A FUNCTIONAL ANALYSIS APPROACH TO SPEECH AND LANGUAGE

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Contents

Preface

Speech clinicians and speech pathologists are constantly searching for new procedures for improving clinical practices. However, many times the relevance of theory and research to speech therapy procedures is not immediately apparent. Also, there is frequently a considerable time lag between the development of an effective procedure within the laboratory and its apparent application within the clinics. This monograph is an attempt to bring theory, research, and practice closer together and to make the results of research available to the practicing clinician. It also provides a systematic framework within which the clinician may develop and evaluate explicit speech therapy procedures.

The systematic framework used in this monograph is referred to frequently as the functional analysis of behavior. The system includes a two-step procedure for the evaluation of behavioral change: (1) establishing a baseline of behavior and (2) assessing the conditions that maintain and modify the behavior. The first pertains to the specification of the exact kind and rate of speech behavior under consideration. The second includes an analysis of the environmental conditions by which speech behavior is developed, maintained, and modified. This system allows the clinician to determine the starting point and the speech modification techniques to be applied in each individual case.

The monograph was made possible through the resources of the Bureau of Child Research of the University of Kansas, the Division of Speech Pathology and Audiology of the University of Kansas, Parsons State Hospital and Training Center, and the Hearing and Speech Department of the University of Kansas Medical Center. The individual studies and the writings of the monograph were supported by grants to the Bureau of Child Research from the National Institute of Neurological Diseases and Blindness (NB 05362), National Institute of Child Health and Human Development (HD 00870, HD 00183), National Institute of Mental Health (MH 01127, MH 8262).

R. L. Schiefelbusch

Lawrence, Kansas
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Chapter I

AN INTRODUCTION TO THE FUNCTIONAL ANALYSIS OF SPEECH AND LANGUAGE

FREDERIC L. GIRARDEAU *and* JOSEPH E. SPRADLIN

Language is one of the most important aspects of human behavior. This is especially true of spoken language or speech. A person without adequate speech is isolated from effective communication with other persons. The speech clinician's goal is to make the speech of the person approximate that of his community. A therapy program consists of a series of procedures designed by the clinician to make correct speech more likely and incorrect speech or absence of speech less likely for a given individual.

The procedures used by the clinician are primarily behavioral. The clinician stimulates, urges, and praises the speech attempts of the child. To be effective, he must know the speech characteristics of persons in the community and the principles which lead to changes in speech behavior. In any effective therapy program, then, there are two essential ingredients: the precise determination of the desired behavior, and a set of principles or procedures which assures that the person will acquire this behavior. This monograph is primarily directed to the second ingredient, the development of a systematic set of principles which can be used to devise procedures for changing speech behavior. The purpose of the present monograph is twofold: first, to review some of the principles and procedures of operant conditioning (or a functional analysis of behavior); and second, to present studies which illustrate the application of these principles to the modification of speech.

The principles derived from previous research now allow for a high degree of control over nonlanguage behavior, and several writers (Brookshire, 1967; Holland, 1967; Mowrer, 1960; Schiefelbusch, 1963; Skinner, 1957; Staats and Staats, 1963) have suggested that the same principles are also applicable to speech and language. The functional analysis of behavior, as described by Skinner (1938, 1953, 1957), Keller and Schoenfeld (1950), and Holland and Skinner (1961), offers several advantages for those interested in speech and language therapy. It is based on data from controlled laboratory research, and systematically extrapolated to verbal behavior (Skinner, 1957). Moreover, the functional analysis of behavior has been quite helpful in developing procedures

for modifying a wide range of human behaviors in applied situations. Now these procedures are being applied to speech and language problems (e.g., see Sloane and MacAulay, 1968).

Assumptions of a Functional Approach to Speech

Before discussing the principles derived from the functional analysis of behavior, it may be helpful to consider some of the assumptions which are involved in this approach.

(1) There is a lawfulness or order to the development, maintenance, and reduction of speech and language behavior. It is free from capricious causative agents such as "will" or "chance." When these and similar causative agents are invoked, the controlling variables are usually ignored.

(2) Speech and language behavior is comprised of potentially observable and recordable physical events. Furthermore, the events which affect the development, maintenance, or reduction of speech and language are potentially observable and recordable. This means that speech and language may be studied in the same manner as other behavior.

(3) For many purposes, and especially in speech therapy, the most useful way to categorize or classify speech is in terms of its functional properties. The perceptual aspects of speech are important in that the listener has been taught to respond to these at a gross level. However, consider the pairs of words, *get* and *git*, and *let* and *lit*. Perceptually, the difference between *get* and *git* is the same as the difference between *let* and *lit*. However, *get* and *git* are functionally similar, whereas *lit* and *let* function quite differently. Even such disparate responses as, "I'm thirsty," "Bring me a glass of water," and "My, that water looks good," may be classified together under a functional system. They will tend to increase in strength as an organism becomes "thirsty," and will be reinforced by the delivery of water. In general, a system or "theory" helps in classifying events.

(4) A science of speech and language behavior can be developed through the precise experimental analysis of the behavior of individuals. It is especially the case that an individual analysis, rather than an approach which utilizes group statistics, is helpful to the speech clinician. At times, group statistics obscure important lawful relationships which an individual analysis may reveal.

Principles of Behavior

Behavior may be divided into two functional classes, respondent and operant. Respondent behavior is elicited by antecedent stimuli. For example, when illumination increases, the pupil of the eye contracts; or, when a loud, sudden noise is presented, a baby cries. Conditioned respondent behavior occurs when a neutral stimulus is paired with an eliciting stimulus and the previously neutral stimulus comes to elicit the behavior. While respondent behavior is im-

portant to human adjustment, it is not the behavior with which we are concerned in this monograph. We are primarily concerned here with operant verbal behavior. The initial control over operant behavior is to be found in the consequences which follow behavior rather than in the stimuli which precede it. This point is so important that it should be repeated: The events which follow behavior are very important in determining the future occurrence of that behavior. Antecedent stimuli come to influence operant behavior, but this is a function of training which uses consequences. Operant behavior is so named because it operates on the environment and in turn is changed by the consequences delivered by the environment.

Consequences or Events Following Behavior

Some consequences of actions increase the probability that those actions will reoccur. Within the present context, those procedures which increase the probability of the behavior reoccurring are called reinforcement. Reinforcement may be either positive or negative. Positive reinforcement occurs when an event or stimulus follows (is contingent upon) a response, and increases the probability of future occurrence of the response. We commonly discuss positive reinforcers in terms of tangible rewards such as candy, pennies, and trinkets. However, positive reinforcement is not restricted to the delivery of such tangible rewards; nor are such concrete rewards always reinforcers. Several of the studies in this monograph included concrete rewards such as pennies, ice cream, and M & Ms. However, Yoder (Chapter II) used the presentation and termination of a TV picture of an attractive young girl to control the vocalizations of adolescent retarded boys, and Hall (Chapter V) allowed the child to engage in favored activities contingent on desired vocal behavior.

Negative reinforcement occurs when an aversive stimulus is terminated immediately following a response (termination is contingent on the response) and there is an increase in the probability of future occurrence of the response. Negative reinforcement should not be confused with punishment; with negative reinforcement there is an increase in the probability that the response will reoccur. For example, "Be quiet," may increase in frequency if it results in the temporary reduction of an annoying noise. Under such conditions the command, "Be quiet," has been negatively reinforced by the termination of the noise, and is more likely to occur in noisy situations in the future.

On some occasions it may be important that a person decrease the rate of certain undesirable or interfering behaviors. This may be accomplished through punishment, in which either negative reinforcers are presented or positive reinforcers are withdrawn contingent on these behaviors. Chapter VII (by Galloway and Sulzbacher) concerns the reduction or elimination of the rate of jargon emitted by a young child. Two techniques were studied. The first was time-out from social reinforcement. Each time the child emitted jargon the adult looked away from the child for a short time period. The second technique involved the adult saying, "Shh" each time the child made a jargon

response. Hall (Chapter V) used time-out from reinforcement within a complex speech training program to decelerate inappropriate behavior such as tantrums.

The diagram below summarizes the general uses and effects of positive and negative reinforcers. All situations involve using the events in a contingent

	Present	*Withdraw*
Positive reinforcer	Positive reinforcement; increases response rate	Punishment; decreases response rate
Negative reinforcer	Punishment; decreases response rate	Negative reinforcement; increases response rate

manner following the behavior being modified. It is important to point out that the properties of events differ from individual to individual and from time to time with the same individual. What is pleasant for one person may be aversive to another.

When faced with the problem of reducing the frequency of disruptive behavior, we often use some form of punishment, but it is also possible to use positive reinforcement to reduce the frequency of behavior. We can arrange to present the positive reinforcement only when responding occurs at a low or infrequent rate. For example, Bradford (Chapter III) reduced rate of speech by reinforcing only responses which occurred two seconds or more after the preceding response. Others (Patterson, 1964; Doubros and Daniels, 1966) have reduced hyperactive behavior by delivering reinforcement to the child whenever hyperactive responses did not occur for a specific period of time. When Yoder (Chapter II) made the occurrence of the pleasant young girl on TV contingent on not talking, talking decreased to near zero. It may be that in these situations one is simply reinforcing behavior which is incompatible with the disruptive behavior. Nevertheless, the contingency is placed on the nonoccurrence of disruptive behavior.

One of the requirements for any therapy program is to extend it outside of the clinic. Fortunately, behavior may be maintained under different conditions than those which were required to establish it. For example, initially it may be necessary to reinforce a response each time it occurs to increase its strength. However, once the subject is responding reliably, the response may be reinforced on an ever-decreasing schedule until, finally, he is receiving reinforcement for only an extremely small percentage of responses. If the reinforcements occur at the right times, it is possible to maintain extremely high rates of stable behavior with very few reinforcers. Hall (Chapter V) initially reinforced each appropriate verbal response emitted by the child. Once the child was emitting the responses at a relatively high rate, Hall reinforced the responses on an intermittent schedule. Contrary to what might be expected, the rate of appropriate verbal behavior increased even though fewer reinforcers were being given.

McReynolds (in Chapter VI) found that early in training, social reinforcement alone would not maintain imitations by a child with severely delayed speech. However, after an echoic response was strongly developed by reinforcement with ice cream, it could be maintained on social reinforcement alone. The ability to maintain behavior on a different reinforcer is, of course, important to speech therapy programs. It means that even though one type of reinforcer may be required in the clinic to establish correct speech, such speech may be maintained later by other reinforcers found outside the clinic.

Potential Reinforcers for Speech Therapy Programs

The speech clinician usually relies on praise as the reinforcer for correct speech. This frequently works, but there are some children for whom praise is ineffective, especially at the beginning of therapy. Also, the potency of praise may diminish over a long therapy program. Therefore, the clinician must be prepared to use and evaluate other types of reinforcers. Two general classes which should be considered are food (especially candy, soda pop, and ice cream) and tokens. The consumption of food does interfere with speech, but its potency as a reinforcer early in the therapy program might outweigh the interference, as the study by McReynolds (Chapter VI) indicates.

Probably the reinforcer system which will be useful in most therapy situations is a token system. Tokens are anything which can be redeemed for merchandise of some sort or the opportunity to engage in certain behavior. Systematic token programs have been used successfully in several modification programs (Allyon and Azrin, 1965; Birnbrauer et al., 1965; Girardeau and Spradlin, 1964; Lent, 1968; Lent, LeBlanc, and Spradlin, in press; Wolf, Giles, and Hall, 1968). Tokens have several advantages which recommend them for use in therapy.

(1) The delivery of a token does not interfere with the speech response being modified as would an unconditioned reinforcer such as candy.

(2) Tokens can be either presented or withdrawn, as in response cost situations. Generally, food and social reinforcers can only be presented. Since there is some evidence that the most effective training program is one which combines positive reinforcers for correct responses and takes away positive reinforcers for incorrect responses, this aspect of the token may make it quite a useful reinforcer.

(3) A token system permits the use of powerful reinforcers (trips to the zoo, use of a record player, 20 minutes of watching cartoons, trips to a restaurant, etc.) which cannot be dispensed in the therapy session. The token system allows the clinician to reinforce small bits of behavior in an economical manner, with the child trading in the tokens later for a large, powerful reinforcer.

(4) A token system allows each child to earn the kind of object or activity that is most reinforcing for him. With this system the child can select his reinforcer from the Sears catalog or a "reinforcing event menu" such as that developed by Addison and Homme (1966).

(5) It is relatively simple to keep track of the number of reinforcements delivered during group therapy since each child's tokens can be counted at the end of the session; thus, recording does not interfere with ongoing therapy. Such records are especially important in group therapy situations in that they indicate the extent of each child's participation and the frequency with which he comes into contact with the reinforcer.

(6) The token is a conditioned, generalized reinforcer and is not as dependent upon temporary deprivation states as are many unconditioned reinforcers. For candy, ice cream, or soda pop to function as reinforcers the child must be relatively deprived. Tokens may be used without regard to these deprivation states.

Similarly, satiation is unlikely to occur when tokens are used, and longer sessions may be scheduled. The effectiveness of tokens in contrast to other reinforcers is, of course, a matter for empirical demonstration with each child.

Stimulus Control

Up to this point the discussion has been concerned primarily with consequences of behavior, or events that occur subsequent to the response. What about the events prior to the response? Laboratory experiments have demonstrated that if reinforcement is delivered for a response only in the presence of a specific stimulus, the response will occur more frequently when the stimulus is present than when it is not present. For example, if a cigarette machine operates only when a light is on, we will learn to put our money in the slot and pull the plunger only when the light is on. Verbal responses are under very specific stimulus control. We tend to talk only when an audience is present. The reason for this is obvious—it takes an audience to reinforce verbal behavior. A polite request to "Please pass the bread" will have no effect if there is no one available to comply with it. Yoder's chapter clearly demonstrates some of the control which an audience can have over vocal behavior.

Skinner (1957) classified verbal responses according to their controlling conditions. One class of verbal behavior is under the stimulus control of another person's verbal response. This is perhaps one of the earliest types of stimulus control. For example, the mother says "bye-bye" and the child repeats it. The reinforcement for an echoic response may be conditioned reinforcement, as when the parent fondles and praises the child for repeating "bye-bye" or it may be unconditioned reinforcement, as when the child is requested to say "cookie" and then is given the cookie for making the imitation.

A second type of controlling stimulus is nonverbal. For example, the infant who sees his father put on his coat and step out the door may say, "bye-bye." In this case, it is the stimulus of a person leaving that controls the response. Or a child may see a cat walking across the room and say "kitty." When such responses occur, they are occasionally reinforced by generalized conditioned reinforcers such as smiles, nods, etc. The verbal behavior under the control of such stimuli has been called "tact" by Skinner. Tacts are probably first trained

TABLE 1. An example of one type of record sheet which might be useful to the clinician. Other types can be devised to fit the particular need of the clinician.

Date	*Clinician*	*Behavior or Activity*	*Time*	*Correct Responses*	*Incorrect Responses*	*Contingency*	*Consequence*
12/7/68	Georgia Smith	initial "th" sound	15 min	20	10	one point for each correct response	points traded in for toys

as multiple controlled responses. That is, the parent points to a cat and says to the child, "Say kitty." When the child says "kitty," he is reinforced. After several pairings of the echoic stimulus and the visual stimulus the child may emit the response "kitty" in the presence of the cat alone. Still later, control of the response "kitty" may be extended to printed words or to statements such as, "What has four legs and goes meow?" McLean (Chapter IV) demonstrates some of the techniques for extending stimulus control in a programmatic fashion in articulation training.

In summary, operant behavior is initially controlled by consequences delivered on some contingency basis.

Response → Contingency → Consequence

Then the response may be brought under the control of stimuli which precede it and the precise ordering of these antecedent stimuli is important. The following diagram shows the relationship of the general system to a specific situation in speech therapy.

Program of Materials	→	Specific Materials or Stimuli	→	Speech and Language Behavior	→	Contingency	→	Consequence
Certain Order of Pictures	→	Pictures Involving "th" Sounds	→	Correct Responses	→	Every Time	→	Verbal Praise by the Clinician

Recording Speech Behavior

Reliable recording of responses is a hallmark of the functional analysis approach to therapy. Without objective data it is impossible to follow precisely the progress or lack of progress being made and to evaluate clinical procedures. The types of records made by McLean (Chapter IV), Hall (Chapter V), McReynolds (Chapter VI), and Galloway and Sulzbacher (Chapter VII) are examples of the precise recording which is essential in the evaluation and development of therapy procedures. An example of one way to organize the data needed from therapy is given in Table 1.

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Chapter II

THE REINFORCING PROPERTIES OF A TELEVISION PRESENTED LISTENER

DAVID E. YODER

The effects of the speaker-listener interchange on the vocal behavior of the speaker are important to an understanding of verbal behavior. One interchange which has reinforcing properties is attention. Skinner (1957) and Staats and Staats (1963) provide some suggestions as to how attention (looking at or listening to) might serve to reinforce the vocal behavior of another person. Attention is classified by these writers as a conditioned, generalized reinforcer because the attention of other people is necessary for other reinforcements from them; e.g., food, affection, approval, and so on. It is when the mother is attending to the child that milk is delivered, uncomfortable clothing is removed, and warmth is provided. People who are attending to us are likely to reinforce our behavior, and we use attention as a means of shaping the behavior of others.

Skinner (1957) pointed out that attention is not a thing, but merely some aspect of behavior. As a conditioned generalized reinforcer, it is effective even though the primary reinforcement upon which it is based is not forthcoming. Thus, in a speaker-listener interchange, the listener does not always have to supply the primary reinforcement for his attention to serve effectively as a reinforcer.

When attention has been paired with positive reinforcers, its presentation will result in an increase in the frequency of behavior on which it is contingent. Conversely, if this attention is withdrawn from the child following a specific behavior, that behavior will be weakened. Furthermore, Staats and Staats (1963) have pointed out that, in some cases, attention is paired not only with positive reinforcers, but also with aversive stimuli. Consequently, attention can function as a conditioned punishing stimulus and weaken behavioral responses. Thus, the probability of verbal behavior is low in the absence of an audience, in the presence of an audience which does not reinforce, or in the presence of one which punishes it.

