ABR in Assessment of Auditory Function in Young Children:
How to Enhance Accuracy While Decreasing Test Time

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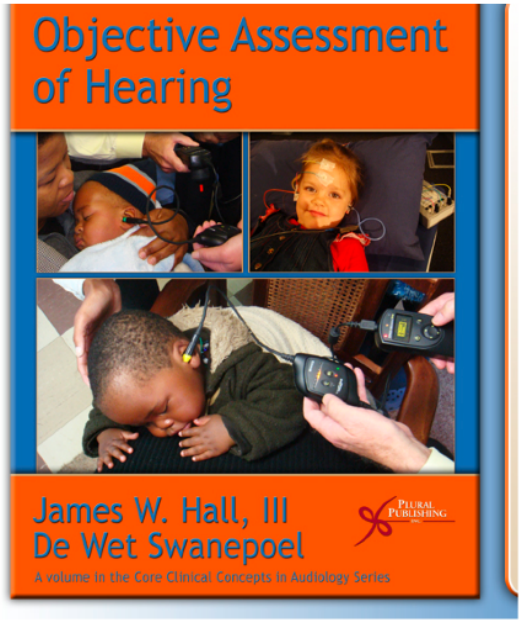
Where can you get more information on objective assessment of hearing in infants and young children?



Diagnostic Application of Supplemental Objective Test Procedures for Auditory Assessment of Infants and Young Children

- Acoustic reflexes
- Electrocochleography (ECochG)
- Bone conduction ABR
- Auditory steady state response (ASSR)

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- Rationale for objective assessment
- Accurate assessment of hearing in young children is standard of care
- Why you should stick with the click
- Protocol for tone burst (frequency specific) ABR
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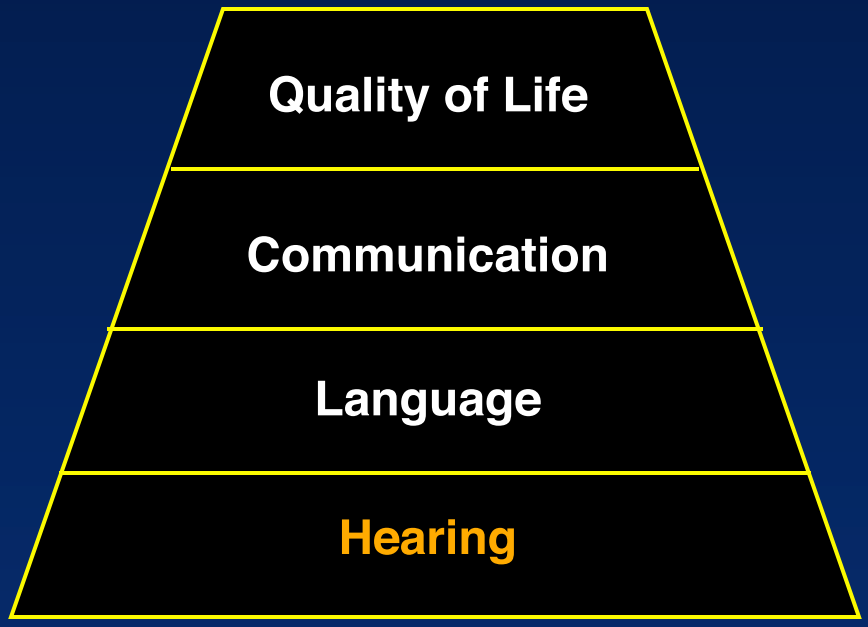
- Summary of strategies for reducing ABR test time
- Sedation and anesthesia

Universal Newborn Hearing Screening and Early Intervention for Hearing Loss in Children: A world-wide movement and goal

Hearing: An Important Building Block in the Foundation for Quality of Life



UNHS Rationale: Effects of infant hearing loss

NIH Consensus Statement "Early Identification of Hearing Impairment in Infants and Young Children" (March 1-3, 1993)

"There is general agreement that hearing impairment should be recognized as early in life as possible, so the remediation process can take full advantage of the developing sensory systems and so that the child can enjoy normal social development."

Recommendation: **Universal Newborn Hearing Screening**


Prof.
Prof.

Language of Early and Later Identified Children with Hearing Loss

- Yoshinago-Itano et al (Univ. of Colorado). Pediatrics 102 (5): 1161-1171, 1998.
  - N = 72 children with HL identified by 6 months and N = 78 children identified later
  - all children received intervention services with 2 months of identification
  - Conclusion: “Significantly better language development was associated with early ID of hearing loss and early intervention . . . the language advantage was found across all . . . degrees of hearing loss.”

American Academy of Pediatrics
Newborn and Infant Hearing Loss: Detection and Intervention

- **Pediatrics 103 (2): 527-529, 1999 (February)**
- **Screening**
- **Tracking & Follow Up**
- **Evaluation**
- **Abstract:** *"This statement endorses the implementation of universal newborn hearing screening. In addition, the statement reviews the primary objectives, important components, and recommended screening parameters that characterize an effective universal newborn hearing screening program."*

Universal Infant Hearing Loss Detection and Intervention: An International Goal

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Avoiding Medical Errors in Audiology:
Defining Professional Liability

"An individual who causes injury to another either intentionally or unintentionally can be held liable for the action. By virtue of advanced knowledge, training, and skill, a professional has a responsibility to conform to certain standards of conduct to protect the public from unreasonable risks.

… The responsibility of licensed and/or certified professionals to conform to those standards may be referred to collectively as professional liability."

ASHA Technical Report (1994). *Professional Liability and Risk Management for the Audiology and Speech-Language Pathology Professions*

Evidence-Based Clinical Practice in Audiology

"Those who fall in love with practice without science are like a sailor who steers a ship without a rudder or compass, and who can never be certain whither he is going."

Leonardo Da Vinci (1452-1519)

Avoiding Medical Errors in Audiology: Selected Legal Definitions of Standard of Care

- Treatment regimen or medical management based on commonly accepted practices.
  (www.nortonhealthcare.com/body.cfm)

- It's the level of care, which an average practitioner would practice. Or in other words how a similar qualified practitioner would manage their patient's care under similar circumstances. Medical Malpractice claims must establish the standard of care and show that the standard has been breached.
  (www.gmlaw.com/medical-malpractice-resources-terms.cfm)

- In medicine, treatment that experts agree is appropriate, accepted, and widely used. Health care providers are obligated to provide patients with the standard of care. Also called best practice and standard therapy.
  (National Cancer Institute)

Avoiding Medical Errors in Audiology: Top Claims from Liability Insurance Broker

(128 claims between 1985-1993, ASHA, 1994)

- Physical injury to the ear/hearing (11 claims)
  - Damage to ear canal
  - Hearing loss caused by assessment or treatment
  - Tinnitus worsened by assessment or treatment
- Physical injury to other parts of the body (11 claims)
  - Burns to face from solvents or electrodes most common in category
  - Eye damage
  - 1 claim for shortness of breath during an examination (maybe SLP)
- Improper diagnosis (10 claims)
  - Improper or misdiagnosis (e.g., failure to diagnose hearing loss in young child)
- Injuries due to falls (9 claims)
  - Patients who fell from examining tables or wheelchairs
  - Falls are a major problem in health care facilities
  - In 2000, the total direct cost of all fall injuries for people 65 and older exceeded $19 billion
  - Fall prevention policies and regular education now mandatory in hospitals

Preventing Medical Errors in Audiology
Timely and Accurate Diagnosis of Hearing in Infants

"An ounce of prevention is
worth a pound of cure."

Preventing Medical Errors in Audiology

"An ounce of prevention is worth a pound of cure."

Benjamin Franklin (1706-1790)

Year 2007 JCIH Position Statement: Protocol for Evaluation for Hearing Loss In Infants and Toddlers from Birth to 6 months

- Child and family history
- Evaluation of risk factors for congenital hearing loss
- Parental report of infant's responses to sound
- "Clinical observation of infant's auditory behavior. *Behavioral observation alone is not adequate for determining whether hearing loss is present in this age group, and is not adequate for the fitting of amplification devices."*
- Audiological assessment
  - Auditory brainstem response (ABR)
    - ✓ Click-evoked ABR with rarefaction and condensation single-polarity stimulation if there are risk factors for auditory neuropathy
    - ✓ Frequency-specific ABR with air-conduction tone bursts
    - ✓ Bone-conduction stimulation (as indicated)
  - Otoacoustic emissions (distortion product or transient OAEs)
  - Tympanometry with 1000 Hz probe tone
  - Supplemental procedures, e.g.,
    - ✓ Electrocochleography (ECochG)
    - ✓ Auditory steady state response (ASSR)
    - ✓ Acoustic reflex measurement (for 1000 Hz probe tone)

Objective Assessment of Auditory Function in Young Children: How to enhance accuracy while decreasing test time

Preparation Before the Procedure Begins

"By failing to prepare, you are preparing to fail."

