Visual Reinforcement Audiometry by Andrew P. McGrath, AuD
Conditioned Play Audiometry

Visual Reinforcement Audiometry, or VRA, is a method of performing pure tone audiometry that is used with children from about six months of age up to about three years. Play Audiometry is often employed with children from about three years up to five years of age. The same general principles used for standard pure tone audiometry apply with VRA and play but the method of eliciting a response from the patient is different. Proper understanding of this chapter will require a good working knowledge of pure tone audiometry; please see the "Pure Tone Audiometry" section.

Audiometry with pediatric patients

The standard method of determining an adult's pure tone thresholds is to have the patient listen for a series of frequency-specific beeping sounds, raising his or her hearing each time they hear the stimulus. At the beginning of testing the patient will be given specific instruction on what their task is to be. The stimuli will initially be presented at easily-audible intensity levels, with the volume incrementally reduced until the patient can no longer hear the signal. The lowest level at which a response is consistently obtained is documented as the pure tone threshold. This procedure will be repeated across the audiometric frequencies (0.5 kHz – 8.0 kHz) and at other frequencies as appropriate until a full audiogram is generated. Clearly this method would not be effective with children younger than about five years of age, as the task may be too complex or, in cases of children four or five years of age, too boring.

For children who are about six months of age up to perhaps three years of age, VRA is generally a very effective method of eliciting behavioral responses to frequency-specific tones and other stimuli. Children younger than six months will often respond inconsistently or not at all for low-intensity stimuli, even in the presence of normal hearing. A "startle reflex" can be observed for loud sounds, but this shows only that the child hears loud sounds, not that they have normal hearing. On the other hand, children older than 30 to 36 months often become bored with the methods used in VRA and the tester may need to employ "play audiometry" when evaluating the hearing of children from three to five years. For children five years of age and older, standard hand-raising techniques are often successful, sometimes with some minimal, child-friendly modifications. Every child is different and will respond differently to sounds and the test environment. The audiologist needs to make some quick decisions about what method to use when testing children. Sometimes, regardless of the method(s) used, consistent responses cannot be obtained during a test session.

Transducers used in testing

Earphones

Most commonly, over-the-ear earphones are used for audiometric testing. These are referred to as supra-aural phones. The benefits of using earphones for testing are that this allows each ear to be tested individually and the tester knows which ear the sound is being heard in. The disadvantage of earphones is that some children will not tolerate phones at all or become uncomfortable after wearing the phones for a few minutes.

Insert earphones are often used in lieu of supra-aural phones, particularly with pediatric patients. Insert earphones are essentially foam earplugs with a small tube embedded within them; the tube protrudes from the outside of the earplug and the lumen extends all the way through to the inside. The outside end of the tube couples to the transducer, which is about one inch square by a quarter inch. This transducer has a clip which can be affixed to the patient's shirt and then is attached to the test equipment by a long cord. The benefit of insert phones is that they may be more comfortable for longer-term use, though many children object due to the fact that something is being placed inside the ear canal. Additionally, because the inserted portion completely occludes the ear canal, this type of phone provides some attenuation for any in-room noise that may be present. Finally, these earphones are clipped to the patient's clothing and are firmly placed inside the ear canal, and they may be more resistant to the child's head movements then the supra-aural phones.

Sound field (speakers)

Some children do not tolerate any earphones, and some children do not seem to condition well or respond well to sound presented through the earphones. Younger children in particular seem to have trouble conditioning to sounds presented through earphones. In these cases the test stimuli may be presented through speakers, or "in sound field." Sound field stimuli is not ear-specific; that is, a person could have normal hearing in one ear with hearing loss in the other and exhibit normal audiometric thresholds in soundfield. This is because they would be hearing the sounds through the normally-hearing ear. There is no way to conclusively determine ear-specific thresholds. On the other hand, testing in soundfield allows for audiometric data to be obtained with a child who will not tolerate or will not respond using earphones.