Reviews by Krasner (1958), Salzinger (1959), and Greenspoon (1962) show that vocal responses can be experimentally controlled by means of vocal and nonvocal reinforcement from a listener (audience). Most of the studies they

reviewed dealt with the modification of various response classes by verbally fluent adults, and were concerned primarily with the reinforcing properties of vocal approval and disapproval.

Studies of the control of vocal behavior of children are few. The vocalization of three-month-old infants was found by Rheingold, Gewirtz, and Ross (1959) to increase in the presence of a social reinforcement and to decrease when the stimulus was withdrawn. Salzinger et al. (1962) demonstrated that speech rate of five-to-seven-year olds increased as a result of reinforcement and decreased or stabilized when reinforcement was withheld. Nininger (1964) demonstrated that attention paired with positive vocal reinforcement contingent upon vocal responses to pictures increased the vocal output of a group of third-grade boys. She also found a significant decrease in vocal output when subjects received no vocal reinforcement.

The present study was designed to investigate the influence of an audience (listener) on the vocal behavior of children under three experimental conditions—reinforcement, punishment, and extinction. The reinforcement effect was studied by presenting a filmed video audience to four subjects contingent on their vocalizations. The effect of punishment on children's vocal behavior was investigated by withdrawing the video audience contingent upon a vocal response. The third condition involved withholding the video audience regardless of the vocalizations of the subject.

METHOD

Subjects

The subjects were four boys from the Parsons State Hospital and Training Center. They were 8 to 12 years of age with a mean chronological age of 10.2 years and a mean mental age of 6.5 years. Their Parsons Language Sample scores (Spradlin, 1963) ranged from 55 to 65 and their Adaptive Behavior classifications (Leland, 1964) were I or II. The subjects had normal hearing as determined by pure-tone audiometric testing and were not under medication for seizure control or for other behavioral problems.

Experimental Task

A filmed video audience was used as the experimental treatment. The video audience consisted of a seven-minute video tape of a female who made smiling and positive head-nodding movements. These specific movements were not contingent upon the responses made by the subject since the tape was made prior to the experiment. The video picture itself was presented or withdrawn when the subjects vocalized, depending upon the experimental contingency.

Testing Suite

All experimental sessions were conducted in a sound-treated suite consisting of an experimental room and a control room, with a one-way mirror between

them. The control room was equipped with a tape recorder, an event recorder, a video recorder attached to a voice-operated relay, and an intercommunications system. The experimental room was equipped with a table, chair, chalkboard, three books, a 17-in. television receiver, a ceiling microphone, and a wall-mounted microphone. The wall-mounted microphone relayed all vocal responses from the subjects to a voice-operated relay (VOR) apparatus which was attached to both the video receiver in the experimental room and the video recorder in the control room. The VOR apparatus interrupted the video circuit and caused the video picture to be present or absent from the viewer, depending upon the appropriate condition.

Procedures

Pretreatment Sessions. Each of the four subjects received three pretreatment sessions to establish a listener-speaker relationship between the subject and the video audience. The subject was seated at a table in the test room and the prerecorded video audience was presented on the television receiver. For three sessions, the video audience was accompanied by live speech. A young adult female presented vocal remarks from a prepared outline and adapted them to the behavior of the subjects. An effort was made to engage the subjects in conversation and to have them describe certain events of interest. There was no attempt to synchronize the speech with the video picture, but rather to make vocal remarks appropriate to the subject's vocal and nonvocal behavior.

Baseline Sessions. Following the three pretreatment sessions, each subject was placed in the same test room as before and given continuous exposure to the video audience without the accompanying vocal comments from the observer. These sessions were used to establish a vocal behavior baseline for each subject. An individual baseline was considered stable when the subject did not vary his total vocalization time more than 30 seconds over 3 consecutive experimental sessions. When the subject attained a stable vocal baseline, he was placed in the reinforcement condition.

Reinforcement Sessions. The subjects were placed individually in the same test room as before. For the duration of each vocal response emitted by the child, the video audience appeared on the television receiver. A pause of approximately two seconds or greater was sufficient to remove the video audience from the screen. No vocal stimuli were presented during any part of these experimental sessions. Each subject continued in the reinforcement procedure until vocalization time during three consecutive sessions increased over baseline by 40%, or until it did not vary more than 7% (30 sec) over 3 consecutive sessions held after the sixth reinforcement session. After the subjects reached either of the criterion levels they were placed in the punishment condition.

Punishment Sessions. Again, the subjects were placed individually in the test room. Within 30 seconds after entering the room, the video audience was pre-

sented via the television receiver. Each time the subject vocalized, the video audience was withdrawn from the screen and withheld as long as he continued to vocalize. When the subject stopped vocalizing, the video audience returned immediately and remained until the next vocal response was made.

The punishment procedure continued until phonation time was 85% less than the vocal baseline for 3 consecutive sessions, or until it did not vary more than 7% (30 sec) over three consecutive sessions held after the sixth experimental session. After the subjects had met either of the 2 criteria, the extinction procedure was initiated.

Extinction Sessions. During this condition the video audience was withheld for the entire session, whether vocal responses were made or not. Each subject remained in this condition until his vocal behavior did not vary more than seven per cent over three consecutive sessions.

Replication of the Experiment. Following the extinction condition, the subjects repeated the experiment with a different order of experimental conditions. The subjects were engaged again in the three pretreatment sessions pairing the video audience with the vocal behavior of the adult. They were then placed in the experimental punishment (P) contingency. Upon meeting criterion, the subjects were given the reinforcement (R) contingency. After meeting the

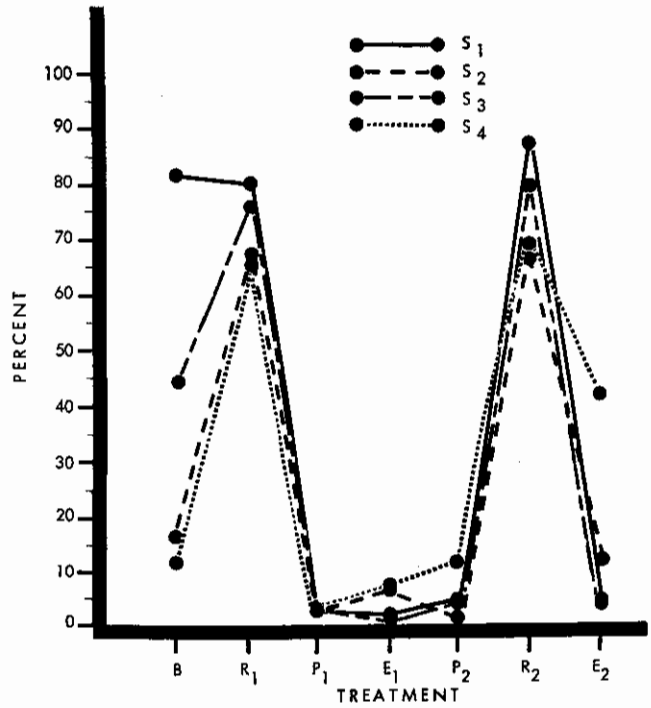

FIGURE 1. Mean percentage of time each of the four subjects engaged in vocal behavior at the baseline and criterion level for each of the six experimental treatment contingencies.

established criterion in the R period, the subjects finished the experiment by completing the extinction (E) procedure. The experimental procedures and criteria for changing conditions were the same as in the first part of the study.

RESULTS

The mean percentages of time the subjects vocalized during the baseline and experimental conditions are shown in Figure 1. In Figure 2 the data are plotted for the group. The graphs indicate that in all the experimental contingencies the subjects responded in essentially the same way. With the exception of Subject 1, they increased their vocal responses from a low baseline level to a peak at the reinforcement (R) criterion.

The subjects did not reach the established criterion levels with the same number of sessions. They required from 4 to 11 sessions ($M = 5.75$) to attain a stable baseline, a range of 9 to 14 sessions ($M = 10.25$) to reach the first R criterion, and from 4 to 9 sessions ($M = 6.75$) to meet the second R criterion. During the first punishment (P) period, there was a range of 4 to 14 sessions ($M = 7.50$) needed to reach the criterion level, and the second P criterion level required from 3 to 9 sessions ($M = 4.75$). It took between 3 to 5 sessions ($M = 3.75$) to reach criterion in both extinction periods, with all but 1 subject reaching criterion level in 3 to 4 sessions.

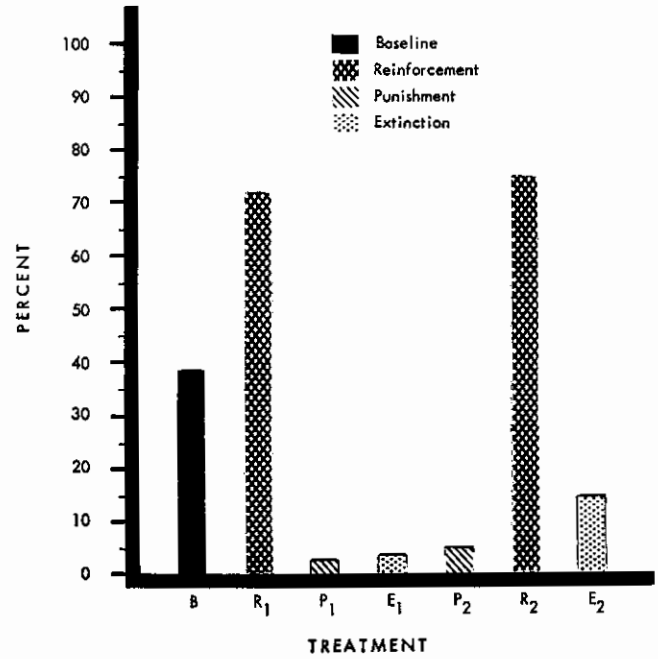

FIGURE 2. Mean percentage of time all subjects engaged in vocal behavior at the baseline and criterion level for each of six experimental treatment contingencies.

The 4 subjects had a combined vocalization time of 38% at the baseline criterion level. They vocalized 72% and 76% of the time at the criterion levels for the first and second R periods. During both P contingencies, the subjects met the first criterion. Vocal behavior was reduced to a mean of 3.5% for the combined P contingencies. This was a decrease of 70% over the combined R periods.

DISCUSSION

The results indicate that the contingent presentation of a filmed video audience, without sound, effectively reinforced the vocal behavior of these four subjects. These results are similar to those of Rheingold, Gewirtz, and Ross (1959), who brought infant vocalization rates under control by presenting adult attention as a social reinforcer. Salzinger et al. (1962) were also able to increase the vocal output of children by using vocal reinforcement concurrent with an attentive paper-mache clown. However, both of these studies paired social-visual reinforcers with vocal reinforcers.

The results of the present study also show that the removal of a video audience contingent upon vocalization was an effective punishing consequence for these retarded boys. The results show further that vocal behavior was low during the extinction phase when the videotape was off regardless of the subjects' vocal behavior.

The four subjects engaged in different types of vocal behavior during the experiment. One subject sang a great deal. He was reinforced early in the experiment for his singing and soon learned that the continuous vocalizing produced by the singing kept the video audience present more continuously than did speaking, which has some pauses. When not singing, the subject spoke in a "sing-song" manner. This behavior was similar to that of another subject who filled many of his speaking pauses with repetitive sounds which were reinforced by the continuous presence of the video audience. These two subjects appeared to learn early to maximize the presence of the audience by vocalizing continually.

Both subjects appeared to vocalize in a manner described by Shames and Sherrick (1963) in a discussion of the speech behavior of nonfluent children. They hypothesized that "attentiveness" of the listener (audience) is important to the continuance of utterance by the speaker and that silence on the part of the listener may act as a punishing stimulus and result in decreased vocal output on the part of the speaker.

The results do not support the Shames and Sherrick hypothesis that silence on the part of the listener is necessarily punishing. Even though the reinforcing stimulus had no auditory component, it was an effective reinforcer. If we may assume that Shames and Sherrick were referring more generally to the removal of attention, however, the present study would support their hypothesis.

Some subjective comments can be made about the vocal responses relative to the influence of the video audience. Observations by the experimenter and

an examination of the tape recordings of the four subjects' vocal behavior indicated that some sang to the video audience, some discussed things they had drawn on the chalk board, some related make-believe stories from books, and some talked extensively about their hospital environment. Two subjects had poor speech intelligibility; however, their vocal responses were reinforced regardless of the manner in which they were emitted. Since the video audience responded randomly with positive head nods and smiles to the behavior of the subjects, their behavior appeared to be controlled by the responses which came from the video audience. An example taken from the recordings is the type of questions which were asked of the video audience. The subject asked a question, "What is your name?" When the video audience did not respond in a vocal manner to "what," "where," and "why" types of questions appropriately, the question was rephrased as, "Is your name Kary?" "Is your name Karen?" "Is your name Mary?" At the point where the video audience would randomly nod affirmatively or smile pleasantly, the subject would move on to another question or topic. Another example was a question like, "When can I go to the Canteen with you?" being changed to, "Will you meet me at the Canteen this afternoon?" Negative questions were infrequently asked, but when they did occur, they, too, were usually changed to comply with the responses being given consistently by the video audience. "You don't want me to talk?" was changed to, "Is it O.K. if I don't talk?"

Since the video audience reinforced all kinds and types of vocal behavior, specific classes of speech were not differentially reinforced. Reinforcement was contingent only on vocal behavior. One subject related personal information about himself and his friends to the video audience. He became intimate with the video audience in terms of expressing affection for her, even to the extent of asking permission to kiss her. Other subjects were at times indifferent to the audience in terms of personal communications expressed, but related with the video audience in an interpersonal way even during the P contingency through drawing, writing, and demonstrative behavior.

Throughout the study, the experimenter observed various superstitious behaviors being developed as a result of accidental pairing of the subject's response with a positive head nod or smile from the video audience. This was true during the reinforcement sessions, but even more evident during the punishment sessions when many nonvocal behaviors were accidentally paired with the presentation of the video audience. There was no attempt to control these superstitious behaviors.

The vocal behavior of three of the subjects was quickly suppressed by the withdrawal of the video reinforcer during the P contingency. However, the vocal responses of a fourth subject suppressed slowly. For him the presence of the video audience was a stimulus for vocalizing. Vocal behavior was never totally reduced in this subject, but he learned after 10 sessions that by whispering softly he could continue to communicate with the video audience without having it withdrawn since the VOR apparatus was not sensitive to whispers. Since the presence of the video audience appeared to be such a strong stimulus

for vocal behavior by this child, it is doubtful whether the whispering could have been suppressed while the video audience was present. This subject's nonwhispering vocal behavior was eliminated, however, in the complete absence of an audience in the E contingency.

Although all four subjects in this study reached the criterion levels which had been established, they varied in terms of the kind of vocal behavior in which they engaged, as well as the amount of time it took them to reach their criterion levels. This variability was present from the baseline period through the final extinction sessions.

SUMMARY

Four mentally retarded boys between 8 and 12 years were selected from the Parsons State Hospital and Training Center to serve as subjects for this study. Their Parsons Language Sample scores ranged from 55 to 65. Their responses to the three experimental contingencies are summarized below:

1. A filmed video audience served as an effective social reinforcer and increased the vocal behavior of the boys when presented to them contingent on vocalizing.
2. The withdrawal of a filmed video audience, contingent upon the subject's emitting a vocal response, served as an effective punishing stimulus, i.e., reduced vocal behavior.
3. The presence of a blank television screen which did not change when the boys vocalized served to reduce and maintain a low level of vocal behavior.
4. Nonvocal behavior increased as vocal behavior decreased in both punishment and extinction situations.

The subjects responded to the video audience in different ways, but all demonstrated that the audience was effective in controlling their vocal responses.

ACKNOWLEDGMENT

David E. Yoder (Ph. D., University of Kansas, 1965) is Assistant Professor of Speech Pathology, University of Wisconsin. This work was supported by NINDB Grant No. NB 5362-03 to the Bureau of Child Research, University of Kansas.

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Chapter III

THE USE OF OPERANT PROCEDURES TO REDUCE RATES OF READING AND SPEAKING

LARRY J. BRADFORD

In Chapter II, Yoder reported a study in which he demonstrated that the amount of time spent vocalizing during a specified period of time may be reduced by an extinction procedure or a punishment procedure. During extinction there was no change in the environment as a function of vocal behavior. In the punishment condition the audience was removed when vocal behavior occurred. In both instances there was considerably less time spent vocalizing in this condition than in the condition in which the video audience appeared contingent on vocal behavior. The present study was concerned with another procedure for reducing the frequency of vocal behavior and utilized rate, rather than percentage of time spent vocalizing, as the measure of vocal behavior.

The present study utilized a combination of instructions (stimulus control) and positive reinforcement for low rate as a procedure for reducing the rate of vocal behavior. The primary focus was on investigating a procedure for establishing a specific temporal pattern of vocal behavior. A secondary aim was to determine if the procedure was equally effective with speaking and reading behavior and if it would generalize from one to the other.

The reduction of vocalization rates with positive reinforcement for low rate (DRL) has been employed only in a limited way. Shearn, Sprague, and Rosenzweig (1961) ran one highly verbal psychiatric patient on DRL schedules at various time requirements and demonstrated progressive reduction in the rates of vocal emission. Lane (1960) ran subjects on a DRL schedule of one value and then changed to another value without informing the speakers of the change, e.g., from 15 to 30 seconds. Initially, the rate of responding was found to be high, but rates decreased over the session, until, at termination, the speakers were responding after waiting only slightly longer than the prescribed temporal requirement. Instructions plus positive reinforcement for speech behavior (not low rate, though) has been used by Salzinger et al. (1962). These investigators instructed nursery school children to talk to a clown to make him

happy. The clown's nose would light up (positive reinforcers) when the child emitted continuous speech. Continuous speech rate increased in frequency with this procedure. Can such a procedure be used to reduce speech rate and produce a specific temporal pattern of low rate?

METHOD

Nine normal adolescent males, randomly divided into three equal groups, served as subjects. At the end of each daily session, they were paid $1.50 for their participation plus the amount earned in reinforcement points for slowing their speech rate.

The experimental design is presented in Table 1. For Group I speakers, the training employed monosyllabic word reading. Baseline and probe vocalization

TABLE 1. A diagram of the experimental procedures used for examining vocalization rates of three groups of speakers.

