A Hearing Assessment Using Operant Audiological Testing with a Severely Retarded Deaf-Blind Child

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A HEARING ASSESSMENT USING OPERANT AUDIOLOGICAL TESTING WITH A SEVERELY RETARDED DEAF-BLIND CHILD

by

Patricia Timpson

A Thesis Submitted to the Faculty of The Graduate College in partial fulfillment of the requirements for the Degree of Master of Arts Department of Psychology

Western Michigan University Kalamazoo, Michigan April 1983
This study assessed the feasibility of teaching a 7-year-old severely retarded, hearing and vision impaired girl to respond consistently to a pure tone stimulus using operant audiometric techniques. The experimenter first shaped a head turn response using the opportunity to rock on a rocking horse as reinforcement. Following response shaping, the experimenter used a bone conduction transducer (BCT) as a tactile stimulus in training the subject to turn her head to the left in a similar fashion to a 500 Hz, 65 dB tone/vibration. After 15 days of transfer training, designed to bring the left head turn response under control of the tone/vibration, the experimenter replaced the BCT with a set of headphones, then used an ascending and descending operant tracking procedure to assess hearing levels and generalization. The experimenter demonstrated in this way that the child's hearing could be successfully assessed by an audiologist. Results suggested that, with careful application, this procedure can be used by classroom teachers to prepare pupils to be professionally tested.
ACKNOWLEDGEMENTS

I would like to thank Paul Knight for initially bringing this assessment to my attention and for his extensive help with the development and review of the paper. Thanks go to Wayne Fisher from Constance Brown Hearing and Speech Center for his extensive consulting on this assessment. Also, I would like to thank George Thompson for his editing expertise; my two data collectors Lori Stanley and Chris Frays for their continued help throughout the study; and finally, Lucretia Meeth for her patience and skill in turning my rough drafts into final type.

Patricia Timpson
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WESTERN MICHIGAN UNIVERSITY M.A. 1983

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CHAPTER I

INTRODUCTION

Recent federal regulations mandate that more thorough educational plans for handicapped children of school age in the United States be developed (P. L. 94-142). Such educational plans necessitate comprehensive assessment of each child's sensory abilities, including hearing assessment. Although sophisticated techniques of audiological assessment are available for use with individuals who can respond to some form of verbal instruction, special testing is required for non-verbal subjects (Fulton & Lloyd, 1975). When multiple handicaps are suspected (e.g., deaf, blind, and severely handicapped), this assessment process becomes particularly difficult (Yarnell, 1973).

One technique for auditory assessment that seems to offer some benefit is the Auditory Evoked Response (AER). The AER assesses whether or not the inner ear is functioning such that a brain response is observed. Bricker and Bricker (1969) mention that this assessment has some limitations as a comprehensive testing device. First, it has no subsequent advantage in other areas of behavioral education or training because the brain response measured in AER cannot be used in any other testing procedure. Second, the cost factor of AER testing equipment rules out its use in small groups or in public schools on a regular basis. Third, and more important, there is some question as to the validity as a measure of "hearing" of the evoked response measured in AER audiometry (Rose & Rittmanic, 1968). Specifically, that group of
subjects who have a positive response at the brain level may still not be able to hear since the processes that occur past the brain stem are not observed.

With increased technology in the animal laboratory, particularly with Blough's (1966) work, investigators have been able to assess the hearing of such diverse species as rats (Clack & Harris, 1963), bats (Dallano, 1965), raccoons (Wollack, 1965), and sheep (Wollack, 1963). The primary difference between conventional human testing and animal testing is that the latter depends on providing reinforcement for the subject's detection responses as opposed to providing reinforcement for following verbal instructions.

One disadvantage in replicating the technique for assessing animals' hearing with children is that the necessary training procedure is time consuming and costly. Also, it is frequently difficult to find an acceptable response with this population. Because of the time factor in teaching a consistent detection response to the auditory stimuli, the responsibility for training a child to participate in a test situation often resides with the classroom teacher or parent since an audiologist frequently can only allow for a small amount of time to work with each client.

However, with some basic information obtained from a preliminary test given by the audiologist, a teacher (or parent) can systematically collect information regarding the possible hearing capabilities of a particular child. One such study by Kershman and Napier (198) showed that when provided with preliminary information by an audiologist, a teacher or parent can systematically make observations regarding
behavior. These investigators utilized a charting system to record observations of each deaf, blind child's responses to tape recorded stimuli. Each sound was presented to the child on a variety of occasions while he/she was positioned in a relaxed setting. Both the teacher and the parent recorded occurrences of previously defined behaviors such as eye blinks, head turns, jerks, or no response at all to the stimulus onset. Results showed, with a high degree of inter-observer agreement, that there were consistent reactions to sounds with similar decibel and frequency measurements and absence of reaction to other sounds with different measurements.

