

# Chapter 6

## Using Behavioral Observation Audiometry to Evaluate Hearing in Infants from Birth to 6 Months

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### Key Points

- Auditory brainstem response (ABR), auditory steady state response (ASSR), and otoacoustic emission (OAE) testing provide critical information about the status of the auditory pathways, but are not direct measures of hearing.
- Only behavioral testing can provide a direct measure of hearing.
- When carefully performed, using appropriate criteria (including changes in sucking as an indication of a response), behavioral observation audiometry (BOA) can accurately measure thresholds in infants younger than 6 months.

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Nonbehavioral tests such as ABR testing, ASSR testing, and OAEs are frequently used to assist in estimating peripheral hearing in infants (ASHA 2004). Although these tests are an important part of the audiology practice, they are, in fact, not tests of hearing. The only true test of hearing is behavioral assessment. ABR, ASSR, and OAE measures provide information about the integrity of specific sites within the auditory system (Delaroche, Thiebaut, and Dauman, 2004; Gravel, 2000; Hicks, Tharpe, and Ashmead, 2000; Sininger, 1993). Only behavioral testing truly tests hearing, since it measures the response of the entire auditory system from the outer ear through the cerebral cortex. Behavioral tests permit measurement of what an infant actually perceives; so they are measures of functional hearing abilities.

Numerous authors have posited the necessity for cross-checking physiological results with behavioral data by using a battery of tests to determine hearing sensitivity (Bess and Humes, 2003; Gravel, 2000; Hicks, Tharpe, and Ashmead, 2000; Jerger and Hayes, 1976; Madell, 1998; Northern and Downs, 2002). Behavioral testing of infants 6 months and older is a well documented part of the clinical practice of audiology (ASHA 2004). Behavioral evaluation of infants younger than 6 months is more difficult to achieve and less well documented. This chapter will describe a behavioral technique that can be used to successfully evaluate hearing in infants younger than 6 months.

### ◆ The History of Behavioral Testing of Infants

As early as the 1940s, attempts were made to develop behavioral techniques to assess hearing in infants (Ewing and Ewing, 1940, 1944; Froeschels and Beebe, 1946). Sir Alexander and Lady Ewing used percussion sounds and pitch pipes to elicit aural reflex responses (eye blinks). Wedenberg began infant screening in Sweden in 1956 using pure tones to elicit the auro-palpebral reflex. Froding continued Wedenberg's work using a small gong and mallet. Some clinicians used the infant's ability to turn toward the sound to assess hearing. Frisina (1963) reported that between 2 to 4 months of age infants could turn toward a sound. However, Northern and Downs (1974) reported that head turning does not

occur before the age of 6 months, and Gerber (1977) reported the average age of head turn to be at 7 1/2 months.

### Noisemakers

Noisemakers were the most common sound source employed for early hearing tests. They were selected for testing because they were readily available, simple and inexpensive, and could be used in any setting (a sound room was not required) and it was believed that infants would respond more reliably to noisemakers than to pure tone stimuli. The difficulty with noisemakers is that they usually have very broad frequency responses. Furthermore, their intensity is not easy to control even with practice exerting the pressure necessary to make the sound, and stabilizing the distance from the infant's ear. Bove and Flugrath (1973), and Poblano et al. (2000) analyzed different noisemakers to determine their frequency responses so that responses to noisemakers could provide more useful information. Even if noisemakers cannot provide sufficient information to be used to assess hearing, they can provide some gross information about how an infant responds to sound. Specifically, noisemakers can provide some evidence of an infant's ability to alert to sound and localize to the source (Northern and Downs, 2002).

Before using any noisemakers, information should be obtained about the auditory signals they emit, including their frequency response and intensity. Results of noisemaker tests must be viewed with caution. For example, a noisemaker may have the bulk of its energy in the 2000 to 4000 Hz range, but also have energy at 500 Hz at 30 to 40 dB less intensity than the high frequencies. What can be surmised about the infant's response to this stimulus? It is possible that the infant hears the high frequency component of the stimulus, but it is also possible that the infant has a high frequency hearing loss, does not hear the high frequency part of the signal, and is responding to the low frequency component.

