MOTOR AND VOCAL IMITATION
AS A FUNCTION OF
AUDITORY STIMULUS CONTROL GRADIENTS

by

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CHAPTER I

Introduction

This research concerns the experimental analysis of the auditory stimulus control gradients of frequency and intensity in retarded children and exploration of the interaction of this purpose with the subject related variables of motor and vocal imitation. Sloane, Johnston, and Harris (1968) stated that diagnostic indices, such as I.Q. scores, level of retardation, psychological functioning or personality were not found to have predictive implications for speech and language training for retarded children. They did report, however, that descriptions of the child's current behavioral repertoire may be regarded as critical index for predicting degree of success in speech and language training, i.e., the child who readily performs modeled motor tasks and repeats manded sounds and words is more likely to benefit from formal speech and language training than is the child who does poorly at these tasks. The research was designed to determine if stimulus control variables are functionally related to pre-training ability at motor and vocal imitation.

Comprehensive speech and language training programs have been developed. These programs are used effectively to train essentially non-verbal children in establishing rule-governed language. The effectiveness is demonstrated by the child's functional speech responses to nonverbal and/or verbal stimuli in appropriate Noun-Verb-Object grammatical form (Stremel, 1971; Guess, Sailor, and Baer, 1972).

The initial step in speech and language training programs for non-verbal children is the development of vocal imitation. The subsequent phases of language training are based on the premise that the child is capable of producing vocal responses which match or approximate the vocal stimuli presented by the trainer. Experience of the author and others working in the Research and Speech and Hearing Departments of Kansas Neurological Institute indicates that even when effective contingency relations have been established for the control of motor imitation, disruptive and attending behaviors, a substantial number of reinforcers are required to establish even the simplest vocal imitative topography. Experience further suggests that attempts to proceed with these children who are experiencing difficulty in learning to imitate vocally to more complex vocal topographies are at best time consuming and frustrating.

To date relatively little inquiry has been made into how stimulus control variables influence the definition of imitative training of retardates. Given the imitative paradigm for speech and language training vocal imitative ability on the part of the subject is critical and may be regarded as predictive with respect to successful training of speech and language. When a child fails to respond correctly to vocal imitative training it is difficult to determine if the failure relates to stimulus control, mediation, response chaining, programming, or some other variables.

Stimulus control refers to the extent to which the value of an antecedent stimulus determines the probability of occurrence of a conditioned response. It is measured in terms of differences in response probability that result from change in stimulus value. The greater the difference in response probability, the greater the degree of stimulus control with respect to the continuum being studied (Terrace, 1966).

In this research, the terms generalization and discrimination are used in an empirical sense and are regarded as reducible to the stimulus control process. To make this point clear, consider the hypothetical data plotted in Figure 1. The curve in this graph simulates the outcome of a study of stimulus generalization in which conditioning procedures have been used to build up response probability to a discriminative stimulus (1K Hz tone). Responses to S-I (2K Hz tone) and S-II (4K Hz tone) have been measured without the prior introduction of differential reinforcement. Note that the response probability value for S-II is greater than zero. This datum signifies that generalization occurred. But this value is appreciably below the response probability value for the discriminative stimulus (1K Hz tone). This conveys the information that the subject reacted differentially to S-II as compared with the discriminative stimulus (1K Hz tone). When regarded in this limiting manner, generalization and discrimination appear to be two ways of reporting the same experimental results. Suppose, further, that some variable is manipulated which will elevate the response probability plotted at S-II (4K Hz tone). This would mean that generalization has increased while discrimination has decreased. In this one limited sense, generalization and discrimination can said to be inversely related or simply two sides of the same coin, neither term explaining the other.

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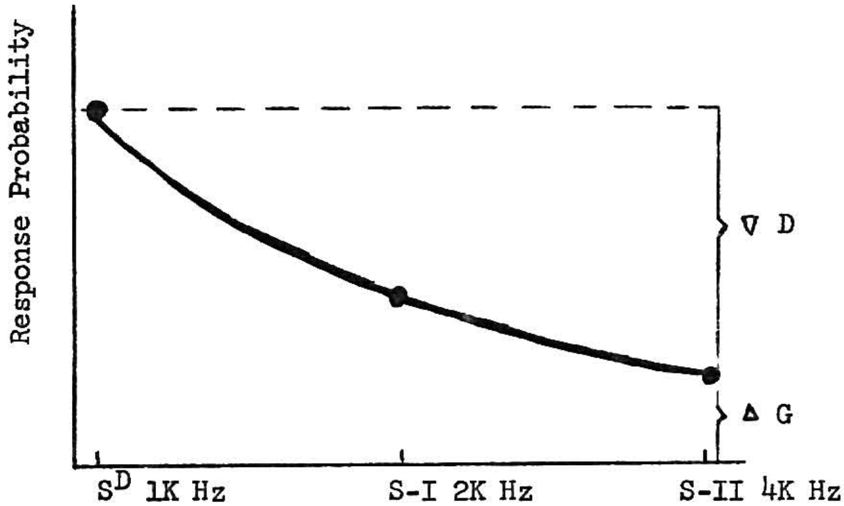

Fig. 1. Hypothetical gradients in which Ss have been trained to the S^D and then are tested by the presentation of S-I and S-II.

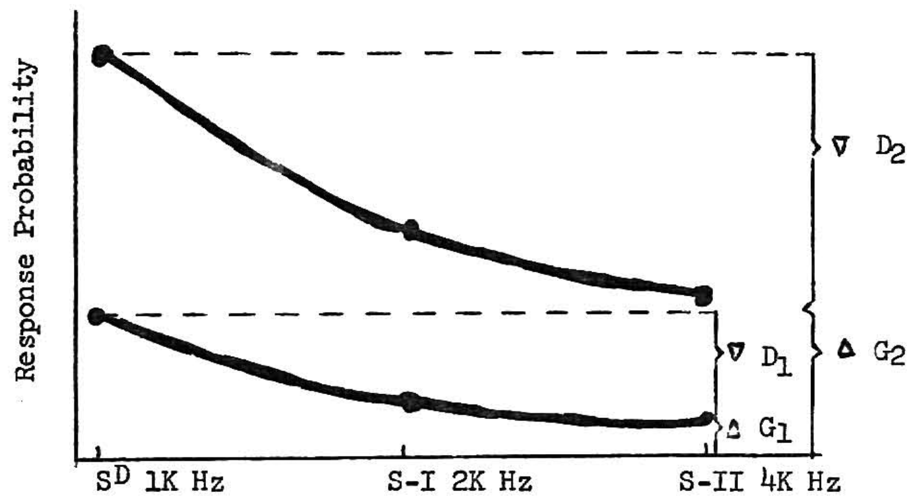

Fig. 2. Upper curve represents a gradient obtained following extensive S^{R+} in the presence of [illegible]^D. The lower curve suggests the outcome of [illegible] S^{R+} to S^D.

