continued

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continued

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Learning Objectives

- As a result of this Continuing Education Activity, participants will be able to:
- Identify 5 evidence-based stimulus parameters for ABR measurement in infants.
- □ Identify 5 evidence-based acquisition parameters for ABR measurement in infants.
- □ List 3 practical steps for minimizing ABR test time.



- □ What do we mean by "evidence-based"?
- Historical perspective
- ☐ The "crosscheck principle" and ABR
- ABR stimulus parameters
- ABR acquisition parameters
- Saving precious test time
- Conclusions
- Questions and answers

Best Practice is Evidence-Based Practice (EBP)

"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)



Evidence-Based Practice (EBP) is Best Practice Best Practice Follows Clinical Practice Guidelines

- Evidence-based practice is "the integration of best research evidence with clinical expertise and patient values" (Sackett et al, Evidence-Based Medicine: How to practice and teach EBM. London: Churchill, 2000, p. 1)
- **■** EBP is a five step process
 - Focused clinical question
 - Evidence is sought to answer the question
 - Clinician evaluates the quality of evidence
 - Clinician must integrate the evidence with the patient's clinical findings and preferred outcome to develop intervention plan
 - Document outcome and identify ways to improve it

US Preventative Services Task Force (www.fpnotebook.com/prevent/epi)

- Level I: Randomized control trial
- Level II: Non-randomized control trial
- Level III: Cohort or case-control study
- Level IV: Ecological or descriptive studies
- Level V: Opinions of respected authorities based on
 - Clinical experience
 - Descriptive studies or
 - Reports of expert committees



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
- 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)
 - ✓ Auditory steady state response (ASSR) is optional
 - Otoacoustic emissions (distortion product or transient OAEs)
 - Tympanometry with 1000 Hz probe tone
 - "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."

Update on Auditory Evoked Responses: Evidence- Based Protocol for Infant Hearing Assessment

- What do we mean by "evidence-based"?
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The First Comprehensive Description of the Auditory Brainstem Response (ABR) in Humans

Jewett DL & Williston JS. Auditory evoked far fields averaged from the scalp of humans. Brain 4, 1971





Robert Galambos

Don Jewett

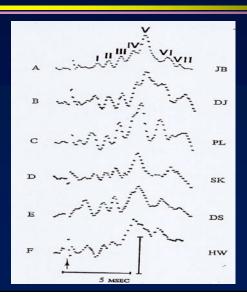
The First Comprehensive Descriptions of the Auditory Brainstem Response (ABR) in Humans

Jewett D and Williston J.

Auditory evoked far fields averaged from the scalp of humans. Brain 4: 681-696, 1971.

Hecox KE & Galambos R.

Brain stem auditory evoked responses in human infants and adults. *Archives of Otolaryngology 99, 1974.*





Auditory Brainstem Response in Infant Hearing Assessment: Beginnings in the 1980s



Update on Auditory Evoked Responses: Evidence- Based Protocol for Infant Hearing Assessment

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The Cross-Check Principle in the Diagnosis of Hearing Loss in Children (Jerger J & Hayes D. Arch Otolaryngol 102: 1976)

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October 1976, Volume 102
Copyright 1976, American Medical Association

The Cross-Check Principle in Pediatric Audiometry

James F. Jerger, PhD, Deborah Hayes, MA

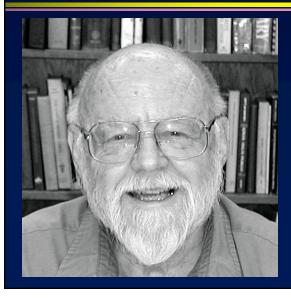
we discuss a method of pediatric audiologic assessment that employs the "cross-check principle." That is, the results of a single test are cross-checked by an independent test measure. Particularly useful in pediatric evaluations as cross-checks of behavioral test results are impedance audiometry and brain-stem-evalued response audiometry. We present live cases highlighting the value of the cross-check principle

kind of response they will give, the deviation of the deaf child will become

We are not so sanguine. We have found that simply observing the auditory behavior of children does not always yield an accurate description of hearing loss. In our own experience, we have seen too many children at all levels of functioning who have been misdiagnossed and mismanaged on the boxis of behavioral test results alone.

