*AN OPERANT TRACKING PROCEDURE IN THE
AUDITORY ASSESSMENT OF PROFOUNDLY
RETARDED INDIVIDUALS*

JAMES E. WOOLCOCK AND LARRY A. ALFERINK

DRAKE UNIVERSITY

The present study investigated a discrete-trials, operant tracking and a descending-series procedure for the determination of hearing levels with profoundly retarded individuals. These individuals were previously diagnosed as untestable. Following stimulus-control training with errorless discrimination procedures, hearing levels for each individual were examined with both procedures. For P-1 and P-2, the operant tracking procedure was administered following a descending-series procedure. Both were observed to "track" their own hearing levels. For P-3, the operant tracking procedure was administered first, followed by the descending-series procedure. Although P-3 also "tracked" her own hearing level, more variable responding was observed. Nonetheless, the operant tracking procedure proved quite workable and may provide for improved hearing testing with "difficult-to-test" individuals.

DESCRIPTORS: auditory testing, tracking, descending-series threshold test, errorless discrimination, profoundly retarded individuals

Federal regulations have mandated increased programming efforts for institutionalized, developmentally disabled individuals (U.S. DHEW, 1974). One aspect of these regulations calls for comprehensive audiological assessments of each individual, with subsequent habilitation programs designed to correct or accommodate auditory deficits. For individuals who do not respond to verbal instructions during these assessments, special testing procedures may be used that depend on the reinforcement of detection re-

sponses, rather than verbal instructions. Such an approach requires careful pretraining, establishing stimulus control of the detection response (Fulton & Spradlin, 1974; Meyerson & Michael, 1960). Errors have been minimized through the use of the descending-series threshold method (Carhart & Jerger, 1959) because the subject is primarily presented with stimulus intensities well above the actual hearing level (Lloyd, 1975). A disadvantage is that only a small portion of the time spent testing produces data from which hearing levels can be determined.

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Alternatively, "tracking" procedures can be used where stimulus intensity is completely dependent upon the subject's behavior. For example, if the designated stimulus (e.g., a 20 dB HL puretone) is correctly detected, the intensity of that stimulus is slightly reduced (e.g., 15 dB HL). If an error occurs, stimulus intensity is slightly increased (e.g., 20 dB HL). "Tracking" procedures have been used in obtaining psychophysical thresholds with experimental animals (Blough, 1958) and in the

clinical assessment of subjective visual acuity with nonverbal children (Newsom & Simon, 1977). In the present study, both a tracking procedure and a descending-series threshold test were used in the determination of hearing levels with profoundly retarded individuals.

METHOD

Participants

Three institutionalized, profoundly retarded residents, one male (P-2) and two females (P-1 and P-3), participated. Their ages were 17, 20, and 26; they averaged 17 years of institutionalization each. Their IQ's were all estimated to be below 25. All were medically diagnosed as retarded since infancy, and P-2 had Down's syndrome. Each was previously untestable with audiometric procedures relying on instructions.

Apparatus

A $52 \times 39 \times 47$ cm human operant conditioning console was used. The response manipulandum consisted of a 4×6 cm translucent panel, recessed in relation to the console front. A smaller white panel, 3.5×3.5 cm was located adjacent to the response panel. A 35-msec light flash on the smaller panel accompanied the delivery of an edible reinforcer. A white light, continuously operated during all sessions, was located at the center of the console front. The panels and session light were illuminated with 6.3 V white lights, located directly behind each panel.

A Davis Scientific Instruments M & M dispenser (model no. MM D-2) was placed directly to the left of the conditioning console. For all tone presentations, a portable MAICO audiometer (model MA-2B), and accompanying supra-aural earphones, were used. The console, M & M dispenser, and earphones were placed on a small table in the training room, a 2.4×2.0 m cement block enclosure. The audiometer and all relay equipment were located in an adjacent room.

In order to validate the testing setting (e.g.,

determine possible contamination by ambient noise), hearing levels of "normal" individuals were obtained in the testing room at times when testing would usually occur. Hearing levels in the normal range were obtained.

Procedures

Stimulus-control training. Initially, participants were acclimated to the training room and conditioning apparatus. Through magazine training, the number of edible reinforcers delivered and session times were gradually increased until each participant had received at least 30 edible reinforcers within one 15-20 min session. In addition, each participant must have worn the earphones throughout this session. Panel-press training was initiated with each participant physically prompted to press the illuminated, large panel. These prompts were gradually faded until independent responding was observed. Each participant was required to produce at least 30 edible reinforcers independently on a fixed-ratio (FR) 1 schedule of reinforcement, and to distribute responses such that interresponse times (IRTs) ranged from 0 to 20 sec.

Responses were then reinforced only during the discriminative stimulus (S^D), a panel light of 120 sec duration, and not during S^Δ , a dark panel present for 4 sec. A panel-press response during S^D periods produced a brief light flash (35 msec) on the smaller panel, an M & M, S^D offset, and S^Δ onset. Responses during S^Δ (i.e., false reports or "errors") precluded onset of the next S^D period for 4 sec. Participants were advanced through the remainder of the program only when they responded correctly to 80% of the S^D periods presented, as well as emitting 80% correct responses (i.e., detection responses/total responses $\times 100$) throughout one entire session (stimulus-control criterion).