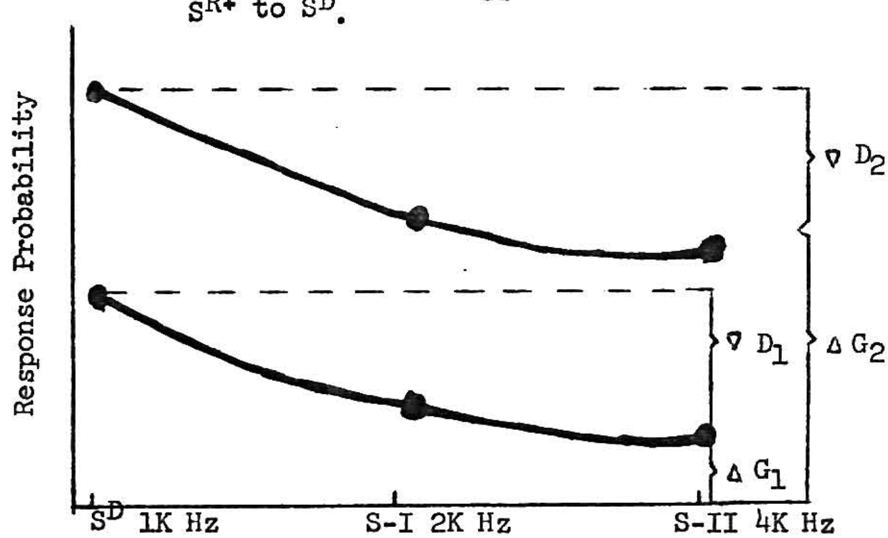

Fig. 3. Hypothetical gradients that are parallel, though different in height.

Now consider what would occur if a different variable is manipulated, e.g., the number of reinforcements in the presence of the discriminative stimulus (1K Hz tone). Figure 2 shows a pair of curves that might be obtained with two values of such a variable. Notice that the gradient becomes higher and steeper when the number of reinforcements in the presence of the discriminative stimulus is raised. Generalization and discrimination both increase. In this case then, generalization and discrimination are seen as directly; rather than inversely related.

Furthermore, if a manipulated variable, such as deprivation or satiation, raises (or lowers) the gradient without altering the slope as in Figure 3, generalization may increase or decrease without in any way affecting discrimination.

From the foregoing, it may be concluded that while the concepts of generalization and discrimination in the limited sense show a functional inverse relation, the two concepts can be shown to be directly related, inversely related, or even quite unrelated, depending on the kinds of variables that have been manipulated (Brown, 1965).

In the empirical sense, generalization refers to changes in response probability to S^{Δ} with pre-conditioning baseline as the referent point and discrimination refers to differences in response probability observed between the S^{D} (discriminative stimulus) and the S^{Δ} (S-delta) points along the continuum being studied. Used in this manner, discrimination and generalization may both be regarded as dependent measures of stimulus control process.

Typical inquiry into the stimulus control process of retardates have stressed the "discrimination process" and tended to regard failure to discriminate as the cause for generalization. In this vein, Kimble (1961, p. 362) asserts "There must be an influence which restricts the range of generalization and restrains the organism from making the same response to all physically similar stimuli. This influence is called discrimination." Clearly, such analysis is treating generalization as an inversely related function of the "discrimination process". Search of the literature has failed to locate research which studied generalization gradients of retardates. It appears safe, then, to conclude that relatively little is known about how stimulus control factors enter into the definition of retardation.

Literature from applied behavior analysis of retardation provides some data on the subject, however. Lloyd, Spradlin, and Reid (1968) and Fulton and Lloyd (1969) reported procedures for testing the hearing of retardates which necessitated differential responding to (tone) S^D and (no tone) S^Δ. Stimulus control was established in 84 percent of the retardates who were untestable by other audiometric procedures. For the remaining subjects, the authors reported that failure in establishing stimulus control was related in each subject to their inability to identify an effective reinforcer. The pre-test training included procedures to facilitate generalization, i.e., reinforced for several frequencies and intensities within the range of the acoustic parameters under test. For _S_s under stimulus control the generalization gradient between S^D (tone) and S^Δ (no tone) may be regarded as relatively sharp, as less than 10 percent of the responses occurred in the presence of S^Δ and 90 percent of the responses occurred in the presence of the S^D. However, there was considerable variability among _S_s with respect to the number of reinforcements in the presence of the S^D required to establish stimulus control and once established, stimulus control was sometimes "lost" within sessions. These data indicate that it is possible to establish a "go-no-go" type of stimulus control with the profound retardate, i.e., differential response to tone versus no-tone. However, the question of sharpness of the stimulus control gradient along frequency or other parameters of the sound remain unanswered.

One may obtain some indirect answers to the questions concerning the sharpness of the auditory stimulus control gradient in the retardate by considering literature concerned with imitation (Baer, Peterson, and Sherman, 1967; Risley and Wolf, 1967; Guess, Sailor, Rutherford, and Baer, 1968; McReynolds, 1969). The fact that the subjects under study reliably produced accurate vocal imitations of complex auditory S^Ds (words) indicates that within the frequency range of the words employed the stimulus control gradients were necessarily sharp with respect to the several S^D - S^Δ continuums. The problem with such evidence becomes apparent when we consider the child who does not appropriately echo vocal mands. Does the subject's failure to respond relate to stimulus control, mediation, response chaining, or some other variable? The proposed research is concerned with the stimulus control aspect of this question.