### Early Infant Hearing Screening Programs

The first large-scale infant hearing screening program in the United States was a citywide hearing screening project in Denver, conducted by Marion Downs and Graham Sterritt in 1964. They used a handheld noise generator that emitted a 90 dB SPL noise centered at 3000 Hz. Downs and Sterritt (1964, 1967), Northern and Downs (1991), and Werner and Gillenwater (1990) attempted to develop a standardized procedure to assess an infant's behavioral arousal, but a significant number of false-positive test results made the testing unreliable. Several authors have described techniques for assessing behavioral responses in infants, including observation of eye widening, quieting, eye shifting, head orienting, limb movement, and changes in respiration. Attempts have been made to calibrate the observer (Mencher et al, 1977; Weber, 1969), to assess the state of the infant (Eisenberg, 1969), and to precisely calibrate the signal (Thompson and Thompson, 1972.) A major problem with using the auro-palpebral reflex, the Moro reflex, or changes in limb movement or respiration is that these behaviors are not elicited to threshold stimuli, but rather are responses to suprathreshold stimuli. Although some infants with hearing loss were

identified using these methods, many with less than severe to profound hearing losses were missed. In spite of all attempts to improve test protocols, BOA continued to be considered "unreliable."

### Infant Thresholds

Because behavioral test protocols frequently did not reveal threshold responses, some audiologists proposed that responses at 60 to 70 dB SPL be interpreted as normal hearing for very young infants (McConnell and Ward, 1967, Northern and Downs, 1984). However, others demonstrated that infants hear at essentially adult levels (Berg and Smith, 1983; Eisele, Berry, and Shriner 1975; Madell, 1995a, 1998; Olsho, 1984; Olsho et al 1988; Spetner, and Olsho 1990; Werner and Gillenwater, 1990). Olsho et al (1984) Olsho et al, (1987b, 1988), and Nozza (2006), reported that average behavioral thresholds of 3-month-olds were worse than thresholds for young adults by 15 to 20 dB between 250 and 4000 Hz, and by about 30 dB at 8000 Hz. By 6 months of age, hearing sensitivity in the high frequencies improves but thresholds at 250 Hz remain elevated by about 15 dB. Thresholds improved by 20 dB between 3 and 6 months. Olsho et al (1988) discussed that the audibility curve of younger infants may differ in shape compared with the curve of older infants and adults. It was assumed that this audibility curve difference was, at least in part, due to the characteristics of the external and middle ears in infants. Arlington (2000) and Olsho et al (1988) postulated that some of the threshold differences may be related to sensory immaturity.

Gravel (2000); Hicks, Tharpe, and Ashmead (2000); and Olsho et al (1987a,b, 1988,) use an observer-based procedure developed by Olsho to reduce tester bias in evaluating hearing in infants as young as 2 to 5 weeks. In this method, a trial consists of a sound or a no-sound interval. One or two trained observers watch the infant and make a determination as to whether the interval contained a sound, or no sound, based on the infant's response. The observer receives feedback as to whether a sound is present. Once the observer demonstrates a false-positive rate of less than 25% reliable, testing begins. Hicks, Tharpe, and Ashmead (2000) used this technique with two observers testing 2- and 4-month-old infants. They successfully obtained thresholds for 4-month-olds, but were not successful in obtaining thresholds for 2-month-olds. Several authors evaluating hearing in infants report that results could be optimized by enhancing the test conditions. This enhancement included reducing visual distractions (Muir, Clifton, and Clarkson, 1989), using a salient auditory stimulus (Thompson and Thompson, 1972), reinforcing desired behaviors (Olsho et al, 1987a, 1988), and using changes in sucking as the response criteria (Delaroché Thiebaut, and Dauman, 2004; Madell, 1995a, 1998). Because of the critical need to obtain reliable test results on infants, research in this area will need to continue.

### The Need for Behavioral Testing of Infants

Over time, the demand for infant hearing screening has increased significantly, so that many states have mandated newborn hearing screening requirements. (See Chapter 4 for

a complete discussion of newborn hearing screening.) As more infants survive and as hearing screening becomes more universal, audiologists are being asked to assess hearing in very young infants who have failed newborn screening and to manage hearing loss when it is identified. One of the first steps in hearing loss management is the selection and fitting of appropriate amplification. Hearing aid fitting requires an accurate assessment of the degree and type of hearing loss, with both ear and frequency specific information obtained by air and bone conduction.

Many audiologists feel comfortable testing hearing in infants older than 6 months using visual reinforcement audiometry (VRA), but do not feel comfortable testing younger infants, developmentally delayed infants, or critically ill infants. If an infant fails a hearing screening at birth, hearing aids should be fit within a few weeks. Work by Apuzzo and Yoshinaga-Itana (1995); Yoshinaga-Itana, Couter, and Thomson (2001), and others have demonstrated that infants who are fit with appropriate technology before they are 6 months old can develop speech and language skills commensurate with their normal hearing peers, and that infants fit with technology older than 6 months, do not catch up to those fit earlier. Sharma, Dorman, and Spahr (2002) have demonstrated that infants who receive auditory stimulation at a sufficiently early age have evoked potential latencies similar to normal hearing peers, but infants who do not have sufficiently early access do not.

