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Diagnóstico audiológico en bebés. Estudio de casos. Demostración práctica.

Audiologic diagnosis in infants. Case studies. Practical demostration.

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II International Symposium
Early Identification, Diagnosis and Treatment of Deafness in Infants
May 26-27, 2011
Madrid

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Audiologic Diagnosis of Infants

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Topics

- Rationale for behavioral audiometric assessment
- Use of evidence based procedures to obtain ear-specific and frequency-specific thresholds
- Description and demonstration of behavioral audiologic techniques including VRA, VROCA and CPA
- Strategies for involving the family in the diagnostic assessment process

Joint Committee on Infant Hearing (JCIH 2000, 2007)

Purpose of audiologic test battery:

- Assess integrity of the auditory system
- Estimate hearing sensitivity
- Identify intervention options
- Describe the hearing loss
  - » ear-specific estimates of type, degree, and configuration of hearing loss

Guidelines for the Audiologic Assessment of Children From Birth to 5 years of Age (ASHA, 2004)

- The use of any test alone for assessing children's hearing sensitivity is discouraged
- The ASHA guidelines recommend a comprehensive pediatric assessment that includes behavioral, physiologic, and developmental measures

Early Infant Hearing Assessment

University of Colorado Hospital, Denver

The Children's Hospital, Denver

- Screening limited to observation of behavioral response to sound
- Limited access to physiologic tests
  - » ABR, ASSR, OAEs not available
- Infant hearing assessment:
  - » Birth-5 months: BOA
  - » 6-24months:VRA

Late 70's: Availability of Physiologic Tests

ABR circa 1980

- Some questioned the reliability and validity of behavioral measures
- Need for use of more than one test i.e. "cross check principle" (Jerger and Hayes, 1976)

Today: Accurate Assessment with Behavioral Audiometry Still Essential!

- Following referral from newborn hearing screen, initial thresholds are estimated using physiologic tests such as ABR and ASSR; however, accurate behavioral audiometry remains essential in order to:
  - » Confirm degree of HL and monitor thresholds over time
    - Some children will have progressive hearing loss
  - » Determine hearing thresholds in children with Auditory Neuropathy Spectrum Disorder (ANSD)
  - » Determine residual hearing in children who have no response on ABR or ASSR

Behavioral Audiometric Methods: Two General Categories

- Unconditioned Response Procedures
  - » Use overt, unconditioned responses to sound in order to estimate auditory sensitivity
- Conditioned Response Procedures
  - » Use operant conditioning procedures to estimate auditory sensitivity

Behavioral Audiometric Procedures

Unconditioned Response

- Behavioral Observation Audiometry (BOA)

Conditioned Response

- Visual Reinforcement Audiometry (VRA)
- Visual Reinforcement Operant Conditioning Audiometry (VROCA)
- Tangible Reinforecement Operant Conditioning Audiometry (TROCA)
- Conditioned Play Audiometry (CPA)

Method Used Depends on Child's Developmental Age

- If child is premature, age adjusted for prematurity
- Knowledge of developmental delays is useful
  - » Parents can help when developmental age unknown

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Unconditioned Response: Behavioral Observation Audiometry

- Child tested in quiet or light sleep state
- An observer judges whether a behavioral response has occurred in response to a complex stimulus (e.g. speech, narrow band noise at 60-90 dBHL).
- This is the only subjective method available for infants under 6 months of age

Behavioral Observation Audiometry

- BOA measures an infant's *awareness* of sound; does not provide threshold information
- High inter- and intra-subject variability
  - » Unable to differentiate between mild and moderate HL
  - » Dependent on state, alertness, attention, etc.
  - » Infant habituation after only a few responses
- May be useful for corroboration of parent/caregiver report but…
- Should not be used to determine thresholds for purposes of hearing aid fitting

ASHA, 2004; JCIH, 2007

Birth to 6 Months: Physiologic Measures are Needed

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Ear-specific and frequency-specific estimates from ABR or ASSR are used during hearing aid fitting.