The mishandling of children bases on the results of behavioral audiom techniques, uniquely suited to the evaluation of young children, have been made available to clinicians. The first, impedance audiometry, is not only sensitive to middle ear disorders, "but in the case of normal middle ear function permits quantification of sensorineural level. ¹⁶ The second technique, brain-stem-evoked response (SERE)," audiomostry, is an electrophysiologic technique that permits the clinician to estimate sensitivity above 500 herts' by both air and

The Cross-Check Principle in for Diagnosis of Hearing Loss in Children (Jerger J & Hayes D. Arch Otolaryngol 102: 1976)







The Cross-Check Principle Pediatric Audiology (Jerger J & Hayes D. Arch Otolaryngol 102: 1976)

Test Battery:

- Behavioral audiometry
- Immittance (impedance) measurements
 - ✓ Tympanometry
 - ✓ Acoustic reflexes (contralateral only with SPAR)
- Auditory brainstem response (brainstem-evoked response audiometry or BSER)
 - √ Click stimulus air conduction
 - ✓ Click stimulus bone conduction

The Cross-Check Principle Pediatric Audiology (Jerger J & Hayes D. Arch Otolaryngol 102: 1976)

- "We have found than simply observing the auditory behavior of children does not always yield an accurate description of hearing loss"...
- "The basic operation of this principle is that no result be accepted until it is confirmed by an independent measure."
- "As long as audiologists are willing to accept the results of a single test measure they will continue to misdiagnosis and mismanage some children."



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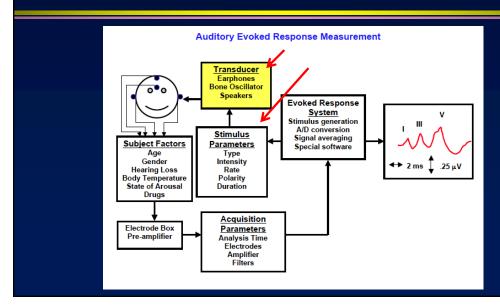
The Cross-Check Principle in Audiology Today 40-Years of Clinical Experience

- Behavioral Audiometry
- Otoacoustic Emissions (OAEs)
- ☐ Aural Immittance Measurements
 - Tympanometry
 - Acoustic Reflexes
- **☐** Auditory Brainstem Response (ABR)
 - Air- and Bone Conduction Stimulation
 - Click, Tone Burst and Chirp Stimulation
 - □ Auditory Steady State Response (ASSR)
- Electrocochleography (ECochG)
- □ Cortical Auditory Evoked Responses



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Update on Auditory Evoked Responses: Evidence-Based Protocol for Infant Hearing Assessment Stimulus Parameters

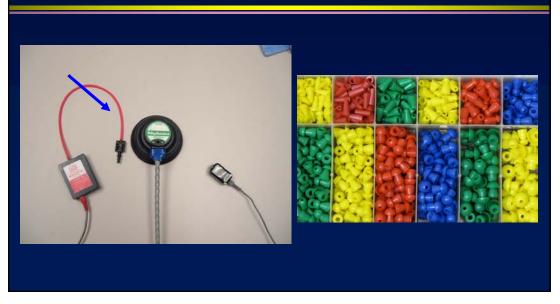




Evidence-Based Frequency-Specific ABR Test Protocol: *Stimulus Parameters*

Parameter Selection **Rationale** Transducer **ER-3A inserts Numerous infant advantages** B71 or B81 Bone oscillator as needed Type Clicks **R/O ANSD Tone bursts** Available on all systems **Chirp stimuli Topic of March 16 AO course** Mode of **Air-conduction Always Presentation Bone-conduction As indicated Polarity** Rarefaction **Condensation as needed**

ABR Transducer Options for Pediatric ABR Recordings: Insert Earphone with Adaptor

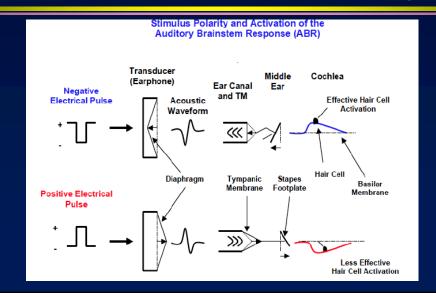




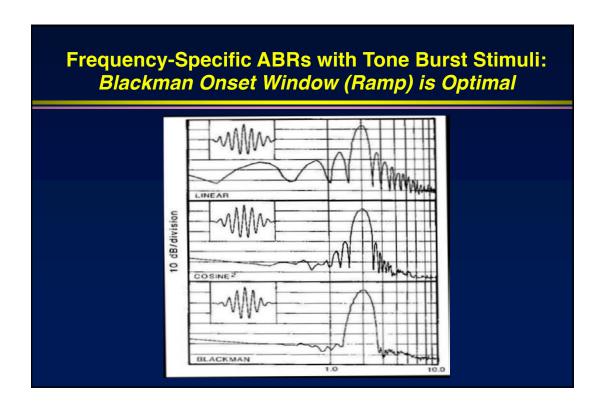
ABR Measurement in Infants and Young Children: Advantages of Insert (ER-3A) versus Supra-Aural Earphones