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Benjamin Franklin (1706-1790)

Objective Assessment of Auditory Function in Young Children:
How to enhance accuracy while decreasing test time

- Preparing for ABR assessment before testing begins
  - Patient information and history are available
  - ABR system is up and running
  - Patient demographics are entered accurately
  - Standard click protocol is selected
  - All supplies are handy, including
    - ✓ Insert earphones with correct size ear tips
    - ✓ Electrodes
    - ✓ Electrode preparation material
    - ✓ Tape

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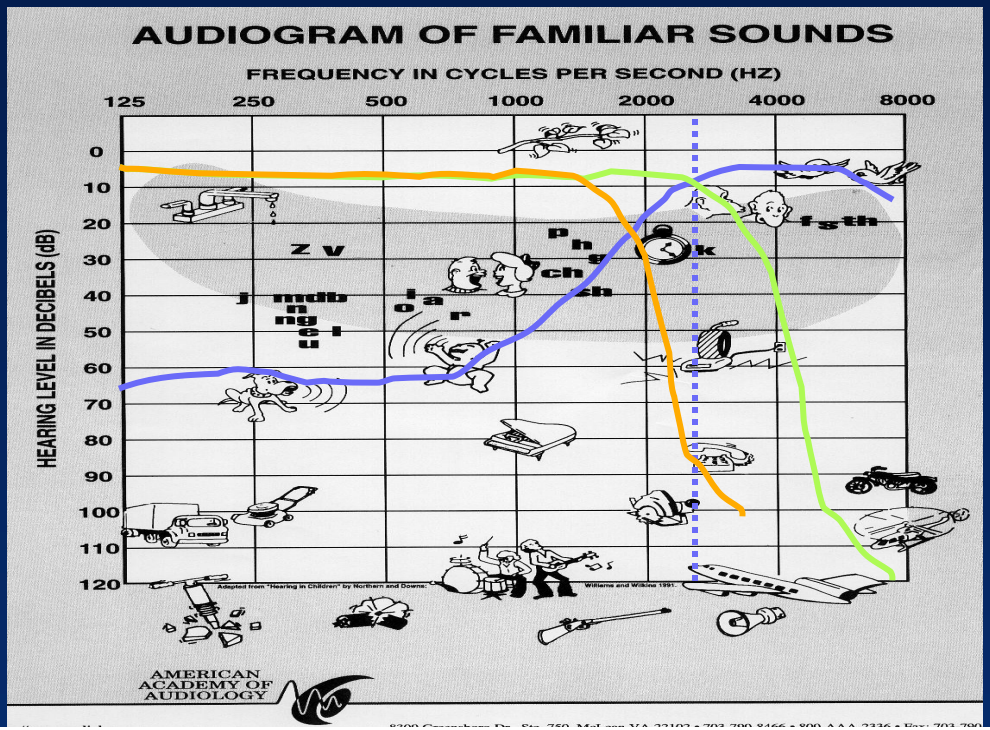
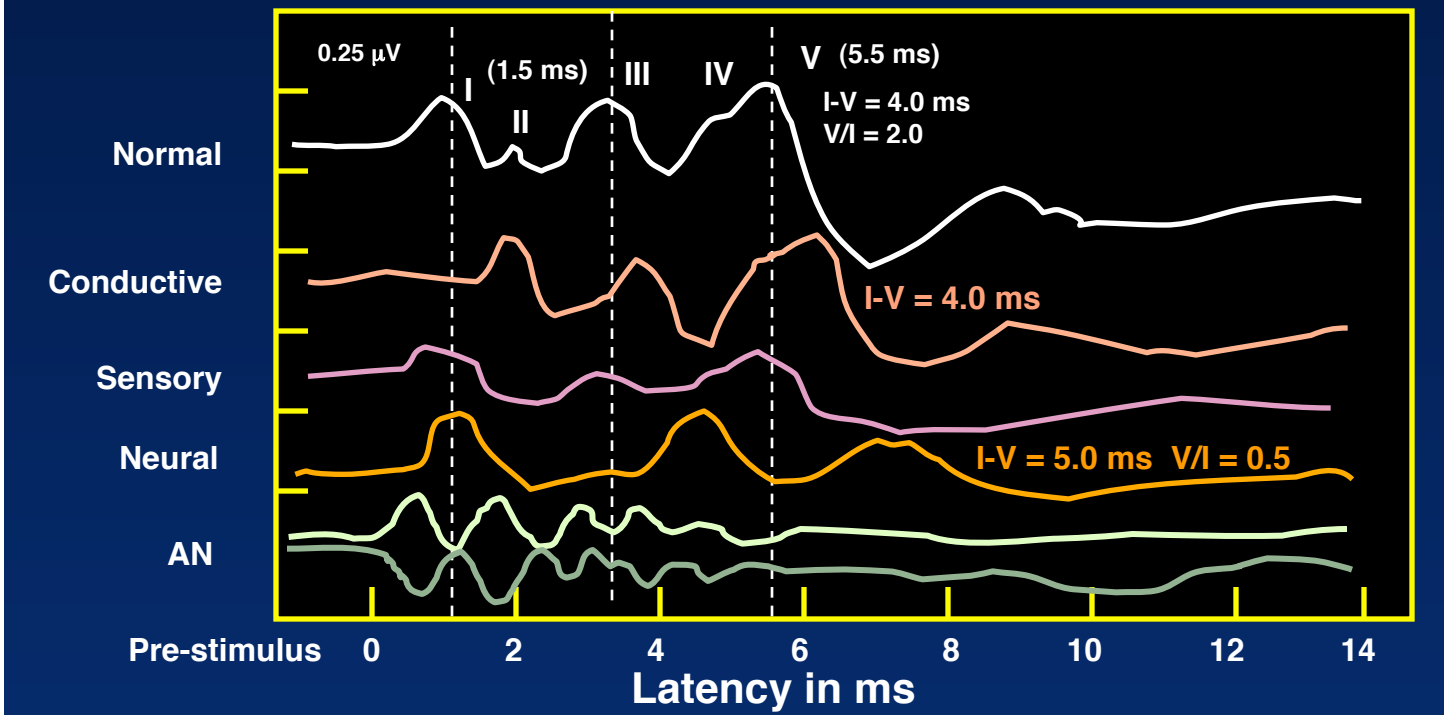
Limitation of Click-Evoked ABR: Lack of Frequency-Specificity



Normal click ABR

Abnormal or no click ABR

Diagnostic Value of the Click-Evoked ABR: Differentiation Among Types of Auditory Dysfunction



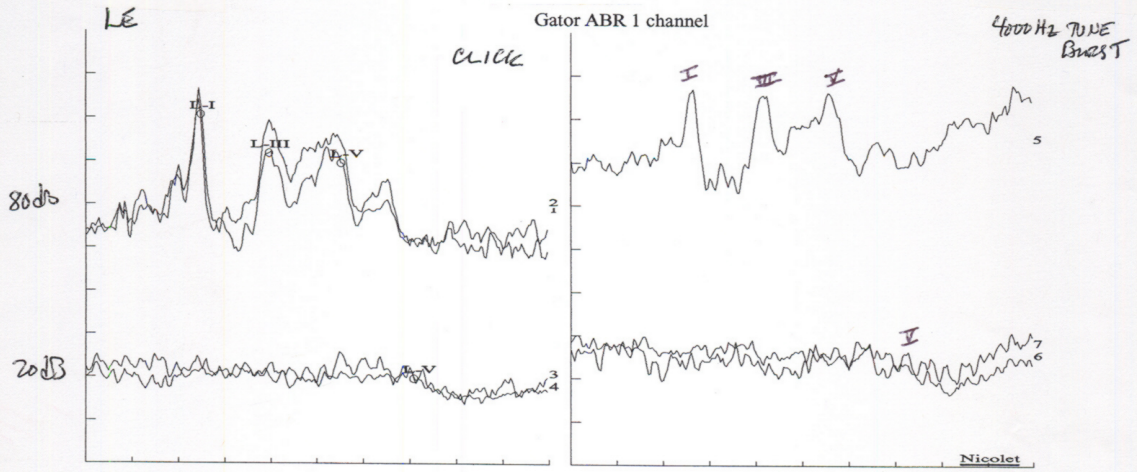
UF DEPT. COMMUNICATIVE DISORDERS
SPEECH AND HEARING CLINIC
PO BOX 100174
GAINESVILLE,FL 32610-0174

Gator ABR 1 channel

AMP	Elect	Mode	Sns	Lff	Hff	Notch	Artifact	REM	Remarks
1	Fz-A1	Run	50uV	30	3K	Off	90	1	
2	Fz-A1	Run	50uV	30	3K	Off	90	2	
3	Fz-A1	Run	50uV	30	3K	Off	90	3	
4	Fz-A1	Run	50uV	30	3K	Off	90	4	
5	Fz-A1	Run	50uV	30	3K	Off	90	5	
6	Fz-A1	Run	50uV	30	3K	Off	90	6	
7	Fz-A1	Run	50uV	30	3K	Off	90	7	

ACQ	Comm	Sweep	Time	Delay	Rate	Trigger	Stim	MISC	Type	Ch#	Accept	Reject	Filter	Fsp/SNR	Date	Time	Add	Sub	Inv	Filter	Smooth
1	A	2000	15ms	-1ms	21.1	Inter	Gated	1	Sum	1	386	0	Butter	7.30	06/10/2004	10:22	no	no	no	no	no
2	A	2000	15ms	-1ms	21.1	Inter	Gated	2	Sum	1	209	0	Butter	1.88	06/10/2004	10:22	no	no	no	no	no
3	A	2000	15ms	-1ms	21.1	Inter	Gated	3	Sum	1	349	0	Butter	0.43	06/10/2004	10:23	no	no	no	no	no
4	A	2000	15ms	-1ms	21.1	Inter	Gated	4	Sum	1	676	0	Butter	0.97	06/10/2004	10:23	no	no	no	no	no
5	A	2000	15ms	-1ms	21.1	Inter	Gated	5	Sum	1	328	0	Butter	3.96	06/10/2004	10:24	no	no	no	no	no
6	A	2000	15ms	-1ms	21.1	Inter	Gated	6	Sum	1	301	0	Butter	0.60	06/10/2004	10:24	no	no	no	no	no
7	A	2000	15ms	-1ms	21.1	Inter	Gated	7	Sum	1	453	0	Butter	1.19	06/10/2004	10:25	no	no	no	no	no

STIM	Trans	Type	Pol	Dur	Level	Freq	Pla	Ramp	Env	Noi	NLev	dB	Trans	Type	Pol	Dur	Level	Freq	Pla	Ramp	Env	Noi	NLev	dB
1	Insert	Click	Rar	100us	80					Off		nHL	Insert	Off								Off		nHL
2	Insert	Click	Rar	100us	80					Off		nHL	Insert	Off								Off		nHL
3	Insert	Click	Rar	100us	20					Off		nHL	Insert	Off								Off		nHL
4	Insert	Click	Rar	100us	20					Off		nHL	Insert	Off								Off		nHL
5	Insert	Tone	Alt		100	4KHz	0cy	2	Blk	Off		nHL	Insert	Off								Off		nHL
6	Insert	Tone	Alt		50	4KHz	0cy	2	Blk	Off		nHL	Insert	Off								Off		nHL
7	Insert	Tone	Alt		50	4KHz	0cy	2	Blk	Off		nHL	Insert	Off								Off		nHL