Behavioral testing allows the parents to participate in testing by allowing them to assist in determining when the infant is responding to a sound. If parents are provided with information about what to observe, they can be active participants in testing, facilitating acceptance, and understanding of hearing loss (Gravel and McCaughey, 2004). Electrophysiologic testing, on the other hand, provides little for a family to observe. It is clear that we must develop test techniques for evaluating very young infants that will provide the ear and frequency specific information necessary for the evaluation, selection, and fitting of amplification. Real-ear measures provide good information about how much sound is reaching the eardrum, but this information is difficult to interpret without good information about the status of the infant's unaided hearing. Tonal ABR and ASSR measures provide some of this information but thresholds obtained may vary by  $\pm 15$  dB. BOA techniques can assist in obtaining ear and frequency specific information and can provide confirmation of information obtained from electrophysiologic tests.

### ◆ Diagnostic Audiologic Evaluation of Neonates

The goal of an audiologic evaluation of an infant is usually to determine if the child has sufficient hearing to develop speech and language. A complete diagnostic evaluation of infants should include immittance testing to assess middle ear status, and a test technique that will provide frequency and ear specific information, ideally for both air and bone conduction. The most common test protocols for evaluating

neonates include immittance testing with a high-frequency probe tone, auditory brainstem response testing (ABR), auditory steady state evoked potential (ASSEP) and/or OAE.

Immittance testing assesses middle ear status, but does not provide information about hearing. ABR and ASSEP provide information about the auditory system's ability to receive sound, but are not direct measures of hearing. OAEs assess function of the outer hair cells of the cochlea but, again, are not a direct measure of hearing. Information about an infant's ability to hear and attend to auditory stimuli can be obtained only with behavioral testing. For that reason, no at-risk infant or child should be released from audiologic follow-up until behavioral test results are obtained. (See Chapter 13 for a discussion of immittance testing, Chapter 14 for a discussion of OAE testing, and Chapter 15 for a discussion of ABR and ASSEP testing.)

#### Pearl

- Although ABR, ASSR, and OAE testing provides important information about the status of the auditory system, only behavioral testing directly tests hearing. For this reason, it is critical that audiologists have a behavioral technique that is accurate for assessing hearing in infants younger than 6 months.

### The Basics of Behavioral Observation Audiometry

#### *What Is Being Observed?*

Historically, many behaviors have been used to assess hearing in infants (arousal, limb movement, respiration changes, eye blink), but these behaviors have not proven to be sufficiently repeatable, and more importantly, they have not been good indicators of threshold. The behavior most likely to provide threshold responses is a change in sucking (Delaroche, Thiebaut, and Dauman, 2004; Madell, 1988, 1995a, 1998; Widen and Keener, 2003). Arousal responses, limb movements, and eye blinks frequently reveal suprathreshold level responses, but rarely threshold, since these behaviors typically are elicited to louder stimuli. Sucking responses, however, although present at suprathreshold levels, are frequently observed at, or close to, threshold. Either initiation or cessation of sucking is an acceptable response. Some infants will start sucking when a sound is presented, others will cease sucking, and some will do both.

#### Pearl

- Cessation or initiation of sucking is the only reliable response for obtaining behavioral thresholds in infants younger than 6 months.

#### *Maximizing Observation of the Sucking Response*

Sucking can be observed with a bottle, nursing at the breast, or with a pacifier. The family should be instructed to bring the infant to the evaluation session hungry so that he will be

ready to suck. The infant needs to be as comfortable as possible during testing, so, if the infant normally drinks from a bottle, the family should bring one. If the infant normally nurses, it would be best if the infant is nursed during testing. For this test procedure to succeed, the mother has to be comfortable being observed nursing, and some women are not. If the mother understands the reason for the intrusion on her privacy, she usually acquiesces. If the infant uses a pacifier, the family should bring one along. After the infant is finished eating, testing can frequently continue by observing sucking with a pacifier. If an infant is very hungry, it is best to allow him a little time to eat to enable him to get over that initial extreme hunger before beginning testing.

As soon as the baby settles down, testing can begin. The best way to observe the sucking response is to be able to see the infant's mouth close-up. A good view of the mouth can easily be obtained by having a video camera in the test room that can be adjusted from the control room. By using the zoom on the camera, it is possible to focus directly on the infant's mouth, which will enable the audiologist to have an excellent view of sucking. If a camera is not available, the audiologist needs to be certain that she can clearly see changes in sucking to use this technique.

#### *How Does One Know That the Sucking Is a Response to a Sound Stimulus?*

As with all other behavioral responses, timing is the key factor. When using play audiometry with a child, we question

the validity of the child's response if it comes a long time after presentation of the stimulus. With any test protocol, (behavioral or electrophysiologic) responses can be accepted only if they fall within a reasonable time window after presentation of the stimulus. Infants are fairly consistent, internally. Some respond to the "on" of the stimulus and others respond to the "off." The timing of the response is also usually consistent. Infants respond at about the same number of seconds after presentation of the stimulus each time, with the response time slightly shorter for louder stimuli (Madell, 1998; Northern and Downs, 2002; Thompson and Weber, 1974; Widen and Keener, 2003).