	Speaking Conditions					
Group	*Baseline*	*Training*	*Post Training Probes*	*Extinction*	*Post Extinction Probes*	*Post Experimental Probes*
I	Mono Reading Speaking	Mono	Mono Reading Speaking	Mono	Mono Reading Speaking	Mono Reading Speaking
II	Reading Speaking	Reading	Reading Speaking	Reading	Reading Speaking	Reading Speaking
III	Speaking Reading	Speaking	Speaking Reading	Speaking	Speaking Reading	Speaking Reading

rates were established for the experimental task (monosyllabic word reading) and the generalization tasks (contextual reading and impromptu speaking tasks).

During training, Group II speakers read contextual materials, and Group III speakers spoke impromptu from slips of paper. Baseline and probe vocalization rates were established for both groups on contextual reading and impromptu speaking.

Visual stimulus materials were made available to the speakers for reading and speaking. The monosyllabic word reading task consisted of 300 monosyllabic words from a high school dictionary (Thorndike and Barnhart, 1957), typed in columns on 30 pages of paper. The contextual reading task for training and extinction was made by having speakers read directly from *The World Book Encyclopedia* (1961). The contextual reading task for baseline and probes consisted of 1000-word passages selected from the *Golden Book Enclyclopedia* (Parker, 1959). The reading materials were selected from two encyclopedias to increase the variety and provide generalization to a wide range of non-

emotional contextual reading materials. Impromptu speaking consisted of vocalizations emitted while the speakers were talking about encyclopedia topic headings typed on slips of paper. Speakers selected the topics to use; but once a topic was used, it was removed from those available for future speaking.

Preexperimental and daily baselines were established on all speakers. Three 3-minute samples were obtained for the respective tasks during the preexperimental baseline, and the average of the three samples constituted the baseline vocalization rate. As established in a pilot study, the vocalization rates were considered stable for the study if the highest rate did not exceed the lowest rate by more than 10%. One 3-minute sample of each speaking task was recorded for each speaker prior to starting the daily experimental session, to examine any day-to-day fluctuation in vocalization rate.

The training condition used instructions and positive reinforcement for low rates of speech. The speakers were told, "slow down and don't talk so fast," and given a demonstration of syllabic speech. Points which accumulated on the speaker's desk counter were used as positive reinforcement. These points were converted to money at the rate of one-third cent per point.

Each training session lasted no longer than one hour. At first, the subject had to wait 1 sec between vocalizations to receive a point (DRL 1 sec). The criterion for increasing to 1.5 sec, and then to 2.0 sec, was for the speaker to obtain reinforcement points for 70% of his total vocalizations for 2 consecutive 3-minute blocks of time. For the 2.0 sec DRL, the criterion was lowered to 67% for 2 consecutive 3-minute blocks of time. Training was terminated when the 2.0 sec DRL criterion was reached or at the end of 1 hour, whichever occurred first. No speaker was to participate in more than four consecutive daily sessions. All speakers participated in the post-training probes each day even if the reinforcement criterion for the 2.0 sec DRL was not reached.

The extinction condition lasted no longer than 1 hour. When the vocalization rate returned to $\pm 10\%$ of the baseline rate for 2 consecutive 3-minute blocks of time, or 1 hour had elapsed, the extinction condition was terminated. After the postextinction phase, probes were obtained immediately on the speaking tasks of the group to which the speaker was assigned.

One 3-minute sample of the speaking task assigned each group was collected one month after completion of the study. This condition was examined for those speakers who had vocalized at terminal criterion (2.0 sec DRL) during training for two consecutive days.

RESULTS AND DISCUSSION

The nine speakers who participated in this study all reduced their vocalization rates during training, although two speakers did not reach the terminal criterion for the 2.0 sec DRL. There was variability among speakers in the amount that the vocalization rates decreased and in the time required to reach the criterion for the terminal contingency. The criterion for the 2.0 sec DRL was reached by two speakers during the first day and by five speakers during the

second day of training. Two subjects failed to meet criterion after four days. For these two speakers, the experimental sessions may not have been long enough to greatly alter rates based on their previous history of reinforcement. Students typically have had a long history of positive reinforcement for reading rapidly.

For most speakers during extinction, the vocalization rates reached the ±10% of baseline criterion very rapidly. Several factors may explain this finding. When speakers participated in extinction, it was immediately preceded by the posttraining probes. The posttraining probes approximated the extinction conditions in that both were preceded by the same instructions and no reinforcements were presented. The probes could be considered as the initial part of extinction. However, the rapid extinction of reduced vocalization rates may have resulted from the speaker's short history of reinforcement during training. Skinner (1953, p. 70) has stated:

> . . . if only a few responses have been reinforced, extinction occurs quickly. A long history of reinforcement is followed by protracted responding. The resistance to extinction cannot be predicted from the probability of response observed at any given moment. We must know the history of reinforcement.

The following conclusions can be made from the analysis of results.

(1) Training with instructions and positive reinforcement for low rate reduced vocalization rates for all speakers with the three speaking tasks of this study. Vocalization rates for the last three minutes of the final training sessions ranged from 16 to 52% of their respective baselines.

(2) Differential effects on vocalization rate reductions occurred during the training conditions. Whereas seven speakers reached criterion for the 2.0 sec DRL, two speakers did not reach the terminal criterion after four consecutive daily sessions. The two speakers who did not reach criterion were participating on the monosyllabic word lists; however, their vocalization rates were reduced to about 44% of baseline. The two speakers participating on the contextual reading, and the three speakers on the impromptu speaking task, all emitted low vocalization rates for the last three of their final training sessions; vocalization rates were between 16 to 20% of their respective baselines. One speaker participating on the monosyllabic word reading task, and one speaker participating on the contextual reading tasks, did not reach the terminal criterion by the end of the experiment, although their speaking rates were reduced.

ACKNOWLEDGMENT

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Chapter IV

EXTENDING STIMULUS CONTROL OF PHONEME ARTICULATION BY OPERANT TECHNIQUES

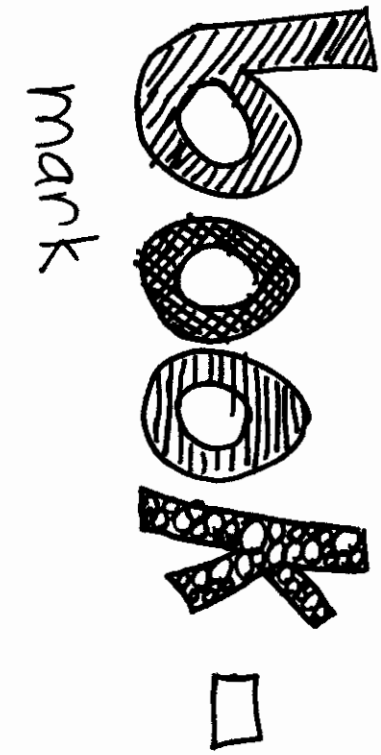
JAMES E. McLEAN

The purpose of this study was to analyze the stimulus method of articulation therapy described by Travis (1931) in terms of the general behavior theory of Skinner (1938, 1953). In undertaking this task, the procedures of the stimulus method were examined in terms of Skinner's (1957) three-term contingency paradigm which describes a relationship between a response, the reinforcement which is contingent on that response, and the stimulus conditions which are present during, or just prior to, that response. The three-term contingency may be presented graphically as $S^D \rightarrow R \rightarrow S^R$, with the S^D representing the antecedent discriminative stimuli present, the R representing the desired response, and the S^R representing the reinforcing stimulus which is contingent on the response.

Stimulus Control

While the reinforcement concepts are fairly well understood and are clearly discernible in the methods of the clinical speech pathologist, the role of the antecedent stimulus is not. Stimulus control is almost the *raison d'être* of his methods and yet few speech pathologists have treated it systematically in experimental contexts. Stimulus control is used in three distinct and critical functional roles by the speech pathologist who is engaged in modifying speech behavior. First, the clinician must have methods which allow him to evoke a particular subclass, or at least an approximation to the subclass of responses that are to be modified. To accomplish this, the clinician usually presents some object or event from the physical world which increases the probability that a particular verbal response will be emitted.

In articulation, the basic unit to be modified is the phone. The clinician can increase the probability that the child will say a word containing a particular sound by showing the child a picture of the object, by showing him the written word, or by speaking the word for him to imitate. The clinician might also



ng or sentence completion. For example, I see the moon. In the daytime I see the bal behavior according to its controlling by spoken words, phrases, and sentences, to the stimulus. Tact behavior is con- erson's environment. Textual behavior is li, and intraverbal behavior is controlled ech.

l, the speech pathologist attempts to in- se emitted will be correct in terms of its xperience and research (Travis, 1931; orrectionist's spoken word is more likely rom a child than is a picture or printed voking stimuli influences the probability ponse. This fact is the foundation of the apy.

ked by one stimulus (for example as an , it can be brought under the control of sion procedures. By securing the response ifting it to textual control, the clinician response is functional. Theoretically, if er a wide range of stimulus conditions, it tends to become functional under similar conditions through a process of generalization. This process of shifting control of responses to several different stimuli seems to be the basic methodology by which the clinician seeks carry-over.

Manipulations of the antecedent stimulus events enable the clinician to evoke the general class of verbal behavior he wishes to modify. It is the antecedent stimulus event which supports the development of the specific topography of the desired speech response. It is also the antecedent stimulus event which holds the key to efficient carry over of the new response. It must be emphasized that the functionality of the antecedent event is established by means of its association with reinforcing consequences.

TABLE 1. A typical pattern of misarticulation of /ʃ/ arranged according to types of evoking stimuli. (+ = correct articulation of the /ʃ/, − = incorrect articulation of the /ʃ/.)

	Stimulus Conditions				
Word	S^1 *Echoic*	S^2 *Picture*	S^3 *Printed Word*	S^4 *Sentence Completion*	*Spontaneous Speech*
Shoe	+	−	−	−	−
Shell	−	−	−	−	−
Ship	+	−	−	−	−
Sheep	−	−	−	−	−
Shovel	+	−	−	−	−

A typical articulation problem can be represented as shown in Table 1. In this case, the phoneme /ʃ/ is usually incorrect, but is appropriately articulated in imitation of spoken words. It is, as Milisen (1954) has called it, "stimulable," and is available in the child's behavioral repertoire. In this situation, the task for the speech pathologist is not one of developing a new response; rather, it is to bring the emission of the existing response under more numerous stimulus conditions. The task, then, is to find ways to extend the stimulus control of phoneme responses. It is this task which this study seeks to analyze.

Research Questions

The study was designed to answer the following questions:

(1) Can articulation responses which can be generated by an imitation of the spoken word stimulus be shifted to the control of picture, printed word, and intraverbal stimuli by a training program which applies behavioral theory and operant conditioning methods?
(2) After the correct response has been brought to training criterion on a new stimulus type, is there generalization of this response to stimulus types on which there has been no training (intratraining generalization)?
(3) After the correct response has been trained to criterion under all new stimulus types, does the response generalize to new word items in which the trained phoneme occurs in the same position in which it occurred in training (new-item generalization)?
(4) After the correct response has been trained to criterion under new stimulus types, does the response generalize to new word items in which the correct response is the phoneme which the subject substituted for the trained phoneme prior to the training (overgeneralization)? For example, if a subject normally substitutes /w/ for /l/, does a newly trained /l/ response generalize to words which correctly require /w/?
(5) After the correct response has been trained to criterion under all new stimulus types, does the response generalize to new word items in which the trained phoneme occurs in a position different from the position in which it was trained (across-position generalization)?

METHOD

Subjects

The subjects were five male residents of the Parsons State Hospital and Training Center whose ages ranged from 11 to 19 years. All subjects had language adequate for communication within the institutional setting. They exhibited moderate to severe articulation defects as determined by the Hejna (a three-position articulation test) using only pictures. When subjects with articulation errors on the Hejna were isolated, they were given a test for stimulability. Specifically, each of the five subjects met two initial criteria:

(1) at least two phonemes defective in all three positions on a picture articulation test of the phonemes /k/, /g/, /f/, /l/, /r/, /t/, /s/, and /z/; and
(2) the ability to imitate correctly one or more of his own defective phonemes in isolation after it had been presented to him no more than five times by the experimenter.

One phoneme which met the criterion of defectiveness in three position, but which the subject was able to imitate in isolation, was selected for each subject. In each case, the response selected for modification consisted of a substitution error in articulation. Two subjects substituted /ʃ/ for /tʃ/, one substituted /w/ for /l/, another substituted /tʃ/ for /s/, and the fifth subject substituted /w/ for /r/.

Materials were developed to evoke 10 different words in which the misarticulated phoneme selected for each subject occurred in the initial position. These materials included 10 stimulus pictures and 10 cards with the words written on them in manuscript print. Ten short phrases designed to evoke these same 10 words as intraverbal responses also were developed for each of the phonemes to be treated. For three subjects, the sounds selected were /l/ and /r/. The /tʃ/ was chosen for the remaining two subjects.

After the five subjects had been identified, a third criterion for inclusion in the study was applied:

(3) each subject failed to articulate correctly the selected stimulable phoneme in the initial position in any of the 10 words when the words were evoked by picture, printed word, or by incomplete phrases.

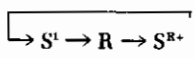
Thus, although each subject could correctly imitate his defective phoneme in isolation, it was not correctly articulated in words which were evoked by pictures, printed words, or incomplete sentences.

Training Program

Each subject was given a training program which successively brought the correct articulation response under the control of four different stimulus conditions. The four stimulus conditions and the criteria for stimulus control are presented in general terms.

Condition I. Ten words which contained the defective phoneme appropriate to each subject in the initial position were presented as echoic stimuli by the examiner who was seated across a small table from the subject in a small, well-lighted, quiet room. The subject was instructed to watch the examiner, to listen to the word, and then to say the word which had been presented to him. Correct articulation responses were followed immediately by the delivery of a penny. Incorrect responses received neither reinforcement nor verbal comment other than an occasional instruction, i.e., "Let's go on." The stimuli were presented in recurring blocks of 10 words until the subject had made correct

articulation responses on his phoneme on at least 50% of the words in each of 4 successive 10-word blocks. When the subject had correctly articulated 5 words in each of 4 successive blocks, Condition I was terminated. Condition I was designed to generate the correct echoic response to spoken words and bring it into contact with the positive reinforcement contingency. Condition I may be presented graphically as:



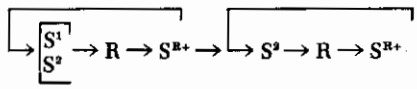
Fifty percent correct on four successive blocks. (S^1 represents the echoic stimulus, R represents the correct response, and S^{R+} represents the positive reinforcer.)

Condition II. The 10 words were presented to the subject under the same conditions as in Condition I. The subject was instructed to watch the examiner, listen to the echoic model of the examiner, and then to say the word presented to him. In Condition II, however, the experimenter presented a picture simultaneously with the echoic stimulus. The experimenter held the picture for each word just to the right of his mouth as he said the word. Thus the subject looked at the experimenter's mouth as well as the picture.

Correct articulation by the subject was positively reinforced. The paired stimuli were presented in blocks of 10 words each until the subject reached a criterion of 20 correct responses in 20 attempts. When criterion was reached in the paired stimulus conditions, the echoic stimulus was eliminated and only the picture was presented. Correct articulation responses were reinforced, and these conditions continued until the subject had reached a criterion of at least 38 correct responses in 40 attempts.

If the number of correct responses decreased in four consecutive blocks of pictures, the experimenter reinstituted the pairing of the echoic stimulus and pictures.[1] In this event, the paired stimuli (echoic and picture) were presented until the subject again achieved the criterion of 20 correct responses in 20 trials. The echoic stimulus again was withdrawn and the criterion of 38 correct responses in 40 trials again was applied for responses to pictures alone. When this criterion was reached, Condition II was terminated. This condition was designed to shift the correct response from spoken words to pictures. It can be presented graphically as:

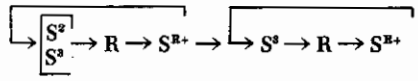
[1]There was a deviation from this criterion for return of S^1 support. It occurred for Subject B and is reported in the section which contains the results for this subject. The graph of Subject C makes it appear that another deviation from this criterion occurred with him since he shows four blocks on a downward trend and S^1 support was not returned. The reader will see, however, that the data charted in Figure 1 are responses judged correct from tape recordings made of the training sessions. The immediate judgments made by the experimenter in the training sessions awarded this subject correct ratings on a small number of responses which were judged incorrect in postsession judging sessions. Since decisions about modifications of treatment conditions had to be made in the training sessions on the basis of the immediate judgments, the postsession judgments could not function to change treatment conditions within a training session. The reliability between the immediate and postsession judgments was generally high, however, and this was the only occasion in the study in which a disparity between them resulted in a missed criterion.



20 correct in 20 (S^1 = echoic stimulus) — 38 correct in 40 (S^2 = picture stimulus)

Condition III. Condition III duplicated Condition II in procedure and criteria, but the stimulus types differed. The pictures and the printed words were paired until the subject emitted 20 correct responses in 20 attempts. When this criterion was achieved, the pictures were withdrawn. Only the printed words were presented, and correct responses were reinforced until the subject emitted 38 correct responses in 40 trials. At this point, Condition III was terminated.

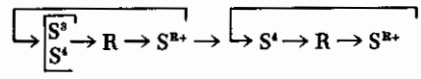
Condition III was designed to shift control of the correct response from the pictures to the printed words. It may be described graphically as:



20 correct in 20 — 38 correct in 40

(S^2 = picture, S^3 = printed word)

Condition IV. Except for stimulus types, Condition IV was identical to Conditions II and III. The initial stimulus conditions in Condition IV paired the printed word with the incomplete sentence. The subject was instructed that he would hear a sentence in which a word was left out. At the conclusion of the sentence, he was to say the word which had been omitted. The incomplete sentence for each word was presented to the subject. Just as the response word was needed to complete the sentence, the experimenter exposed the printed-word card. The stimuli remained paired until the subject had emitted 20 consecutive correct responses to the paired stimuli. The printed word then was removed and the responses were evoked by the incomplete sentence only. When the subject had emitted 38 correct responses in 40 trials, Condition IV was terminated. When subjects reached criterion on S^4, the treatment aspect of the experiment was completed, Condition IV may be presented graphically as:



20 correct in 20 — 38 correct in 40

(S^3 = printed word, S^4 = incomplete sentence)

Tests for the Effects of Training

The following procedures were used to evaluate the effects of the training program.