Insert Phone Dly: 0.90 msec

Sensitivity and Sweep Time Per Division

1	0.31 uV	1.5 msec	2	0.31 uV	1.5 msec	3	0.31 uV	1.5 msec	4	0.31 uV	1.5 msec
5	0.31 uV	1.5 msec	6	0.31 uV	1.5 msec	7	0.31 uV	1.5 msec			

ABR

L-I	1.82ms	L-I-L-III	2.22ms
L-III	4.04ms	L-III-L-V	2.34ms
L-V	6.38ms	L-I-L-V	4.56ms
L-V	8.72ms		
L-V			
L-V			
L-V			
L-V			
L-V			
L-V			

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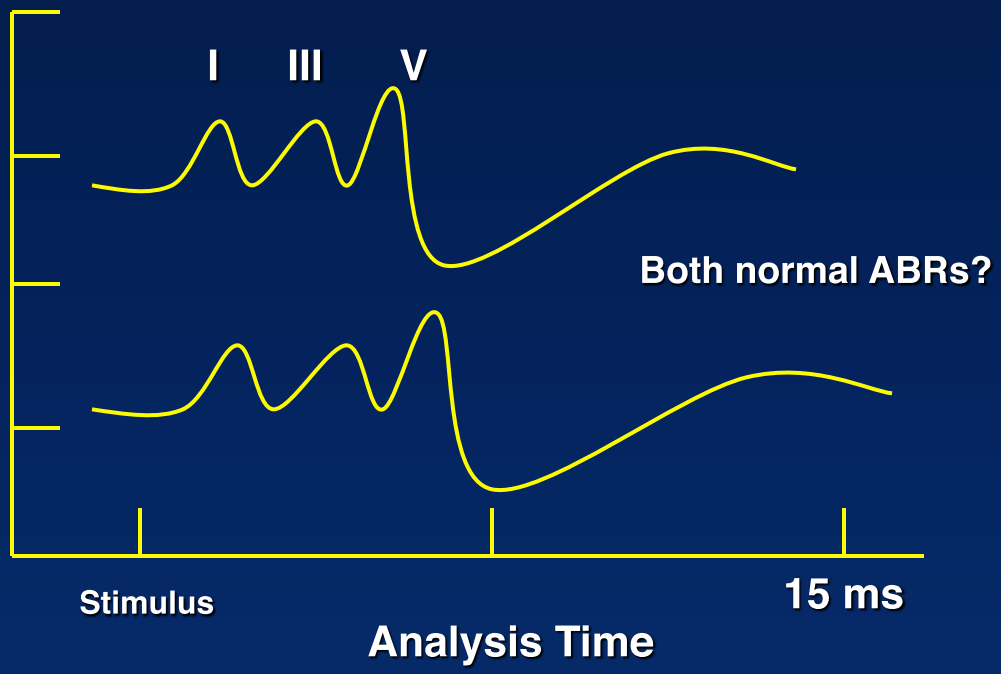
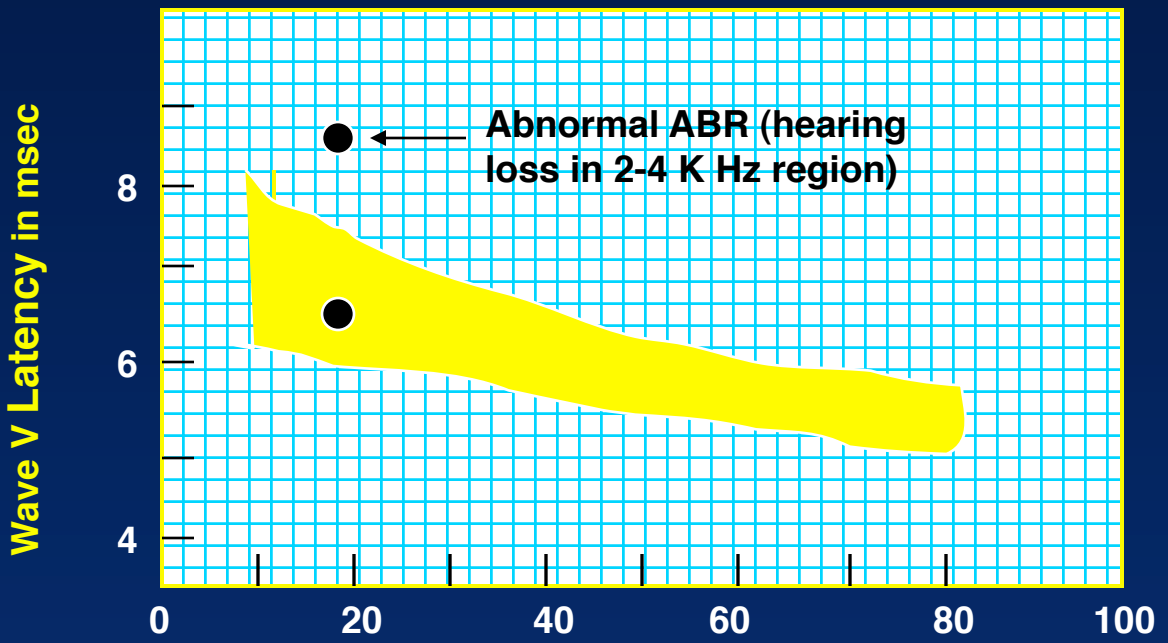
Importance of Latency Calculation in ABR Analysis: Differentiation of Normal versus Abnormal



AUDITORY BRAINSTEM RESPONSE (ABR): Wave V Latency-Intensity Function



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Adhering to a Protocol

"Diligence is the mother of good luck."

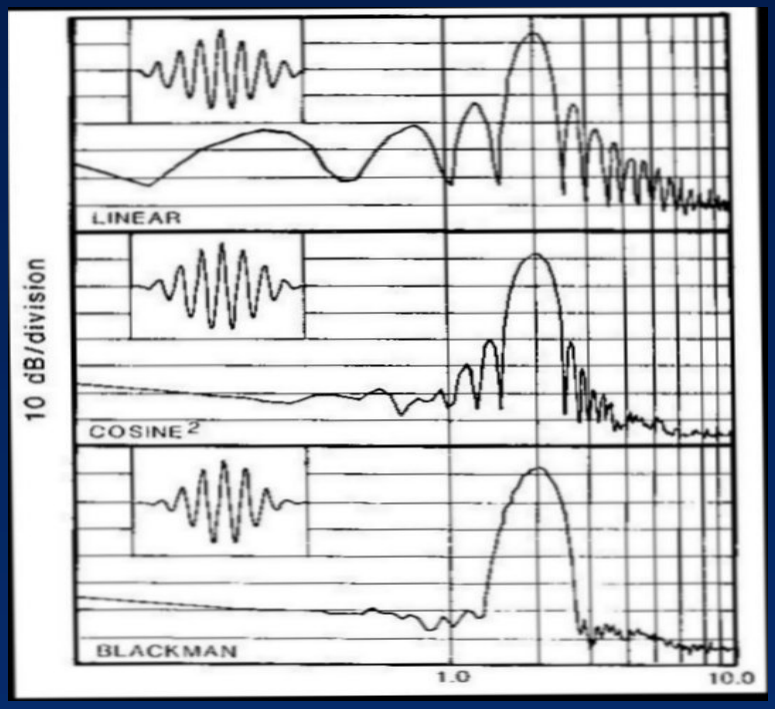
Benjamin Franklin (1706-1790)

Frequency-Specific ABR Test Protocol: Stimulus Parameters

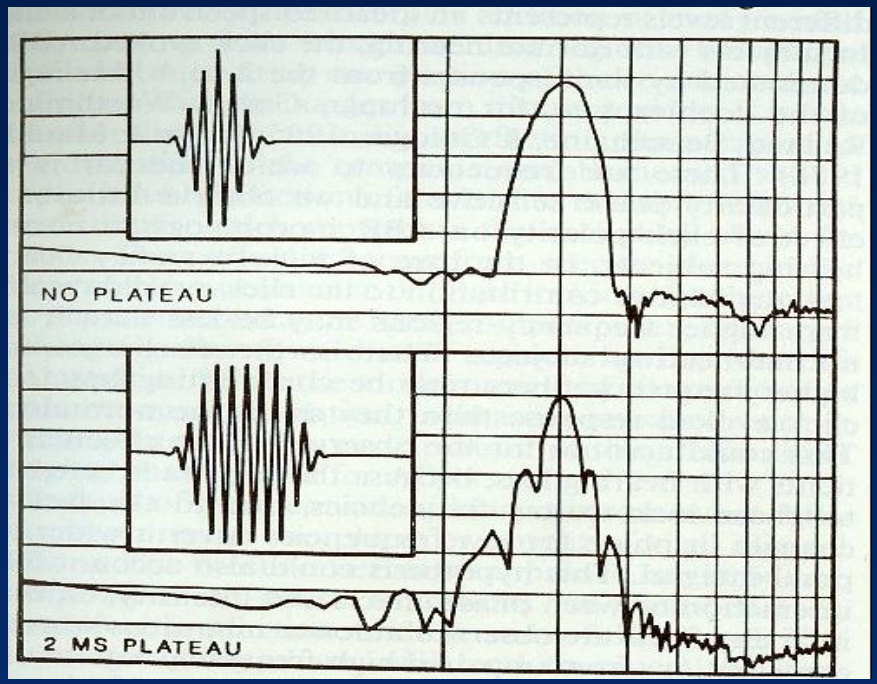
Parameter	Selection	Rationale
Transducer	ER-3A inserts	Numerous infant advantages
Type	Tone bursts	Available on all systems
Frequencies	1, .5, 4, 2 K Hz	Sequence varies clinically
Duration	2-0-2 cycles	Abrupt frequencies 0 plateau < spectral splatter