When stimulus control with the panel light was obtained, a 750 Hz (1,500 Hz for P-3), 70 dB hearing level (HL) puretone was presented through the right earphone only. The schedule of reinforcement was then changed

from an FR 1 to FR 3 schedule (FR 2 for P-3). When the stimulus-control criterion was reached with the light-tone S^D , the panel light fading sequence began. The sequence totaled 11 steps, with a correction procedure determining the particular sequence for each participant. Responding correctly to an S^D presentation advanced the sequence by one step. An incorrect response, i.e., any response occurring during S^A periods, reversed the sequence by one unit. To ensure generalization, each test frequency (500, 1,000, 2,000 and 4,000 Hz) was presented successively at 70 dB for 5 trials.

Hearing level testing. In the first 10 trials of each testing session, the four testing frequencies were presented, and meeting the stimulus control criterion was required before testing began. Hearing level data were obtained from one puretone frequency per test session. Therefore, each hearing level test required a minimum of four sessions. For purposes of validity, probe trials were used during descending-series sessions when participants demonstrated hearing levels of 20 dB or lower at any particular frequency. These trials involved presenting a sub-threshold tone (i.e., 0 dB HL) during a testing sequence to determine whether any extraneous cues were affecting the participant's behavior. Probes were limited to one trial per test session. As in previous phases, M & M's were delivered for correct tone detections. All testing was performed for the right ear only with all participants.

In the descending-series test, each session began with the puretone intensity at which training had been conducted. Then, a series of puretone intensities, gradually decreasing by 5 decibel units, was presented. When a detection failure or false report was observed, the intensity level was increased 20-30 dB and a new descent initiated. At least three descents were obtained and each test session was terminated when 30-40 M & M's had been delivered. The operant tracking test involved the use of a staircase procedure (Cornsweet, 1962) which is applicable in discrete-trial situations. Each session began at

the puretone intensity where stimulus-control training had been conducted. Each subsequent tone presentation was dependent upon the participant's response to the previous presentation. If a puretone was correctly detected, the intensity of the next tone presented was reduced by five decibels. False reports, or failures to detect a particular tone, increased the intensity of the next tone presentation by five decibels. Each test session terminated when 30-40 M & M's had been delivered.

P-1 and P-2 received three consecutive descending-series tests, followed by one staircase test. P-3 received three consecutive staircase tests, followed by one descending-series test.

RESULTS

Data obtained from P-1 are shown in Figure 1. Except for the initial test sessions at 500 and 1,000 Hz, consistently low hearing levels were demonstrated across all four puretone frequencies during the descending-series sessions. The lowest hearing level correctly detected (i.e., low points) ranged from 10 to 20 dB HL across the testing frequencies. These low hearing levels prompted the presentation of probe trials (i.e., presentation of a 0 dB HL puretone during a "sweep") during some test sessions. No correct detection responses were noted during the probe trials. Hearing levels similar to those demonstrated during the descending-series sessions were produced with the staircase procedure for P-1. Little variability within the staircase sessions is also evident. These data would indicate a hearing level within the normal range.

Although the data for P-2 are not presented, the testing sequence was similar to P-1. Higher hearing levels were demonstrated during the descending-series sessions, with low points ranging from 25 to 45 dB HL across testing frequencies. Subsequent low points ranging from 20 to 40 dB HL were obtained during the staircase sessions for P-2. These data would indicate a slight hearing loss. For both P-1 and P-2, the descending-series sessions allowed for median

Fig. 1. Individual test session performances for P-1 during the descending-series (DS) and staircase hearing level tests. Probe trials are the presentation of a 0 dB HL puretone during the second sweep of a descending-series session.

hearing levels to be determined at each testing frequency. Across these frequencies, U-shaped functions were evident, thus approximating those typically obtained with normal individuals.

P-3 received three staircase sessions, followed by one descending-series session at each testing frequency. As shown in Figure 2, P-3 exhibited greater variability across staircase sessions than had P-1 or P-2, with low points ranging from 0 to 25 dB HL across testing frequencies. Higher hearing levels were obtained during the descending-series sessions, especially at 2,000 and 4,000 Hz. The variability both within and across test sessions precludes any definitive diagnosis of hearing capabilities for P-3.

DISCUSSION

The systematic use of stimulus control training procedures enabled the assessment of hearing levels using two testing methods, the descending-series and the staircase procedure. All

participants were observed to “track” their own hearing levels with the staircase procedure. In addition, similar clinical judgments were obtained with the tracking procedure, as compared with the more typical descending-series method, for both P-1 and P-2. However, the variability in the tracking data for P-3, and the higher hearing level estimates obtained with the descending-series test warrant comment.

Regarding the within-staircase variability, the repeated exposure to the “tracking” contingencies with P-3 may have produced a gradual loss of stimulus control. Previous investigators have indicated a disruption of stimulus control with tracking procedures (Stebbins, 1970). Alternatively, the responding of some individuals in hearing tests is best characterized by the variability exhibited (Koegel & Schreibman, 1976).

Further exploration of the higher hearing level estimates obtained with the descending-series test would have to include a contingency analysis of the respective testing methods. For

Fig. 2. Individual test session performances for P-3 during the staircase and descending-series (DS) hearing level tests.

example, higher hearing levels may be more likely with the descending-series method because errors are consequated with greater intensity increases, thus approximating conditions similar to those present during stimulus-control training (Blough, 1958). Based on the current results, further research on testing method differences and reducing variability with repeated exposure to tracking procedures is warranted.

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