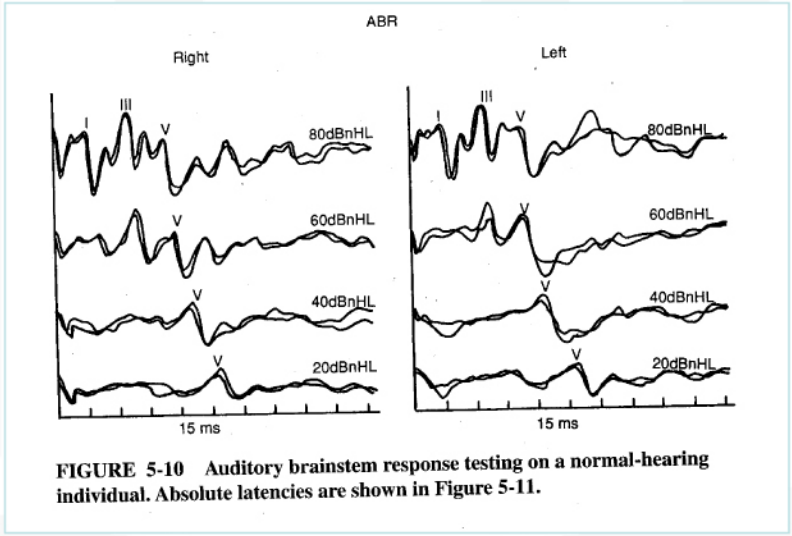


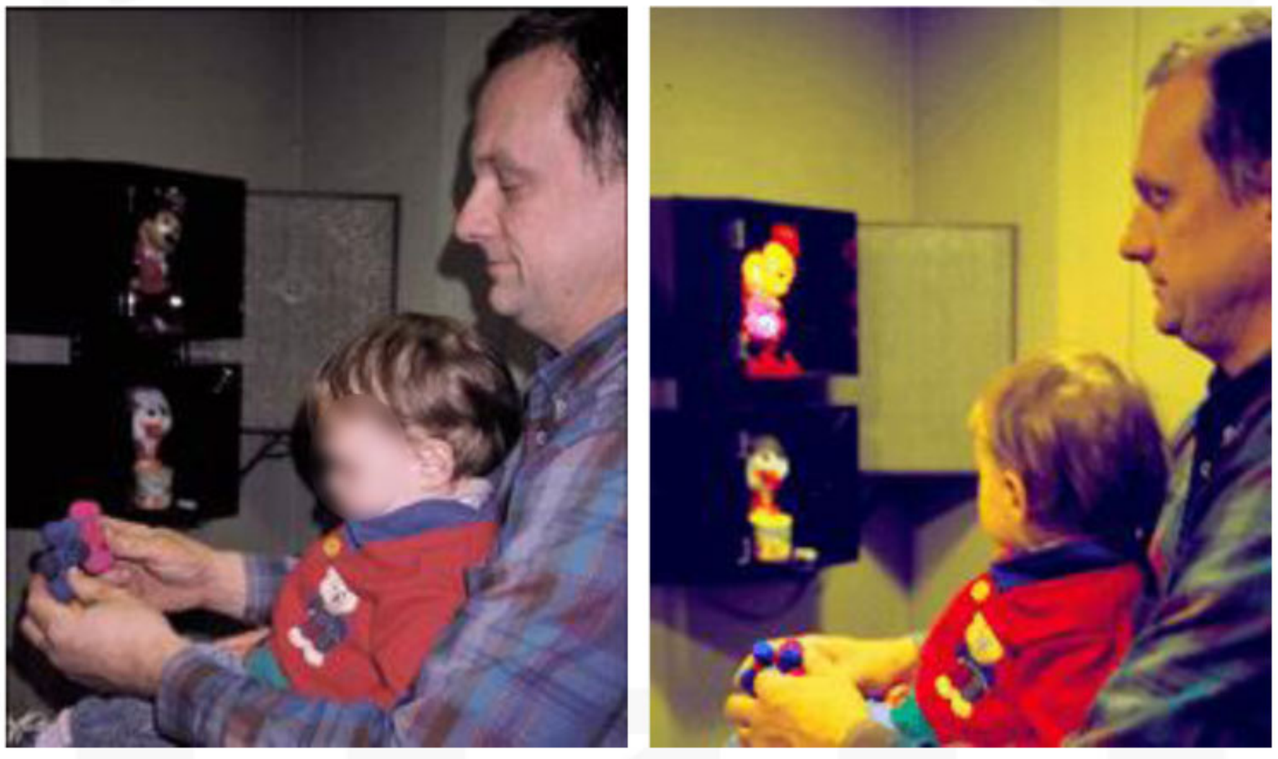
FIGURE 5-10 Auditory brainstem response testing on a normal-hearing individual. Absolute latencies are shown in Figure 5-11.