ABR Transducer Options

FREQUENCY-SPECIFIC ABRs:
Effect of Tone Burst Onset Window (Ramp)



FREQUENCY-SPECIFIC ABRs:
Effect of Tone Burst Plateau



Frequency-Specific ABR Test Protocol: Stimulus Parameters

Parameter	Selection	Rationale
Polarity	Rarefaction	Minimize stimulus artifact
Rate	37.1/sec	Rapid data collection with adequate response integrity
		with longer analysis time
Intensity	dB nHL	RE: adult behavioral data, but variable unknown Increases in effective intensity for infants are likely

Tone Burst Duration: Relation between cycles and milliseconds

Tone burst Frequency	Duration					
	Cycles			Milliseconds		
	rise	plateau	fall	rise	plateau	fall
500 Hz	2	0	2	4	0	4
1000 Hz	2	0	2	2	0	2
2000 Hz	2	0	2	1	0	1
4000 Hz	2	0	2	0.5	0	0.5

Tone Burst Intensity: Relation between "dial" value and dB nHL

Tone burst Frequency	Examples of dial values for behavioral threshold*	dB nHL
Click	0 dB	0
500 Hz	35 dB	0
1000 Hz	20 dB	0
2000 Hz	15 dB	0
4000 Hz	15 dB	0

* *Behavioral threshold data collected from small group (e.g., N = 5) of normal hearers in ABR test environment (e.g., clinic room, O.R., intensive care nursery) with evoked response system signals and earphones.*

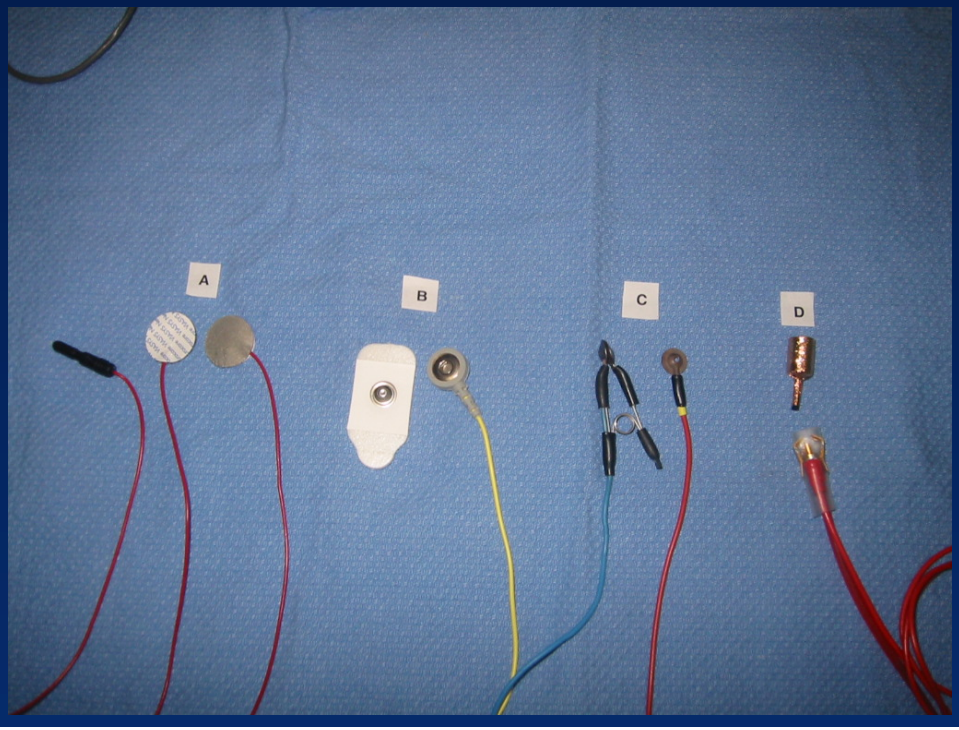
Frequency-Specific ABR Test Protocol: Acquisition Parameters

Parameter	Selection	Rationale
Artifact reject	On	Minimize muscle artifact
Analysis time	20 ms	Encompass delayed wave Vs and SN10 after wave V
Sweeps	> 2000	Whatever is needed for SNR for poor morphology ABRs
Reliability	2 or 3 runs	"If it doesn't replicate, you must investigate"

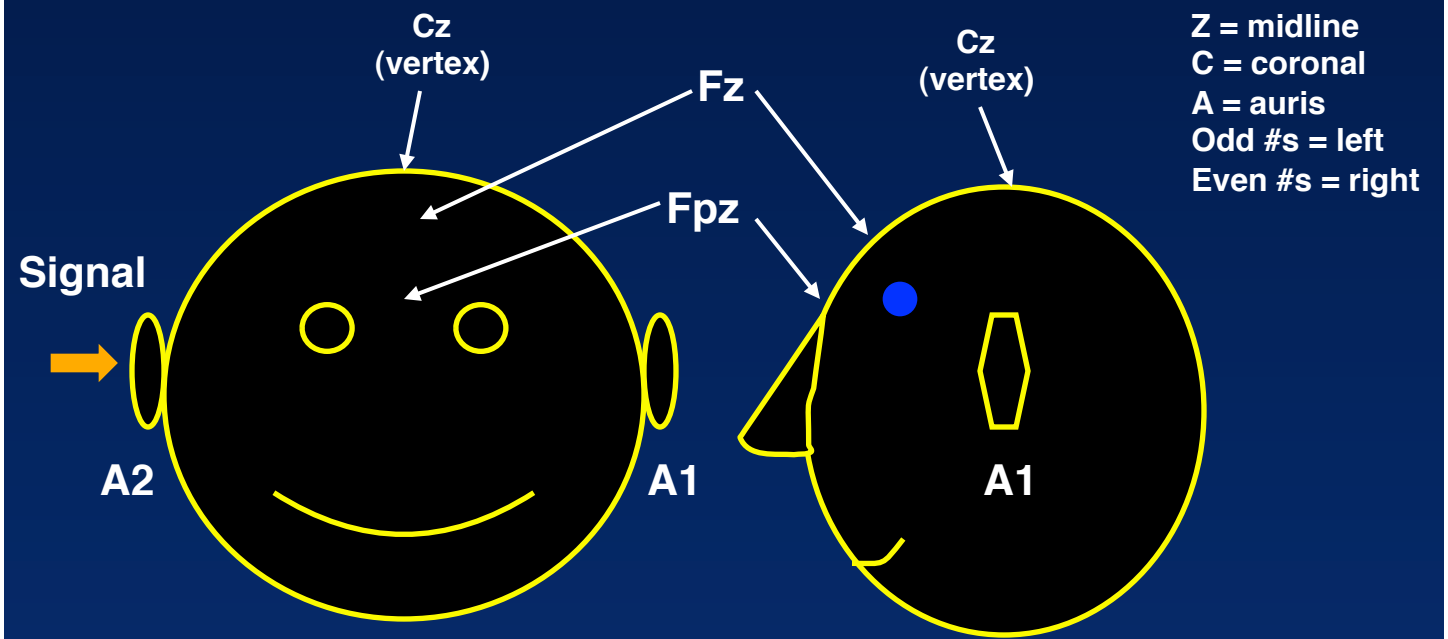
Frequency-Specific ABR Test Protocol: Acquisition Parameters

Parameter	Selection	Rationale
Electrode type	Disc & ear clip or disposable	Ease of application
Electrode location	Fz - Nape or Ai Fpz ground	Optimal infant response Good for BC stimulus Permits ipsi/contra meas't
Filter settings	30 - 3000 Hz No notch filter	Encompass infant spectrum
Artifact reject	On	Minimize muscle artifact

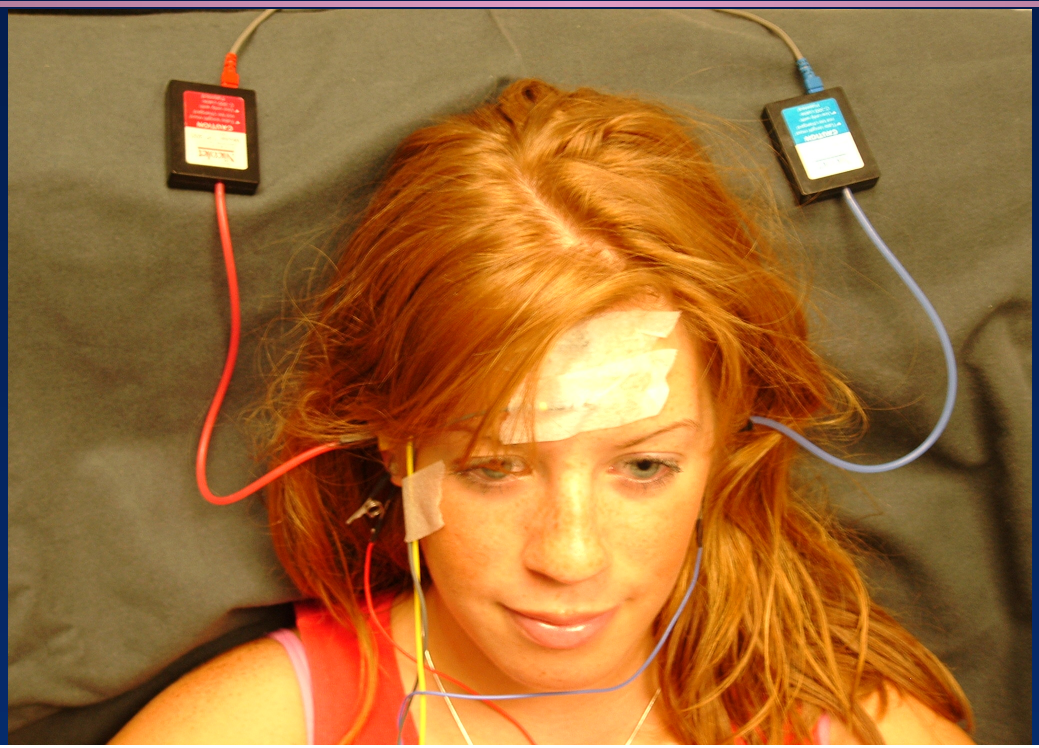
ABR Measurement:
Clinical Electrode Options