The purpose of this research is to obtain auditory stimulus control gradients for several classes of retardates, namely subjects who exhibit: I. Strong motor and strong vocal imitative repertoires, II. Strong motor and weak vocal imitative repertoires, and III. Weak motor and weak vocal imirative repertoires. What difference in stimulus control gradients might we expect to find? Assuming we differentially reinforce for several hundred trials in the presence of an S^D (1K Hz tone) with S^Δ equal to no tone, then probe 1K Hz, 2K Hz, 4K Hz, and 8K Hz tones, if stimulus control variables are the exclusive control variables to the vocal imitative process, the results might be as follows: For subjects with strong motor and strong vocal imitative repertoires we would expect a relatively sharp stimulus control gradient with a well defined peak at 1K Hz. For subjects with weak motor and weak vocal imitative repertoires, a relatively flat stimulus control gradient would be anticipated. Gradients for subjects who showed strong motor and weak vocal imitative repertoires would be expected to fall between the first two categories. If such an ordering of stimulus control gradients was in fact observed, it may be possible, through errorless discrimination training, to sharpen the slope between S^D and S^{Δ}. Further, it could be determined by direct test if such training increases the subject's imitative repertoirs of facilitates the imitative learning process.

CHAPTER II

Method

Subjects Six mentally retarded children of the resident population of Kansas Neurological Institute served as subjects. They were free of severe neuromuscular impairments which would interfere with the required motor and vocal imitations. The subjects were categorized by motor and vocal imitative repertoires as follows:

I. Strong motor and strong vocal imitative repertoires defined as imitating more than 70 percent of both motor and vocal models ($n=2$);

II. Strong motor and weak vocal imitative repertoires defined as imitating less than 30 percent but more than five percent of the vocal models with at least 50 percent more motor imitation than vocal imitations ($n=2$);

III. Weak motor and weak vocal imitative repertoires defined as imitating less than 30 percent but more than five percent of both the motor and vocal models ($n=2$).

Subjects were categorized by a specific imitation test to be described next. The subjects tested who did not fall into one of the categories listed above were dismissed from further participation in the study. The age, sex, and adaptive behavior level for the participating subjects are listed in Table I. The mean age of the selected subjects was 14.3 years with a range of 10 to 18 years. Five subjects were males and one was female. Adaptive behavior levels (Heber, 1961) ranged from borderline -4 to -3 to -4. These subjects came from the Fundamental Basic Skills, Advanced Basic Skills, and Academic Pre-Vocational Units of Kansas Neurological Institute.

TABLE I

Age, Sex, and Adaptive Behavior Levels of Subjects Listed by Experimental Groupings

Group I — Strong Motor-Strong Vocal Imitators	Subject 1	Age-	18 years
		Sex-	Female
		A.B.-	-4 to -3
	Subject 2	Age-	13 years
		Sex-	Male
		A.B.-	-4
Group II — Strong Motor-Weak Vocal Imitators	Subject 3	Age-	15 years
		Sex-	Male
		A.B.-	-4
	Subject 4	Age-	12 years
		Sex-	Male
		A.B.-	-4
Group III — Weak Motor-Weak Vocal Imitators	Subject 5	Age-	10 years
		Sex-	Male
		A.B.-	-4
	Subject 6	Age-	18 years
		Sex-	Male
		A.B.-	-4

Imitation Test When administering the Motor and Vocal Imitation Test, each child, individually was seated opposite the experimenter in a manner to exclude the possibility of his leaving. The imitation models and acceptable imitations are listed below.

a. Motor Imitations

1. Touch table.
   Model - Touch table top with the hand closet to table.
   Imitation- Touch table top with either hand.

2. Touch lips.
   Model - Place fingers of right hand flatly on lips.
   Imitation - Touches any parts of lips with fingers of either hand.

3. Touch head.
   Model - Touch front portion of hair with right hand.
   Imitation - Touches any portion of hair with either hand.

4. Open mouth.
   Model - Open mouth wide; do not protrude tongue.
   Imitation - Opens mouth wider than normally would.

5. Nest box.
   Model - Places small box inside larger box, then takes small box out and places it in original place.
   Imitation - Places small box inside the larger one.

6. Protrude tongue.
   Model - Stick tongue out as far as possible.
   Imitation - Protrudes tongue further than normally would.

7. Touch shoulder.
   Model - Touch left shoulder with right hand.
   Imitation - Comes within two inches of touching one shoulder with opposite hand.

8. Pucker lips.
   Model - Pucker lips as if to kiss.
   Imitation - Lips are put together and extended forward.

9. Empty box of paper.
   Model - Remove a piece of paper from open box, a minimum of three inches above box, then replaces.
   Imitation - Removes paper entirely out of box.

10. Clap hands.
    Model - Clap hands once.
    Imitation - Palms of two hands make contact.

b. Vocal Imitations

1. /a/
2. /i/
3. /m/
4. /p/
5. /pa/
6. /mi/
7. /pi/
8. /ma/
9. /map/
10. /pim/

After each response was demonstrated, the experimenter waited 10 seconds before scoring a non-imitation, then demonstrated another response. If the subject imitated the response within 10 seconds after the demonstration, the imitation was not scored until 10 seconds had elapsed since the imitation was emitted. After the scoring, another response was presented. When vocal responses were demonstrated, the subjects were given two short demonstrations (i.e., /a/ - /a/). The motor and vocal demonstrations were intermixed and each response was demonstrated twice during a session, totalling 40 demonstrations per session. The subjects were reinforced noncontingently, approximately every 30 seconds (Guess, Sailor, and Baer, 1972).

It was found that many of the children demonstrated imitative abilities which did not fall within the limitations of the categories. Approximately 250 children were screened before each established category was filled with two subjects. Some children demonstrated no imitative ability, some demonstrated motor imitation but no vocal imitations, while others showed both motor and vocal imitations which did not meet the specified percentages of any of the categories.

Reinforcer Selection When the subjects had been selected, effective reinforcers were determined for each subject. The specific procedures for selecting the reinforcers were as follows:

a. Choose a number of edible items which may serve as reinforcers.

b. Give the subject a small protion of each item to consume.

c. Place a small portion of the items in a row on the table in front of the child. Holding one arm, permit the child to pick and consume one item. Remove all items and score the portion selected by the child.

d. Repeat step (c) 14 additional times (total 15 trials).

e. Use as reinforcers those items selected most frequently.

After the reinforcer selection was completed and before the initial training was begun, the Motor and Vocal Imitation Test was readministered to assess the stability of the imitative repertoires of the selected subjects.

Stimulus Control Training Initial training followed that employed by Fulton and Lloyd (1969) in as much as periods of S^D (1K Hz, 70 dB re ISO) alternated with periods of S^{Δ} (no tone).