#### *Positioning the Infant*

The necessity of appropriately positioning the infant cannot be overstated. Positioning may, in fact, be the most important factor in obtaining accurate test results with behavioral observation audiometry. To obtain reliable test results, the infant needs to be resting in a comfortable position with full support of the head and torso, and must be visible to the testers. If the child is nursing, the mother will be holding the child in her arms. If the child is using a bottle or a pacifier, the child may be held in someone's arms or placed in an infant seat (see Fig. 6-1A-C). The advantage of an infant seat is that the infant will not be receiving any "signals" from the mother when he hears the sound. Involuntary movements such as stiffening by the mother in response to sound or movement of the breast or bottle can be transmitted to the infant; therefore, changes in sucking may



A



B



C

**Figure 6-1** Positioning the infant for testing: (A) using a bottle, (B) using a pacifier, and (C) nursing at the breast.

occur that are not related to the auditory stimuli. If the infant is being held, the mother or other person holding the infant should be very carefully instructed about the need to remain silent and still throughout testing to eliminate interfering with test results. It is sometimes useful to have the mother wear earphones to prevent her from hearing and being influenced by the sound; however, many mothers prefer not to wear earphones because they want to hear what their baby is hearing.

### *The Role of the Test Assistant*

BOA is best accomplished by using two or more observers. One is the audiologist controlling the test equipment, usually outside of the room where the infant is placed. The second observer typically is sitting next to the infant. Positioning of all players needs to be carefully orchestrated to be certain that both testers can easily see the infant.

The test assistant has several responsibilities. He must constantly be monitoring the infant to be certain that the baby's head and torso are comfortably balanced to minimize or preclude fussing and straining. If the infant becomes fussy, testing will need to stop until the infant can be made comfortable (Madell, 1998). For older infants, or infants using a bottle or a pacifier, the test assistant must keep the infant focused at the midline, again so that the infant is comfortable and not distracted. It is sometimes helpful to hold a colorful toy (Madell, 1998) or an LED (light emitting diode, usually a small red light) (Hicks, Tharpe, and Ashmead, 2000; Olsho, 1987a) in front of the infant in a position that allows the infant's head to be centered. The toy should not be held above the infant's head so he needs to move his neck to see it. Visual distractions need to be kept to a minimum (Muir, Clifton, and Clarkson, 1989) to be certain that extraneous stimuli are not interfering with observation of responses. It is important that the person holding the toy or LED make no change in the movement of the toy when the sound is presented. Any change in movement can confound the interpretation of whether the infant is responding to the sound or to the change in the distracter. If the infant is in an infant seat, the test assistant may be the one holding the bottle or pacifier and holding the visual distracters. Finally, the test assistant will be one of the observers who judges whether or not the infant responded to the sound presentation by changing his or her sucking behavior.

### *The Role of the Parents*

The parents cannot be relied on as observers. Their stakes are too high, they are not experienced in the task, and they may not understand exactly what constitutes an acceptable response. Parents are, however, very valuable in helping the testers to understand the baby and assisting in making the baby comfortable. At least one parent needs to be in the test room to assist in understanding the test protocols and test results. If both parents are present, the other parent can observe from the control room. The audiologist in the control room can point out responses during testing to assist in the parent's understanding of the tests. Their observation of how the baby does or does not respond will be helpful when interpreting the final test results and presenting subsequent follow-up recommendations (Flasher and Fogel, 2004).

## Testing Protocol of Behavioral Observation Audiometry

### *Soundfield versus Earphone Testing*

A complete audiogram includes air and bone conduction thresholds in each ear at frequencies of 250 to 8000 Hz. However, infants will provide only a limited number of responses in one test session, so testing protocols need to be designed to obtain the most information with the fewest responses. The goal of the initial audiologic evaluation of an infant is usually to be certain that the infant has sufficient hearing to develop speech and language. It may not be necessary to obtain ear specific information at the first visit. (Occasionally, a child is referred to a pediatric audiologist because of a medical condition that requires ear-specific information immediately, but this is more frequently the exception rather than the rule. When detailed information is required during the first test session, the test protocol will obviously have to change.) Ear specific information is important and must be obtained prior to releasing an infant from audiologic follow-up, but the more important question at the time of the initial evaluation is, Does the infant hear enough to learn language? Should the initial audiologic evaluation indicate that hearing is normal in at least one ear utilizing soundfield testing, it may not be critical to obtain information about each ear separately at that visit. However, if the initial testing indicates that hearing is not within normal limits in the soundfield, then ear-specific information is critical so that management can proceed. No infant should be released from audiologic follow-up until ear-specific information is obtained.