Pretraining and Posttraining Tests. Each subject's responses to the 10 training words in all 4 stimulus conditions were recorded before the training sequence began and again 24 hours after the training sequence was completed. The in-

structions appropriate for each stimulus condition were given, but there was no reinforcement. Thus, the test responses represent the operant level performance before and after training.

Intratraining Probe Tests. After the criterion level was attained for each stimulus type, the subject's unreinforced responses to the next stimulus type were recorded. Thus, a probe test with printed words was made after the subjects had reached criterion on pictures, and another probe was made with incomplete phrases after subjects had attained criterion on printed words. These intratraining probe tests showed the number of correct responses to untrained stimulus types which occurred after training to criterion on a preceding stimulus type.

Table 2 shows the sequence of the training program and the details of each condition. This table also shows the relative place of the various intratraining probe tests and the pretraining and posttraining tests used to evaluate the effects of the training program. The stimulus conditions, the reinforcement contingencies, and the criterion applied for each experimental condition are evident when one reads across the rows of the chart. By reading down the first column, the reader may observe the sequence of the training program and the tests associated with it.

Tests of Generalization after Training

Twenty-four hours after the conclusion of training and immediately after the administration of the posttraining tests, three tests of stimulus generaliza-

TABLE 2. Sequence of training conditions and related tests showing the stimulus type, reinforcement contingency, and criterion associated with each. ($^{a}S^{1}$ = echoic; S^{2} = picture; S^{3} = printed word; S^{4} = incomplete sentence.)

Sequence of Training Conditions	*Stimulus Type(s)*[a]	*Reinforcement Contingency*	*Criterion*
Pretraining Tests	S^1 S^2 S^3 S^4	None	10 responses to each type
Training Condition I	S^1	Positive	50% in each of 4 blocks
Training Condition II	S^1 S^2 paired S^2 alone	Positive Positive	20/20 correct 38/40 correct
Intratraining Probe on S^3	S^3 alone	None	10 responses
Training Condition III	S^2 S^3 paired S^3 alone	Positive Positive	20/20 correct 38/40 correct
Intratraining Probe on S^4	S^4 alone	None	10 responses
Training Condition IV	S^3 S^4 paired S^4 alone	Positive Positive	20/20 correct 38/40 correct
Posttraining Tests	S^1 S^2 S^3 S^4	None	10 responses to each type

tion were given to each subject. Generalization was tested only in response to the picture stimuli. The three types of generalization tested were new item generalization, overgeneralization, and across-position generalization.

New Item Generalization. Each subject was presented with pictures of five new word items containing his phoneme in the initial position. The subject was given the standard instructions, "Tell me the name of this picture," and his responses were recorded and judged. If he responded correctly to the new items, generalization was considered to have occurred. No reinforcement was given during this test.

Overgeneralization. In this test, each subject was presented with pictures of five new words in which a phoneme the subject had previously substituted for the trained phoneme occurred in the initial position. Overgeneralization occurred if the subject produced the phoneme on which he had been trained rather than the correct phoneme. For example, prior to training, Subject B substituted a /ʃ/ for the /tʃ/ sound. He was trained on the /tʃ/ phoneme, and his test for overgeneralization consisted of five words which, when correctly produced, begin with /ʃ/. When Subject B incorrectly initiated these words with the newly trained /tʃ/, overgeneralization was considered to have occurred. No reinforcement was given during these tests.

Across-Position Generalization. Generalization of this type occurred if the subject produced his training phoneme correctly in new words which had the phoneme in the medial rather than in the initial position. Each subject was presented with pictures of five new words in which his trained phoneme appeared in the medial position. Correct articulation of the phoneme was considered to constitute across-position generalization.

Retention Tests

After the training program, when probe tests and generalization tests had been terminated for one week, each subject was given another test of his 10 training words under the picture stimulus conditions. Each subject also was asked to respond again to the 15 words which were used in testing the 3 types of stimulus generalization. Changes were identified by comparing the data from these retention tests with the posttraining tests in Condition II (pictures) and with the posttraining generalization tests.

Recording and Reliability of Data

The positive reinforcement contingency required that the experimenter make immediate judgments about the correctness of the articulation responses emitted during the training sequences. The criteria for changing the conditions also required that the experimenter maintain a running tally of correct responses

during the training sessions. It was not possible to check on the judgments of the experimenter during the actual sessions. Tape recordings were made of all training sessions and these were replayed immediately after each session, and the number of correct responses was judged by the experimenter. These post-session judgments were used as the experimental data reported in the study.

Interjudge Agreement. The recorded responses on all tests and most sections of the experiment in which criteria were attained were copied on another tape using a companion tape recorder. Approximately one month after all experimentation had been completed, these responses were judged independently by another experienced speech pathologist. The percentages of agreement between the experimenter and the independent judge were computed and are reported as interjudge agreement.

RESULTS

The results of this study are reported in the following order: (1) Pretraining Tests; (2) Results of the Training Program; (3) Posttraining Tests; (4) Intra-training Probe Tests; (5) Stimulus Generalization Tests; (6) Tests of Retention; (7) Reliability of Data; and (8) Summary of Results.

Pretraining Tests

The responses of all subjects on the tests given in each stimulus condition prior to the training program are shown in Table 3.

The data in Table 3 show that none of the subjects articulated his phoneme correctly when the response occurred in the presence of pictures, printed words, or incomplete sentences. Four of the subjects, however, could articulate correctly some of the words when they were evoked by an echoic stimulus model. One subject did not articulate his phoneme correctly in any of the stimulus conditions prior to the training program. The correct responses in response to echoic stimuli did not go beyond 60% for any of the subjects. The results of the pretraining tests indicated that the operant level for correct articulation responses was generally low. These data did show, however, that the echoic stimulus had some control over the correct response prior to training.

TABLE 3. Number of correct articulations of 10 words when evoked by four types of stimulus presentations prior to training.

	Stimulus Types			
Subject	S^1 *Echoic*	S^3 *Picture*	S^2 *Printed Word*	S^4 *Incomplete Sentence*
A	6	0	0	0
B	5	0	0	0
C	2	0	0	0
D	2	0	0	0
E	0	0	0	0

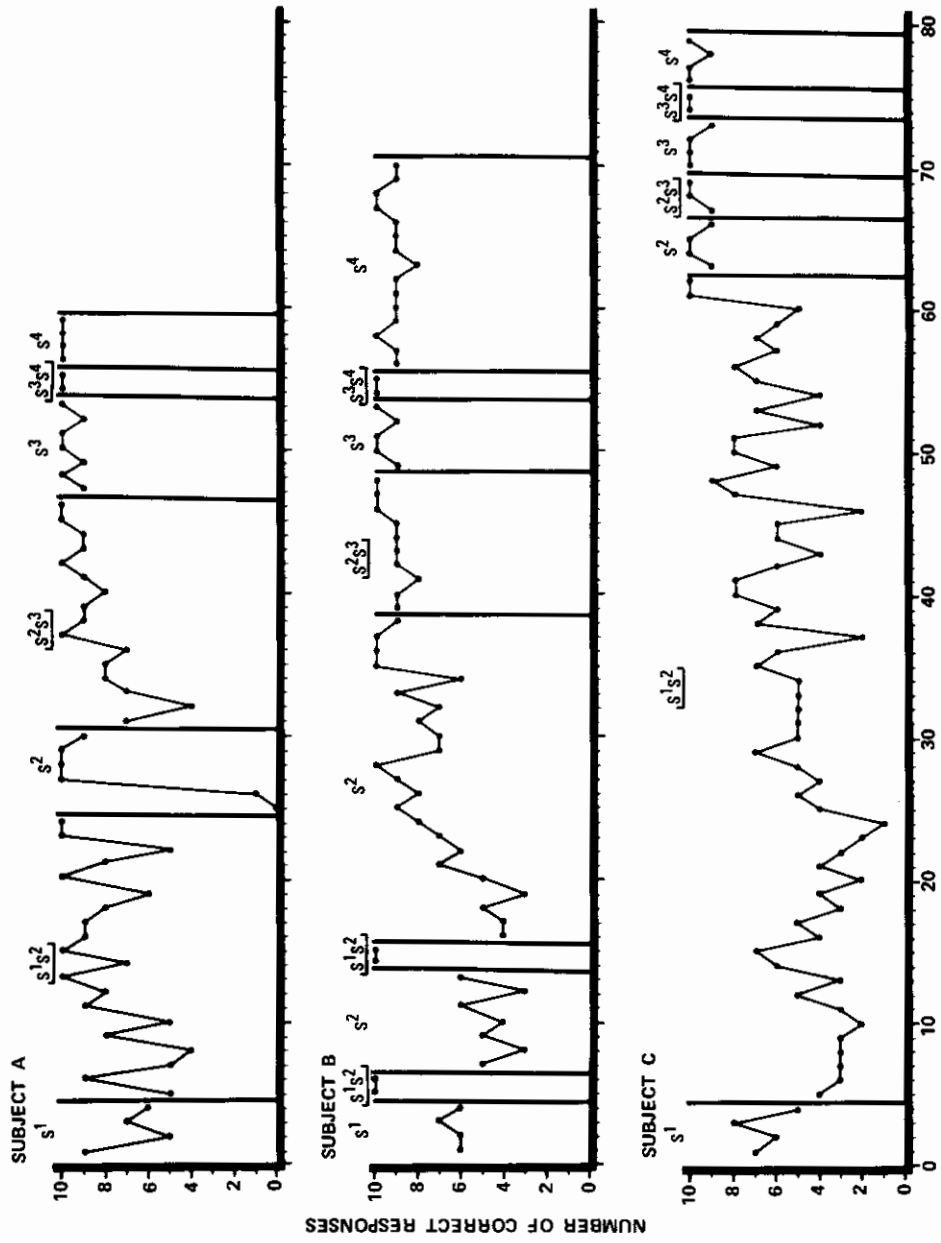
Results of the Training Program

Figure 1 shows the number of correct responses for each training block of 10 words for each subject in each of the 4 training conditions. Each subject's graph begins with the correct responses made in Condition I (echoic stimuli) and reports the number of correct responses for each block of 10 words until criterion is reached in the second stage of Condition IV (incomplete sentences) ,which was the final condition in the training program. When a final condition was attained within any of the conditions, the change in conditions is marked with a vertical line through the graph.

Figure 1 shows that four of the five subjects (A, B, C, and D) reached the final criterion of the training sequence after a total of blocks ranging from 59 for Subject A, to 79 blocks for Subject C. Subject E made little progress in response to the echoic stimuli of words, and so he was dropped after 26 blocks of trials. Since Subject E was eliminated from the study, the following description of the results will be confined to Subjects A, B, C, and D.

All four subjects reached the criterion of at least 50% correct articulation responses for 4 consecutive blocks of 10 responses within 7 blocks during the echoic condition. The subjects were then given the combined echoic and picture stimulus. Two subjects (B and D) reached criterion of 20 correct responses within 2 blocks of 10 trials. Subjects A and C met criterion in 20 and 58 blocks of trials, respectively. It is of interest that when the echoic stimulus was withdrawn from Subjects B and D, the rate of correct responses to the picture alone failed to increase and the spoken word had to be reinstated. This was not true for Subjects A and C. The echoic condition was reinstated for Subject D because his correct responses decreased for four consecutive trial blocks. It was necessary to return to the echoic condition for Subject B even though his correct response rate didn't decrease for four consecutive trial blocks. The reintroduction occurred as a result of a session of emotional crying on the part of Subject B when he did not reach 100% correct responses to the pictures.

The experimenter also was forced to depart from the standard procedures with Subject D during Condition III. Subject D became ill during the experiment. He had reached criterion in the initial stage of Condition III and then missed one week of training because of his illness. When he returned to the training sessions, his articulation was still good, but the word he produced was often not the word printed on the card. The experimenter rejected the wrong word responses by verbal comment, "That is not the word this card calls for." The subject's second attempt would frequently deteriorate to the substitution response. In order to reduce the influence of the reading difficulty, the experimenter elected to pair the word cards again with the pictures to provide support for reestablishing the correct reading response without providing specific support for the articulation response such as return of the spoken word would have done. The pairing of the picture and printed word was carried out for two blocks of ten trials. The subject appeared to have regained correct associations with the printed word after the second block of pairing. The picture support


SUBJECT A
SUBJECT B
SUBJECT C
NUMBER OF CORRECT RESPONSES

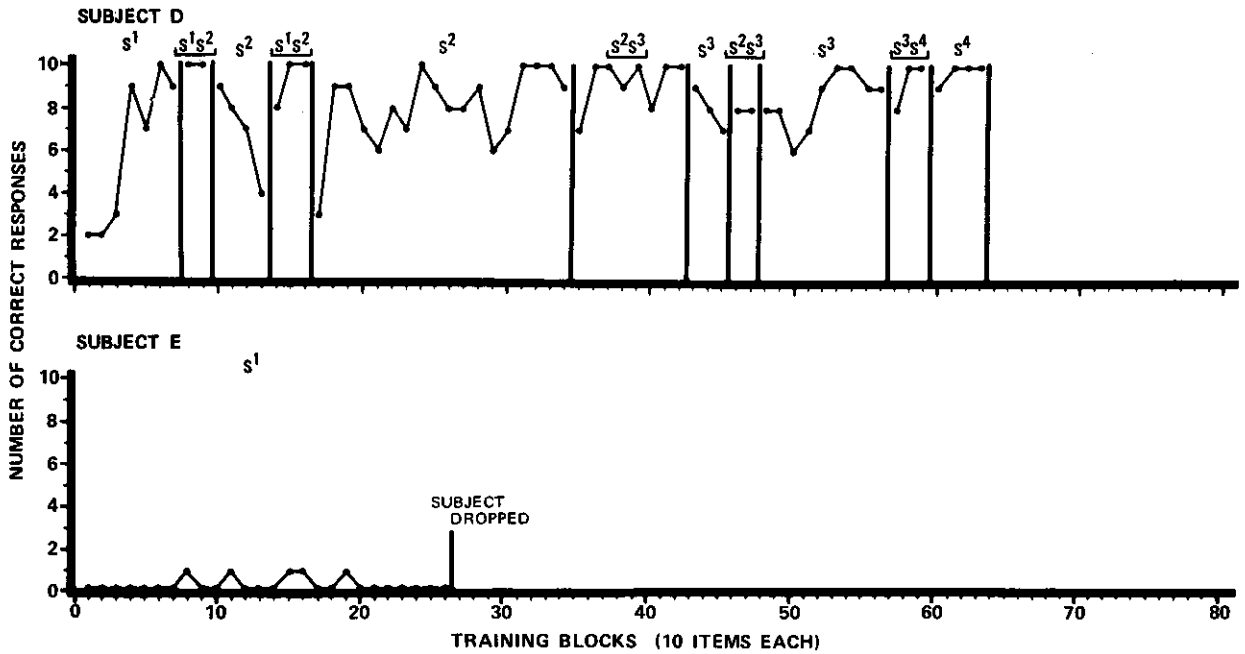


FIGURE 1. Correct responses in each training block under all stimulus conditions for all subjects. (S^1 = echoic, S^2 = picture, S^3 = printed word, S^4 = incomplete sentences.)

was withdrawn, and again only the printed word stimuli were used to evoke the response. The correct articulation responses were at a relatively low level for the first few blocks after the pairing, but the subject was able to recover rapidly, and the criterion of 38 correct responses in 40 attempts was accomplished within 9 blocks.

The final training phase involved shifting the control of the correct articulation response from the printed word to the incomplete sentence. A criterion of 20 consecutive correct responses to the combined printed word and incomplete phrase was achieved within 3 blocks of trials for all 4 subjects and the printed word stimulus was withdrawn. Three of the 4 subjects (A, C, and D) required only 4 blocks of trials to meet the 38 of 40 criterion for correct articulation responses to the incomplete sentence alone. Subject B required 15 blocks of trials to reach criterion. The high number of trial blocks required for Subject B to reach criterion during the incomplete phrase condition was due primarily to a consistent misarticulation of a single word, "chest."

Posttraining Tests

The data in Table 4 show that the four subjects who completed the training program emitted extremely high levels of correct responses when they were

TABLE 4. Number of correct articulations of 10 words when evoked by four types of stimulus presentation after training.

	Stimulus Types			
Subject	S^1 *Spoken Word*	S^2 *Picture*	S^3 *Printed Word*	S^4 *Incomplete Sentence*
A	9	10	10	10
B	10	9	10	9
C	10	10	10	10
D	10	10	9	9

tested in all of the stimulus conditions 24 hours after training had been completed. The occasions in which the subjects misarticulated a word do not appear to be systematically related to any of the stimulus types. A comparison with the pretraining test data (Table 3) shows the gains which occurred during the training program.

Intratraining Probe Tests

The unreinforced probe tests administered to test spontaneous generalization are reported in Table 5. These data indicate that the subjects varied in their ability to articulate correctly in the untrained stimulus condition after they had responded to criterion on the preceding stimulus type.

Subject A showed only moderate generalization of the correct response after training on the preceding stimulus type. His responses were still relatively

TABLE 5. Number of correct responses on pictures before any training, printed words after training on pictures, and incomplete sentences after training on printed words (intratraining probe tests).

Subject	*Pictures*	*Printed Words*	*Incomplete Sentences*
A	0	4	5
B	0	10	9
C	0	9	10
D	0	4	8

erratic after the completion of Condition II (pictures) so that the low number of correct responses on the Condition III stimulus probe (printed words) was congruent with the subject's response during early training in Condition III. During Condition III, however, this subject attained extremely high percentages of correct responses which were maintained during Condition IV (incomplete sentence) training; yet the probe tests for Condition IV were low for subject A. The other three subjects showed degrees of generalization on the intratraining probe tests which were compatible with the data reported in the training sequence. For example, Subject B attained high, stable response levels by the end of Condition II, which were maintained throughout Conditions III and IV. These high response levels are reflected on the probe tests.