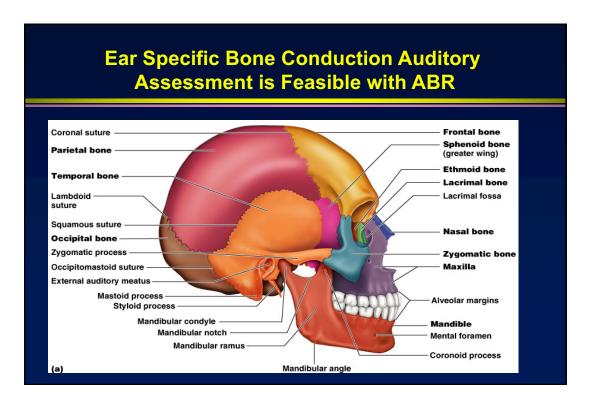
- General
 - Increased inter-aural attenuation
 - Increased ambient noise attenuation
 - Elimination of ear canal collapse
 - Increased patient comfort
 - Improved aural hygiene
 - More precise placement (increased reliability)
- ABR specifically
 - Reduced transducer ringing
 - Reduced stimulus artifact (with separation of transducer from inverting electrode)

Stimulus Factors in ABR Measurement: Rationale for Rarefaction Stimulus Polarity

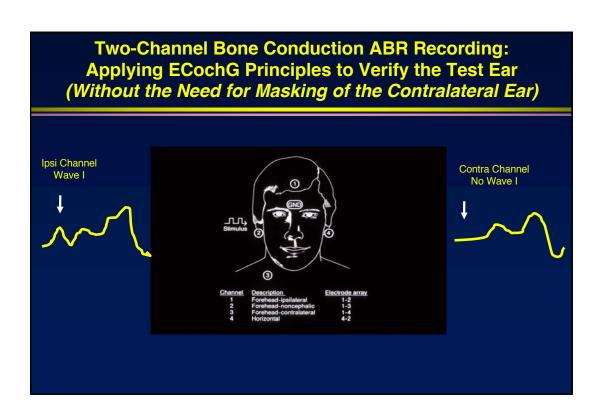








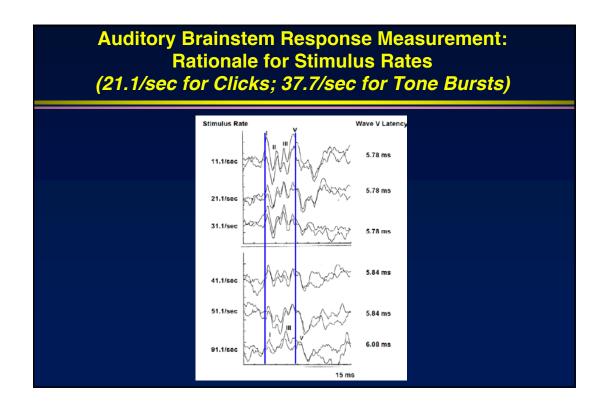


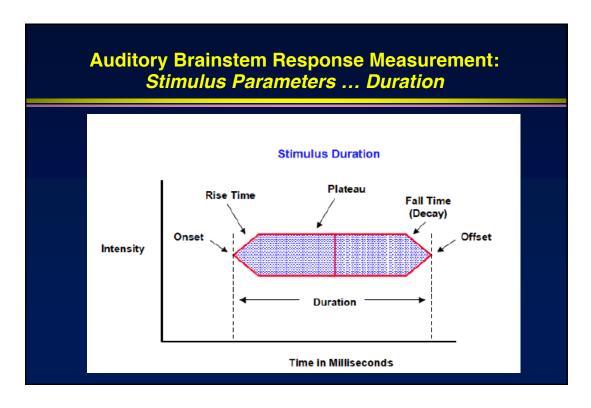


Evidence-Based Frequency-Specific ABR Test Protocol: *Stimulus Parameters*

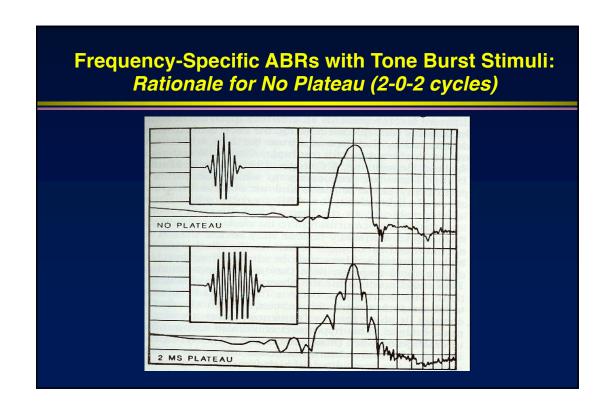
| Parameter Rate | Selection Click: 21.1/sec TB: 37.7/sec | Rationale Record wave I in less time Record wave V in less time |
|-------------------|--|---|
| Frequencies | .5, 1, 2, 4 K Hz | Sequence varies clinically |
| Duration | 2-0-2 cycles | Equal intensities; < splatter |
| Ramping | Blackman | More frequency-specific |
| Intensity | dB nHL | Calibration in peRETSPL plus normal behavioral thresholds for each stimulus |