Under most conditions, testing should begin in soundfield. Soundfield testing is less stressful for the infant and allows two ears to be stimulated at the same time. This ensures testing of the best hearing ear. It also permits parents to hear the sounds; this can be very useful in their understanding of the test results. Earphone testing can follow later in the initial test session, or in a subsequent test session. When earphone testing is being attempted, insert earphones are the earphones of choice for infants. Insert earphones (**Fig. 6-2**) will remain appropriately seated in the ear canal and will provide the most accurate results in tiny ears. Circumaural earphones are frequently too large and are very difficult to keep in place.

If testing indicates thresholds at lower than normal hearing levels, bone conduction testing is essential. The bone vibrator should be held in place with either a pediatric sized headband, or a fabric one that goes around the head and across the forehead using Velcro to secure it in place. If a metal headband is used, soft material such as foam or other padding should be used for comfort and to keep the headband from moving. If a hearing loss is confirmed, the same test protocols can be used to assess functional gain with amplification in soundfield.

### *Test Stimuli*

When planning the test session, it is important to keep in mind that infants will provide only a limited number of responses; and so each stimulus presentation must be considered carefully. The goal of the testing is to obtain frequency-specific test results. Warble tones or narrow bands of noise



**Figure 6–2** Infant with insert earphones.

will provide this information. Broadband stimuli such as music, conversational speech, or white noise will not. Narrow bands of noise are frequently easier for an infant to respond to (Gravel, 2000; Madell 1998), and may provide thresholds that are 5 to 10 dB softer than those obtained with warble tones.

Speech awareness thresholds to low (ba), mid-high (sh), and high (s) frequency speech stimuli can be used to confirm warble tone/noise band thresholds. The threshold for “ba” should be close to the threshold obtained at 500 Hz, “sh” should be close to the threshold obtained at 2000 Hz, and “s” should be close to the threshold obtained at 3000 to 4000 Hz (Ling, 2002; Madell, 1995b, 1998).

#### *Presentation of Test Stimuli*

Many normal hearing infants respond better to high-frequency stimuli, so it is reasonable to begin at a high frequency, usually 2000 Hz. To explain, if there is concern about middle ear pathology, low-frequency hearing could be compromised, so it may be better to begin with a high-frequency stimulus (2000 Hz). On the other hand, if a significant sensorineural hearing loss is suspected, hearing

may be better at low frequencies, so testing should begin with 500 Hz. After obtaining thresholds at 500 and 2000 Hz, make a determination about what is the next most important piece of information to have. For example, if thresholds at both 500 and 2000 Hz are normal, it would be more important to obtain a threshold at 4000 Hz than at 1000 Hz, since hearing is likely also to be normal at 1000 Hz. However, if hearing at 500 Hz is at 30 dB HL and hearing at 2000 Hz is at 70 dB HL, it would be very important to know what hearing is at 1000 Hz.

Several indications can clue the audiologist about which frequencies and intensities should be used to begin testing:

- ♦ Observe the infant’s responses to noisemakers.
- ♦ Observe the infant’s responses to voice and environmental sounds.
- ♦ Question the parents about the infant’s response to sound before testing.

Presentation of stimuli should begin at a soft level slightly above where you expect the infant to respond, and then be increased in 10-dB steps until a response is observed. The initial stimulus should not be so loud as to startle the infant. If the initial stimulus is much louder than threshold, it may be difficult to regain the infant’s attention to threshold-level stimuli. When the infant responds, decrease intensity in 10-dB steps, decreasing stimuli in 5-dB steps when close to estimated threshold, and then increase intensity in 5- or 10-dB steps as would be done with any other population. Especially with infants, no response should be recorded until it is observed at the same level three times.

Timing is critical. If stimuli are presented too quickly, the infant will ignore them. A sound that comes out of silence is more likely to elicit a response. To obtain reliable responses, it is important to observe the infant carefully. If an infant startles to a sound, it is probably significantly above threshold. The way the baby responds when the stimulus is loud will provide clues about the type of response and latency that can be expected. This information can be used to interpret responses when the stimulus intensity decreases (**Table 6–1**).