Each subject was placed individually in the experimental room. He was seated at a table on which a Davis Feeder Box was resting. Directly behind the seated subject was a loud speaker through which the warbled tones were delivered.

In initial steps, the S^D (1K Hz, 70 dB ISO) was presented for a length of 20 seconds with the S^{Δ} period being a variable interval with a mean length of five seconds. An experimenter was present, shaping the response of touching the operanda during the S^D and not touching it during the S^{Δ}. The experimenter initially held the subject's hand from touching the operanda during the S^{Δ} and physically placed the subject's hand on the operanda during the S^{D}. Gradually, the experimenter's shaping actions were faded out until the subject was on his own to press the operanda during the S^{D} and to avoid touching it during the S^{Δ}.

If the response was emitted during the S^{D} period, the previously determined effective reinforcer was dispensed to the subject, at which time the program recycled to S^{Δ} which was in effect for a variable time period. If a response occurred during the last five seconds of the S^{Δ}, an additional five seconds was added to the S^{Δ} period to insure extinction of responding in the presence of no tone. Shortly after responding appeared to be stabilizing at the values of S^{D}-20 seconds, S- V5 seconds, the S^{D} period was gradually decreased to five seconds as the S^{Δ} period was gradually increased to 20 seconds. When response rate stabilized on the crf schedule, the schedule of reinforcement was changed to a variable interval schedule where each response in the presence of the S^{D} had a 70 percent chance of being reinforced. When the behavior of responding to S^{D} and not responding to S^{Δ} appeared stable among sessions, the probability of reinforcement in the presence of the S^{D} was decreased to 25 percent. The schedule was held at a variable density of 25 percent reinforcement until the subject responded to 90 percent of the S^{D}'s for three sessions.

Upon meeting the above criteria, testing for the auditory stimulus control gradients was initiated. Following the Guttman and Kalish (1956) procedure, reinforcement ceased and probing began. Subjects 2, 3, 4, and 6 were first tested on the frequency parameter. Stimulus values of 1K Hz, 2K Hz, 4K Hz, and 8K Hz were randomly alternated in the temporal slot formerly occupied by the 1K Hz, 70 dB tone. The frequencies were presented at intensities which were judged to be equally loud to a 1K Hz, 70 dB tone (Robinson, 1956). Subjects 1 and 5 were tested on the intensity continuum before being tested on the frequency continuum. Intensities of 70 dB, 55 dB, 40 dB, and 25 dB at 1K Hz were randomly presented in place of the previous 1K Hz, 70 dB training stimulus.

After probing three sessions, varying either the frequency or the intensity parameters, the subjects were placed back on the variable interval schedule with the probability of reinforcement in the presence of the S^D, 1K Hz, 70 dB, being 25 percent. A few extra reinforcers were initially provided to bring the response rate under stimulus control. When five sessions of retraining to the 1K Hz, 70 dB tone were completed, the continuum not tested during the first three testing sessions was substituted, i.e. five of the seven subjects were first tested on the frequency continuum, then on the intensity continuum, while the order of intensity, then frequency, was used in testing the other two subjects.

Forty playing cards, ten from each suit, were shuffled to determine the random order of the four frequencies and four intensitites presented during each session of forty trials. Each frequency and intensity was assigned to one suit. As each card was drawn from the top of the shuffled stack of cards, its assigned value in frequency and intensity was recorded. Eight programs were derived for random frequency presentation and eight for random intensity presentations.

During the testing session, two stop watches were in operation. One watch timed the overall length of time of the session, while the other watch was used to time the latency of response from onset of the tone. If no response occurred during the S^D, a minus symbol was placed to the side of that trial, while a plus sign was recorded in the event of a response. Thus, on the program data form, response/no-response, time latency of response in the presence of S^D, and total time of the session were recorded. The number of responses during S^Δ was automatically counted, and this figure was also recorded.

By adding the latencies incurred during each tone presentation, a total S^D time was determined. By subtracting S^D from total session time, the S^Δ time was found. The average number of responses per second during S^D was derived by dividing total S^D time by the number of responses made in the presence of the tone. The response rate per second during S^Δ was found by dividing the number of responses during S^Δ by the total S^Δ time.

A breakdown by individual frequency or intensity was made. The response rate per second for each frequency and intensity was computed and the total number of responses emitted during each session was determined.

CHAPTER III

Results

During the stimulus control testing phase, the response rate per second in the presence of each probe stimulus and a mean response rate for each frequency were found for each subject over a period of three sessions. Figure 4 presents the response rate for each subject at each frequency. Group I consists of those subjects demonstrating strong motor and strong vocal imitative ability. Evidence for both discrimination and geralization is observed in both subjects of this group. Subject 1 shows a higher response rate than subject 2. Subject 1 also demonstrates greater discrimination of the 1K Hz tone. The 2K Hz tone elicited a higher response rate than the 1K Hz tone in subject 2, but the 1K Hz tone produced a higher response rate than either the 4K Hz or the 8K Hz tones, showing a discrimination of the 1K Hz tone over the two tones furtherest from the training stimulus. Response rate at each frequency was greater than the S^{Δ} response rate, indicating evidence for generalization. Group II is comprised of those subjects demonstrating strong motor and weak vocal imitative repertoires. Again, there is evidence for both discrimination and generalization occurring. An increase in response rate at the 2K Hz level is evident in subject 3, indicating a shift of stimulus control from the 1K Hz tone to the 2K Hz tone. Discrimination of the 1K Hz tone is evident, however, in view of the fact that the response rate at 1K Hz is greater than the response rate at 4K Hz and 8K Hz. Both Terrace (1966) and Pierrel and Sherman (1962) found a similar shift of stimulus control in a portion of their subjects.

