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CONDITIONED ORIENTATION REFLEX AUDIOMETRY

By

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B.A., University of Montana, 1976


Presented in partial fulfillment of
the requirements for the degree of
Master of Communication Sciences and Disorders

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Approved By:


Chairman, Board of Examiners


Dean, Graduate School

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It is difficult for me to find a proper way to thank all the people who have helped me through my graduate years. I hope that my appreciation and love have been obvious and that my warm and special thanks will be accepted at this time.

My thanks go to the faculty of the Department of Communication Sciences and Disorders, University of Montana, who have helped me immeasurably through the highs and lows of my graduate education. Special thanks to the staffs of the Speech Pathology and Audiology Departments at both Denver General and Denver Children's Hospitals for providing me with an excellent externship experience. And finally, I am especially thankful for my family and friends, who have been supportive and encouraging at all the right times.

CHAPTER I

INTRODUCTION

A major concern for the audiologist assessing the hearing acuity of young children is the early detection and habilitation of the child with a hearing loss. The importance of auditory input to the overall development of the child during his/her first two years of life is becoming more apparent. Hearing aids are being recommended at increasingly earlier ages. Such developments necessitate the routine use of an accurate, reliable procedure for the audiometric testing of young children.

One of the earliest and most important contributions to pediatric audiometry was the introduction of play audiometry by Dix and Hallpike in 1947.¹ This method applies Thorndike and Skinner's theory of "instrumental conditioning"—i.e., teaching a child to perform in a certain way when she/he hears a sound stimulus (for instance, dropping a block in a box). It is generally agreed that play audiometry is an excellent and reliable method for testing hearing of children three to six years of age. Several variations of play audiometry have been introduced over the years, but none have proven very successful with children below the age of three

years. The limited success of play audiometry and the lack of viable alternatives for children under three years of age led to the introduction of Conditioned Orientation Reflex (COR) audiometry by Suzuki and Ogiba in 1961.²

COR audiometry is an operant conditioning system that utilizes a wholly unconditioned "orientation reflex." This method is based on the premise that when an unusual or interesting stimulus is presented to a child, the child will instinctively orient or turn toward the source of that stimulus. COR audiometry elicits this reflex through a paired acoustic/visual presentation. After several of these paired presentations, the visual stimulus is delayed until the child orients to the acoustic stimulus alone. The visual stimulus is then presented as reinforcement for the child's orientation to the acoustic stimulus. Using this technique, thresholds can be routinely obtained on children as young as one year, and frequently, even younger.³

CHAPTER II

EQUIPMENT AND PROCEDURE

The physical arrangement for COR audiometry places the child between the speakers and adjacent visual stimuli within a sound-treated room as shown in Figure 1.⁴ Suzuki and Ogiba's original equipment included two semitransparent toys mounted adjacent to each speaker at a height easily seen by the child. The toys were fitted with a small electric lamp so that they could be illuminated from the inside of their bodies. Initially, this illumination draws the child's attention and acts as the unconditioned stimulus. Once conditioning is achieved, the illumination provides reinforcement for the child's orientation to the acoustic stimulus.⁵

Typically, the child is held by the parent and a second adult centers the child's attention toward the midline. The second adult is frequently not necessary, but often makes testing simpler. The first step of the test is the conditioning and Suzuki and Ogiba suggest the following procedure. The test tone is presented through one of the speakers at an intensity level of approximately 30 dB above the estimated threshold of the child followed immediately by the illumination of the toy on the same side. The child will instinctively