By the end of Condition II, Subject C also had established a high percentage of correct responses which was maintained during Conditions III and IV. His probe tests on the untrained stimulus types reflected nearly complete generalization prior to specific training, a generalization pattern similar to that of Subject B.

Subject D did not show generalization to a high degree on the printed word stimuli prior to training on them. However, this subject did have difficulty reading the printed words until after they had been paired with pictures for several blocks of trials. Thus, his probe tests are compatible with his training data. On incomplete sentence stimuli, Subject D generalized well prior to training. He had attained some relatively high percentages of correct responses in the later stages of the condition preceding it, and these were maintained during Condition IV. This is reflected in the probe test results on the Condition IV stimulus before it had been trained.

Stimulus Generalization Tests

Three of the four subjects who completed the training program showed:

(1) complete generalization of the trained phoneme to new word items which were initiated by the trained phoneme;
(2) complete generalization of the trained response to new word items which, if correctly produced, required the phoneme which the subject had substituted for the trained phoneme prior to training; and

(3) no generalization of the trained response to new word items in which the trained phoneme was required in the medial position.

Table 6 shows the results of the three tests of stimulus generalization.

TABLE 6. Percentage of correct articulations of the trained response in new items which tested various types of stimulus generalization.

	Types of Generalization[a]		
Subject	*New Item*	*Over-generalization*	*Across-Position*
A	0%	0%	0%
B	100%	100%	0%
C	100%	100%	0%
D	100%	100%	0%

[a]New Item = Trained response in new words correctly requiring the trained response in the initial position.

Overgeneralization = Trained response in new words which, if correctly produced, required the phoneme substituted for the trained response prior to training.

Across-Position = Trained response in new words in which the trained response was required in the medial position.

Subject A did not produce his trained phoneme correct in new words which began with the /l/, in new words which correctly required the /w/, or in new words which required the /l/ in the medial position. This total lack of generalization of the trained response was at variance with the behavior of the three others who completed the training program.

Subject B correctly articulated his trained /tʃ/ in all five of the new items which required /tʃ/ in the initial position. He also overgeneralized and produced the /tʃ/ in new words requiring the /ʃ/ sound which he had substituted for the /tʃ/ prior to the training program. However, subject B did not generalize the /tʃ/ response to words which required its use in the medial position.

Subject C also was trained on the /tʃ/ sound. His generalization responses were identical to those of Subject B. He generalized to new items, and overgeneralized to new words requiring the /ʃ/ sound. He did not produce the /tʃ/ correctly in words in which it appeared in the medial position.

Subject D was trained on the /s/ sound. He generalized his trained response to new items which required it in the initial position. He also overgeneralized the /s/ to words which, when correctly produced, require the /tʃ/. He did not articulate the /s/ correctly in words in which it appears in the medial position.

Tests of Retention

Table 7 shows the percentage of correct responses of the trained phoneme in the various retention test conditions. The data in Table 7 show that the responses trained and correctly articulated on previous tests were well main-

TABLE 7. Percentage of correct articulations of the trained response in picture conditions on various tests one week after training (retention tests).

Subjects	*Trained Words*	*New Item Generalization*	*Over-generalization*	*Across-Position Generalization*
A	100%	40%	0%	0%
B	100%	80%	100%	0%
C	100%	100%	100%	0%
D	100%	100%	100%	0%

tained after one week. Each subject maintained 100% correct articulations on the 10 words on which he was trained. Subjects C and D maintained 100% generalization of their trained responses in the new item test and in the test for overgeneralization. Subject B failed to articulate his phoneme correctly in one of the five new item words and thus dropped to 80% correct on this test. Subject B did maintain his 100% overgeneralization pattern, however. Subject A showed some generalization to new words one week after training, which he had not demonstrated in the tests given 24 hours after training. As in the first test for across position generalization, none of the subjects generalized his trained phoneme across position. In summary, these responses are highly similar to the responses to the initial generalization tests.

Reliability of Data

The dependent data of this study consisted of articulation responses which were judged to be correct. In order to establish the reliability of these data, a sample of 260 responses was taken from the tapes of each subject, and each response was judged as correct or incorrect by another judge who had 10 years' experience as a speech pathologist.

Responses from the various phases of the experiment were copied on another tape and scored by the independent judge. The proportion of total response output used in the reliability sample ranged from 0.32 of all Subject C's responses to 0.44 of Subject A's.

After the reliability judgments had been completed, they were compared to the experimenter's judgments of the data under each of the conditions. Each difference in the number of responses judged correct in each condition was tabulated and summed across all conditions. This sum, representing the total number of responses on which the judgments disagreed, was subtracted from the total number of responses judged. The number remaining represented the number of responses for which both judgments agreed. A percentage of agreement between judgments was calculated by dividing the number of responses on which the judgments agreed by the total number of responses judged.

Table 8 indicates that from 89.9% to 98.8% of the responses were judged the same by the experimenter and the independent judge. The interjudge agreement for all subjects was 95.4%.

TABLE 8. Percentage of agreement between examiner and the independent judge on the articulation of 260 responses by each of four subjects.

Subject	*Number of Responses Judged*	*Percentage of Agreement Between Judges*
A	260	96.1%
B	260	98.8%
C	260	98.0%
D	260	89.9%
All Subjects	1040	95.5%

Summary of General Results

The data for this study in articulation modification show that four in five subjects were trained by operant techniques to articulate correctly a sound which they had previously misarticulated. By a process of generating correct responses under one stimulus condition, reinforcing them with pennies, and pairing the controlling stimuli with stimuli which had not evoked the response previously, the correct articulation response was brought under the control of three new stimulus types. A fifth subject was dropped from the study when he was not able to articulate his phoneme correctly in words in imitation of the experimenter's echoic stimulus.

Once a phoneme was emitted at high, stable levels under one stimulus type, it could be readily shifted to other stimuli which had not evoked the response. After a phoneme had been trained and was emitted correctly under all of the stimulus types, subjects tended to generalize the response to new items and to overgeneralize it to their old substitution phonemes. None of the subjects, however, generalized the response when the trained phoneme was changed in its position. One subject did not show any of the three types of generalization.

One week after training, all subjects still were able to articulate correctly the ten words on which they had been trained. All four subjects also maintained their original generalization patterns. However, one subject who had not generalized in the previous test, showed some generalization to new items one week after training.

DISCUSSION

This study attempted to use the principles of operant conditioning to analyze a current procedure for modifying articulation. The results of this study indicate that such an approach is useful and that additional research along these lines may provide data of pertinence to the speech pathologist. The discussion of these results will be organized under the three headings: 1. Training Program, 2. Generalization, and 3. Summary.

Training Program

The basic rationale of this study was that the general procedures of the stimulus method of articulation therapy have, as their base, a program of shifts of stimulus control of a new phoneme response. It was hypothesized that a program of such shifts could be developed using operant conditioning techniques and that the application of such a program could provide a better understanding of the dynamics of articulation modification.

There was no assumption that the procedures used in this study represent the only way articulation may be changed. It was assumed, however, that if the successful practices of speech pathologists were cast in operant conditioning systems, successful results should be obtained and, importantly, should be more readily analyzed in terms of their dynamics. Some discussion of these dynamics appears desirable at this point; further, such discussion appears best presented within the organization afforded by the three variables manipulated in the study (reinforcement, stimulus conditions, and response) and within the area of generalization.

Reinforcement Variable. Money was selected as the reinforcer for this study and proved to be quite effective. No attempt was made in this particular study to determine how money would compare with some other S^R, or even whether an S^R was necessary at all.

Stimulus Variable. The echoic stimulus usually evoked correct articulation responses. Since the subjects were selected for this study on the basis of imitating an isolated phoneme, such effectiveness was expected. Beginning with the pretraining tests, however, a differential effect of the echoic stimulus was demonstrated by the occurrence of correct responses when that stimulus was in force and by incorrect responses when any other type of stimulus was presented. When the echoic stimulus was withdrawn during the training program, three of the four subjects showed a marked deterioration in response. The exception was Subject C who, significantly, had a much longer exposure time to the echoic condition than did any other subject. A return to echoic stimulus support for Subjects B and D reversed what was classed as a serious deterioration of the response. After their reexposure to the echoic stimulus, these subjects showed an immediate increase in the number of correct responses. Thus, the echoic condition was demonstrated to be an effective means of generating an emission of the desired response when other stimulus conditions failed. The response generated in this manner proved to be relatively easy to extend to other stimulus conditions.

Once an articulation response in a word was brought under the control of the initial nonechoic stimulus (pictures), its shift to other stimulus types was relatively easy to effect. There are indications within these data which suggest that extremely prolonged exposure to echoic stimuli may suffice to allow effi-

cient shift of stimulus control. The response patterns of Subject C indicate that the response was shifted to pictures (and all following stimulus types) with minimal difficulty after criterion had been attained under the echoic picture pairing. This subject, however, had responded under echoic support for 58 blocks—almost three times as long as the next longest exposure time per subject to these conditions. (One subject completed the entire program in 59 blocks of training.) The other three subjects needed exposure to at least one nonechoic stimulus type before the response shifted to another stimulus in optimum fashion.

Once the picture controlled the response, a shift to the control of the printed word was surprisingly easy. It had been hypothesized that the procedure of pairing controlling stimuli with noncontrolling stimuli would be necessary throughout the training sequence. The experimenter now believes, however, that once picture control is attained, the pairing procedure is not necessary to shift the control to the printed word and to the intraverbal stimuli. Although the pairing procedure was extremely useful in establishing the association between the previous responses and the desired repetition of those responses in an efficient manner, the intratraining generalization probes show that each subject had at least four correct responses to incomplete phrases after criterion was attained on printed words. These levels of correct responding may have been sufficient to have allowed the effect of the positive reinforcer to increase the frequency of occurrence of these responses to criterion under the new stimulus conditions. In cases similar to that of Subject D, however, who needed pictures paired with the printed words in order to acquire the correct reading response, the pairing procedure is most useful. Further research seems appropriate on the value of using a well-conditioned, nonechoic stimulus in supporting correct responses to another nonechoic stimulus.

It should be emphasized, however, that the extension of the correct response to new stimulus types was not a spontaneous event after one stimulus shift had been accomplished. The curves show that the response was subject to deterioration under each new stimulus type for some subjects. For example, Subjects A and D showed declines in articulation performance even after reaching criterion on pictures. Subject D needed extended exposure to the reinforcement variable in order to reach criterion in both paired pictures–printed words, and printed words alone. While the extension of stimulus control occurred abruptly in some cases, in others it occurred gradually under reinforcement conditions.

The extension of stimulus control demonstrated in this study seems to offer data which will be useful in the speech pathologist's consideration of functional carry-over of newly learned articulation responses. Those techniques were shown to be effective, and the responses they generated were highly generalizable. Further investigation of carry-over using these methods would be fruitful.

Responses. Although the articulation responses were dichotomously classified as either correct or incorrect, they varied in degrees of adequacy. A relatively large number of responses which would not meet conventional norms for cor-

rectness were positively reinforced in training because they represented significant deviations from the previous patterns and seemed to the examiner to be directed toward a more correct response. These approximations were not judged as correct responses in the data, but they were reinforced in a process of shaping a response toward the correct topography. The occurrences of these reinforced approximations were more frequent in the early stages of the training. They were present in conditions of paired spoken words and pictures, and they were present also in the picture condition for Subjects A and B. These subjects reflected serious deterioration of the response after spoken word support was removed and, consequently, they needed relatively long exposure to pictures before they attained criterion. The experimenter felt that reinforcement of approximations to the correct response was necessary during this stage to reduce the frequency of the habitual misarticulation. By reinforcing a response which was unlike the habitual response, the habitual response was less likely to occur. It is apparent, however, that the shaping procedure involved experimenter judgment rather than explicit, tested criteria for determining and reinforcing responses which more closely approximated the correct articulation of the response. It is possible that the experimenter was reinforcing responses which were, in fact, incompatible with the correct response and that the attempt to shape successive approximations may have interfered with learning. These procedures need additional investigation. The techniques of shaping articulation in relation to articulation responses have not been investigated. The differential reinforcement of various topographic features of the phonemes, such as those described by Miller and Nicely (1955), might be undertaken as one approach to such techniques.

Generalization

Intratraining Generalization. Generalization of the responses from one stimulus type to another was most obvious after criterion had been attained on the initial nonechoic stimuli (pictures). No probe data were taken on pictures following criterion on echoic stimuli. Such data would be useful in comparison with probe-test data on the other two stimulus types. The number of correct responses on the first training block in pictures alone, however, indicates that the number of correct responses to pictures, even under positive reinforcement, was extremely low, except for Subject C. Since the intratraining probe scores to printed words and incomplete sentences were found to correspond highly with data from the initial training blocks under these same conditions, it is likely that the generalization to pictures from echoic training also would have been highly related to the training blocks and would have been, therefore, relatively low. Generalization from paired spoken words and pictures did occur, however, and it remained as the base for all the behavioral changes that were made during the training.

All of the evidence indicates that responses which have been trained under one stimulus condition generalize to some degree to new stimulus types and,

further, that responses which have been trained under two stimulus types generalize to a still higher degree to other types of stimuli. Thus, generalization between stimulus types appears to be increased by each extension of the number of stimulus types which control the response being generalized. Such information has important implications for extending the functional level of new articulation having been acquired in a clinical session with a speech pathologist. If articulation responses can be extended functionally by bringing those responses under the control of a critical combination of stimulus types, new programs for establishing carry-over into functional speech may be established.

New Item, Across-Position Generalization, and Overgeneralization. The 100% new item generalization and overgeneralization by three of the four subjects indicate that articulation responses which have been conditioned by the procedures of this study have a high level of operant emission. It does not appear, however, that the generalization patterns can be explained only in terms of increased operant level of emission. If this program had merely increased the operant level of specific phonemes in the initial position of words, attempts on the word items used to test for across-position generalization also would have reflected the overgeneralization of the new responses to the initial position of these words. This occurred in only one isolated instance. Subject D emitted his trained phoneme of /ʃ/ on his first attempt to the across-position items. He emitted /s/ as the initial phoneme in the word *glasses*, which was used to test for generalization of the /s/ to the medial position of words. In all other items of the across-position test, however, this subject produced his usual approximation of the initial sound which was appropriate for each word item. No other subject generalized his trained response to the initial position of any of the other words used to test across-position generalization. Further, the one subject who made such a generalization did so only on the first of ten such responses made to the initial tests of generalization and the tests for retention.

These findings are generally in line with the findings of Winitz and Bellerose (1963) who found that previously conditioned phonemes did generalize to new stimuli which were removed from the conditioned phoneme by no more than two of the linguistic features described by Miller and Nicely (1955). In the current study, the generalizations which occurred demonstrated similar restrictions. The /s/ overgeneralized to the /tʃ/ and the /tʃ/ overgeneralized to the /ʃ/. With Subject A, however, the /l/ did not overgeneralize to the /w/. It is also interesting to note that in testing for across-position generalization, neither Subject B nor C overgeneralized his trained /tʃ/ response to an item with an initial /t/ sound. There were no other phonemes in the across-position tests sufficiently near the trained phonemes to allow further analyses of this type. It does appear, however, that the phoneme had to be similar to the trained phoneme before any generalization occurred. Thus, although the high operant response level of the phoneme in the initial position was evident, generalization was restricted to words in which the initial phoneme had features highly similar to those of the trained phoneme.

It is also important to observe that these generalizations were effected at the level of the phoneme within a word. It has been suggested by Winitz and Bellerose (1963) that the linguistic unit in which a phoneme is carried has important implications with regard to generalization. The indication would be that phonemes trained in words have extremely high generalization potential to new words in which the trained phoneme occurs or in which a phoneme which closely approximates the features of the trained phoneme occurs.

The lack of across-position generalization may indicate that differences in position also restrict generalization of the responses. Any analysis of the factors which brought about this restriction, however, is beyond the reach of this study.

Beyond these attempts to understand the basic factors which restricted the generalization of the responses trained in this study, one may consider also the functional operations which might affect the generalization patterns. It appears quite possible, for example, to secure the appropriate generalization and to suppress the inappropriate generalization by manipulations which could be added to the training program. It is probable that modifications in the paradigm which would require discriminations in the position of the phonemes and discriminations between the phoneme being trained and the phonemes adjacent to it might result in significantly different generalization patterns. The ear-training program traditionally used by speech pathologists (Van Riper, 1963) contains training in just such discriminations. Although, as this study has shown, such a program is not necessary to modify articulation responses on phonemes which are stimulable, such training may be highly functional in attaining appropriate generalization. An analogue of such training could be integrated easily into the present training paradigm.

SUMMARY

This study was designed to investigate the use of operant conditioning techniques to modify articulation behavior. Five high-level mentally retarded males were given a training program designed to transfer a correctly articulated response from the control of echoic stimuli to pictures, printed words, and incomplete spoken sentences.

The correct articulation of the experimental phonemes in words was increased by delivery of a penny as a positive reinforcer for each correct response. The steps of the program consisted of the following:

(1) The correct response was brought to criterion level under the echoic stimulus;
(2) Pictures were paired with the echoic stimuli until correct responding reached a criterion level;
(3) The echoic stimulus was withdrawn and the response was evoked by only the picture stimuli;
(4) The pictures were paired with printed words;

(5) The pictures were withdrawn and the response was evoked by the printed words alone;
(6) The printed words were paired with incomplete sentences which had been designed to evoke responses on the training words;
(7) The printed words were withdrawn and the response was evoked by the incomplete sentences alone;
(8) When the subject reached criterion for correct responding in the incomplete sentences condition, the training program was terminated.

At the conclusion of the training program, four of the five subjects articulated their experimental phonemes correctly under all stimulus conditions. The fifth subject was dropped from the study when he could not articulate his experimental sound in words under the echoic stimulus condition. The four subjects who completed the training program all showed erratic levels of correct responding in the early stages of the program, but eventually attained high, stable levels of correct responding.

During the course of the training, generalizations of the new responses to stimulus types on which no training had yet occurred were tested after the training on the preceding stimulus type had reached criterion. The results of these tests of intratraining generalization to untrained stimulus types indicated that when a correct articulation response had been brought under the control of one stimulus type, it did show some spontaneous generalization to stimulus types on which no training had occurred. The data of this study also indicate that generalization to untrained stimulus types increased as the number of stimulus types which controlled the response increased; that is, the generalization to the third stimulus type was generally higher than the generalization to the second stimulus type.