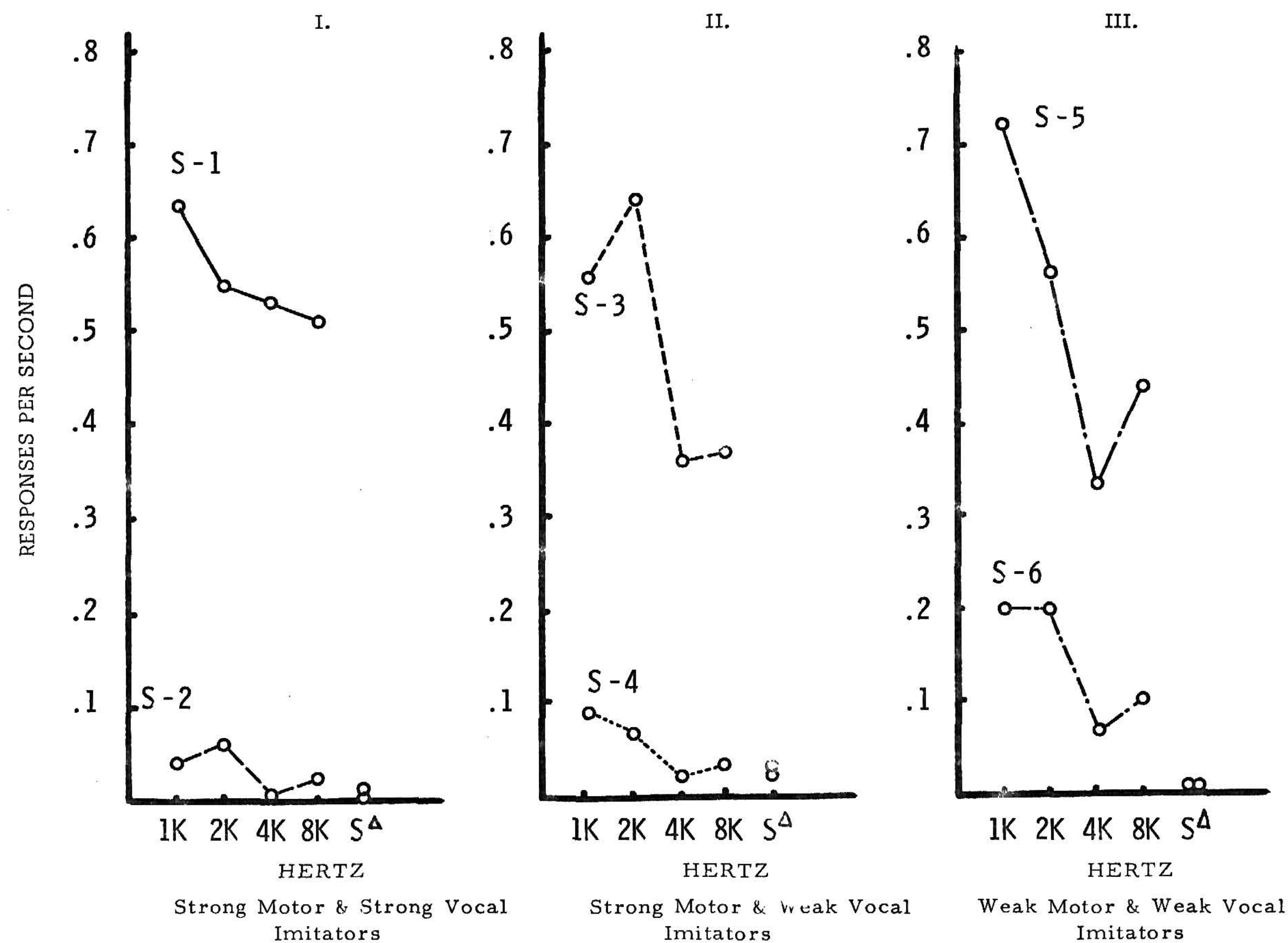

Figure 4. Mean responses rate per second for each subject at each frequency over a period

Subject 3 emitted a higher response rate than subject 4, but both demonstrated evidence for discrimination of the 1K Hz tone. Generalization is also apparent due to the response rate of all frequencies, with the exception of the 4K Hz tone in subject 4, exceeding the S^{Δ} response rate. Approximately the same results were obtained during the testing processes of those subjects in Group III. Subjects 5 and 6 demonstrated weak motor and weak vocal imitative ability. Discrimination and generalization are both evident in this group, as in Groups I and II. In Group III, stimulus control appears to be shared by 1K Hz and 2K Hz, as the mean rate of response was equal at these two frequencies for subject 6. The response rate was higher at 1K Hz and 2K Hz than at the 4K or 8K tones, showing evidence for discrimination. Subject 5 emitted a higher response rate than subject 6 and showed discrimination of the 1K Hz tone. As in the other groups, the response rate of each subject was greater than the S^{Δ} response rate, giving evidence for generalization. Considering this data, there is little support for imitation ability being a function of stimulus control of auditory frequencies.

In five of the six subjects, a phenomenon occurred in the frequency dimension. In all but one subject, an increase in response rate was observed from the 4K Hz tone to the 8K Hz may be attributed to the 8K Hz tone serving as a novel stimulus eliciting a higher response rate than the 4K Hz tone.

Intensity data was calculated in the same manner as the frequency data. Figure 5 presents the mean responses per second for each intensity tested. Again, three sessions were used to collect the data for 30 trials per stimulus value. Group I subjects demonstrated strong motor and strong vocal imitative repertoires. Both subjects 1 and 2 showed evidence for