Conditioned Response: Visual Reinforcement Audiometry

- Effective for infants 6-24 months
- Conditioned head turn in response to sound
- When child responds to sound, rewarded by presentation of attractive toy, with or without animation
- It is optimal to have a trained assistant in the booth but can be done with one audiologist and audiometer in same room if necessary

Visual Reinforcement Audiometry

- Audiologist outside of sound booth controlling presentation of sound and reinforcer
- Child seated on parents lap or in highchair inside sound booth
- Variety of bright, colorful reinforcement toys will increase number of responses obtained
- Best if reinforcer is 90 degrees to side of child



University of Michigan Health System

Visual Reinforcement Audiometry (VRA)

- Can be completed in sound field, with insert earphones, or via bone-conduction
- Baby's own earmolds can be attached to earphone transducer
  - » Helpful in obtaining ear specific measures on young infants already fitted with hearing aids

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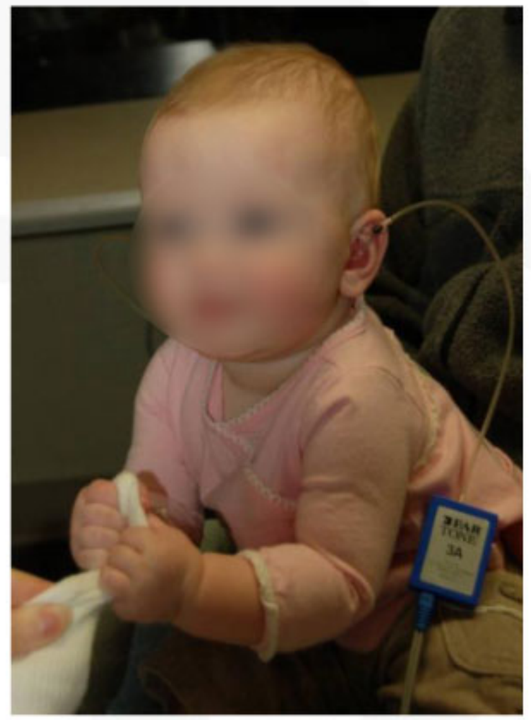
Visual Reinforcement Audiometry (VRA)