Friedlander, Silva, and Knight (1973) worked with deaf-blind children using a mechanical "toy" called Playtest (Friedlander, 1970, 1973, 1975) that produced music at two different decibel levels with a "vibratory assist." Each suspected hearing impaired child was allowed to choose at any time one or two tracks of music, one louder than the other, by manipulating levers on the Playtest toy. The music was presented by two speakers in the test room. The room had been padded to prevent vibration from reaching the child. The vibratory assist consisted of the investigator moving the child's hand to the speaker if he/she did not respond in a certain amount of time. Results showed that the child chose one track over the other at a statistically significant level. It was thus inferred that the child could hear at some level.

In Woolcock and Alferink (1982), an operant tracking and a descending procedure was used to determine the hearing levels of profoundly retarded individuals. This procedure allowed the subject to "assess"
his/her own hearing threshold by responding correctly to presentations of a sound stimulus with intensity decreasing with each successive correct response. By dispensing M & M's contingent upon correct lever pulls in the presence of a light, then a light/pure tone pairing, and finally pure tone presentation alone, the investigator was able to determine the subject's hearing threshold. This study had an advantage over previous research in that it measured a discriminative response. The subject had to respond to one set of stimuli and not respond at any other time.

Most investigative procedures currently employed in operant audiometry involve the pairing of a sound stimulus with a light stimulus (Bricker & Bricker, 1969; Lloyd, 1965). Using such an approach to assess hearing thresholds presents obvious problems when assessing suspected deaf-blind subjects in that neither stimulus may be perceived by the subject.

The purpose of the present study was to develop and test a method of operant hearing assessment that could be used to evaluate deaf-blind multiply handicapped children who are labeled "untestable" with conventional audiometric testing techniques. These children are often labeled deaf because hearing cannot be confirmed. In this study, the intent was to develop a procedure low in cost, relatively short in duration, and simple to execute, since teachers from the classroom who were untrained in audiological assessment would, theoretically, be using it. In addition, the final results would have to be validated by a professional audiologist so that information regarding the hearing assessment could be included in the permanent files upon which
educational plans could be made.
CHAPTER II

METHOD

Subject and Setting

The subject was a 7-year-old female who had been identified, using Michigan Special Education Guidelines (P. A. 451), as severely mentally impaired (I.Q. greater than four and one-half standard deviations below the mean), hearing impaired, and visually impaired. She had no receptive or expressive language and emitted only guttural, undifferentiated vocal behavior. She frequently engaged in self-stimulation behaviors, such as hand sucking, finger flicking, and rocking. Virtually all of her free time was spent sitting on the floor and self-stimulating.

Based on observations of the subject in the classroom, the only behavior that she preferred to engage in aside from self-stimulation was rocking on the rocking horse. Although she was completely ambulatory, she would not walk without being led.

The subject was taking Phenytoin and Phenobarbital to control seizures that she had exhibited since birth. She had not had a major seizure in three years.

The research took place in a small room (8' x 10') adjacent to the subject's classroom. The room was sufficiently isolated so that the sound levels were less than normal classroom level.
Materials

Materials used included a Beltone audiometer, model number 10-D (Beltone Electronics Corporation), with a bone conduction transducer (BCT) and headphones, a rocking horse (Wonder Rawhide from Wonder Products, Inc.), and two chairs.

Procedure

At the start of the session, the subject was placed on the rocking horse and allowed to rock for 5-15 seconds. The horse was then tilted back by the experimenter who was positioned in front of the horse. The tilt was a large enough angle that the subject had to hold on to at least one of the handles of the horse to keep from sliding off the back of the horse. This was done to eliminate some of the self-stimulation that was occurring, such as hand sucking and finger flicking, and to deprive her of access to "free rocking." As soon as the subject approximated a head turn to the left, the horse was released; and she was allowed to rock for another 5-15 seconds. This procedure was continued for 1/2 hour on 3 consecutive days to reach the criterion of turning her head 45° or more within 10 seconds of being tilted back.

Reinforcement Training

Two 1/2-hour sessions were conducted daily, Monday through Friday, at 9:00 and 11:00 a.m. Data were collected by an independent observer.