After the training program had been completed, 15 new words were presented to each subject. These words were selected to test the generalization of the new responses (1) to new words which called for the trained phoneme in the same word position in which it had been trained, (2) to words in which the position of the trained phoneme was different from that in which it was trained, and (3) to words which required the phoneme the subject had substituted for the training phoneme prior to training.

The generalization of the trained phoneme to new items which required the trained response in its trained position was 100% for three of the four subjects. The generalization of the trained phoneme to words which correctly required the phoneme which had been previously substituted for the trained phoneme was also 100% for three of the four subjects. One subject did not show either of these types of generalization. None of the four subjects generalized the trained response to words which required the trained phoneme in a position different from that in which it had been trained.

One week after all training and testing had been completed, the responses to the ten words on which each subject had been trained were tested with picture conditions. The three types of generalization of new words were also re-

tested. The results of these tests of retention indicated that the trained response was emitted in 100% of the training words by all four subjects one week after training. Generalization to new words maintained the same general patterns which had been demonstrated in the first of such tests.

ACKNOWLEDGMENT

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Chapter V

REINFORCEMENT PROCEDURES AND THE INCREASE OF FUNCTIONAL SPEECH BY A BRAIN-INJURED CHILD

R. VANCE HALL

A number of studies have demonstrated that verbal behavior can be established, maintained, or eliminated using operant conditioning techniques. Isaacs, Thomas, and Goldiamond (1960) used gum as a reinforcer in reinstating verbal behavior by mute psychotics. Similarly, vocalizations of a mute, retarded child were increased by the contingent delivery of "joggling" and singing (Kerr, Meyerson, and Michael, 1965), and vocalizations of normal infants were increased by the contingent delivery of smiling, tickling, and "clicking" (Rheingold, Gewirtz, and Ross, 1959). Sherman (1965) used positive reinforcement to reinstate verbal behavior in long-term, mute psychotics. Risley (1966) and Lovaas (1966) used reinforcement to establish speech in speech deficient children. Risley and Wolf (1967) developed verbal behavior in echolalic children by using food reinforcers to establish verbal imitative behavior and then used shaping and fading techniques to increase the complexity of the verbal behavior.

The studies reported above were largely carried out by skilled researchers, most of whom had extensive training in employing systematic reinforcement procedures, including laboratory work with lower animals. In contrast, the present study was carried out in a school setting by an experimenter with little experience in either speech training or operant procedures and no experience in an animal laboratory. Furthermore, the subject had been labeled as "brain injured" and had been termed "not ready" for speech training because of his extreme hyperactivity and inattention when speech testing had been attempted.

The primary purposes of this present study were to (1) examine the applicability of systematic reinforcement procedures to the speech training of a brain-injured child not deemed an appropriate subject for usual speech therapy sessions; and, (2) determine whether such training could be carried out in a school setting by an experimenter initially unskilled in either systematic reinforcement procedures or speech training techniques.

Description of the Child

Jackie was a six-year-old boy who had been variously diagnosed as brain injured and autistic. According to psychological tests, his level of functioning was that of a youngster with moderately severe mental retardation.

When he entered school in the fall of 1963, he was hyperactive and often ran about flopping his hands. He liked making puzzles and playing records. He did not play with other children. His speech included unintelligible vocalizations. Most of his intelligible speech was inappropriate to the situation and echolalic in character.

After more than two years in school, Jackie still exhibited these behaviors. He chanted snatches of songs, rhymes, and nonsense syllables in jargon with occasional clearly articulated words appropriate to the situation. He seldom responded to verbal directions. He sometimes wrote from memory titles of songs he had seen on records, and had a surprisingly large reading vocabulary. He still was not playing with other children.

The school speech clinician had recorded occasional appropriate use of speech during extensive observations of Jackie prior to the experiment. Within a two-hour period, the amount of appropriate intelligible speech ranged from none to three or four words or phrases. Jackie's teachers reported that he was unresponsive to adult verbalizations. Furthermore, when adults attempted to contact him or give him approval, he often responded by running from them and making bizarre gestures and vocalizations. His mother and teachers also reported that he liked to play records and to color in coloring books. Although he was described as a poor eater, he liked peanuts, Fritos, raisins, cookies, and apple juice. The parents reported great difficulty in getting him to go to bed and to eat properly. They also reported many temper tantrums and that he used little appropriate speech at home. In spite of his age and the fact that he had been enrolled in school over two years, he had made little progress in speaking or responding to speech appropriately and was considered "not ready" for the usual speech therapy program available at the school.

PROCEDURES AND RESULTS

Physical Arrangements

Experimental sessions were held in a 9′ × 10′ room which contained a large desk, two chairs, a filing cabinet, and two bookcases. The room was not soundproof and the noise of a typewriter and the sound of voices from the adjacent office and hallway could be heard intermittently.

Prior to the first session, Jackie's parents agreed to furnish a daily snack of apple juice and foods such as peanuts, Fritos, potato chips, candy, or raisins. No provisions were made for control of Jackie's food intake at breakfast, although his mother reported that this usually consisted of a slice of buttered toast and fruit juice.

No changes were made in Jackie's regular school sessions during the experiment, except that he did not receive the snack usually given members of the group near the end of the school session. He was picked up and brought from class to the experimental room by the experimenter at approximately 10:30 each morning.

Recording Data

Jackie's verbal responses were tallied by the experimenter. Simultaneously, a tape recording was made of each 30 to 35 min session to allow for a reliability check. An independent observer scored tape recordings of various sessions throughout the experiment and tallied the number of various types of verbal responses made by the subject during a session. This tally was then compared to the scores obtained by the experimenter. The number of responses on which there was agreement was divided by the total number of responses to find the percentage of agreement. The percentages ranged from 87% to 95% on data taken directly from the tape by both the experimenter and the second observer. Agreement between data taken live during the sessions and those on tape ranged from 82% to 89%.

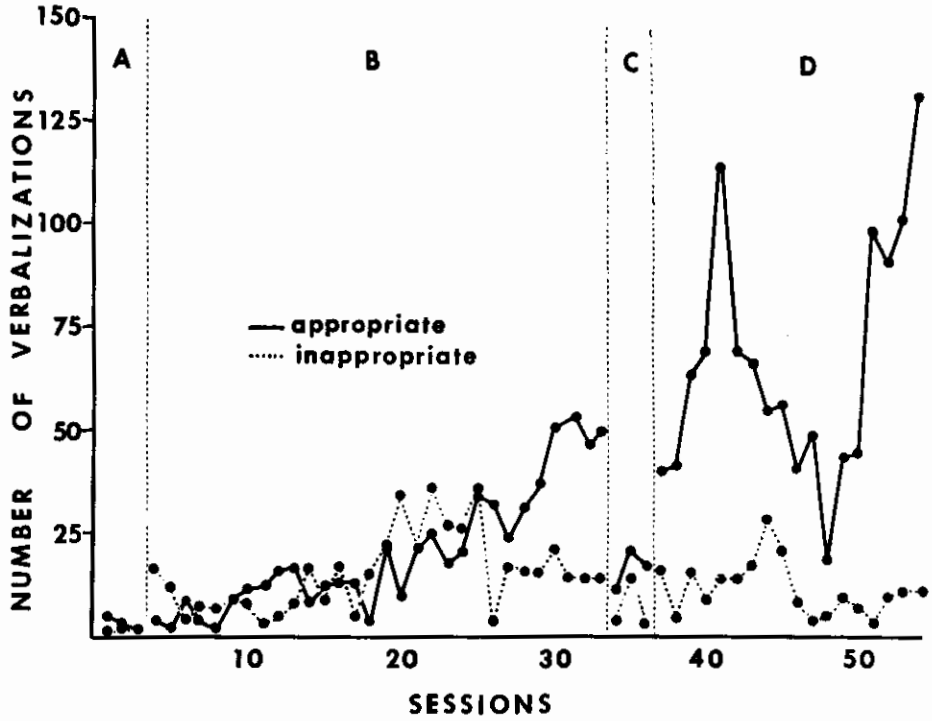

FIGURE 1. A record of Jackie's appropriate and inappropriate verbalization. (A. Baseline period, prior to contingent reinforcement. B. Reinforcement period, verbalizations reinforced by food, play materials and the E's attention. C. Reversal period, return to baseline conditions of noncontingent reinforcement. D. Second reinforcement period, return to procedures of contingent reinforcement.)

The Baseline Period: Sessions 1 Through 3

During the three baseline sessions, no attempt was made by the experimenter to reinforce Jackie's verbal behavior. He was allowed to play records, to color, was fed bites of snack, and was freely given verbal approval by the experimenter.

During the baseline sessions, 10 appropriate intelligible verbalizations (a mean of 3.3 per session) were recorded (Figure 1, Section A.) Jackie made only 2 appropriate and 1 inappropriate, intelligible responses to the experimenter's 296 questions, statements, commands, greetings during the sessions. Thus, the percentage of appropriate response for these sessions was less than 1% (see Section A of Figure 2).

Although he frequently "talked" in jargon or made other unintelligible sounds during these initial sessions, there was relatively little clapping, or other bizarre behavior. No tantrum behavior was encountered.

The Reinforcement Period: Sessions 4 Through 33

Beginning with Session 4, bits of snack and access to play materials were made contingent on intelligible and appropriate verbalizations by the subject. Bites of food also were given when Jackie obeyed the experimenter's verbal commands, even though they did not require verbalizations. These changes in conditions resulted in an increase in his general activity during the

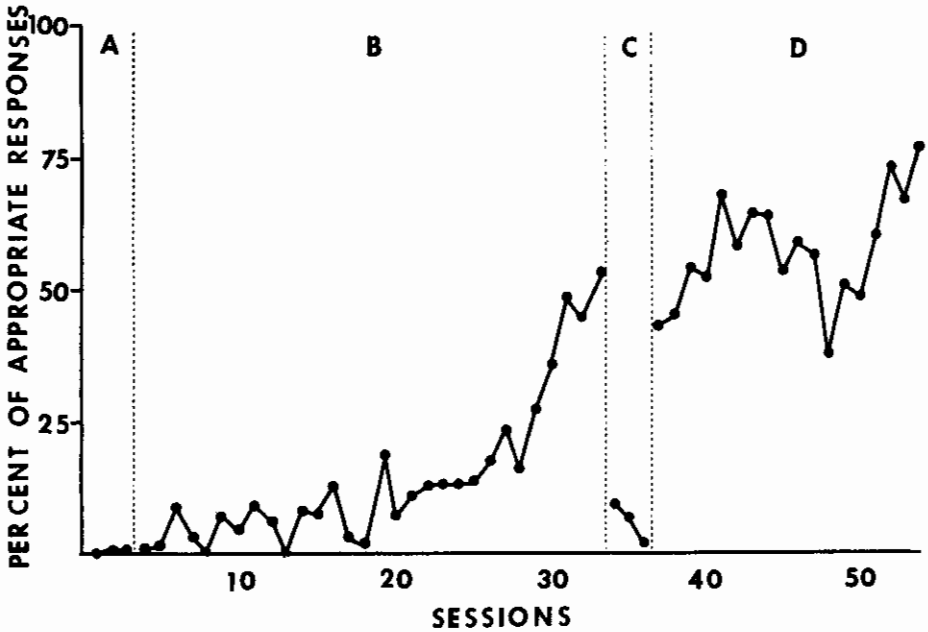

FIGURE 2. A record of the percentage of Jackie's appropriate responses to the Experimenter's verbal S^Ds. (A, B, C, D, same as in Figure 1.)

first two sessions, with a display of a considerable amount of clapping, crying, bizarre laughing, pacing, and jargon. There was also an increase in the amount of intelligible but inappropriate speech. Often Jackie would point to the food or play object and would cry, scream, clap his hands, and emit a wracking cough if the experimenter did not give the item to him. While Jackie was engaged in this bizarre behavior, the experimenter asked what he wanted or named the desired object, waiting for Jackie to answer appropriately or imitate the name of the object. Very often, however, Jackie would cover his ears with his hands.

In Sessions 6 and 7, the experimenter turned away from Jackie when he engaged in bizarre behavior. This was done on the assumption that the experimenter's attention and verbalizations during tantrums might be maintaining them. Attention was also withdrawn when he was off the chair, whether or not he was engaging in bizarre behavior. This resulted in a decrease in bizarre verbalizations by the subject, with periods of long silences while Jackie was off the chair, and not attending to the experimenter.

In Session 8, Jackie had largely quit attending to the experimenter and spent a great deal of time pacing the room or lying on the floor. He received very little of his snack since there was almost no appropriate speech. Therefore, after Session 8, it was decided that the criterion of reinforcing only appropriate verbal responses should be altered, since these were occurring at a very low rate and Jackie was not receiving enough reinforcement to maintain responding.

Beginning with Session 9 (point A in Figure 1), all intelligible verbalizations, whether appropriate or inappropriate, were followed by a bite of snack, verbal approval, or access to a desired play material. Verbalizations (both appropriate and inappropriate) increased in frequency during this procedure.

In Session 14, there was a drop in appropriate verbal responding which coincided with two temper tantrums lasting a total of more than eight minutes. These occurred when the experimenter refused to help put one of Jackie's shoes back on his foot until he said, "shoe." Following this session, as the experimenter took the subject outside to his mother, Jackie addressed the experimenter and clearly enunciated, "I want to kiss you," and did so.

Beginning in Session 19 (point B in Figure 1), an effort was made by the experimenter to follow intelligible verbalizations more quickly with the words, "Good boy," and a bite of snack or access to desired materials; an analysis of the recordings of the previous sessions indicated there was often a delay between the time of Jackie's response and the reinforcement given by the experimenter. This decrease in latency resulted in an increase in rate of verbalization which was maintained and generally accelerated in the remaining experimental sessions.

During the conditioning sessions, Jackie came to repeat the experimenter's responses of "Good boy," and "That's a good boy," with high frequency. In Session 20, the experimenter discontinued reinforcing the phrases "Good boy," or "That's a good boy," when Jackie uttered them inappropriately. This attempt at extinction resulted in a temporary increase in the subject's inappropriate

vocalizations ("That's a good boy," occurred 25 times in Session 20), and a decrease in rate of appropriate vocalization. In the sessions which followed, however, the rate of these utterances declined and then extinguished completely by the fortieth session, while the rate of appropriate responding accelerated.

In Session 24, the experimenter introduced Jackie to a tracing book which had pictures of the cartoon characters "Mush Mouse," and "Punkin Puss." Tracing copies of the pictures in the book with a pen provided by the experimenter proved to be an effective reinforcing activity to Jackie. When using the pen was made contingent on saying, "a pen," this vocalization became an imitative response to the command, "Say, *a pen*," and an answer to the question, "What is this?" Once this response was controlled by the experimenter's questions, "What is this?" and "What do you want?", the rate of naming other objects and pictures of objects appropriately in answer to these questions was accelerated.

Since by Session 27 Jackie was responding appropriately 30 or more times per session, reinforcement (in the form of bites of snack, use of the record player, or the opportunity to trace in a tracing book) was discontinued for all inappropriate verbalizations. When this was done in Sessions 4 through 8, the subject received so little reinforcement that his verbal behavior almost ceased; at this point (Session 27) appropriate responding continued at higher rates while inappropriate responding decreased. By the last session of the reinforcement period Jackie was responding appropriately to the experimenter's questions, statements, commands, and imitative S^Ds more than 50% of the time.

During the 30 sessions comprising the reinforcement period, 601 appropriate intelligible vocalizations were recorded for Jackie, a mean rate of 20.0 per session. As can be seen by an examination of Section B of Figure 1, inappropriate vocalizations had also increased, but by the twenty-fifth session, inappropriate vocalizations were fewer than appropriate vocalizations and the difference increased after Session 25.

Reversal Period Sessions 34 Through 36

Beginning with Session 34, a brief return to baseline conditions was instituted in order to observe the effect of noncontingent reinforcement. During these sessions, no reinforcing consequences were provided following Jackie's intelligible verbalizations. Rather bites of snack and access to materials were given on a noncontingent basis. This change in conditions brought about marked changes in rates of responding to the experimenter's verbal cues. Whereas, in the preceding three sessions, Jackie had responded appropriately to verbal cues given by the experimenter 48.3%, 44.8%, and 53.7% of the time, in the three reversal sessions, the rates were 9.6%, 6.7%, and 1.6%. Thus, he responded appropriately to but 10 of the 175 verbal cues given by the experimenter; the mean rate for the three sessions was 5.7% (see Section C, Figure 2).

During reversal, 37 of the 48 appropriate verbalizations recorded were free, verbal operants and their character was restricted. In the last two sessions of reversal, all of the 31 appropriate free, verbal operants consisted of the three phrases, "a pen," "the green pen," or, "a book."

Near the end of the last reversal session, Jackie began substituting a jargon expression for his requests for the above objects when they were not supplied as a consequence of naming them appropriately. The rate of jargon and other bizarre behaviors also increased in the sessions. Hand clapping, lying and sitting on the floor, and jumping (behaviors which had largely been extinguished) reappeared.

The Second Reinforcement Period: Sessions 37 Through 54

In the first session of the second reinforcement period, Jackie did not respond appropriately to the first few of the experimenter's questions, imitative cues, or commands. Several times he repeated jargon sounds. Once an appropriate vocal response occurred and was reinforced, however, the number of intelligible vocalizations and the rate of appropriate responding to the experimenter's verbal cues rose quickly. Total intelligible vocalizations for the session rose from 20 in the previous session to 55. The appropriate responses to the experimenter's verbal cues rose from 1.6% to 43.7%.

In Session 38, the experimenter began reinforcing the subject's appropriate responses with food or access to desired play materials or activities on a variable ratio schedule in which reinforcement occurred about 70% of the time. In subsequent sessions, the rate of appropriate vocalizations rose rapidly.