Electrode Locations in ABR Measurement (10-20 International System)



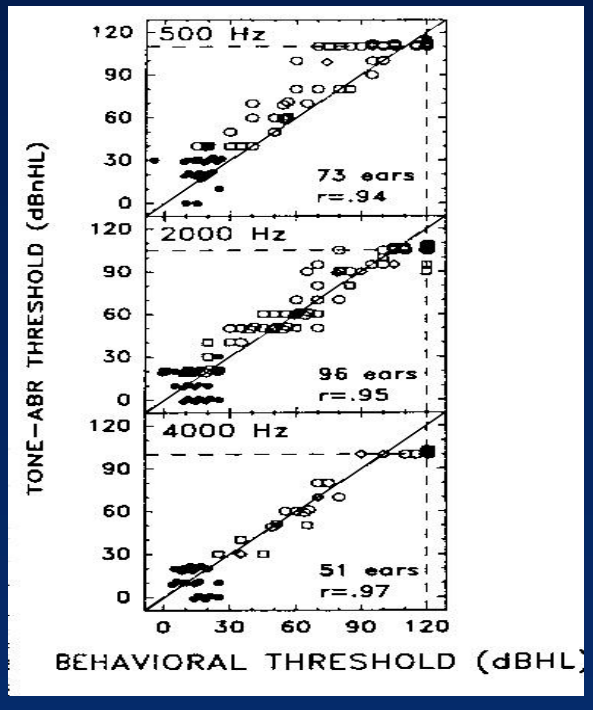
ABR Measurement: Electrodes and Tranducers (never together)



ABR: Frequency-specific stimuli

- How accurate is estimation of pure tone thresholds with tone burst ABR?
  - High correlation (> .94) between ABRs elicited with tone bursts in quiet or in notched noise vs. pure tone thresholds for infants and older children *(e.g., Stapells et al, 1995)*
  - >90% of ABR thresholds were within 20 dB of PT thresholds, and majority were within 10 dB
  - audiometric configuration of the hearing loss does not affect accuracy (Oates & Stapells, 1998)

FREQUENCY-SPECIFIC AUDITORY BRAINSTEM RESPONSE (ABR): Relation to Audiogram (Oates & Stapells, 1998)



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Steps in Accurate Estimation of Auditory Thresholds

- With ABR system, obtain average normal behavioral thresholds (from 3 to 5 normal hearing adults) for click and each tone burst signal
  - Minimally click plus 500, 1000, 2000, and 4000 Hz
  - Calculate “dial” reading that is equivalent to 0 dB nHL
  - With ABR system
  - In typical test environment (s)
- ABR thresholds in dB nHL are not equal to pure tone hearing thresholds in dB HL
  - Subtract 10 dB from ABR threshold to estimate auditory threshold
- Plot estimated auditory thresholds on “tone burst ABR audiogram”