In this phase (see Figure 1), a trial began when the horse was
Figure 1. Reinforcement Training Flowchart Describing the Steps of the Training Procedure.
REINFORCEMENT TRAINING

START

SUBJECT ROCKING

HEAD AT MIDLINE 3 - 15 SECONDS?

WAIT

NO

YES

TILT HORSE

HEAD AT MIDLINE 5 - 15 SECONDS?

WAIT

NO

YES

TONES OFF

TURN ON TONE/VIBRATION FOR 5 SECONDS

HEAD TURN TO LEFT WITHIN 5 SECONDS?

TURN OFF TONE/VIBRATION RELEASE HORSE

Figure 1.
tilted back by the experimenter. Once tilted back, the subject had to have her head positioned at midline for 5 consecutive seconds (later for up to 15 consecutive seconds) before the tone/vibration was presented for 5 seconds. The tone/vibration was delivered via a bone conduction transducer (BCT) attached by a headband over the subject's left mastoid bone (directly behind her left ear). The tone/vibration was set at 500 Hz at 65 dB to produce the largest amount of vibration possible through the BCT (Fulton & Lloyd, 1975). A correct head turn was scored if the subject moved her head 45° to the left of midline. Intertrial interval head turns (incorrect head turns) were scored as occurring if the subject moved her head away from midline to the left at all without the presence of the tone. If the subject turned her head 45° to the left between the 2nd and 4th second of the tone (Fulton & Lloyd, 1975), the horse was released; and she was allowed to rock for 5-15 seconds. Then, a new trial would begin. If the subject responded on the 1st second, 5th second, or not at all, the tone would stop; but she would remain in the tilted position; and a new trial would begin after a 5-15 second delay. These 5-15 second intertrial intervals were calculated using a random numbers table to ensure that the subject was not responding on a temporal schedule but rather responding to the tone/vibration.

If, during the trial, while the subject was tilted back on the horse, she began to rock her head rapidly back and forth (a form of self-stimulation), the intertrial interval was immediately lengthened to 15 seconds beginning from the point of her last head turn.
Transfer to Headphones

After 3 consecutive days of 85% or better appropriate head turning, the BCT was removed; and headphones were placed on the subject's head. A 500 Hz at 65 dB of pure tone was used as the first training stimulus setting. The procedure remained the same except the tone was presented via headphones to the left ear; therefore, there was no vibration. Until this point, the subject could have been turning her head to the stimulus of the sound, the vibration, or to the tone as heard by her right ear (the BCT allows the sound to be heard by both ears as it travels through bones), or all of these components.

Headphone Training at Various Frequencies

Beginning with the training stimulus (500 Hz at 65 dB) in the left ear, the experimenter systematically presented the pure tone via the headphones to the subject while tilted back on the rocking horse. After moving up and down the decibel scale from 500 Hz at 25 to 95 dB in increments of 10 dB, the experimenter switched to 250 Hz and repeated the ascending and descending series. This same measure was completed at 750 Hz and 1000 Hz. This series was repeated over several days to ensure accuracy.

If the subject did not turn her head for four consecutive presentations of the same pure tone stimulus, the tone was changed back to the training stimulus so that the subject could respond correctly to get out of the tilted position.
Interobserver Agreement

Interobserver agreement was calculated using the formula agreements of head turning over agreements plus disagreements. Data were collected on 4 separate days by the experimenter. Agreement on correct head turns was 100% for each collection period; agreement on intertrial interval head turns was 95%, 93%, 97%, and 97%, respectively.
CHAPTER III