In Session 40, the experimenter began teaching Jackie to preface his requests with "I want." This was accomplished by having him imitate the experimenter's vocalization "I want a record." When this was being imitated consistently, the experimenter would hold up a favorite record. Jackie would say, "a record." The experimenter would say, "I want a record," and Jackie would imitate. When he was responding consistently, the experimenter would hold up a record and say, "I want," and Jackie would say, "a record." Then the experimenter would say, "I," and prompt him by forming the voiceless mouth movement for "want" and Jackie would say "want a record." Then the experimenter would do the same with the word "I" until the subject was saying, "I want a record" without any prompt. In later sessions, this same fading technique was used to teach Jackie to say, "I want the green pen," "I want the paper," and similar requests.

Following Session 43, Jackie's mother reported that he had begun, for the first time, to request things at home by prefacing them with "I want." Similar fading procedures had been used beginning in Session 39 to teach him to respond to "Hi, Jackie" with "Hi, Mr. Hall."

Beginning in Session 42, a fading technique, utilizing Jackie's reading skills, was used to teach him appropriate answers to such questions as "Who is your teacher?" "What is your name?" "Who is your sister?" "How old are you?" "What school do you go to?" Jackie would readily read the appropriate written

answers to these questions, which were then progressively removed until he was responding appropriately to the experimenter's questions without written prompts.

Just prior to Session 46, Jackie missed four days of school due to illness. During that session and the three following, he was listless and uninterested in bites of snack. He spent long periods lying on the floor. The total number of vocalizations for these sessions decreased. In Session 48 (point C in Figure 1), he was inactive; he would lie on the floor and moan. He drank juice several times but refused any bites of his snack. He requested the examiner to unlatch the door on four occasions. The session was terminated after approximately 16 minutes. The number of appropriate intelligible vocalizations and the percentage of appropriate responses to the experimenter's verbal cues were reduced. In Session 49, Jackie was still lethargic but the full session was held.

Session 50 occurred after a weekend. Jackie's mother reported he was feeling well again. Unfortunately, the tape recorder malfunctioned after 15 minutes of recording. In spite of the shortened session, the number of appropriate responses was greater than in the previous full session.

In the last four sessions (51 through 54), the number of appropriate responses increased, reaching 132 in the final session. The percentages of appropriate responses to the experimenter's verbal cues were also generally higher, reaching a peak of 78.5% in the final session.

In the last sessions of the experiment, very little jargon, clapping, crying, or other bizarre behavior was observed. In four of the last seven sessions, no inappropriate, free, verbal operants were recorded.

During the 18 sessions comprising the second reinforcement period, 1005 appropriate vocalizations were recorded, a mean rate of approximately 55.8 per session (Section D of Figure 1); 362 of the intelligible vocalizations were appropriate, free, verbal operants. Typically, these consisted not only of the appropriate naming of objects and the reading of words appearing on records (as was observed in the first reinforcement period), but also more complex phrases and statements, some of which were taught or shaped by the experimenter, and some of which were emitted without training.

Among the more complex phrases and sentences initiated by Jackie without verbal prompting were "I want a drink of apple juice," "I want a candy," "I want to play," "Oh, it's time to go," "Please open the door," "Loosen it," "Thank you," "I want you to take it off," "I want to write," "Get the lunch pail," "Be quiet," and "Mother is here." By the last experimental session Jackie was using speech as an appropriate means of communication and was increasing the complexity of his speech.

Evidence of Generalization of Speech Training at Home and in the Classroom

During the course of the speech training experiment with Jackie, there was some evidence that the increase in appropriate speech observed in the experimental setting generalized to the classroom and the home.

Jackie's mother recorded the number of intelligible vocalizations he made at home during a six-day period prior to the beginning of the experimental procedures. A total of 27 or 4.5 per day was recorded by the mother. Twenty of the 27 were 1-word vocalizations. During the first six days of reinforcement procedures, the mother recorded 69 or 11.5 vocalizations per day. Only 7 of these were 1-word responses. At a parent meeting on the day of the 16th session, Jackie's father stated to the experimenter, "I don't know just what you're doing, but Jackie is sure talking more."

In a five-day period corresponding to the nineteenth through the twenty-third sessions of the experiment, the mother recorded 94 or 18.5 verbalizations per day for Jackie. Of these, only 2 were 1-word responses. On the day of the 24th experimental session, Jackie's mother reported his verbal production was too great for her to record adequately and no further attempt to record home vocalizations was made until three months after the experiment had terminated. At that time, the mother recorded his vocalizations for one day from 3:30 p.m. until bed time. There was a total of 32 appropriate sentences and phrases, and no single words recorded. Among those in the repertoire were "A riding horse, giddy-up," "Sharpen the pencil," "Want a fig bar," "Wash a hands," "Hung up the towel," "Run up and to potty," "Mail a letter, put in a mailbox," "Bowl of potato chips," "A vacuum, put it together," "Turn it on," "Turn it off," "Mommy unplugged it," and "Plug it in." A record of the number of Jackie's verbalizations at home is shown in Figure 3.

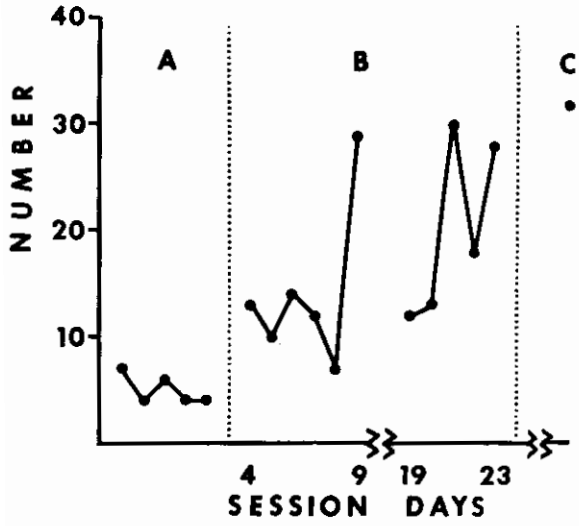

FIGURE 3. A record of Jackie's intelligible appropriate verbalizations at home. (A. Baseline period, prior to experimental procedure; B. Reinforcement period, on days of reinforcement procedure sessions; C. Postexperiment, three months after termination of the experiment—3:30 to 9:00 p.m.)

At the conclusion of the experiment, the mother reported that since the experiment began she had noticed a definite increase in the amount of Jackie's speech, the addition of sentences, and an increased willingness to respond to "Hi!" or, "Good-bye," from about 5% to 60% of the time, as well as a decrease in temper tantrums.

Jackie's father reported that his son's speech had developed from meaningless words and unintelligible syllables to sentences with "meaning." He also reported that there had been an increase in Jackie's asking for things and "his understanding of us."

Evidence of the effects on Jackie's behavior in the classroom was reported by the teachers at various times during the experiment. On several occasions, teachers noted that when the experimenter came to get Jackie for his sessions, he would verbalize appropriately in the experimenter's presence, saying such things as, "Hang up the coat," "Open the gate," "Open the door," "Good-bye." On the day of the 33rd (final reinforcement period) Session, Jackie's teacher volunteered that Jackie seemed to be beginning to listen and attend to what was being said. Subsequently, both she and the assistant teacher of the group reported that Jackie began to follow verbal directions consistently for the first time in the two years he had attended the school.

Both teachers reported toward the end of the experiment that Jackie began participating in the group activities in the classroom and responding verbally to the questions as the other children had been doing throughout the year. The teachers also reported more frequent appropriate verbal responses in other school situations.

A follow-up observation of the subject was made by the experimenter three months after the termination of the experiment. At that time, Jackie was enrolled in the outpatient clinic of the Child Psychiatric Ward at the University of Washington Hospital. Among the behaviors noted was that Jackie continued to obey vocal commands by adults to do things such as, "Come with me," "Read this page," and "Sit down."

A record was kept of his intelligible vocalizations and responses to the verbal cues of his teachers during approximately 4 hours and 15 minutes of observation on 3 different days. During this period, a total of 264 intelligible vocalizations was recorded. Of these, 205 were judged appropriate and 59 inappropriate to the situation. The appropriate vocalizations included reading from books in the classroom, naming objects and pictures, and sentences such as, "Hi, Mr. Hall," "Let's go see the fountain," "C'mon outside," "That's my folks," "Play a record," "Hey, it's time to go," "Play with the railroad track," "I want the green pen" (when he saw this in the experimenter's hands), "There's Mr. Hall." Generally, the data indicate that Jackie was emitting appropriate, intelligible vocalizations at a higher rate than before the experiment in speech training.

DISCUSSION

This study indicates that reinforcement procedures were effective in a speech training program for a boy diagnosed as brain injured or neurologically impaired. The study also calls into question the assumption that behavior of such children is inherently different from normal organisms (Strauss and Lehtinen, 1947; Lewis, Strauss, and Lehtinen, 1960). This assumption was questioned

previously in relation to nonverbal behaviors of brain-injured children (Hall and Broden, 1967).

Although it is possible that the etiology of Jackie's inappropriate speech was related to brain damage, it is apparent that this speech behavior was subject to environmental control, and was amenable to modification using reinforcement procedures. This is not to say that the speech behavior of children diagnosed as brain injured is unrelated to their medical histories, but it does indicate that even with such an etiology reinforcement techniques for accelerating appropriate speech may be employed successfully.

The fact that the present experimenter was able to use reinforcement procedures to increase functional speech indicates that they can be used even though the person employing them lacks an extensive background of training in an experimental laboratory. The case of the successful use of reinforcement procedures in speech therapy is strengthened further because the experimenter did not have a background as a speech correctionist.

There seems to be little reason why speech correctionists should not experiment with reinforcement procedures. Of course, one would want to familiarize himself with the literature available and, to be sure, it would be most advantageous for anyone attempting operant speech training to consult with someone skilled in the application of reinforcement principles. The experimenter in this case did consult with a person (Donald M. Baer) who was quite knowledgeable regarding operant principles. One critical point of technical assistance came when, after hearing a tape recording of a session, the consultants suggested decreasing the latency between the time of Jackie's vocal response and the delivery of reinforcement. Except for this help, however, the experimenter developed techniques and modified procedures as the need arose during the session. The fading technique of using written cues which were gradually withdrawn, for example, had not been used previously and was devised during the experiment.

Another aspect of the study which was different from operant speech training studies reported previously was the extensive use of access to play materials and compliance to the requests of the subject as a reinforcing consequence. Homme et al. (1963) used the opportunity to engage in highly probable activities as reinforcement for engaging in less probable activities. It was discovered in the present experiment that giving Jackie the opportunity to use the experimenter's pen, or permitting him to play a favorite record or gain access to other objects were often more effective reinforcing consequences than were bites of snacks. Therefore, the experimenter utilized such consequences extensively, expanding them to include such things as holding Jackie aloft contingent on an appropriate request ("Up," or later "Up in air, Mr. Hall."), opening the door or the gate, giving him objects, unfastening the arm on the record player, turning the record player on or off, allowing him to trace pictures on onionskin paper, etc.

It is probable that food would have been more effective as a reinforcer if greater deprivation had been induced. This was not attempted, however, because the experimenter wished to maintain the conditions which existed in the

school setting with as little change as possible. Another advantage of reinforcers other than food may be that generalization to the nontherapy environment may occur more rapidly. For example, very soon after Jackie was taught to preface requests for objects with the words, "I want," his parents reported that he had begun to ask for things at home using these words and they could reinforce his requests by giving him the desired object or by letting him engage in the desired activity.

In summary, the data from this study are evidence that reinforcement procedures offer promise for working with children who are deemed not ready for usual speech therapy. Secondly, the data suggest that speech correctionists should consider using reinforcement procedures in a systematic manner. Even though they have limited backgrounds in using reinforcement procedures, they are likely to find, as did the author, that self-training occurs very rapidly in the process of carrying them out. Finally, the data suggest that, in addition to food, access to desired play materials or the opportunity to engage in highly probable activities may be used advantageously as reinforcers during speech training.

ACKNOWLEDGMENT

R. Vance Hall (Ph.D., University of Washington, 1966) is a Research Associate with the Bureau of Child Research, University of Kansas; and Coordinator of Juniper Gardens Children's Project, Kansas City, Kansas. This study was supported in part by NICHHD grants HD 00870, HD 00870 04S1, 1P01 HD 03144-01, MR HDP, Bureau of Child Research, University of Kansas.

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Chapter VI

REINFORCEMENT PROCEDURES FOR ESTABLISHING AND MAINTAINING ECHOIC SPEECH BY A NONVERBAL CHILD

LEIJA V. McREYNOLDS

Recent investigations have demonstrated that some of the complex skills involved in speech can be taught to extremely deviant children through the application of operant conditioning principles (Baer, Peterson, and Sherman, 1967; Lovaas et al., 1966; Kerr, Meyerson, and Michael, 1965). Results from the studies have shown the importance of consequent events in training. One of the consequences used by speech clinicians is verbal approval. Because it is used so frequently in therapy situations, it seems important to investigate how well it functions to modify speech responses.

When social reinforcers are used, the clinician usually follows each appropriate response with "Good boy," "That's right," "O.K.," or some other verbalization which is intended to indicate approval. The clinician assumes that this verbal approval will increase the frequency of the appropriate response. If the anticipated increase in correct responses does not occur, the clinician may attribute the lack of increase to the child's inability to acquire the behavior, or decide that the antecedent events were inappropriate or poorly programmed. It is also possible that the clinician's verbal approval is a weak reinforcer, or may not be a reinforcing event at all. The child's behavior in this case may be taken as an indication that the consequence is ineffective.

The present study was designed to delineate the effects of social (verbal praise) and nonsocial (ice cream) reinforcement in establishing and maintaining speech responses. A primary concern was to determine if social reinforcement could be used as effectively as nonsocial reinforcement during all stages of vocal imitation training. Could it be used equally effectively in response acquisition as in maintaining the response?

The subject was a four-year-old brain-damaged child. He had been evaluated and found unsuitable for speech training or any special education program because he exhibited little measurable behavior. During three days of observation he did not emit any vocalizations, either spontaneously or imitatively; he failed to imitate any arm, leg, or hand movements; and he did not respond to

simple verbal directions such as, "sit down." After this 3-day observation period an experimental speech program was designed in which he was seen 5 days a week, the average length of a session being 20 minutes. The mother was asked to observe each session, but no special effort was made to gain her cooperation. At no time during the entire training period was the child deprived of either food or social reinforcement at home.

The child emitted no vocalizations during baseline, and so it was not possible to bring him into contact with the reinforcer by reinforcing vocalizations. Therefore, the imitation paradigm was chosen for training, since this presented an opportunity to establish the contingencies by starting with other motor imitations. The child did not imitate arm, leg, or hand movements during baseline. However, it is probably easier to train motor imitation than vocal imitation because the experimenter can manually move the child's arm through the required motion while the child sits passively, and at the completion of the movement he can present the child with a reinforcer. In this procedure the manual prompts are continued by the experimenter. As the child begins to acquire the behavior the prompts are gradually faded. Finally, the prompts are removed entirely; when the child imitates a movement without a prompt, the contingency has been established. In the initial phase of the program, the child received training in imitation of hand movements because it was a readily trained behavior which could be used to establish positive reinforcers and make the contingencies explicit for the child. When the child emitted a correct response, the experimenter would smile and say, "Good boy," and then present him with a bite of ice cream. Within two weeks under this condition, the child acquired several imitations and gave them in a specific sequence. The motor imitation accomplished its purpose; reinforcement was established and the child's behavior was brought under the control of the experimenter.

Motor imitation, however, was not the terminal behavior which the experimenter wished to train; imitative speech was the goal. As the motor-training continued, the experimenter vocalized each time she reinforced the child. After two weeks on this program it was observed that the child also vocalized occasionally when he was reinforced. The experimenter began to reinforce these "vocalizations" and slowly dropped out the motor imitation. With five additional sessions the child had increased his vocalizations within a session from 23 to 144 with ice cream and praise as positive reinforcers. Although vocalizations had been shaped with these procedures, it was still necessary to train the child to imitate speech sounds. This was accomplished by using reinforcement to shift the child's spontaneous utterances to imitations of the experimenter's vocal model. A vocal model (phoneme) was presented by the experimenter and the child's imitation of the phoneme was followed by a bite of ice cream and praise. When the child's emission of phonemes had been brought under echoic control, word-training was initiated.

The procedure for word-training consisted of backward chaining procedures. In backward chaining, the final response in the chain is trained first. After this response has been established (that is, the child correctly imitates the sound

about 80% of the time) the next to the last response is added. The child now responds with the new item preceding the original item and is reinforced only if he emits the entire chain. In the word "cream," for example, the child was initially trained to imitate /m/. When he acquired this response, the /i/ was added, preceding the /m/. The appropriate response in this stage was /im/. The third and fourth phonemes were added in a similar manner until at the end of training the child was emitting /krim/. Reinforcement was consistently administered following the /m/, but only if it was preceded at each stage by the other phonemes in the chain. It was during word-training that the effectiveness of social and nonsocial reinforcement was first investigated. At this stage of training the child's behavior was considered stable enough that differential effects, if they occurred, could be observed most readily. The effectiveness of the social and nonsocial reinforcement was assessed during three stages of therapy; (1) during training in acquisition of a response, (2) directly after the response had been acquired but before it had stabilized, and (3) after further training on the response, i.e., after it had stabilized, during maintenance.

The procedure for training vocal imitation consisted of the following sequence of events: The experimenter sat facing the child and said, "Do this _____." The blank was filled by the speech response being trained at that particular time, a phoneme, a word, or a sentence. A response by the child was reinforced if it was correct. The experimenter said, "Good boy," and gave him a bite of ice cream on a spoon. If the response was incorrect, the experimenter said nothing and did not offer the child ice cream. Approximately 10 seconds later, the experimenter presented the vocal model again, and the child's response was reinforced if it was correct.

When social reinforcement was evaluated during acquisition, the experimenter selected a response which was not in the child's vocabulary. In the first 13 minutes of the session the experimenter presented the model and only verbal approval was presented for correct responses. At the end of the first block of 13 minutes, the ice cream was included in the consequent event. Both ice cream and praise were continued for the next 12 minutes of the session, and then the ice cream was again removed. In the final 8 minutes of the session only social reinforcement was presented for correct responses. Results of the procedures are presented in Figure 1.

