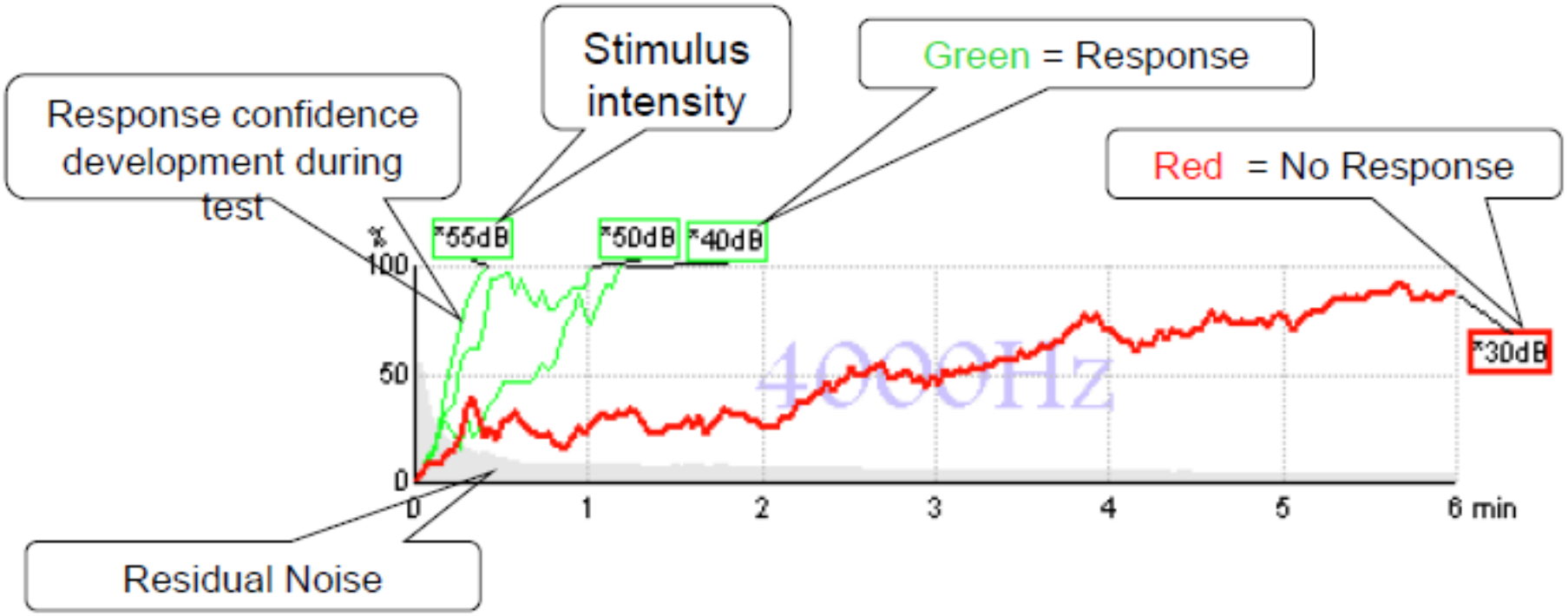


FM +/-AM signal



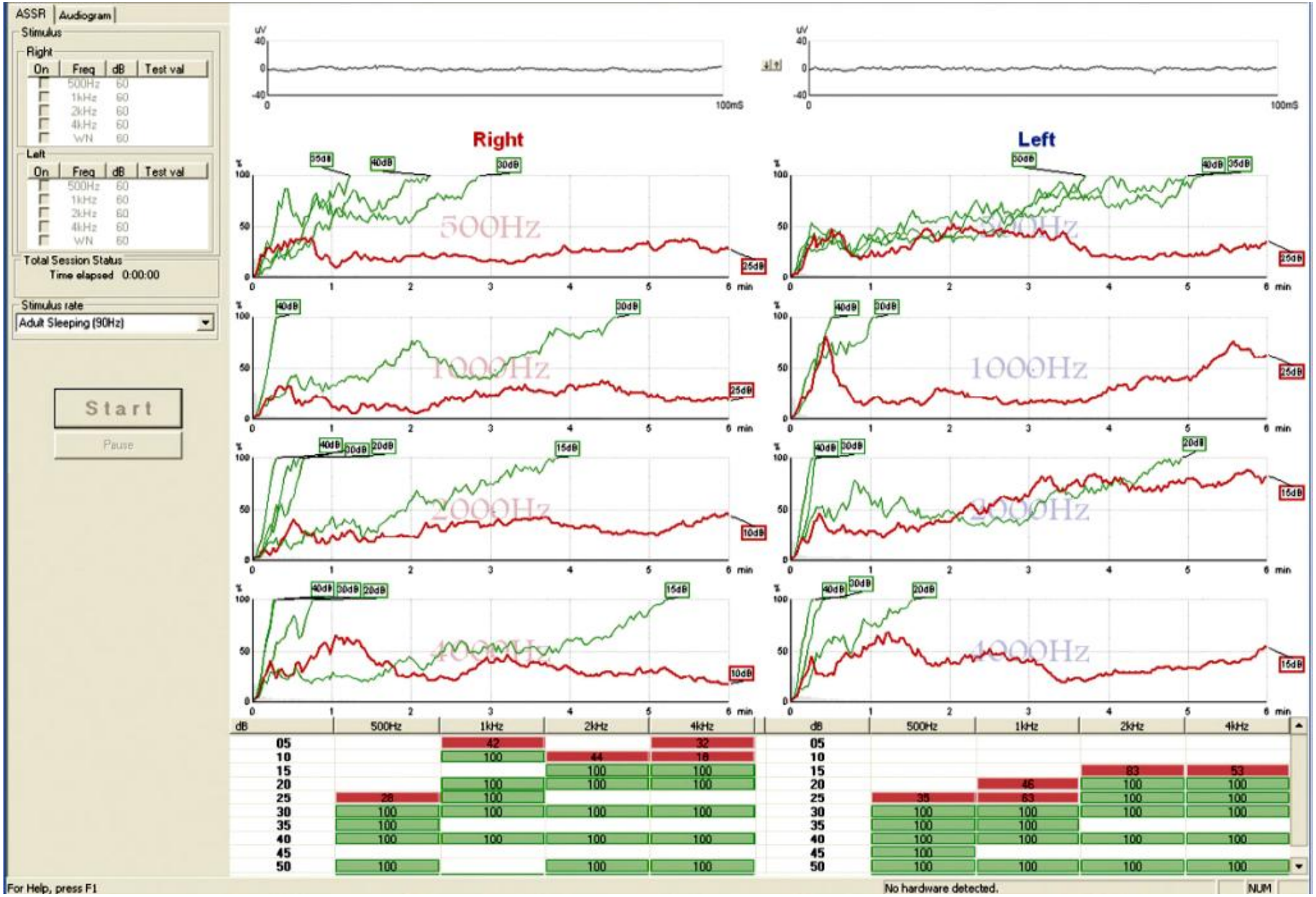
Auditory steady state response (ASSR)

- Carrier Frequencies (FP) : 500, 1000, 2000, 4000 Hz
- Modulation Frequencies (FM) : 90 Hz