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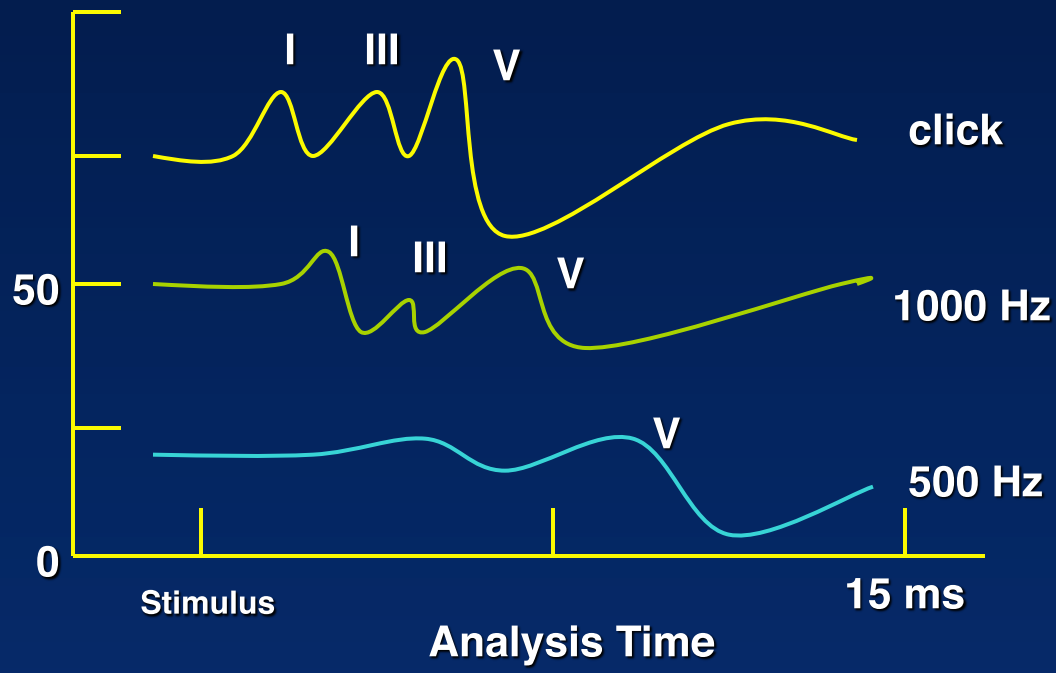
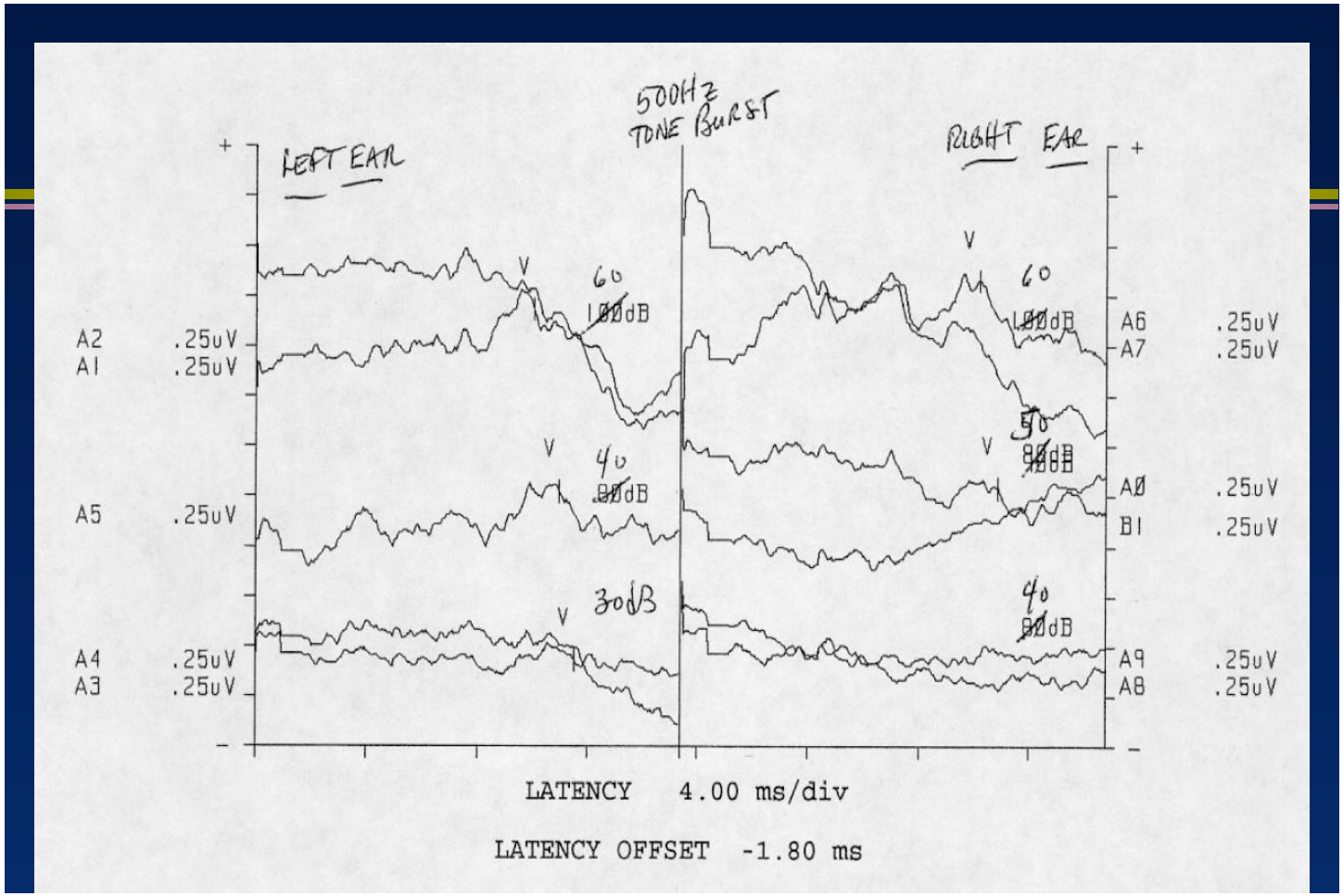
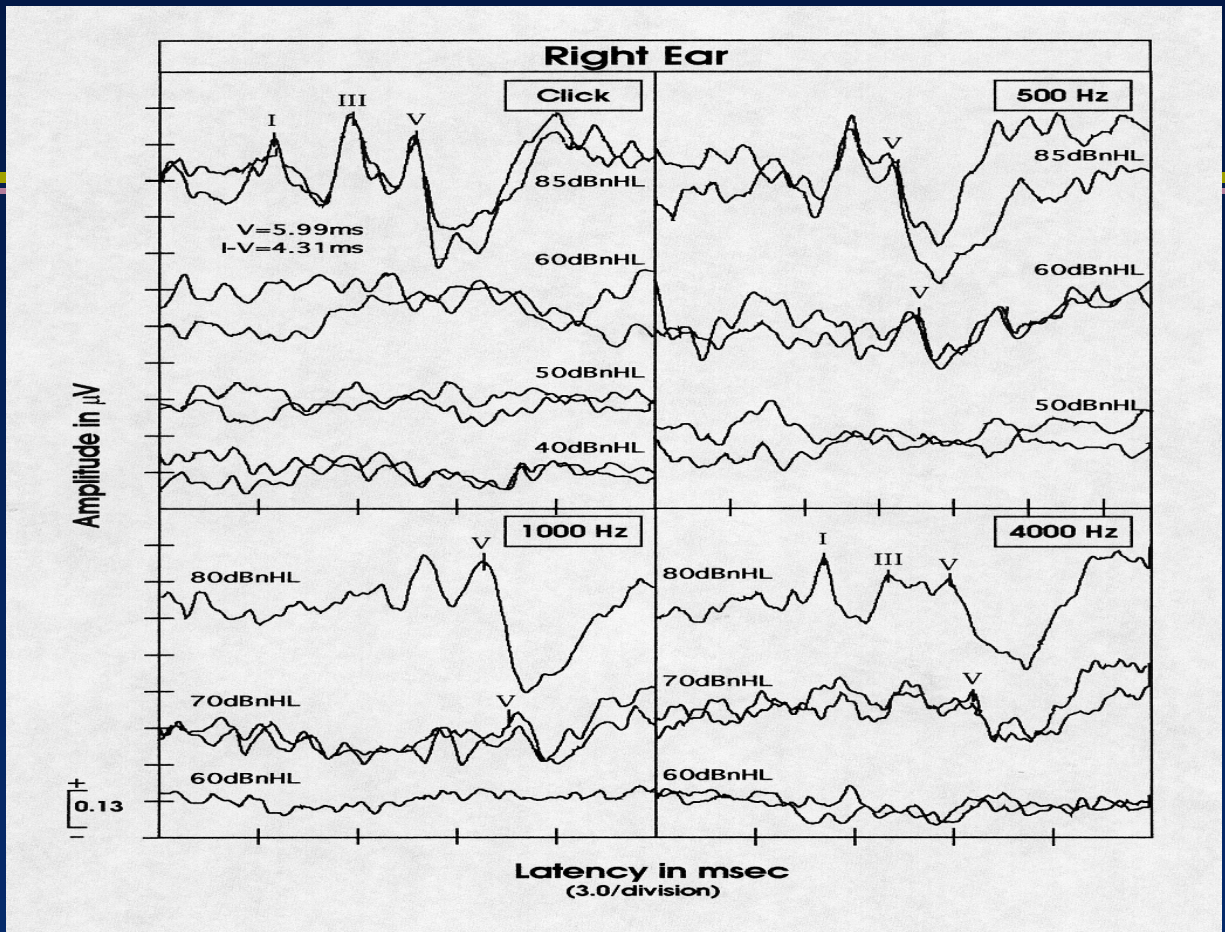
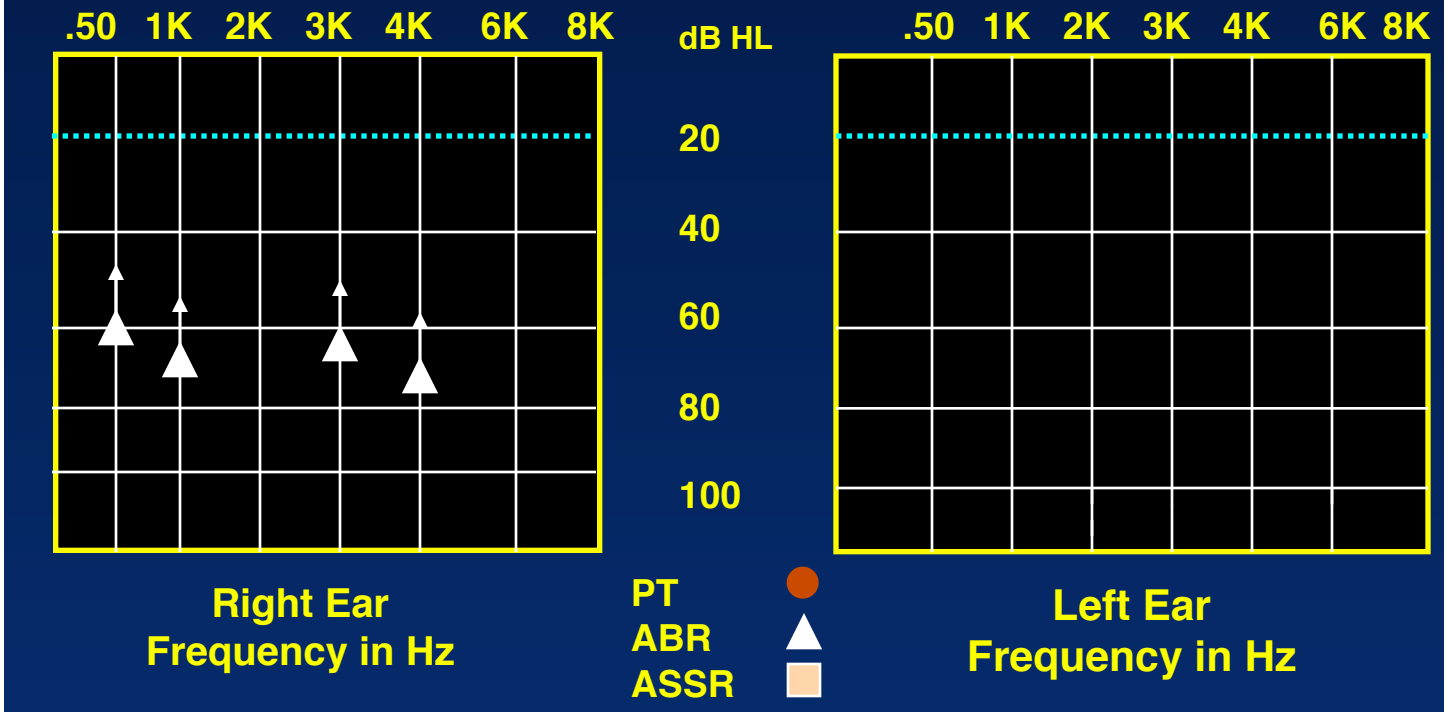
Click versus Tone Burst ABRs




500Hz
TONE BURST
LEFT EAR
RIGHT EAR
+
-
V
60
40
30dB
A2 .25uV
A1 .25uV
A5 .25uV
A4 .25uV
A3 .25uV
A6 .25uV
A7 .25uV
A0 .25uV
B1 .25uV
A9 .25uV
A8 .25uV
LATENCY 4.00 ms/div
LATENCY OFFSET -1.80 ms


Right Ear
Click
500 Hz
1000 Hz
4000 Hz
I
III
V
85dBnHL
60dBnHL
50dBnHL
40dBnHL
V=5.99ms
I-V=4.31ms
80dBnHL
70dBnHL
60dBnHL
Amplitude in μV
0.13
Latency in msec
(3.0/division)

Electrophysiologic Estimation of the Audiogram



Estimation of Auditory Sensitivity with Auditory Brainstem Response (ABR)*

Date of Visit: _____ Diagnosis: _____

Reason for Evaluation: _____

History / Medical Complications: _____

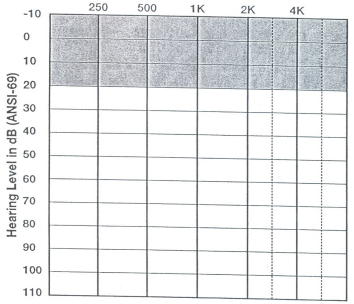
Pain Scale (1 - 10): _____

☐ Pt without new complaints

☐ Pain commensurates with dx / condition

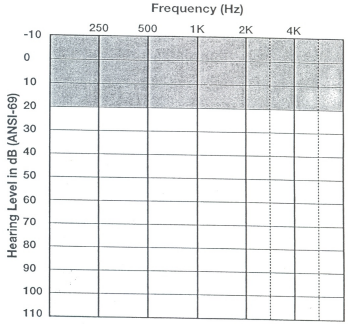
RIGHT EAR

Frequency (Hz)



LEFT EAR

Frequency (Hz)



○ = Air Conduction (AC) Threshold
△ = Bone Conduction (BC) Threshold
● = Masked AC Threshold
▲ = Masked BC Threshold
T = Estimated Behavioral Threshold

Click and tone burst stimulation used to elicit the ABR. Auditory thresholds are approximately 10 dB better than minimum intensity levels producing an ABR wave V.