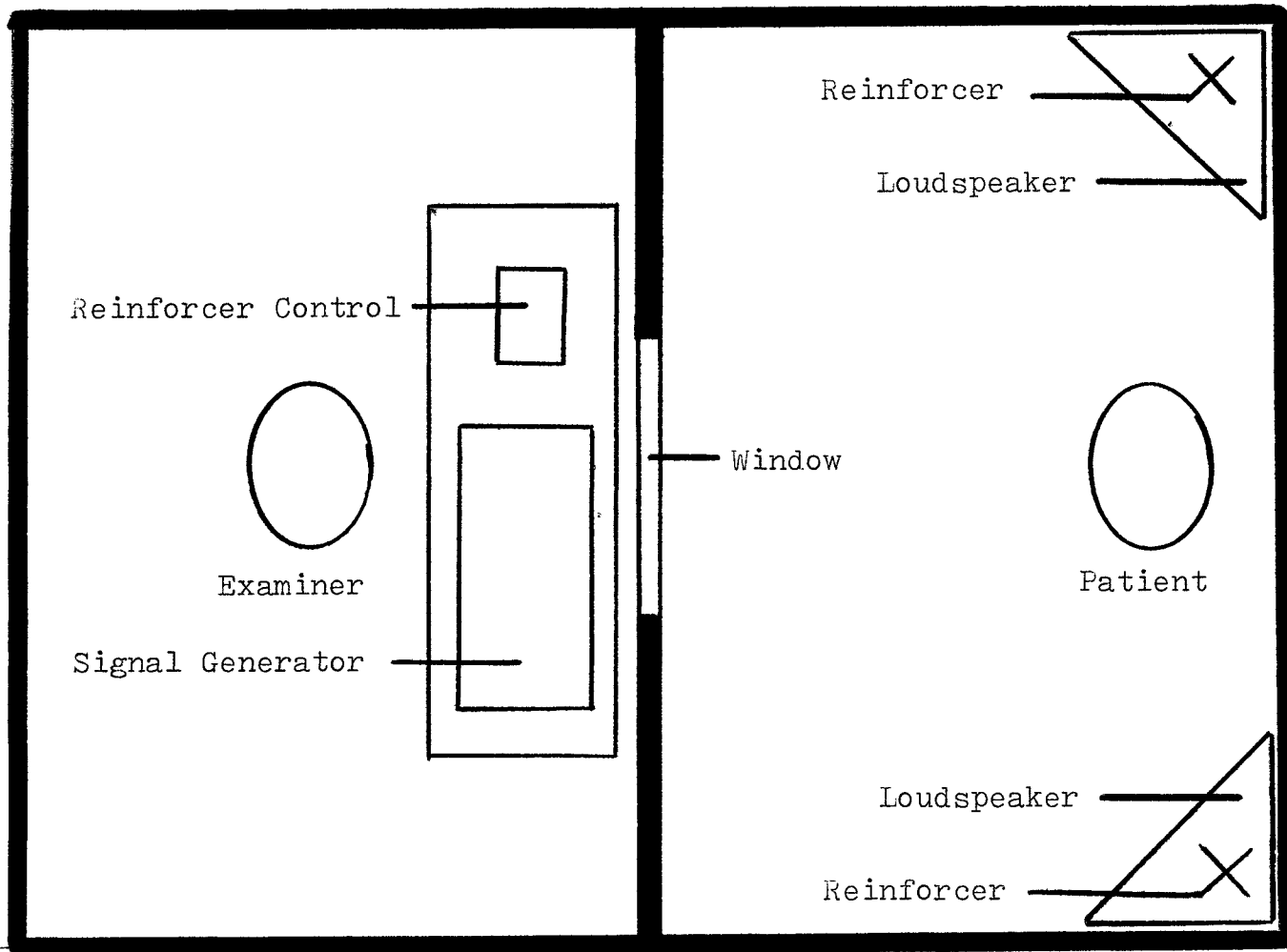


Figure 1

orient or turn toward the source of the tone/light presentation. For conditioning, this process is repeated three to four times. It is important that the tone/light presentation be irregular in both time and direction of signal presentation. Following several of these paired presentations, the illumination of the toy is delayed momentarily until the child orients to the sound by itself. Once the child has turned toward the source of the sound, the toy is illuminated as reinforcement.⁶

The second step involves measurement of threshold. Suzuki and Ogiba recommend reducing the intensity of the test tone to near the estimated threshold of the child, and presenting the tone from one side. If the child orients to the tone, she/he is considered to have heard it and the toy is illuminated. The intensity of the test tone is then reduced and the process repeated until the child fails to respond. Using this procedure, the child's hearing threshold for a given frequency can be obtained.⁷