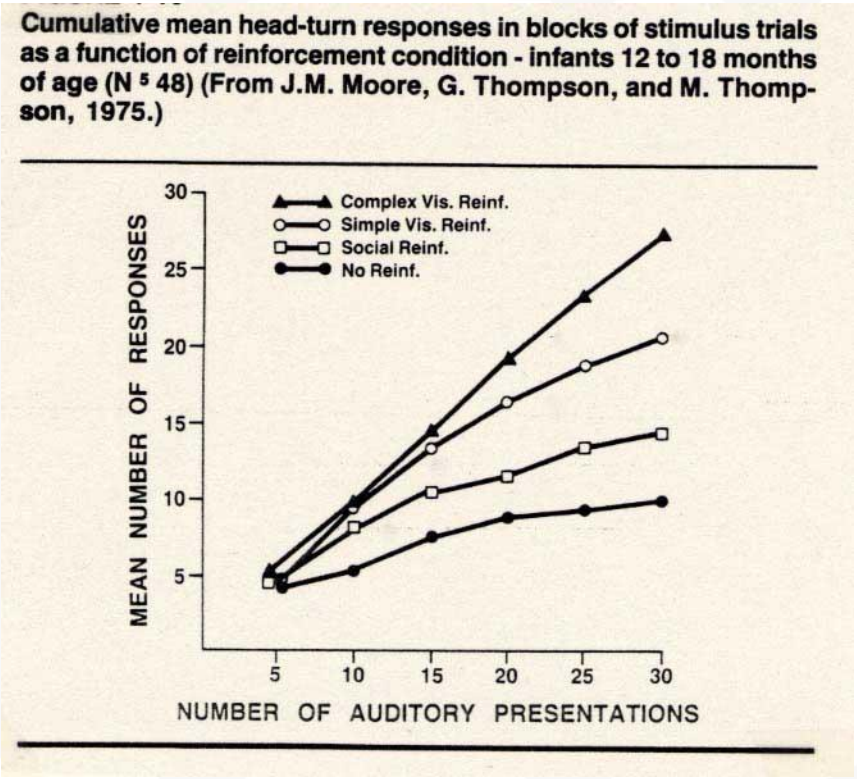
- Best if infant is able to sit up and has good head control
- Normal hearing infants condition more easily than infants with hearing loss
  - » Children with HL lack auditory experience
- Children with severe to profound HL may need to be conditioned using a vibratory signal from bone conduction transducer

Role of Test Assistant

- Keeps child visually centered and mildly distracted
  - » Use soft, quiet toys for centering
  - » Only allow child to handle toys as last resort
  - » Assistant should not to be “too interesting”
- Checks earphones and reinserts when needed
- For very young infants it may be helpful for assistant to sit on same side as reinforcer to help shape infants head-turn response
- For older infants, sometimes helpful to provide a few small edible snacks; e.g. cereal (check with parents first)
- Wireless infrared system helpful for communication between tester and assistant

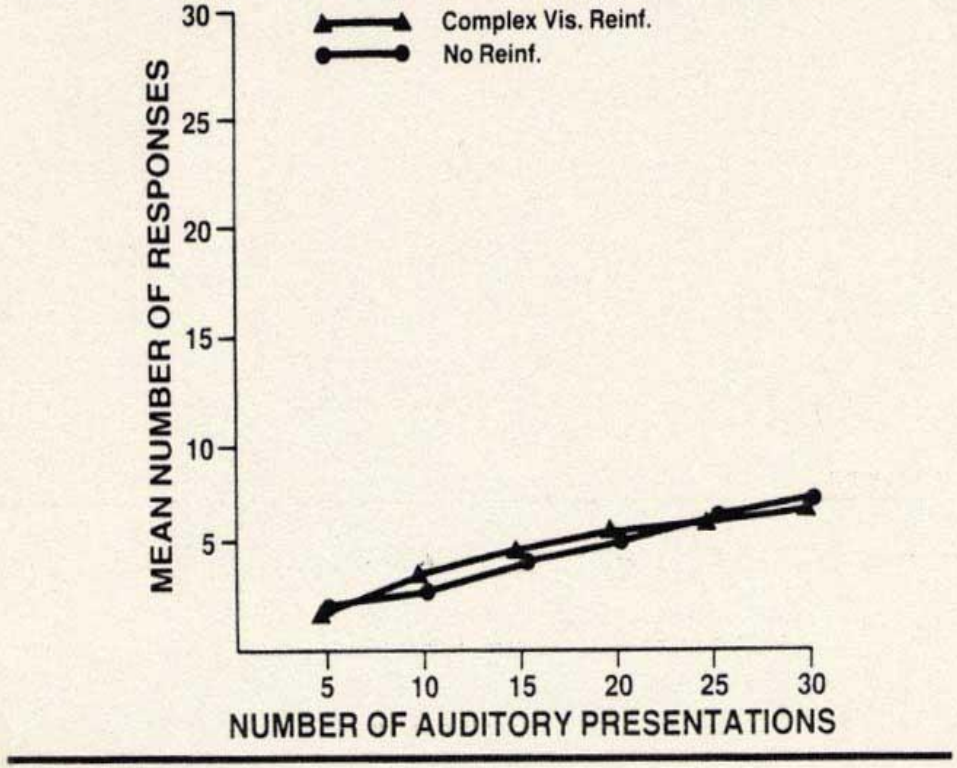
Visual Reinforcement Audiometry (VRA)