Results / Impressions: _____

Recommendations: _____

Referred by: _____ Audiologist: _____ Provider #: _____

Patient Name: Patient Identification #:

UNIVERSITY OF FLORIDA

TH0005

Speech and Hearing Center
Department of Communicative Disorders
352-392-8888

Rev. 5/5/06
PS61941

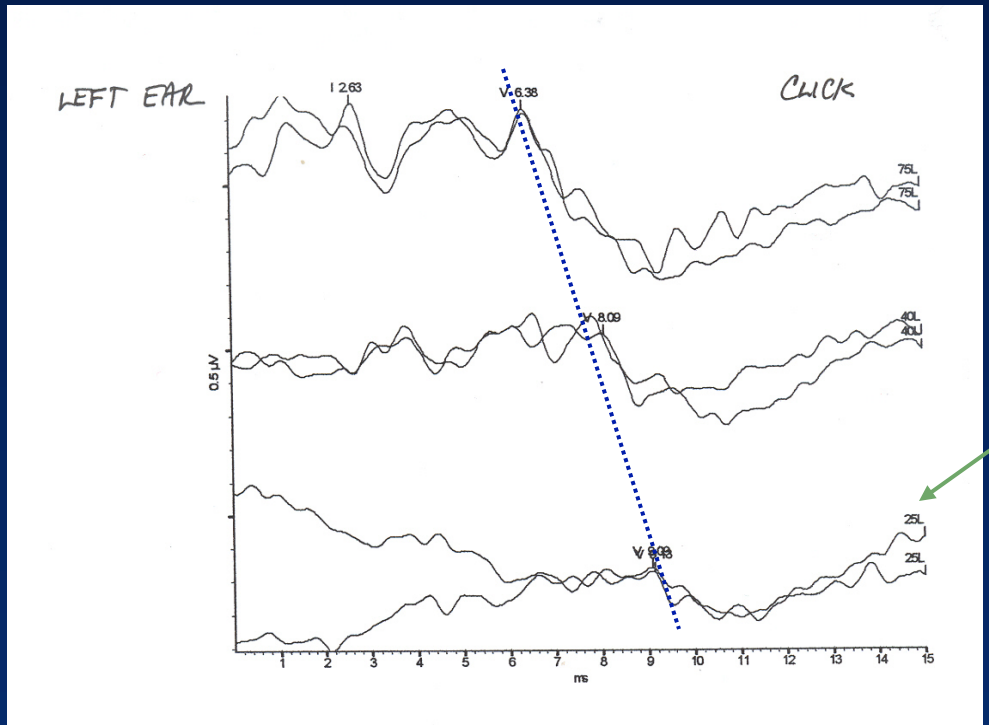
Objective Assessment of Auditory Function in Young Children: How to enhance accuracy while decreasing test time

Practice, Practice, Practice

"Experience is a dear teacher, but fools will learn at no other."

Benjamin Franklin (1706-1790)

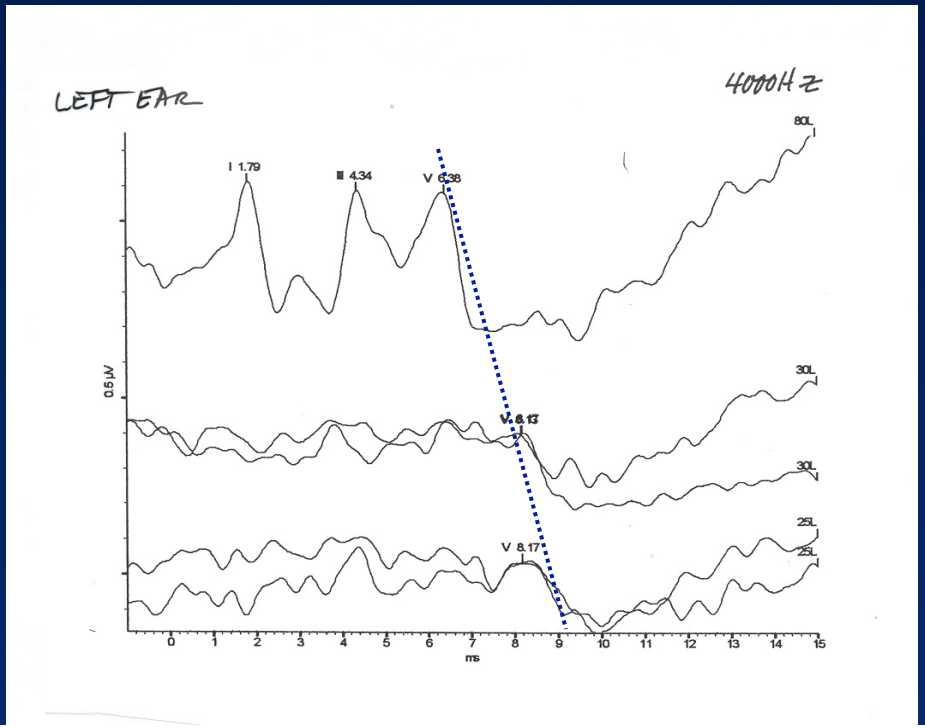
Examples of ABR Elicited with Tone Burst Stimuli:
Click ABR
(1.5 year child with language delay; parents from Thailand)



75 dB nHL to 40 dB HL ***(Why waste time with other intensity levels?)***

25 dB nHL = 15 dB HL ***(Why go lower?)***

Examples of ABR Elicited with Tone Burst Stimuli: 4000 Hz stimulus



Examples of ABR Elicited with Tone Burst Stimuli: 1000 Hz stimulus

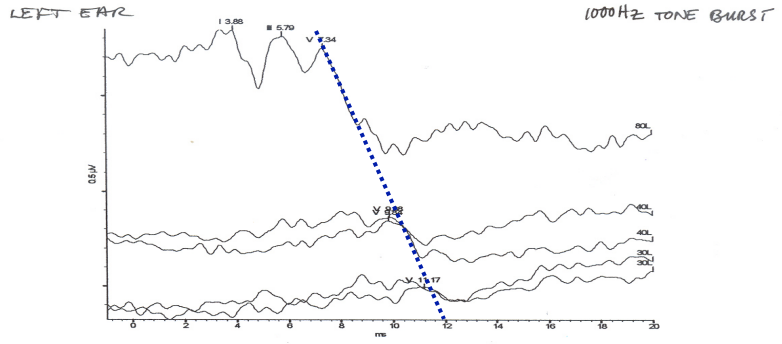
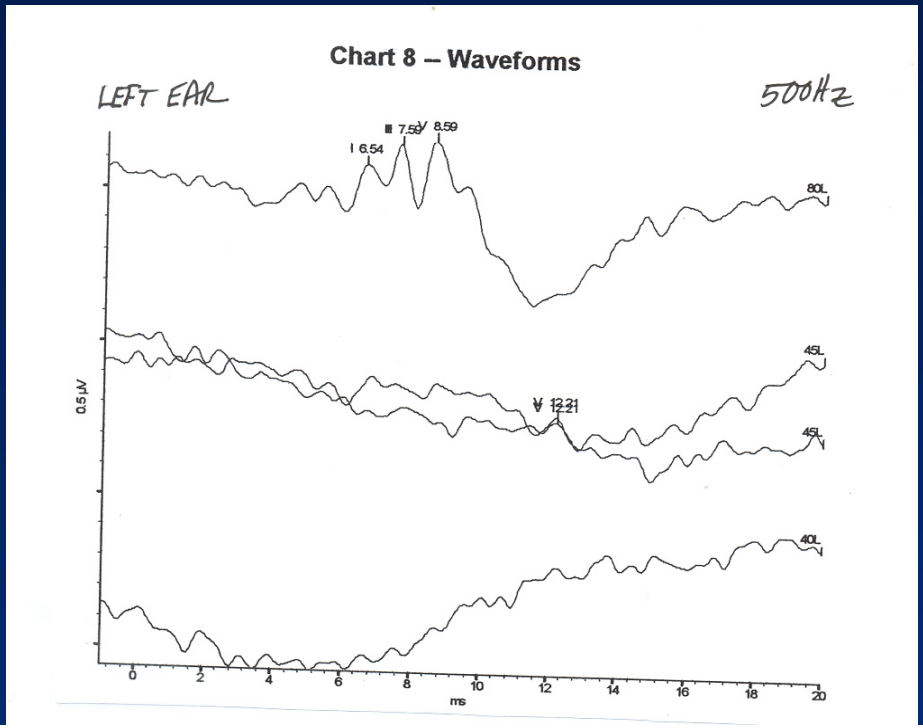


Chart 6 — Measurements

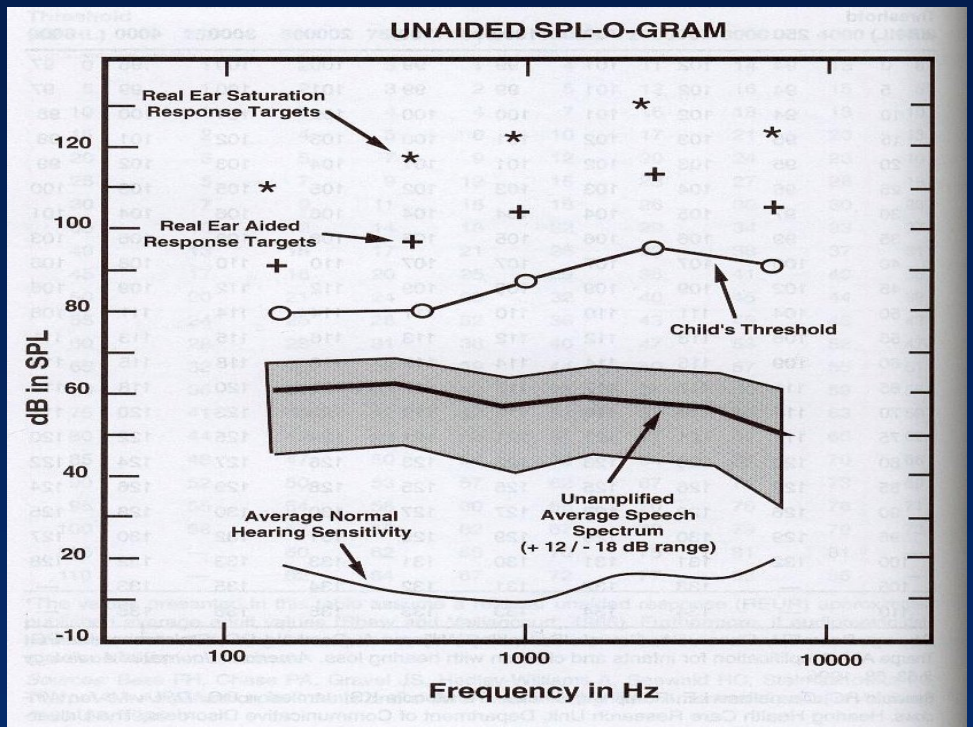
Trace	Ear	Stim Level	I Latency	II Latency	III Latency	IV Latency	V Latency
T22 80.0 dB nHL L 33.10 Hz [22]	Left	80.0 dB nHL	3.88ms		5.79ms		7.34ms
T24 40.0 dB nHL L 33.10 Hz [24]	Left	40.0 dB nHL					9.88ms
T23 40.0 dB nHL L 33.10 Hz [23]	Left	40.0 dB nHL					9.84ms
T25 30.0 dB nHL L 33.10 Hz [25]	Left	30.0 dB nHL					
T26 30.0 dB nHL L 33.10 Hz [26]	Left	30.0 dB nHL					11.17ms

Trace	I-III Interv	III-V Interv	I-V Interv	V/I Ratio
T22 80.0 dB nHL L 33.10 Hz [22]	1.92ms	1.54ms	3.46ms	
T24 40.0 dB nHL L 33.10 Hz [24]				
T23 40.0 dB nHL L 33.10 Hz [23]				
T25 30.0 dB nHL L 33.10 Hz [25]				
T26 30.0 dB nHL L 33.10 Hz [26]				

Examples of ABR Elicited with Tone Burst Stimuli: 500 Hz stimulus



Estimation of Frequency-Specific Auditory Thresholds with Tone Burst ABRs: Initial Data Points for DSL



Objective Assessment of Auditory Function in Young Children: How to enhance accuracy while decreasing test time

Decreasing Test Time

"Time is money ."