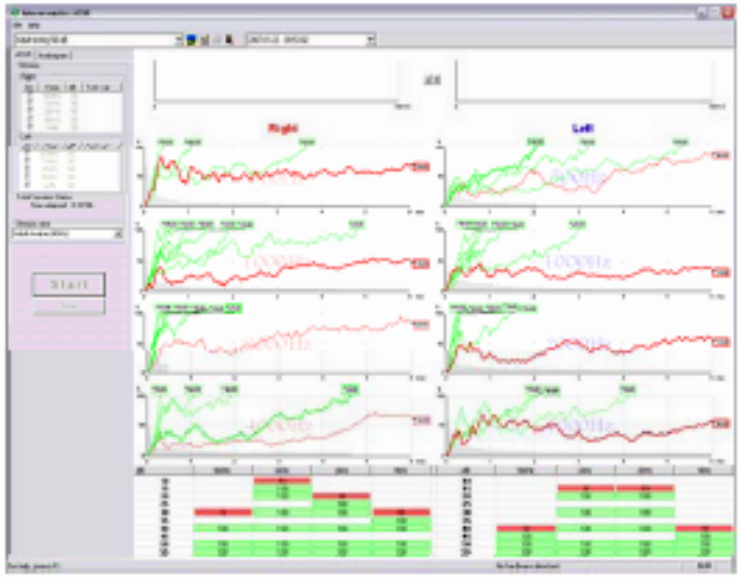


To optimize session strategy decisions as test progresses, the response confidence is tracked over time for each test frequency

Testing 4 frequencies in both ears at a time!