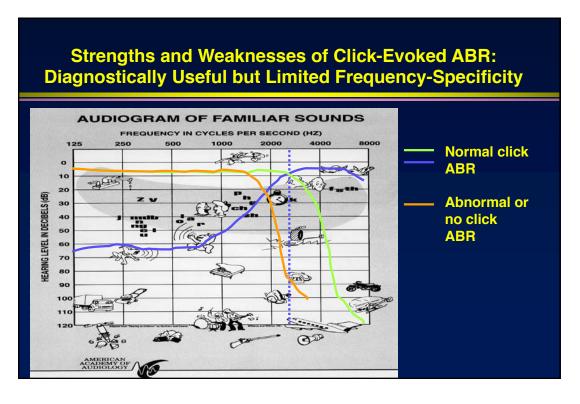




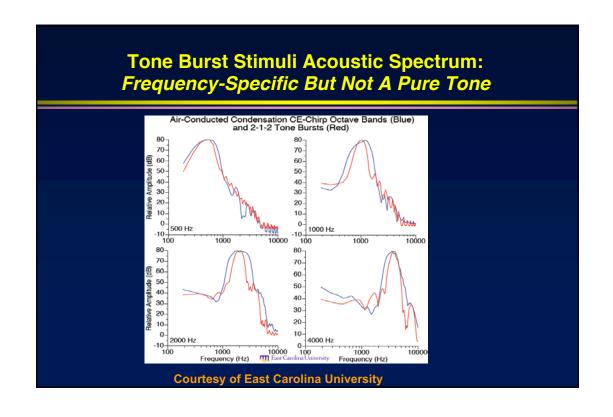


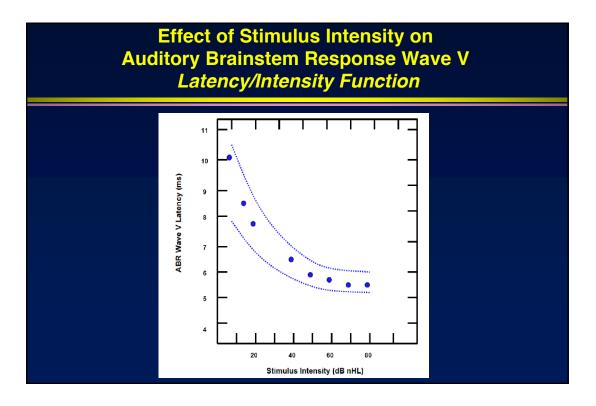






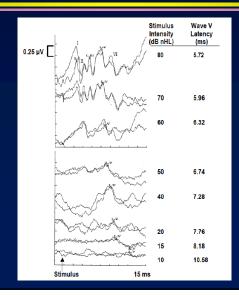




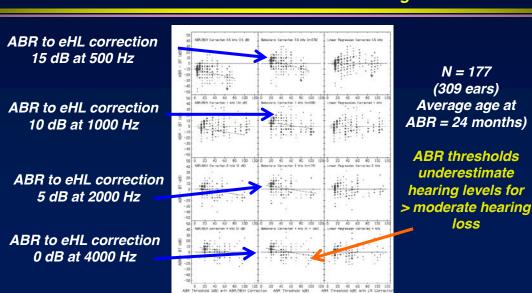




Effect of Stimulus Intensity on ABR: Changes in Morphology

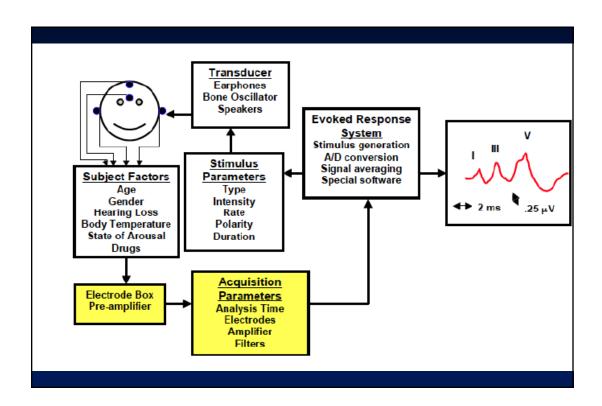


McCreery et al (2014). The impact of degree of hearing loss on auditory brainstem response predictions of behavioral thresholds. *Ear & Hearing*





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Evidence-Based Frequency-Specific ABR Test Protocol: Acquisition Parameters

| Parameter Artifact reject | Selection On | Rationale Minimize muscle artifact |
|---------------------------|-----------------|--|
| Analysis time | 15-ms 20-ms | Click, 4000 Hz, 2000 Hz 1000 Hz and 500 Hz Encompass delayed wave V and SN10 after wave V |
| Sweeps | Variable | To produce an SNR of > 3:1 To increase test efficiency |
| Reliability | 2 or 3 runs | "If the waves don't replicate, you must investigate!" |

Evidence-Based Frequency-Specific ABR Test Protocol: *Selection of Analysis Time*

ABR wave V latency for click stimulus at 85 dB nHL

Decrease in intensity to 20 dB nHL

Conductive hearing loss component of 50 dB

Age related latency increase for term infant

Latency increase with hypothermia (4 degrees)

Pre-stimulus baseline

-6.0-ms

+2-ms

+1-ms

+1-ms

Total = 14-ms

Goal: ABR Wave V Midway in the Analysis Time



Auditory Brainstem Response Measurement: Signal Averaging ... Rationale for the Number of Sweeps

Signal-to-Noise Ratio (SNR) =

Signal Amplitude X Number of Averages

Noise Amplitude