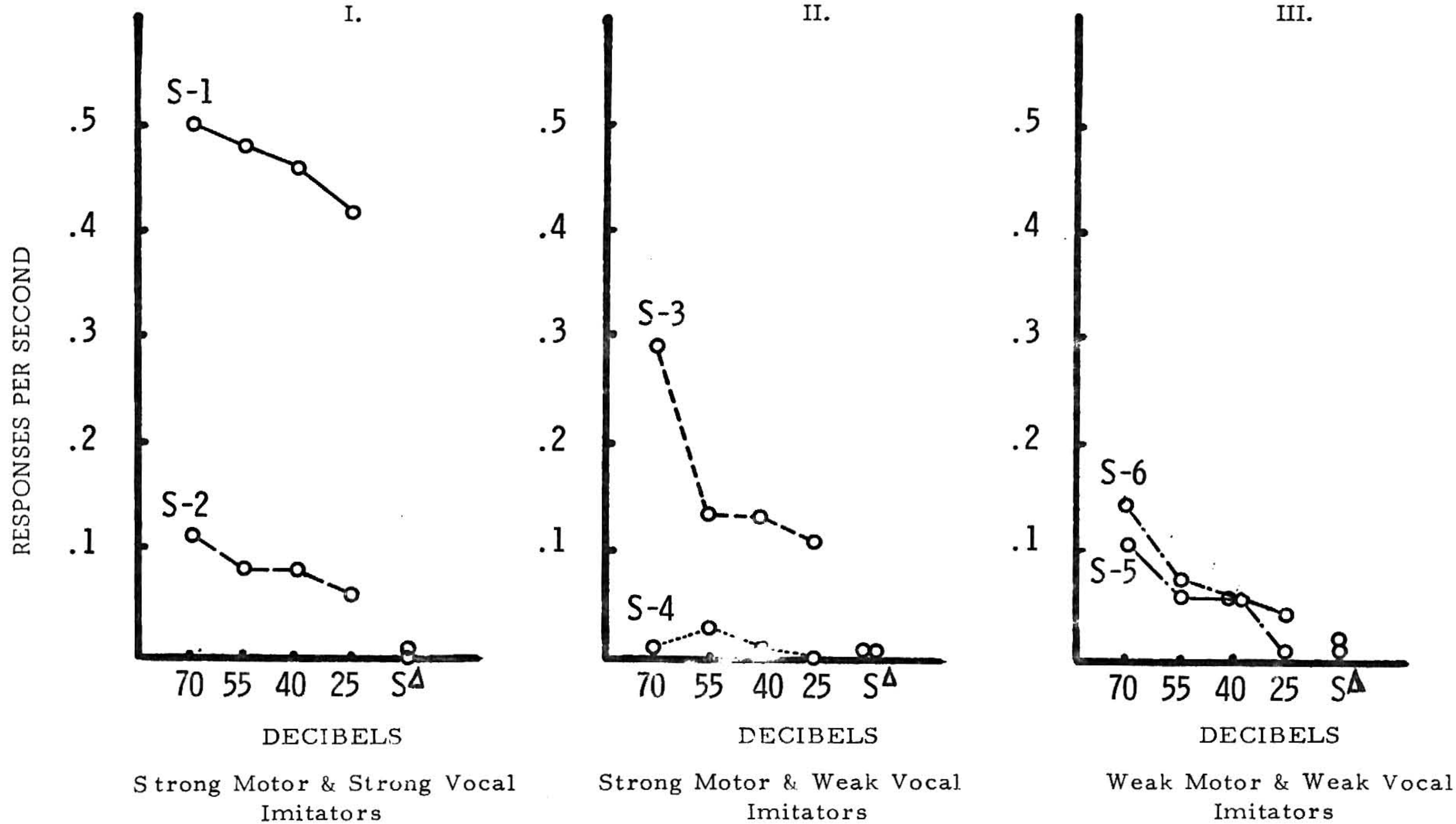

Figure 5. Mean responses rate per second for each subject at each intensity over a period of three sessions.

discrimination of the 70 dB tone, to which they emitted a higher response rate than to any of the other tone presentations. Generalization is also evidenced by the rate of responding to each tone being greater than the S^{Δ} response rate. The subjects in Group II are strong motor and weak vocal imitators. Subject 3 demonstrated both discrimination and generalization. This subject's response rate was much higher than that of subject 4 who emitted an extremely low response rate. Subject 4 extinquished to the task within the first session. The response rates of the weak motor and weak vocal imitators are illustrated in Group III. The subjects demonstrated discrimination of the 70 dB tone and generalization to the 55 dB, 40 dB, and 25 dB tones, by responding to all tones but at a higher rate to the 70 dB tone than the others. It appears that the imitative repertoires of these six subjects are not a function of the auditory intensity dimension.

The results presented in Figures 6 and 7 illustrate the individual mean response rates emitted in each frequency and each intensity and give the total number of responses emitted by each subject. This supplemental data further indicates that imitation ability is not a function of auditory stimulus control gradients, as the generalization gradients are similar between the imitative groups. The generalization gradients for both dimensions closely resemble those found by Sherman and Pierrel (1961) when testing the generalization of auditory intensity. The order of presentation of dimensions appears to have no affect upon the rate of responding in either continuum. In this research, subjects 1 and 5 were first tested on the auditory intensity parameter, then on the frequency parameter. Subjects 2, 3, 4, and 6 were first tested on the frequency dimension, then on the intensity dimension, with no apparent affect on response rate.