Visual Reinforcement Audiometry

Visual reinforcement audiometry is based on the principle that when a child hears a sound, he or she will look to see what that sound was. So, for example, if a child hears a sound from his left side, he is very likely to look to his left to see what that sound was. VRA testing may be performed using earphones or in sound field. When performing VRA techniques, a specialized test room is equipped with toys situated to either side of the child, at about 90 degrees to the right and left. These toys are typically housed inside a dark plastic box and cannot be seen until they are activated by the tester. Upon activation the toy will light up and move inside its box. The tester, located outside the test room, has control of both the auditory signals and the visual reinforcement.

Initially, the auditory stimulus may be presented at a fairly high intensity and the visual reinforcement presented simultaneously with the sound. These conditioning trials may number two or three or more. The idea is for the child to associate the light-up toy with the sound they are hearing. Next, the loud sound is presented without activating the toy. If the child looks, the toy is then activated as reinforcement. If the child does not look, he or she may not be conditioned and the simultaneous presentation may need to be re-attempted, perhaps with another type of auditory stimulus or a different visual reinforcer. Sometimes a second tester located inside the test room or the parent may need to help the child to recognize that there is something to look at over at the side. In other words, the child may hear the sound but not see that a toy lights up when the sound is heard, or they may not immediately recognize that there is a connection between the sound and the toy. After the child has been prompted once or twice, the prompting would need to cease and the child would need to look on his or her own in order to be considered conditioned.

Once the child is conditioned to look towards the sound, the intensity level of the stimuli will be reduced in increments until a threshold or minimum response level is obtained. The testing will then continue with another frequency tone or in the other ear. In this fashion it is possible to obtain a complete set of behavioral test results. In practice, many children become disinterested in this task or otherwise uncooperative before a complete set of data is obtained. A break may be taken and testing re-convened, or testing may be continued on another date. Partial behavioral data, coupled with other test data, may be considered to be enough to determine hearing status.

Conditioned Play Audiometry

Play audiometry is a variation of audiometric testing designed to be used with children of about four or five years of age. These children may be too young to perform "standard" audiometry, that is, "raise your hand when you hear the beep," as would be used with older children or adults. They may become quickly bored, however, with the visual reinforcement technique described above.

Play audiometry incorporates a simple game into the hearing test. The specific game doesn't make much difference, so long as it can be adapted to the general instructions "Do this when you hear the beeping sound." Any number of games can be used, and often two or three may be used in a test session. The general idea is as follows:

The child is seated in a comfortable position, either on her own or in her parents lap. They may be most comfortable sitting on the floor. There is generally a test assistant in the test room in addition to the audiologist outside the booth. Testing may be performed with earphones or in sound field. The child is presented with a set of small, colorful blocks and a bucket. She will be instructed to choose a block and hold it up to her ear. She should listen carefully for the beeping sound and when she hears the sound she should quickly put the block in the bucket. This task will be modeled for her by the test assistant and maybe by her parent as well. Everyone holds a block up to their ear and listens very carefully. The tester will present a sound, usually fairly loud so there is little question that it will be heard, and the assistant will quickly put the block in the bucket. The child will be encouraged to put her block into the bucket if she didn't already. Often children catch on quickly to this and further instruction may not be necessary. The modeling is repeated as necessary. The child is instructed to try it on her own, or to "be the first to put the block in the bucket." This can sometimes be turned into a friendly competition, depending on the child. A good deal of encouragement or praise may be desirable.

This method of testing can easily be adapted depending on the child, for example putting a piece of a puzzle in place when the sound is heard, lining up toy cars, stacking blocks into a tower, putting pennies into a piggy bank, etc.

Once the child is consistently performing the task (block into the bucket, etc.) for louder sounds, the volume will be reduced until a threshold or minimum response level is found. This level will be confirmed and recorded, and then a different sound will be used. In this fashion it is possible to obtain a complete set of hearing test data, so long as the child continues to cooperate. If the child begins to lose interest a different game may be used; children often transition quickly without a tremendous amount of re-instruction.