**Table 6–1** Behavioral Observation Audiometry Test Protocol

1. Bring infant into test room in hungry state.
2. Seat infant so torso is supported and infant is not fidgety, and so tester(s) can easily see mouth.
3. Monitor infant state during testing and stop if infant becomes fidgety.
4. Instruct parents not to respond to test stimuli or responses from the child.
5. Test assistant will keep infant centered, observe responses, and monitor parents’ behavior.
6. Begin testing in soundfield.
7. Begin testing with a stimulus that is slightly above estimated threshold.
8. Test one low (500 Hz) and one high (2000 Hz) frequency initially and select additional frequencies to test depending on initial responses.
9. Reduce thresholds in 10-dB steps and increase in 5- to 10-dB steps to bracket threshold. Record a response after three reversals.
10. Take breaks as needed to calm the infant and increase usable test time.
11. If soundfield testing indicates a hearing loss, test bone conduction.
12. If infant is still responding, or at the next test session, test with insert earphones.
13. Test with technology as needed.

### Other Factors That Influence Behavioral Observation Audiometry Test Results with Infants

The audiologist must know something about the infant to obtain reliable test results. Spending a little time with the infant before beginning testing will increase the likelihood of obtaining reliable test results. It is important to have a good estimate of the infant's developmental, neurologic, and behavioral status. Can the infant do whatever is required for testing? If we are looking for sucking changes, we need to know that the infant sucks steadily. Some infants take a few sucks and stop, then start again. When an infant has an irregular sucking pattern, it becomes very difficult to use sucking to assess hearing. Some infants, because of serious medical conditions, will be fed with a gastrointestinal tube. If the infant uses a pacifier, it may still be possible to test hearing by measuring nonnutritive sucking responses. However, if the infant does not use a pacifier, it will not be possible to measure hearing using a sucking technique.

Are there concerns about the infant's neurologic status that could affect testing? For example, is the child alert to the environment? A baby may indicate visual and tactile awareness by making postural changes and meaningful eye-gaze to people and environmental events. In a visually alert baby, lack of response to sound is strongly suggestive of a true hearing loss. However, if the infant is not alert to visual or tactile stimuli, an inability to respond to auditory stimuli may not be an indication of hearing loss.

### Adding Objectivity to Behavioral Observation Audiometry

#### *The Test Setting*

#### **Infant State and Positioning**

Monitor the infant's state to increase the likelihood that it will be possible to accurately observe responses. State refers to the infant's level of arousal, from deep sleep to hysterical crying (Fig. 6-3).

#### **Movement of Test Assistant and Parent/Caregiver**

Everyone in the test room with the child must

- ♦ be still and nonresponsive to the test stimuli
- ♦ keep the infant focused at midline
- ♦ be reminded not to respond to the stimulus by altering the movement of the toy or facial expressions

#### **Test Stimuli and Response**

The most critical element in obtaining reliable responses is to predetermine what will constitute a response (Flexer and Gans, 1986; Madell, 1998; Widen, 1993). If it has been decided that sucking is the acceptable response, the audiologist should not then also accept eye widening or a head turn



**Figure 6-3** Position of infant for observation audiometry.

as a response. Changing response criteria during testing runs the risk of accepting behaviors as responses that are not actually responses. The response must be time-locked to the presentation of the stimulus. All of the infant's responses must be repeatable. The use of multiple observers to determine if a response is present also will increase reliability, as will the use of silent controls (Gravel and McCaughey, 2004).

#### *Comparison of Behavioral Observation Audiometry Thresholds to VRA, CPA, and ABR*

By carefully following the sucking test protocols detailed in this chapter, and observed on the accompanying DVD, observation responses can be used to obtain reliable thresholds. **Figs. 6-4A-D** are typical of many multiple audiograms which demonstrate that thresholds can be obtained accurately by using BOA. These audiograms make the best possible case for the reliability of the BOA sucking technique by comparing thresholds obtained with BOA, VRA, and play audiometry over several years on four children. Work is currently being conducted at our center on infants referred for hearing evaluation after failing newborn hearing screening or referred by parents because of family history or concern about the infants' responses to sound. Results indicate that BOA, appropriately conducted, using the sucking paradigm discussed in this chapter, can accurately identify hearing levels in infants when compared to ABR thresholds.

#### *Developing Comfort Using Behavioral Observation Audiometry*

Clinicians who are comfortable using ABR to assess infants may want to add BOA to their protocol to gain experience with the technique before making behavioral testing a regular part of clinical practice. As with most other skills, it