CHAPTER III

BASIC PROPERTIES

Visual Stimulation. COR audiometry is based on the premise that a visual stimulus can reinforce auditory localization behavior in infants and young children. Suzuki, et al, concluded that illumination of semitransparent toys is sufficiently effective as the unconditioned visual stimulus, at least for children one year of age or older.⁸ Moore, et al, agree that the visual stimulus does reinforce auditory localization behavior, but they suggest that a more complex visual stimulus (such as a colorful, animated toy) is more apt to reinforce localization behavior than simple blinking lights.⁹

Conditioning. The initial conditioning for COR audiometry is achieved by presenting paired tone/light stimulations at suprathreshold levels. This is repeated several times with both the time and direction of the stimulus being alternated irregularly. Suzuki, et al, report that the conditioned reflex can typically be established within three trials of the conditioning procedure. They go on to say that "easy conditioning" is followed by "easy extinction" if visual reinforcement is inconsistent.¹⁰ The child must

be reinforced by illumination of the toy each time she/he orients to the acoustic stimulus. If the child is not reinforced or reinforced for false-positive responses (i.e., random head turns), the conditioned reflex will be quickly extinguished.

Response. COR audiometry utilizes the inherent reflex movement called "orientation reflex" for the child's response to the auditory stimulus. The conditioned reflex (head turn toward the source of the stimulus) can be distinguished from random movements of the child's head by the quickness of the turn and the latency of this response will be between .5 to 2 seconds.¹¹

Success Rate. Suzuki, et al, investigated the success of COR audiometry in obtaining four frequency threshold audiograms in normal children of different age groups.¹² They were successful with approximately 40 percent of children below one year of age, 85 percent successful with one and two year old children, and 65 percent successful with three to four year old children. COR audiometry proved to be too simple for 35 percent of the older children and some form of play audiometry was considered to have been more appropriate.

Test-Retest Reliability. Suzuki, et al, also investigated the test-retest reliability of 23 normal one and two year old children.¹³ The testing interval was from two to 16 days. They reported that more than 90 percent of the

total thresholds measured through COR audiometry had a test-retest reliability within 5 dB.

CHAPTER IV

CONCLUSIONS

COR audiometry has proven to be a quick, simple, inexpensive procedure that yields a reliable threshold audiogram in over 80 percent of small children tested ranging in age from one to three years. It has also been used successfully to assess the hearing acuity of older, difficult to test children and adults.¹⁴

Although COR audiometry is quite simple in theory, success seems dependent upon both clinical technique and judgement. It is important to move rapidly through the test making sure that the presentations are irregular in both time and direction of signal presentation. This will help maintain the child's attention and reduce the possibility of false-positive responses. Clinical judgement becomes important when distinguishing between the conditioned reflex and random movement. The conditioned reflex is typically a quick head turn within .5 to 2 seconds of the sound presentation. Once the reflex is identified, it is important to reinforce the child immediately. Keep in mind that failing to reinforce the child visually or reinforcing the child for a random head turn will lead to early extinction of the conditioned reflex.¹⁵

The main disadvantage of the test is that it is typically administered in sound field which makes information on unilateral hearing acuity difficult to obtain. COR audiometry has been successful with earphones following conditioning in sound field in isolated cases, but general effectiveness is unknown.¹⁶ A variation of COR (i.e., having the child orient to one speaker and visual stimulus rather than localizing) has been suggested for obtaining information with earphones and through bone conduction.¹⁷

Although variations of COR audiometry have proven effective in appropriate clinical applications, little appears in the literature regarding practical duplication of such systems. Craig describes an animated reinforcement mechanism that is simple, durable, and inexpensive in his "construction cookbook" if duplication is desired.¹⁸

With this background, a demonstration video-tape has been produced to emphasize the practical application of COR audiometry. The accompanying narrative (Appendix) will provide a brief history of each child and the diagnostic information obtained through COR audiometry.

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APPENDIX

NARRATIVE OF THE DEMONSTRATION VIDEO-TAPE

COR audiometry was originally introduced by Suzuki and Ogiba in 1961. It was developed to test the hearing of children under three years of age who do not condition easily to play audiometry. COR audiometry is based on the premise that young children tend to orient to relatively loud sounds and also to bright and interesting visual stimuli. The acoustic and visual stimuli are presented simultaneously at supra-threshold levels until the child is conditioned to orient to the sound in the absence of the visual stimulus. The visual stimulus is then used as reinforcement for the child's orientation to the very softest sound. Using this technique, thresholds can be obtained on children as young as one year, and sometimes, even younger.