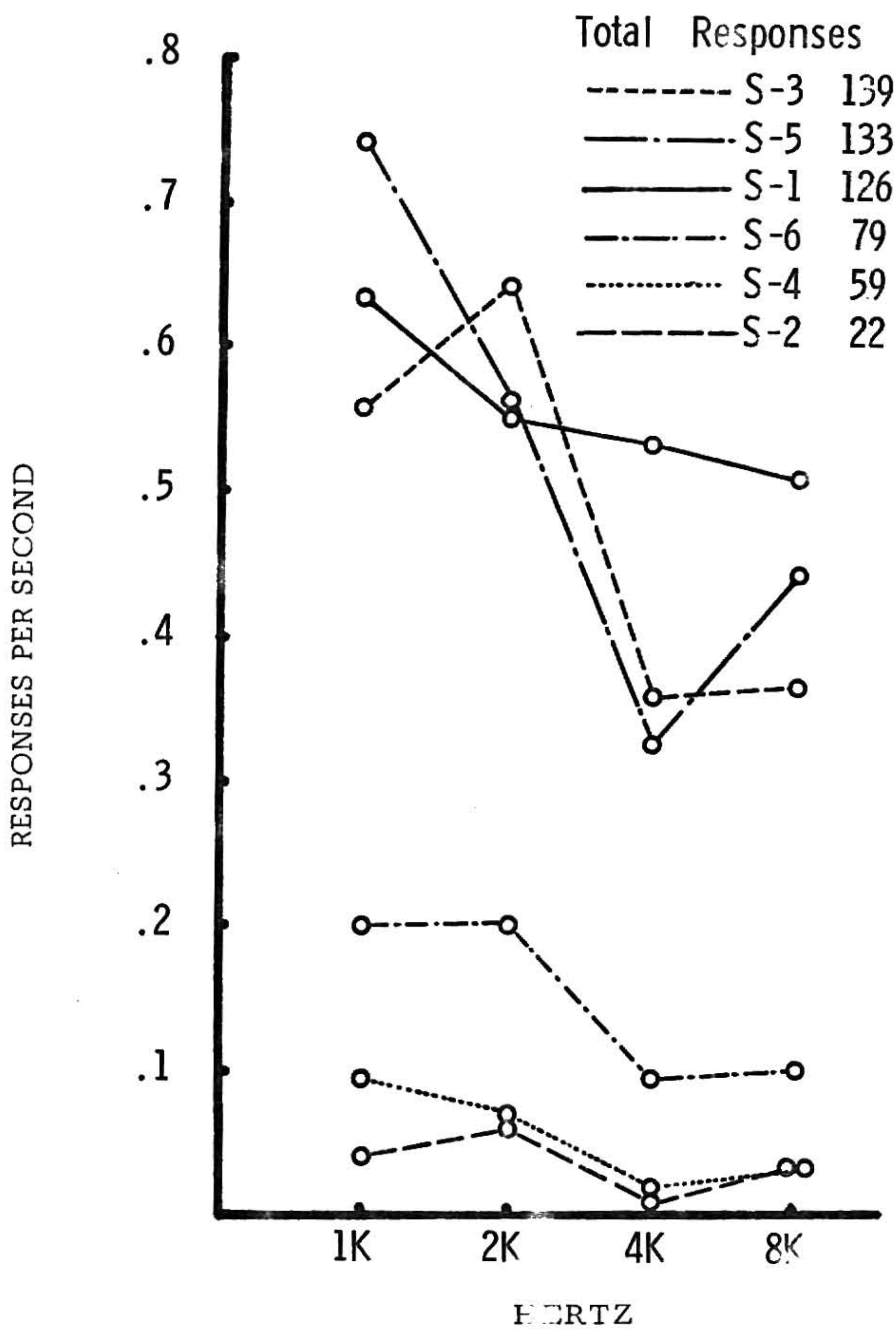

Figure 6. Mean response rate per second at each frequency and total number of responses emitted by each subject over a period of three sessions.

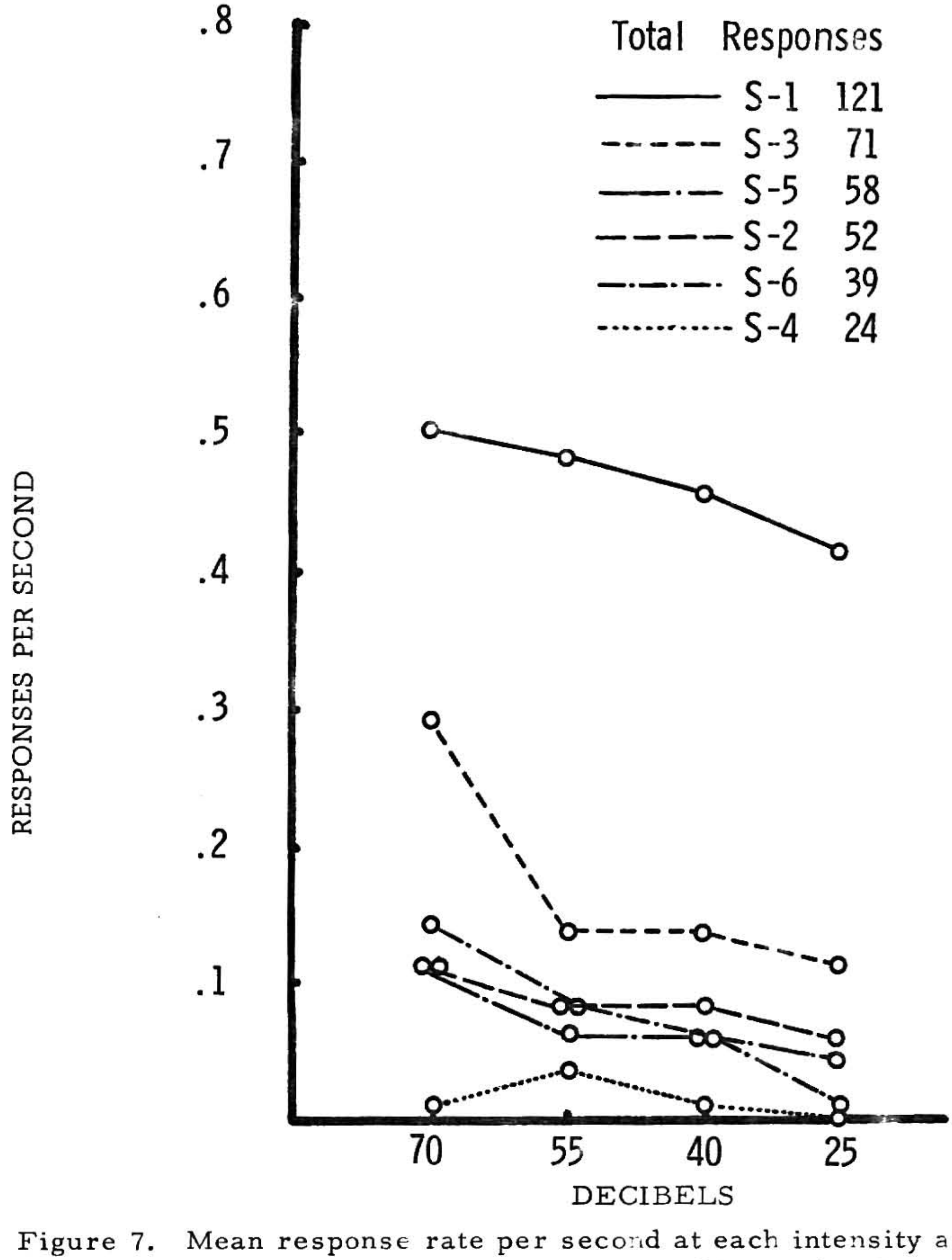

Figure 7. Mean response rate per second at each intensity and total number of responses emitted by each subject over a period of three sessions.