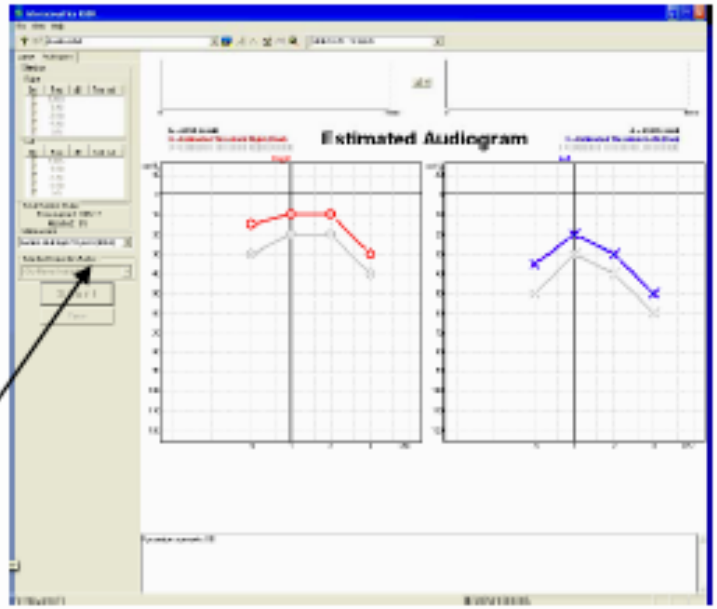


ASSR provide objective audiogram

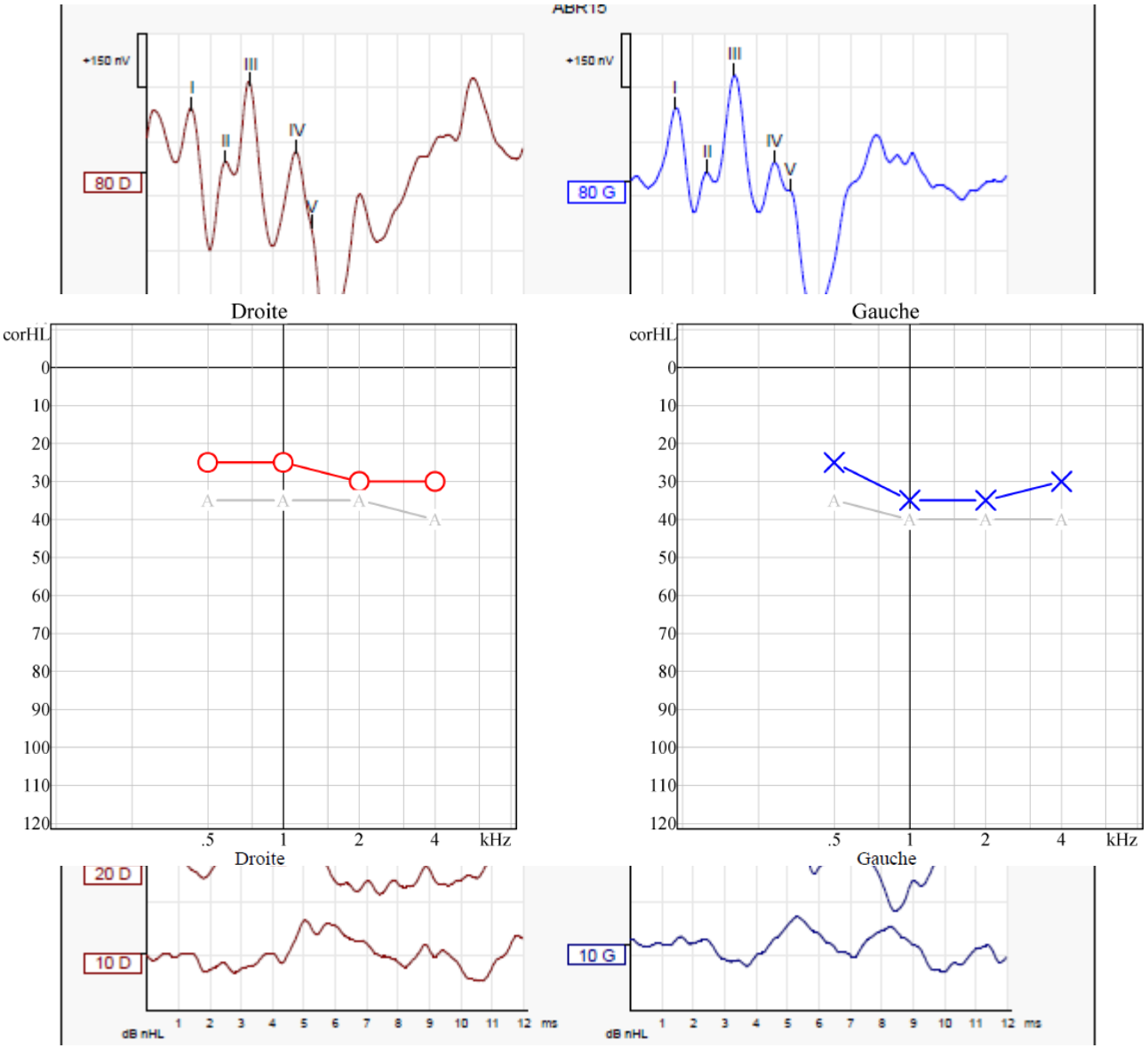


Press one button
for Audiogram anytime

Apply appropriate
correction table



Click-ABR *vs* ASSR threshold



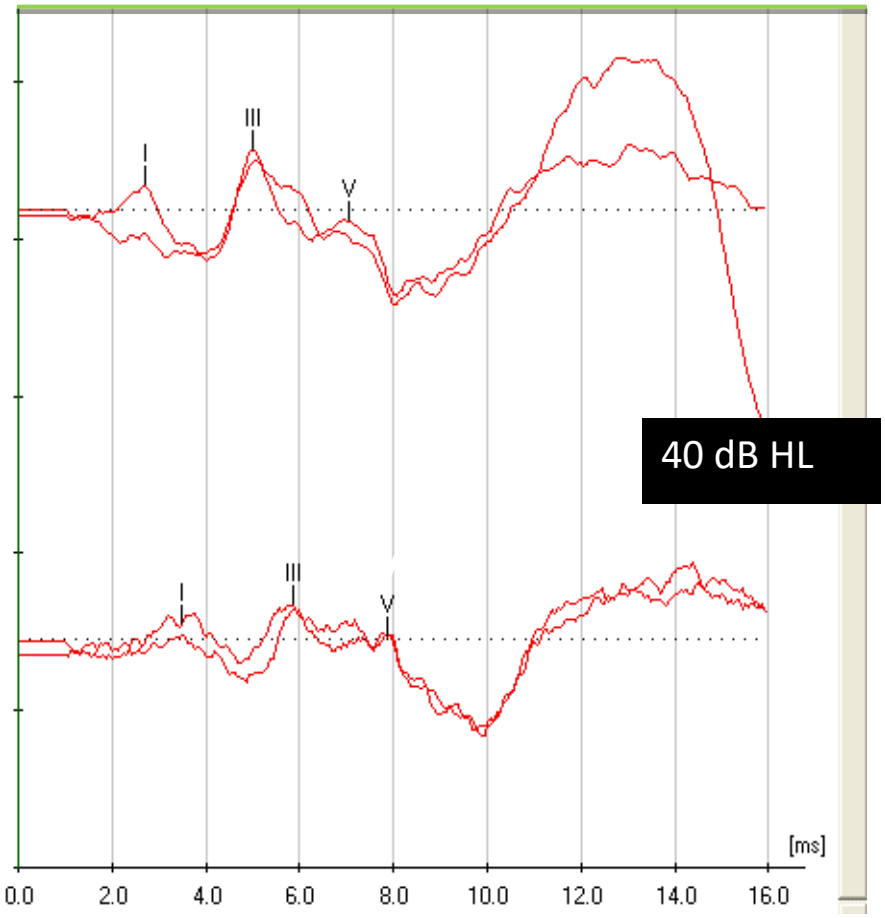
Auditory Evoked Potentials (AEP)

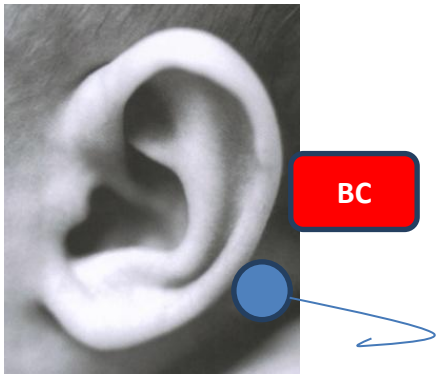
I) CLICK ABR

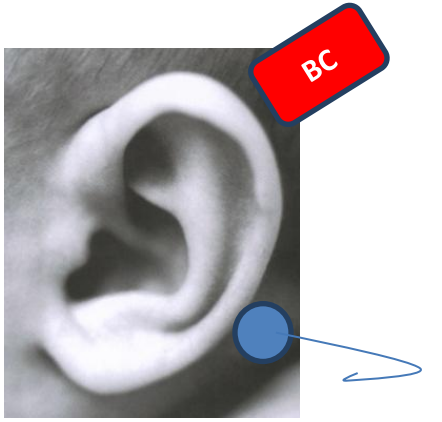
II) FREQUENCY-SPECIFIC DIAGNOSIS

III) HOW TO GET RID OF CONDUCTIVE HL

BC ABR







With permission from Ribeiro & Chapchap, Hospital Sao Luiz - Sao Paulo

Behavioral Audiometry: when and how

Objective measures: what is child specific?

Diagnostic strategy

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TAKE HOME MESSAGES

- Combine otoscopic, endocochlear and afferent auditory pathway examination
- It's always nice to see the ABR traces
- If you can't get a precise idea of middle ear status, go for Bone conduction testing
- Frequency-specific diagnosis can be done at follow-up

Thank you!

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