Our procedure places the child between the visual stimuli and the speakers. We often have the parent hold the child and a second adult centers the child's attention toward the midline. The second adult is frequently not necessary but it often makes the testing simpler. Ideally, thresholds are obtained in sound field for speech, and then, for warble tones from 250 to 8000 Hz. Monaural thresholds are then obtained

under headphones followed by impedance measurements. The amount of information obtained during one session varies with each child and follow-up must be scheduled accordingly.

The first child is a one year, five month old boy with a history of recurrent otitis media. Eugene is sitting on his mother's lap facing an older sibling who is attempting to center Eugene's attention toward the midline.

As Chris mentioned, the bone oscillator was placed on Eugene's left mastoid. When a conductive problem is present, the child typically localizes to the most involved side. Eugene localized to his right suggesting that his left ear was functioning somewhat better than his right. This is particularly useful information when monaural measurements cannot be obtained. Eugene was showing a mild to moderate hearing loss that appeared to be primarily conductive in nature. This impression was supported by impedance measurements which demonstrated poor mobility of both tympanic membranes with the left responding slightly better than the right. Eugene's mother was referred back to her otolaryngologist for medical direction and a re-check was scheduled in two months.

Our next child is a one year, eight month old boy, again with a history of recurrent otitis media, returning for a two month follow-up evaluation. At the time of his last evaluation, Brett was demonstrating a mild conductive hearing loss bilaterally. Impedance studies showed reduced mobility of the left

tympanic membrane and poor mobility of the right. Brett is being tested without the benefit of a family member or adult centering his attention.

Brett's thresholds to speech and to warble tones were within normal limits. Impedance measurements demonstrated grossly normal mobility of both tympanic membranes. These results indicate significant improvement over those obtained two months ago. It was recommended that Brett's hearing be re-checked at his physician's request. His mother was also encouraged to monitor speech-language development and schedule an evaluation at age two years if significant development is not evident.

Leanne is a three year old hearing-impaired girl that was fitted binaurally approximately two months ago. She is currently going through a developmental evaluation to assess all areas of development and to determine if her perseverative behaviors have an organic basis. Leanne's aural rehabilitative therapist is providing reinforcement as well as centering her attention toward the midline.

Leanne has a bilateral mild low frequency hearing loss which quickly increases to a severe loss through the mid and high frequencies. Her aids were functioning appropriately. Impedance measurements showed large volumes indicating that both tubes were patent. An annual hearing and hearing aid evaluation is recommended routinely for all hearing-impaired children.

The next child is a two and a half year old hearing-impaired girl who is also fitted binaurally. Carmel's mother is deaf and both she and her husband have always used sign language to communicate with their daughter. Carmel's language development is excellent considering the extent of her hearing loss. Although Carmel's father has normal hearing, oral communication is not used in the home.

Carmel has a sloping moderate to severe sensori-neural hearing loss bilaterally. Her aids were functioning appropriately. Impedance measures were not taken.

Donny is a two and a half year old multi-handicapped child that is functioning at approximately the one year level. He has a profound hearing loss bilaterally and has been fitted monaurally.

Donny's best responses were to speech, although speech doesn't always catch his attention. He fatigues quickly and numerous test sessions were necessary to evaluate his hearing.

The next child is a nine month old girl that has been hospitalized for a suspected seizure disorder. Because very young children lose interest so quickly, it is often better to start below the child's threshold and come up rather than the reverse.

Melanie is at the lower limit for COR audiometry but she did demonstrate some localization in addition to good facial awareness. Thresholds were obtained at 25-30 dB which is within normal developmental levels.

The last child is a two year, ten month old boy with a history of otitis media.

Ricki was the ideal COR candidate. He was actively interested in the testing technique and was easily conditioned in both sound field and under headphones. Thresholds were obtained within normal limits and impedance measures showed good mobility of the tympanic membranes bilaterally.