CHAPTER IV

Discussion

After training the six subjects to make a response of touching the operanda in the presence of the 1K Hz, 70 dB re ISO tone, probing for auditory discrimination and generalization across frequency and intensity dimensions was conducted. The subjects were divided into three groups of two subjects on the basis of their imitative ability. The imitative repertoires of the subjects failed to produce differences in auditory frequency and intensity generalization gradients. All six subjects demonstrated discrimination of the 1K Hz, 70 dB tone when reinforcement ceased and 1K Hz, 2K Hz, 4K Hz, and 8K Hz tones, judged to be of equal loudness to the 1K Hz, 70 dB tone (Robinson, 19[illegible]), were randomly presented. Generalization for the frequencies 2K Hz, 4K Hz, and 8K Hz was demonstrated by the response rate at these frequencies generally exceeding the S^{Δ} response rate. Evidence for discrimination and generalization also occurred on the intensity parameter. Tones of 70 dB, 55 dB, and 25 dB were randomly presented at 1K Hz in the temporal slot occupied by the 1K Hz, 70 dB tone during stimulus control training. In all subjects, the highest response rate was produced in the presence of the 70 dB tone, indicating evidence for discrimination for the training stimulus. The response rate during the other probing stimuli, 55 dB, 40 dB, and 25 dB, remained above the response rate of S^{Δ} in most cases, indicating evidence for generalization. Discrimination for the 1K Hz, 70 dB tone and generalization to all of the probing stimuli along the frequency and intensity dimensions was demonstrated by all subjects. Therefore, little evidence was found to support imitative ability as being a function of auditory stimulus control gradients.

Along the frequency dimension, two subjects demonstrated a higher response rate to the 2K Hz tone than to the 1K Hz tone. The rate of responding during the presence of 1K Hz exceeded the response rate to the 4K Hz and 8K Hz tones, indicating evidence for discrimination. This apparent stimulus shift shown by an increase in response rate from the 1K Hz tone to the 2K Hz tone is consistant with findings of Terrace (1966) and Pierrel (1962). A similar stimulus shift occurred in several of their subjects. The generalization gradients obtained from the frequency dimension probing and the intensity dimension probing closely resemble those gradients found by Sherman and Pierrel (1961) when testing generalization of auditory intensity.

An interesting phenomena occurred along the frequency parameter. An increase in response rate at 8K Hz over the response rate at 4K Hz was observed in five of the six subjects. Search of the literature has failed to locate similar data. Although the reason for this increase in response rate to the stimulus the furtherest from the S^D cannot be determined, a possible explanation may be that the 8K Hz tone served as a novel stimulus to the subjects.

Current operant procedures for testing the hearing of retardates include extensive generalization training for several of the frequencies and intensities to be tested (Lloyd, Spradlin, and Reid, 1968; and Fulton and Lloyd, 1969). The present study indicates that generalization occurs across frequencies and intensities when only one training stimulus was used. In view of this observation, much of the generalization training preceding the audiometric hearing testing may be eliminated with no negative effect on the individual's performance during hearing testing. Over a long time span, considerable time and effort would be saved by reducing the amount of unnecessary generalization training prior to the actual testing procedures. This leads to an implication for further research to determine just how much, if any, generalization training is necessary to facilitate hearing testing in the retardate.

In relation to speech and language training, the results of the present research indicate that auditory stimulus control is not the critical variable in imitative ability. Imitative behavior has been found to have predictive implications for speech and language training for the retarded child (Sloane, Johnston, and Harris, 1968). It is assumed that the imitative process is critical in the development of speech and language. When a child fails to respond correctly to vocal imitative training, the failure may be related to many factors, one of which may be stimulus control. No research studying generalization gradients of retarded children has been located through searching the literature. For this reason, apparently relatively little is known about stimulus control factors in relation to retardation. This research failed to find any functional relationship between auditory stimulus control along the dimensions of frequency and intensity and the imitative repertoires of the six subjects. All of these subjects demonstrated similar generalization gradients independent of imitative groupings. Failure to imitate may be related to mediation, response chaining, programming, or some other variable, excluding auditory stimulus control. Further research is needed to determine the crucial variable in the imitative process.

In summary, regardless of imitative repertoires, similar generalization gradients were observed with respect to auditory stimulus control gradients along the dimensions of frequency and intensity.

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MOTOR AND VOCAL IMITATION

AS A FUNCTION OF

AUDITORY STIMULUS CONTROL GRADIENTS

by

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This research concerned the experimental analysis of the auditory stimulus control gradients of frequency and intensity in retarded children and exploration of the interaction of this process with the subject related variables of motor and vocal imitation.

It is assumed that the imitative process is a critical variable in speech and language development. The child's imitative repertoire may be regarded as a predictor for the degree of success in speech and language training. Failure to imitate may be dependent upon any number of variables including auditory stimulus control.

To determine if imitative ability is a function of auditory stimulus control gradients, six mentally retarded children of the resident population of Kansas Neurological Institute served as subjects for this study. The subjects were categorized by motor and vocal imitative abilities determined by administering the Motor and Vocal Imitation Test. The categories were (I) strong motor and strong vocal imitators, (II) strong motor and weak vocal imitators, and (III) weak motor and weak vocal imitators. After subject selection for the study was completed, effective edible reinforcers were determined for each subject.

The initial stimulus control training followed that employed by Fulton and Lloyd (1969) in as much as periods of S^{D} (1K Hz, 70 dB re ISO) alternated with periods of S^{Δ} (no tone). Each subject was placed in an experimental room seated at a table on which a Davis Feeder Box rested. The warbled tones were delivered through a free field speaker located directly behind the subject. When the responses of touching the operanda during the S^{D} period and not touching it during the S^{Δ} period appeared stable with the probability of reinforcement in the presence of the S^{D} being 25 percent, testing for the auditory stimulus control gradients following the Guttman and Kalish (1956) procedure was initiated. Three sessions of random presentations of the frequencies 1K Hz, 2K Hz, 4K Hz, and 8K Hz, all judged to be of equal loudness to the 1K Hz, 70 dB tone with no reinforcement available were introduced to four of the six subjects. The other two subjects were first tested on the intensity dimension with 70 dB, 55 dB, 40 dB, and 25 dB at 1K Hz being randomly presented. After three testing sessions, the subjects were placed back on the variable interval schedule for five sessions of retraining to the 1K Hz, 70 dB tone. The dimension not tested during the first three testing sessions was introduced for three sessions.

The response rate per second in the presence of each stimulus value was computed and a mean for three sessions was determined for each subject. The results indicated evidence for auditory discrimination and generalization in all subjects. The response rates to the 1K Hz, 70 dB tone indicated discrimination. Response generalization to all other stimulus values occurred in each subject. The results indicate that imitation ability does not appear to be a function of auditory stimulus control along the dimensions of frequency and intensity, as the generalization gradients were similar between the imitative groups.

The findings of the present research may have implications in the area of operant procedures for testing the hearing of retardates. The current procedures include extensive generalization training which appears to be unnecessary due to generalization occurring across frequencies and intensities when only one training stimulus is used.