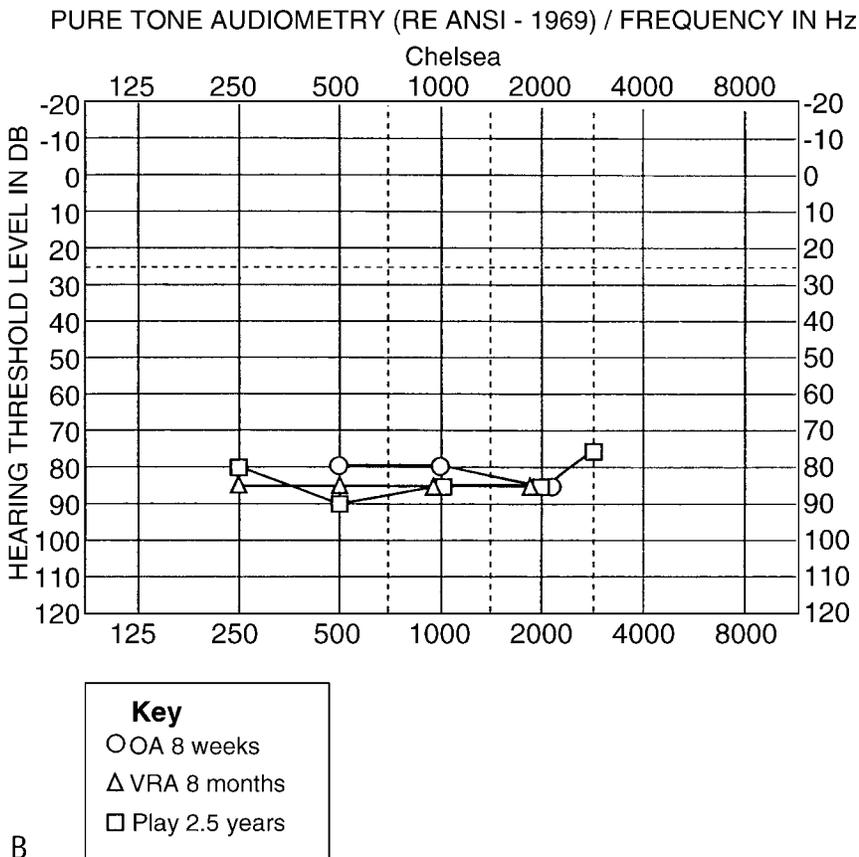
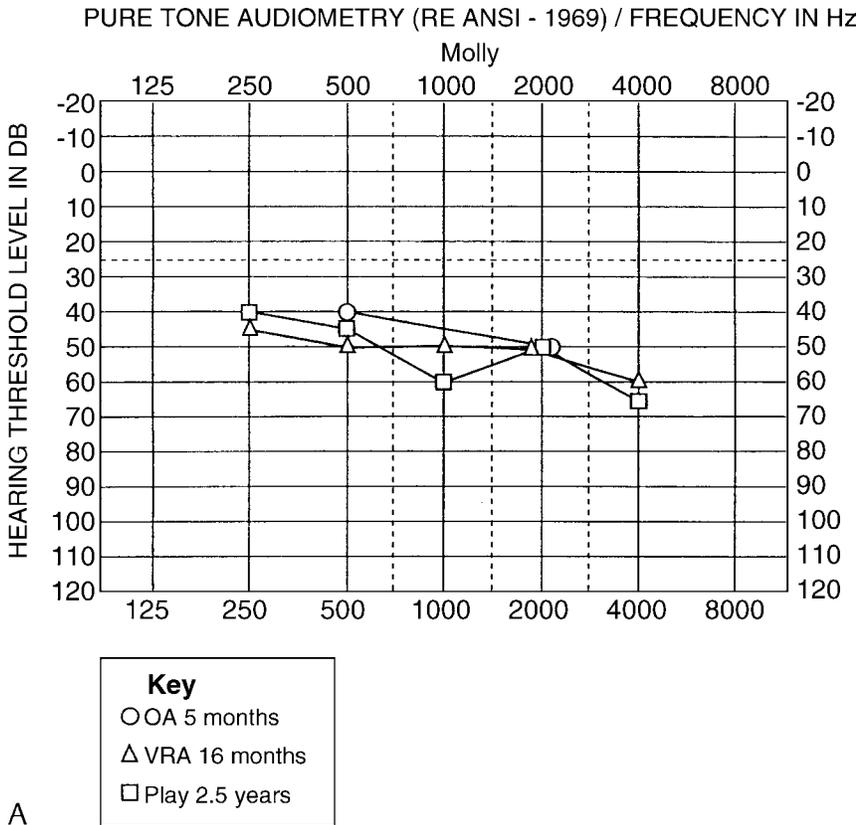


Figure 6-4 (A-D) Comparison of thresholds with behavioral observation (BOA), visual reinforcement (VRA), and play audiometry.