- Classic studies conducted at Univ. of Wash, Seattle, in the 1970's are still relevant!
- Number of responses obtained is dependent on type of reinforcement used e.g. social, simple, complex (Moore et al., 1977)



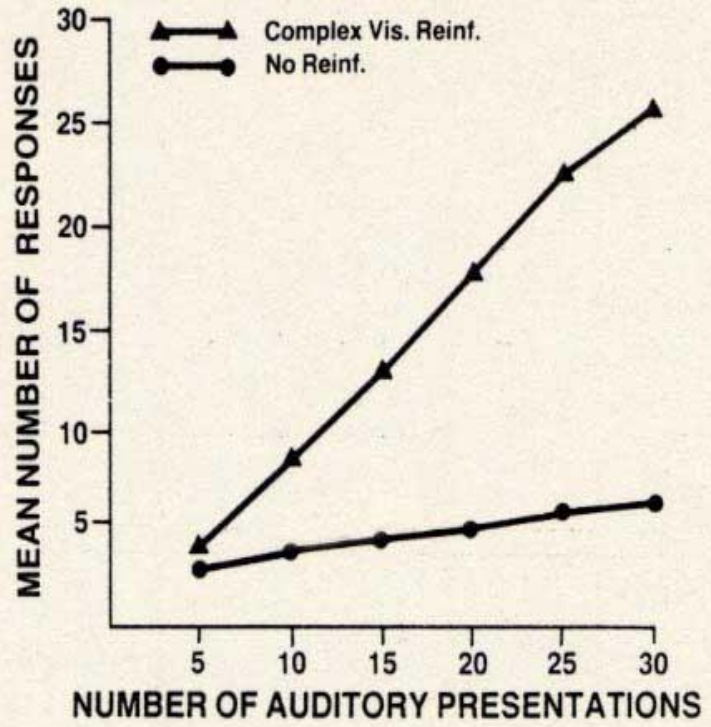
Complex VRA vs No Reinforcement 4 Month Olds

Cumulative mean head-turn responses in blocks of stimulus trials as a function of reinforcement condition - infants 4 months of age (N = 20) (From J. M. Moore, W. R. Wilson, and G. Thompson, 1977.)



Complex VRA vs No Reinforcement 5-6 Month Olds

Cumulative mean head-turn responses in blocks of stimulus trials as a function of reinforcement condition - infants 5 to 6 months of age (N = 20) (From J. M. Moore, W. R. Wilson, and G. Thompson, 1977.)



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8-12 Month old Infants and VRA - Widen et al 2000

- Identification of Neonatal Hearing Impairment: Hearing Status at 8-12 months chronological age using VRA (N=3134)
- 96 % (2,995) infants successfully conditioned
  - 90% of these infants gave 4 frequency audiograms for each ear
- Average number of trials for 10 month-olds is 45 responses over 15-20 minutes
  - Important not to waste responses/time *above* threshold

Ear and Hearing 2000;21;471-487

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A VRA Protocol
Based on Widen et al., 2000