RESULTS

Shaping the initial left head turn response took three 1/2-hour sessions to complete using a standard shaping procedure. It took 15 days to bring the left head turn response to criterion of 85% correct responding per session using the reinforcement training procedure (see Figure 1). Figure 2 shows 3 representative days of that training including the 1st day of the final step of the procedure where the headphones replaced the BCT. The cumulative record shows correct left head turns (triangles) and intertrial interval head turns (dots). Initially, the intertrial head turns (incorrect responses) were occurring at a high rate while correct head turn responses (responses to the 500 Hz at 65 dB tone/vibration) were occurring at a moderate level. As the training continued, head turn responding in both conditions (with and without the tone/vibration stimulus) decreased (see Figure 2, graph dated 2/15). On 2/28, the frequency of intertrial head turns fell below the number of correct head turn responses and continued to decrease in number while correct head turning increased to criterion. In the first session, using headphones in place of the BCT (see Figure 2, graph dated 3/3), the correct responding to a 500 Hz at 65 dB pure tone stimulus without vibration remained at a high rate of responding while intertrial interval responding continued to decrease. These data indicate that successful generalization occurred from the initial pairing of the pure tone with the vibration to the tone presented alone.
Figure 2. Cumulative Records Showing the Number of Correct Head Turn Responses as Compared to the Number of Intertrial Head Turn Responses.
Figure 3 shows the results of the test situation where the sound stimulus was systematically presented across two dimensions—decibels and hertz. All of the sound stimuli were presented to the left ear only. Each hertz level (250, 500, 750, 1000) was assessed separately so that different decibel levels could be presented in an ascending and descending order. The closed data points represent correct responding to the pure tone stimulus. The open data points represent trials where the subject did not respond for four consecutive presentations of that particular tone stimulus. When there was no response for four consecutive presentations, the tone was changed back to 500 Hz at 65 dB. After several trials at different pure tone levels, the experimenter moved back to the training stimulus to re-establish stimulus control. The training stimulus was presented a total of 110 times throughout the data collection period.

Compared with normative data (Licklider, 1951), there appears to be no significant hearing loss evidenced in the threshold measurement at 1000 Hz.

The test data were collected with a audiologist present so that an evaluation could be made as to the clarity of the head turn response to the various tones. The audiologist indicated that the response to the tone stimulus was as clear as responding that occurred in more conventional test situations.
Figure 3. The Test Presentations of the Tone Stimulus across Hertz and Decibels.
CHAPTER IV

DISCUSSION

The results show that, using a shaping procedure, it is possible to teach a severely retarded, suspected deaf-blind subject a consistent response to a tactile stimulus; then, by pairing that tactile stimulus with a sound stimulus, transfer the control to a second sound stimulus.

The present study came about as a result of a search for a low-cost procedure that could be used in a classroom setting to teach severely retarded deaf-blind pupils a consistent response to a stimulus that would aid an audiologist in assessing the hearing capabilities of that group of handicapped children.

Initially in this study, immediately after the shaping of the head turn response, an avoidance procedure was implemented. In this procedure, the subject was placed on the rocking horse and was allowed to rock while the tone/vibration was presented for 5 seconds. If the subject did not turn her head to the left during the 5 seconds of tone, the horse was tilted back (the tone was continued) until the subject did turn her head. At that point, the tone was stopped; and the horse was released. Responding during the first 5 seconds (before the tilt of the horse) was very low, probably due to the lack of strength of the aversive stimulus (the horse being tilted back).

Several other problems occurred that could hinder replication of the present study. First, it was necessary to locate a stimulus change that would function as powerful reinforcement for the subject. Rocking
on the rocking horse was one of the few behaviors the subject exhibited at a high rate. One other high-rate behavior that could conceivably be used as a reinforcer was self-stimulation. Because of the logistics of the present procedure, most of the self-stimulation was incompatible with participation during a trial. That is, the subject had to hold on to the handles of the horse and, therefore, could not use her hands to self-stimulate. However, several other effects were noticed. First, other, less frequent self-stimulatory behaviors occurred more frequently as others were partially eliminated; one in particular was head weaving, which greatly affected the data collection. Secondly, once a correct response was emitted, the rocking horse was released; and the subject could rock. However, it was often the case that the subject would self-stimulate rather than rock. Allowing this behavior to occur may have functioned as another source of reinforcement. Third, the problem of finding an appropriate length for an intertrial interval was greater than anticipated. Although mechanical devices are costly, they do have the capability of consistently regulating the randomness of the length of the intertrial interval with more ease than a human. If one chooses not to purchase mechanical equipment, then be prepared to observe the behavior emitted by the subject closely to be able to determine if he/she is making a temporal discrimination as opposed to a tone discrimination, as was initially the case with the subject in this study. Also, for clear results, the behavior of interest has to occur between the 1st and 4th second of the stimulus and at no other time.

In the present procedure, when training began with the headphones, generalization to other tones might have occurred more smoothly had the
experimenter spent more time at the training level before varying the decibel and frequency level for the testing. In future investigations, the experimenter should consider the move from the BCT to the headphones as a new training phase before beginning to assess generalization.

This operant audiological assessment procedure offers a beneficial, more cost-effective method for evaluating hearing levels with the mentally retarded population. The time spent by a teacher in training a response to a specific stimulus can become more cost effective if other assessments can be tailored to use the same set of responses.
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