(Continued)

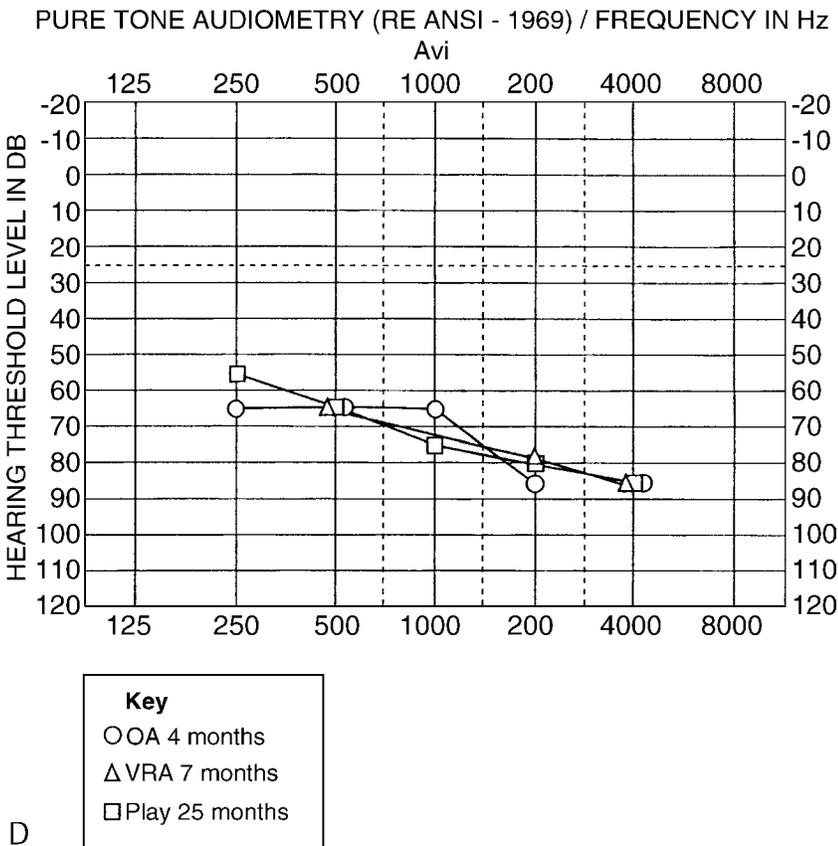
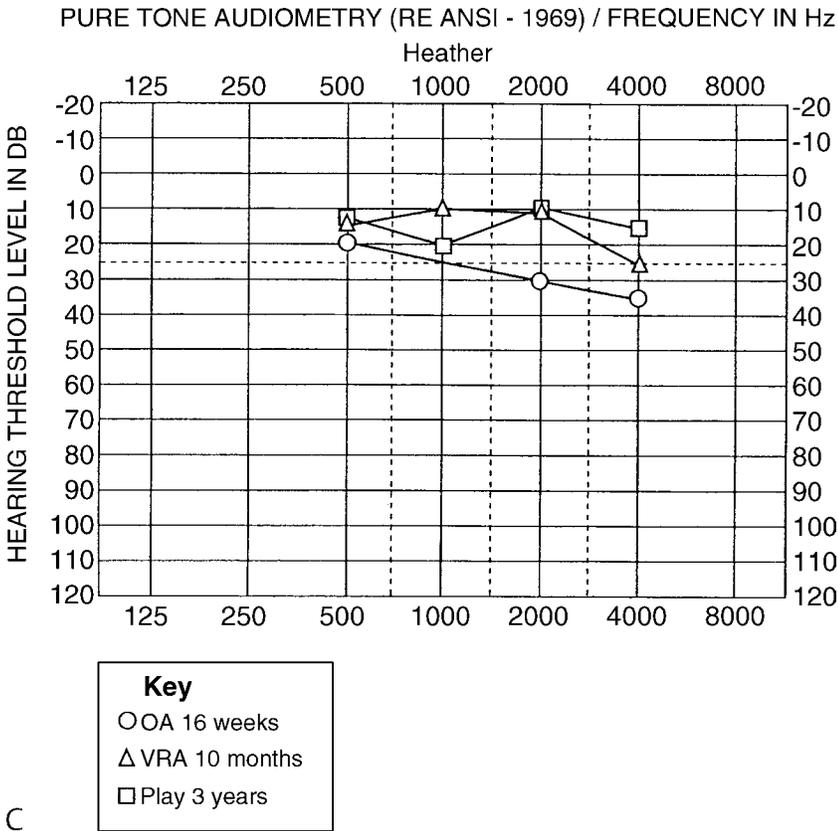


Figure 6-4 (Continued) (A-D)

takes experience to become a competent tester when using the BOA sucking paradigm detailed in this chapter. It is important to be certain that the test situation is appropriately organized so as to maximize the ability to observe changes in sucking. The clinicians should have good communication with each other to enable them to share information during testing. All infant responses should be repeatable. Viewing the DVD that accompanies this book will be helpful in developing the necessary BOA skills.

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## Discussion Topics

1. Discuss why behavioral observation audiometry has not been considered a good clinical tool in the past.
2. Discuss why sucking is a more reliable threshold response when testing infants.
3. Discuss ways to maximize objectivity in BOA.

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