- **Set Up:**
  - **Stimuli**: Warbled tones, speech
  - **Transducer** (in preferred order): Insert earphones, inserts with ear molds, sound field
  - **Test frequencies** (in preferred order): 500, 4000, 1000, 2000, 250 Hz
- **Begin at 30dBHL (or appropriate starting level based on threshold estimates from ABR)**
  - If baby turns naturally:
    - Two consecutive responses on his/her own---go to TEST PROTOCOL
  - If no head turn, increase stimulus to 50dBHL----if turn, reinforce to side of head turn
    - Two consecutive responses on his/her own---go to TEST PROTOCOL
  - If no turn go to CONDITIONING
- **Conditioning:**
  - 50dBHL paired with reinforcer to side of stimulus (2 times)
  - Probe with unpaired stimulus to see if head turn
    - If two consecutive responses to probe, go to TEST PROTOCOL
    - If no turn increase in 20dB steps and repeat pairing until two consecutive responses
  - If no response at higher levels, try changing frequency, ear, transducer or reinforcer
    - May be appropriate time to introduce vibratory stimulus from bone conductor

Suggested VRA Protocol Based on Widen et al., 2000

- **Protocol:**
  - Down 20dB, Up 10dB
  - If no response at the same level twice, increase in 5 dB steps until head turn
    - Lowest level 15dBHL
  - Record threshold where 2 consistent responses were obtained with no consistent responses at a lower level
  - Switch ears
    - Reinforce to side of head turn
  - Start at threshold for last frequency
  - Switch frequency according to above order after obtaining thresholds for both ears at one frequency
  - Test order (ear, frequency, reinforcer side) may be adjusted for individual children but make all efforts to at least obtain 500 and 4000 Hz for both right and left ear.
  - Re-condition if child begins to habituate
    - Test at level where child previously responded
    - 1 paired trial and 1 probe
  - If turn, proceed with TEST PROTOCOL
  - If no turn, repeat CONDITIONING

VRA Six Month Old

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VRA Six month old (profound loss)

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Conditioned Response: Play Audiometry

- Important to have variety of simple but fun toys
- Change game as needed to maintain attention
- If assistant not available, portable audiometer in the test room may be better choice

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Play Audiometry

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Conditioned Response: Visually Reinforced Operant Conditioning Audiometry (VROCA)

- Combination of play audiometry and VRA
- Child responds as during play audiometry but is only reinforced by use of animated VRA toy
- Works well to keep attention of children who are not quite ready for play audiometry