"Lost time is never found again."

Benjamin Franklin (1706-1790)

Simple Techniques for Saving Valuable Time in Frequency-Specific Estimation of an Audiogram with Tone Burst ABRs *(test time of 30 minutes or less)*

- Be prepared to begin ABR as soon as the child is asleep
  - Equipment is set up with patient information
  - Electrodes are handy with electrode gel or paste
  - Tape is cut
  - Insert earphones are ready with proper size tips
- Record ABR with measurement conditions that optimize the SNR, I.e, maximize the signal (ABR) and minimize the noise (all other electrical activity)
  - Sleeping, sedated, or anesthetized child
  - Low and balanced electrode impedance
  - Little or no electrical artifact
  - Deep fitting insert earphone to minimize ambient acoustic noise
- Use a stimulus presentation rate of about 37.7/sec to speed up data collection
- Immediately trouble-shoot if the ABR findings are different from what you expect

Simple Techniques for Saving Valuable Time in Frequency-Specific Estimation of an Audiogram with Tone Burst ABRs *(test time of 30 minutes or less)*

- Think ahead to the next step in the assessment while signal averaging … *don't* do your thinking between periods of data collection
- At high stimulus intensities
  - Discontinue signal averaging as soon as a clear response is detected (< 500 stimuli or sweeps)
  - Immediately replicate with even fewer averages
  - Calculate latencies and amplitudes while also collecting data at the next intensity level
- Drop the stimulus intensity level as quickly as possible to near threshold (e.g., from 80 dB nHL down to 40 dB nHL if the ABR has a wave I and wave V)
- After hearing thresholds are estimated with click stimuli, begin presenting subsequent tone burst stimuli at intensity levels 20 to 30 dB above anticipated ABR threshold
- Don't replicate "flat" ABR tracings (when you have nothing you have nothing to repeat)

Objective Assessment of Auditory Function in Young Children:
How to enhance accuracy while decreasing test time

- Rationale for objective assessment
- Accurate assessment of hearing in young children is standard of care
- Why you should stick with the click
- Protocol for tone burst (frequency specific) ABR
- Three important steps in the accurate estimation of auditory thresholds from the ABR
- Analysis of tone burst ABRs
- Summary of strategies for reducing ABR test time
- Techniques for un-sedated ABRs
- Sedation and anesthesia

UNSEDATED PEDIATRIC ABR Measurement: Techniques

- Non-medical techniques
  - Sleep deprivation
  - Record ABR immediately after feeding
  - Bean bag "bed" to minimize movement
  - Benedryl (with pediatrician approval)
  - Melatonin
    - ✓ Schmidt et al. Melatonin is a useful alternative to sedation in children undergoing brainstem audiometry with an age dependent success rate: A field report of 250 investigations. *Neuropediatrics 38: 2-4, 2007*.

UNSEDATED PEDIATRIC ABR Measurement: Techniques

UNSEDATED PEDIATRIC ABR Measurement: Techniques

- Selected publications on use of melatonin to induce sleep in medicine
  - Brzezinski A. (1997) Melatonin in humans. *N Engl J Med, 336*, 186-195.
  - Dodge NN & Wilson GA. (2001). Melatonin for treatment of sleep disorders in children with developmental disabilities. *J Child Neurol, 16*, 581-584.
  - Johnson et al. (2002). The use of melatonin as an alternative to sedation in uncooperative children undergoing an MRI examination. *Clin Radiol, 57*, 502-506.
  - Milstein V et al. (1998). Melatonin for sleep EEG. *Clin Electroencephal, 29*, 49-53.
  - Seabra et al. (2000). Randomized, double-blind clinical trial, controlled with placebo, of the toxicology of chronic melatonin treatment. *J Pineal Res, 29*, 193-200.
  - Wassmer E et al. (2001). Melatonin is useful for recording sleep EEGs: a prospective audit of outcome. *Dev Med Child Neurol, 43,* 735-738.

UNSEDATED PEDIATRIC ABR Measurement: Techniques

- Melatonin
  - Hormone naturally produced by pineal gland (small gland in center of the brain)
  - Controls circadian rhythms
  - Inhibited by light
    - ✓ Exposure at night to incandescent light for 39 minutes reduces melatonin by 50%)
    - ✓ Chronic reduction in melatonin linked to cancer risk
  - Enhanced by darkness
  - Strong antioxidant activity
  - Exogenous melatonin (synthetic, e.g., tablets) causes rapid sleep induction without sedation
  - Peak serum concentration reached in about 60 minutes
  - Concentration declines within 4 hours

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ABR in the Clinic with Conscious Sedation (e.g., chloral hydrate)

American Academy of Pediatrics Guidelines for Conscious Sedation (WWW.AAP.org/policy)

Pediatrics 89, 1992, p 1110-1115

Guidelines for Monitoring and Management of Pediatric Patients During and After Sedation for Diagnostic and Therapeutic Procedures

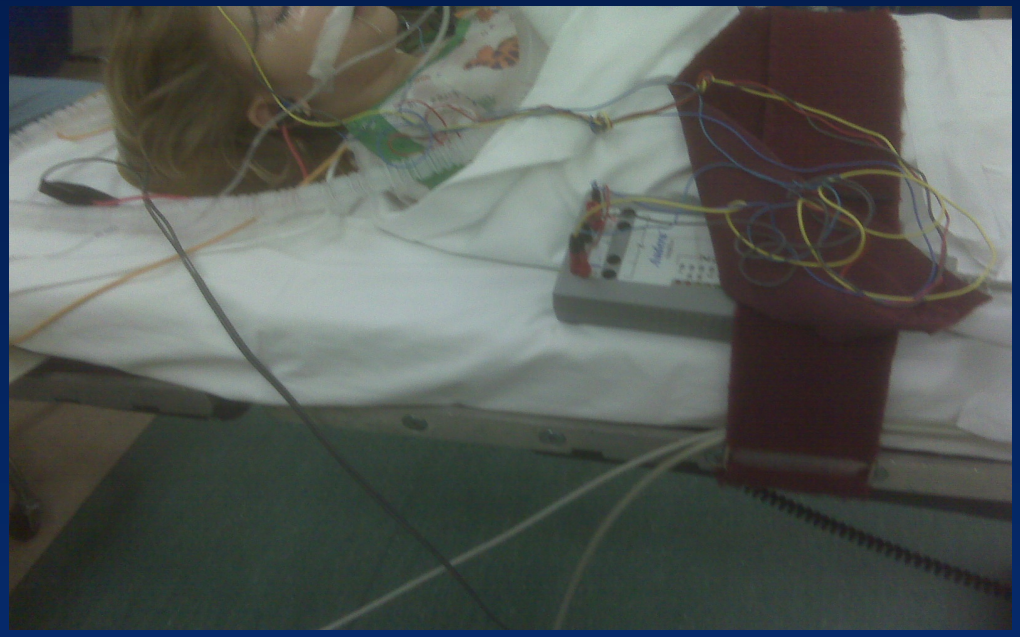
Pediatrics 110, 2002, pp 836-838

Guidelines for Monitoring and Management of Pediatric Patients During and After Sedation for Diagnostic and Therapeutic Procedures: Addendum

ABR in the Operating Room Following Otologic Surgery

ABR in Ambulatory Surgical Center with Light Anesthesia (e.g., Propofol)

ABR in Ambulatory Surgical Center with Light Anesthesia (e.g., Propofol)



ABR in Ambulatory Surgical Center with Light Anesthesia (e.g., Propofol)

SEDATION OPTIONS:
Clinic versus Operating Room

Setting	Advantages	Disadvantages
Clinic	Less expensive Near or in audiology Scheduling ease	Limited sedation options Limited medical support Increased liability Uncertain success/> time
O.R.	Medical (ENT) support Ideal patient state Controlled sedation Limited liability	More expensive Remote location Noisy environment Complicated scheduling

Disadvantages of Anesthesia for in ABR Assessment of Children

- Delayed diagnosis (many months) due to problems with scheduling time in the operating room with medical support team (e.g., anesthesiologist)
- Ten fold increase in cost (>$4000 versus $400) associated with services in the operating room
- Medical risk of anesthesia and related procedures (e.g., intubation)
- Possible secondary neurological and cognitive deficits of anesthesia in children at risk for learning problems
- Inability to conduct a full auditory assessment in remote location outside of the audiology clinic

Objective Assessment of Auditory Function in Young Children: How to enhance accuracy while decreasing test time

Continuing Education

"A learned blockhead is a greater blockhead than an ignorant one. ."

Benjamin Franklin (1706-1790)