Goal = SNR > 3:1
(ABR wave V: Residual Noise)

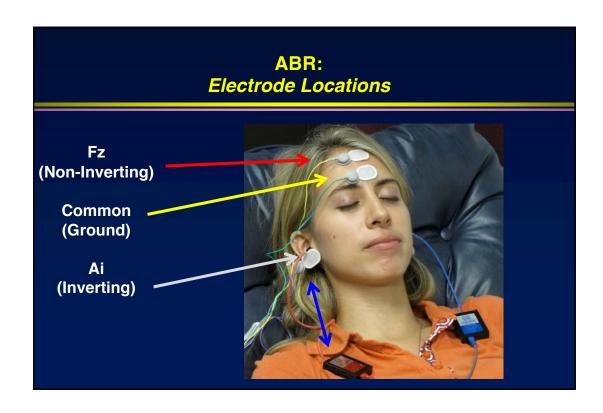
Factors:

Signal = Stimulus Intensity, Hearing Status, Chirp Noise = Muscle and Electrical Activity

Evidence-Based Frequency-Specific ABR Test Protocol: *Acquisition Parameters*

| Parameter | Selection | Rationale |
|--------------------|---------------------------------|--|
| Electrode type | Disc & ear clip or disposable | Disposable = < infection |
| Electrode location | Fz - 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 |





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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
 - Insert earphones are ready with proper size tips
- Record ABR in conditions that optimize the SNR
 - Sleeping, sedated, or anesthetized child
 - Low and balanced electrode impedance
 - Little or no electrical artifact
 - Deep fitting insert earphone (minimize acoustic noise)
 - Chirp stimuli
- Stimulus presentation rate of about > 37.7/sec
- Immediately trouble-shoot if the ABR findings are unexpected

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 with minimum criteria for stimuli or sweeps (e.g., 1000)
 - 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



Thank You! May I Introduce You to A New Textbook? eHandbook of Auditory Evoked Responses (2015) James W. Hall III

- 1000+ pages of practical information on auditory evoked responses
- Procedures and protocols for recording ECochG, ABR, ASSR, AMLR, ALR, and P300
- Available from Kindle Direct Publishing (Amazon.com)
- Download directly to smart phone, tablet or laptop from this link:http://www.amazon.com/dp/B0 145G2FFM