VROCA 28 Month Old

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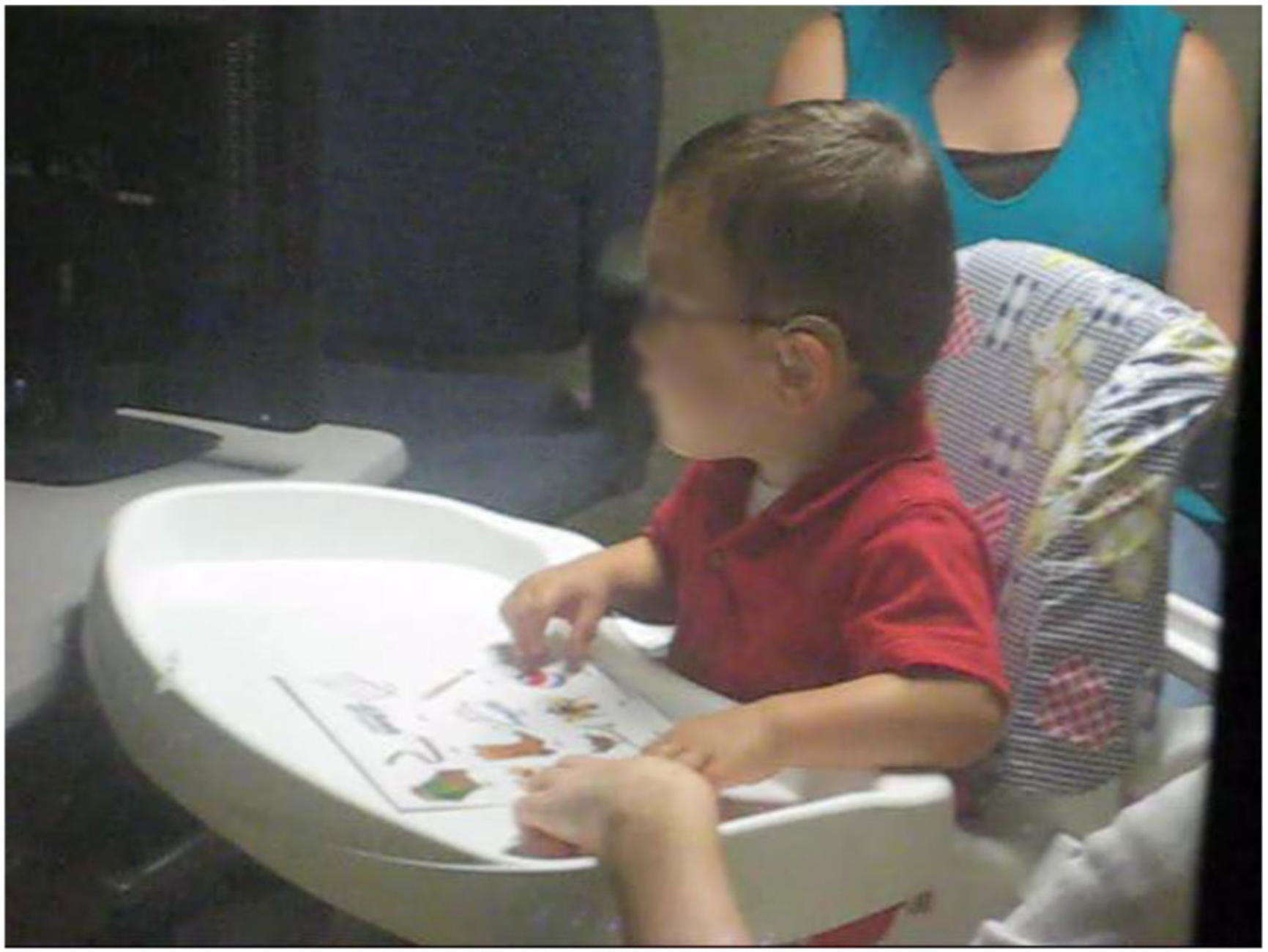
Use of VROCA for Speech Recognition Testing



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Play Audiometry using Video

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Conditioned Response: Tangible Reinforcement Operant Conditioning Audiometry (TROCA)

- First described by Lloyd et al in 1968
- When child gives correct response an edible treat is dispensed from TROCA unit
- If child responds incorrectly no treat dispensed
- Accompanied by social reinforcement
- Useful for young children who are required to give many responses e.g. during CI programming

Strategies for Involving Family

- Prior to test initiation explain:
  - Goal of test session
  - Type of procedure (e.g. VRA,VROCA,play) and how it will be accomplished
- Important for family to observe the evaluation:
  - In past, testing done in sound field and stimuli were audible
  - Protocols now require individual ear measures with insert phones and family unable to hear sounds presented
  - At least one test in sound field for demonstration purposes is helpful for parents to experience what child can hear
  - Have parents take turns in sound booth with infant and watching from control room with audiologist
    - Explain what you are doing and ask the parent if they feel child has responded to presentation of sound

Summary of Behavioral Test Measures by Age:

- 6 Months – 24 Months
  - » Visual Reinforcement Audiometry (VRA)
- 24-30 months:
  - » VROCA, TROCA
- 24 Months – 5 years
  - » Conditioned play audiometry (CPA)
- Important to remember that ages are based on infant's *developmental* age

Summary

- Physiological tests such as ABR remain the best method for estimating thresholds for purposes of hearing aid fitting for infants under six months of age.
- Behavioral audiometry is essential in management of infants with hearing loss and can provide reliable thresholds for infants who are at a developmental age of 6 months and older
- For best results use established protocols such as those described by Judith Widen and Judith Gravel
- Accuracy of hearing aid fitting is only as good as our ability to determine an infant's auditory capacity

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Muchas Gracias!