When the imitation was initially presented in the early minutes of the session, the child's responses were correct a large percentage of the time. Each correct response received verbal approval from the experimenter. From the third to the sixth minute, however, the number of correct responses decreased and continued to decrease until the ice cream was introduced. At that time, correct responses increased rapidly to almost 100% correct imitations. When the rate was high, the ice cream was removed and verbal praise was again the only consequent event. Correct responses once more decreased from a high of 80% to a low of 30%.

Similar results were obtained for the second stage sample (see Figure 2). In this sample the response had been acquired very recently. But the child was

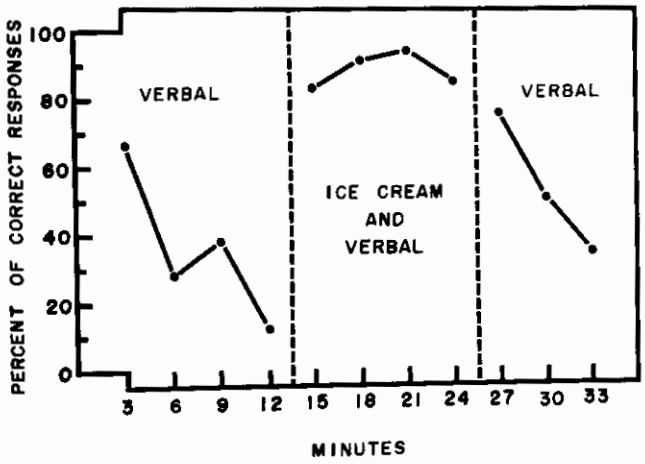

FIGURE 1. Percentage of correct responses as a function of ice cream and verbal approval vs verbal approval alone, during maintenance after the appropriate response has been well established.

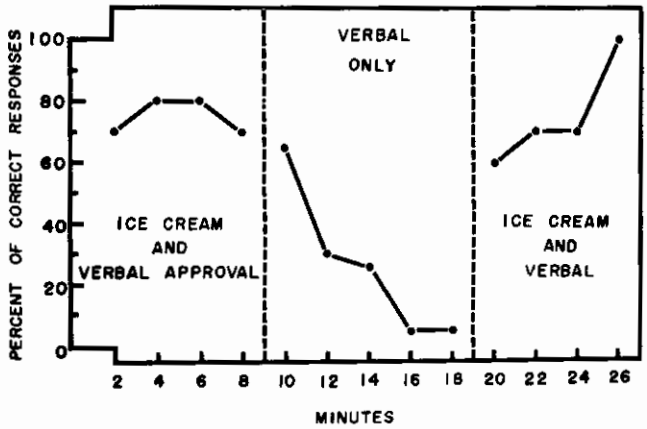

FIGURE 2. Percentage of appropriate responses during acquisition as a function of ice cream and verbal approval vs verbal approval alone.

emitting the response at the 70 to 80% level in the first nine minutes of the session with ice cream and social approval. To test the effectiveness of the social approval, the ice cream was removed for the next nine minutes, and only social reinforcement was presented for correct responses. Correct responses decreased to almost a 0% level when only social reinforcement was presented. With the reinstatement of ice cream and verbal praise in the final seven minutes of the session, the correct responses gradually increased to a level of 100% in the final two minutes of the session.

The final samples tested the effectiveness of social approval for maintaining a response once it had been acquired. In these samples the child had been

emitting the appropriate response for at least two sessions and the range of correct responses during a session had stabilized within 80 to 100%. In one of the sessions the social reinforcement alone condition was introduced at the start of the session, whereas in the other sample the social reinforcement condition was instituted in the final 15 minutes of the session. In Figure 3 the session was started with ice cream and verbal approval and then the ice cream was removed after 16 minutes of the session had passed.

As the results show, the child's correct responses were maintained at the 80 to 100% level during the first 16 minutes of the session with ice cream and verbal approval. Removal of the ice cream in the final minutes of the session resulted in no change in the percentage of correct responses emitted by the child. His behavior was maintained by the social reinforcement alone.

In the second sample a different response was being trained. During the first 16 minutes of the session, the child was presented with verbal approval only for correct responses. In the next 12 minutes the ice cream was given in combination with the verbal approval. Results are shown in Figure 4.

In this session also, the correct response was emitted at a high level. When the session was started with only verbal approval, the frequency of correct responses did not decrease within the 16 minute period. With ice cream and verbal approval the response remained stable and with ice cream alone it did not change. Throughout the session, changes in the consequent events did not change the frequency of correct responses; the response remained stable within a range of 80 to 100% correct.

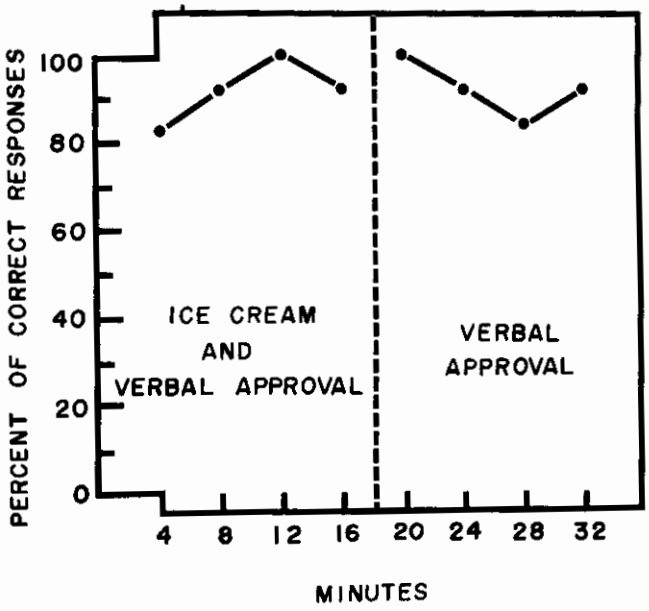

FIGURE 3. Percentage of appropriate responses as a function of ice cream and verbal approval vs verbal approval alone, early in training.

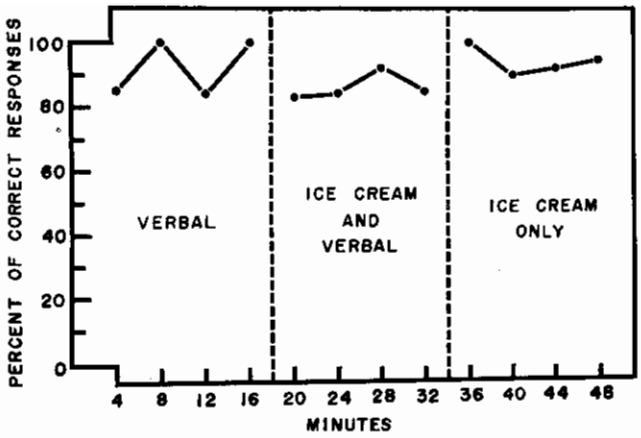

FIGURE 4. Percentage of appropriate verbal responses as a function of combined ice cream and verbal reinforcement vs ice cream and verbal reinforcement presented singularly during maintenance.

Discussion and Conclusions

When the clinician attempted to use verbal approval during the initial training of a response or very shortly after it had been acquired, the social reinforcement was found to be ineffective. Once the response had been shaped and was stabilized in the child's repertoire, social reinforcement was sufficiently strong to maintain it. In a speech training situation in which a new response is to be acquired, a social reinforcer is not as effective as a nonsocial reinforcer. It is possible that more effort to match the model is required by the subject during acquisition than during maintenance. It appears to take a powerful reinforcer to accomplish changes in movements on the part of the subject. Speech clinicians frequently use only social approval, even in the initial stages of training. If a child, however, does not acquire the response with social reinforcement, the clinician might find the behavior is acquired if a different reinforcer is provided. Before concluding that a child is incapable of responding correctly on a task, the effect of changing reinforcers should be assessed.

Establishing a social reinforcer, however, has certain advantages. A child may emit many responses in a training session. In this study, for example, the child was emitting between 150 and 200 responses during some sessions. If ice cream had been used exclusively and presented to the child for each correct response, he would probably have become satiated before the session was terminated. Establishing social reinforcement alleviated this situation. Once praise had been shown to be effective, the clinician put the child on an intermittent schedule for ice cream while continuing with praise for each correct response. In this way the child's correct responding was maintained, but he did not satiate before the clinician was ready to terminate the session.

Another reason for establishing social reinforcement sometime during training is its wide use in the environment outside the clinic situation. Social reinforcement is probably the most frequently used consequence for appropriate behavior. If the child's behavior can be maintained almost exclusively with social reinforcers, it will have a greater probability of being reinforced outside the speech therapy situation. In the present study it was found that social reinforcers could not be used exclusively, even in maintaining ongoing correct responses. At periodic intervals, the ice cream was reinstated as a backup reinforcer when the behavior evidenced some decrease in rate. Reinstating ice cream at these times served to effectively increase the frequency of correct responses. Keeping systematic records of each training session enables the clinician to make immediate changes in procedures thereby increasing the efficiency of training.

Results from this study indicate that social reinforcement may not always be an effective positive reinforcer for all children in all stages of therapy. The results suggest that training procedures can be increased in effectiveness if reinforcers which are appropriate to each child are used. It emphasizes the importance of establishing a consequent event empirically and verifying its function in the therapy situation.

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Leija V. McReynolds (Ph.D. Stanford, 1964), is a Research Associate with the Bureau of Child Research, University of Kansas. The work was supported by NICHHD Grant No. HD 00870. Recognition is given to Eve Walker, who acted as the experimenter during the administration of the training program.

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Chapter VII

DECELERATION OF INAPPROPRIATE VOCAL BEHAVIOR IN A HARD-OF-HEARING CHILD

KAY GALLOWAY *and* STEVEN SULZBACHER

Sometimes, before speech correction can be started, certain behaviors which are incompatible with those to be taught must be eliminated. For example, the child with defective articulation who puts his thumb in his mouth when he is with the speech clinician cannot be taught better articulation until the thumb-sucking is eliminated. Or the stutterer who presses his lips tightly together and tries to say, "Please," is also engaging in a behavior incompatible with speaking. One behavior which we consider appropriate for a young child, but maladaptive if it continues when the child grows older, is jargon behavior. Jargon may be defined as vocalizations which are characterized by inflectional changes, time patterns, and phoneme combinations similar to those of spoken English, but unintelligible. In some cases jargon may be shaped into meaningful speech. However, with the hard-of-hearing child, it may be more feasible to eliminate jargon and then to teach the child new functional speech. In the case of Lora, a six-year-old girl with a moderate to severe bilateral hearing loss who had never worn a hearing aid, the decision was to decelerate jargon before starting speech training, rather than to shape the jargon.

When the experiment started, Lora was using 15 or 20 words or phrases recognizable by those in her immediate environment. These included, "yeah," "mama," "bye," "shut up," and "don't." She often used jargon when speech would have been appropriate. None of her jargon vocalizations were intelligible, even to her family. The greater portion of her vocal behavior for at least three years had been jargon, and her parents estimated that she had added only two or three new words to her vocabulary in the last year.[1]

Lora appeared to be a happy, affectionate girl. She responded appropriately to gestured commands as long as the command was simple. She usually attempted some sort of response to verbal requests, but was not successful until shown what to do. Lora imitated simple motor acts and tried to imitate short words. She could also imitate vocal pitch changes. Her scores on standardized tests indicated that her language behavior was not above the two-year level

[1]Taped samples of Lora's speech may be obtained by writing to the first author.

and that her social behavior was at about the four-year level; her chronological age was six years at the start of the study.

Lora was fitted with a hearing aid prior to initiating procedures for modifying her vocal behavior. In order to insure success, motor tasks which Lora could perform adequately were included as activities in the session. Procedures were designed to decelerate jargon behavior and simultaneously accelerate appropriate "looking" responses when her name was called, and imitative responses to motor tasks. Candy or sugar-coated cereal was given contingent upon looking or imitation.

Lora was seen five times a week for approximately 20 minutes each session. Both Lora and the experimenter were observed through a one-way observation window by an assistant who kept daily records on specific behaviors. Decelerating the total duration of jargon within sessions was the first concern. Since jargon did not occur as discrete events, a frequency measure was not feasible. Therefore, jargon was measured by having the assistant start a stop watch when Lora began to emit jargon and stop it each time jargon ceased. The criterion measure was the total accumulated jargon time per 20 minute session.

The first attempt to decelerate jargon behavior involved a contingent time-out procedure, consisting of withdrawal of all clinician-delivered reinforcement for a specified length of time. When Lora began to emit jargon, the clinician immediately looked away and did not respond to her for 5 seconds, or until the jargon ended. The criterion for initiating speech training was set at less than 1 minute of jargon out of a 20 minute session (or less than 5% of the session.)

A representative sample of total jargon time was taken from a 15-minute tape-recorded session during which Lora and the assistant played with toys. A second measurement was taken from a similar tape during the first week of modification. These two samples are represented by A and B in Figure 1. Jargon behavior occurred for about 40 to 45% of the therapy session.

Although the time-out procedure decelerated the rate of jargon, at no time during the first nine sessions did the total duration of jargon drop below criterion. A decision was made to eliminate the time-out procedure and to try a different one. The reinforcement of "looking" responses and motor imitation remained the same, but the clinician began saying *shh* as a consequence of jargon instead of using time-out. During the first session after the *shh* was instituted and during all subsequent sessions when that procedure was used, the duration of jargon was below criterion. The effectiveness of this procedure is evident from Figure 1. At this point, word imitation tasks were gradually programmed into the sessions.

After 18 sessions during which *shh* was used, it was removed. Again, all other procedures remained the same and word imitation tasks continued to be given. The clinician did not make any specific response to jargon. On the third session after the removal of the *shh* procedure, the duration of jargon again went above criterion. On the following day, *shh* was reinstated as a consequence of jargon, and the duration of that behavior returned to the previously low rate. Periodically, for the following six months, jargon was timed during the sessions and

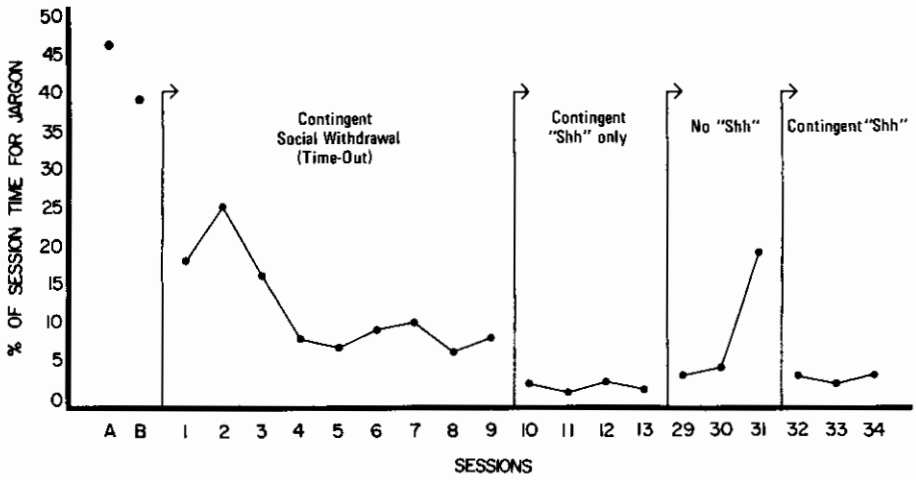

FIGURE 1. Lora's inappropriate jargon was more effectively controlled when it was followed by the clinician's *shh* than by contingent social withdrawal. Points A and B indicate representative samples of Lora's initial level of jargon. Throughout the project, 5% of the session time, or less, was set as an acceptable amount of jargon.

at no time did it go above the criterion of more than 60 seconds of a 20-minute session.

More complex tasks were programmed for Lora, and she maintained a relatively high rate of success on imitative and spontaneous verbal tasks.

In this case we have demonstrated that one procedure was more effective than another in producing and maintaining a desired change in behavior. Of course, a particular procedure will not work with all patients. But, by keeping continuous data on well-defined behaviors, we are able to evaluate and make changes in procedures when the results indicate inadequate control of those behaviors. This is simply a method of setting objective goals in therapy and assessing the effectiveness of the procedures employed to achieve those goals.

ACKNOWLEDGMENT

At the time this work was done, Kay Galloway (M.A., Kansas, 1966) was a speech clinician in the Speech and Audiology Department, Menorah Medical Center, Kansas City, Missouri. She is now supervisor of speech and hearing services, Clover Bottom State Hospital and School, Donelson, Tennessee. Stephen Sulzbacher (M.A., Hollins College) was a research trainee in the Bureau of Child Research, University of Kansas, 1965-66. He is now with the Mental Retardation and Child Development Center of the University of Washington. This work was supported in part by NIMH Grant No. 8262.

Chapter VIII

THE IMPLICATIONS OF A FUNCTIONAL APPROACH TO SPEECH AND HEARING RESEARCH AND THERAPY

JOSEPH E. SPRADLIN *and* FREDERIC L. GIRARDEAU

The work of Skinner (1938, 1953, 1957) is having a profound influence in the field of speech and hearing. Since 1960, several articles have suggested how procedures drawn from a functional analysis of behavior can be applied to the study, evaluation, and modification of speech and language. Shames and Sherrick (1963) suggested that stuttering can be explained and modified through operant conditioning. Holland and Matthews (1963) suggested that the principles of programmed instruction can be used to modify discrimination and articulation. Brookshire (1967) and Holland (1967) have summarized the tenets of the functional analysis of behavior and have demonstrated that the principles can be applied to speech. Siegel (1969) essentially used the operant framework in his recent discussion of research dealing with the vocal behavior of infants. Lloyd (1966) analyzed audiology from an operant point of view.

The influence of the functional analysis of behavior has not been confined to theoretical articles. Flanagan, Goldiamond, and Azrin (1958) demonstrated that stuttering could be modified through response-contingent consequences. Their results were later confirmed and extended by Martin and Siegel (1966a, 1966b). Goldiamond (1965) has reported nearly complete elimination of stuttering through the use of a delayed auditory feedback technique. Shames, Egolf, and Rhodes (1969) have recently reported on the development of experimental therapeutic programs for stuttering based upon the principles of operant conditioning. Isaacs, Thomas, and Goldiamond (1960) and Sherman (1965) reported success in reestablishing speech in mute schizophrenics through the use of straight, positive reinforcement techniques. McReynolds (1966, 1967, 1969) and Schell, Stark, and Giddan (1967) reported on discrimination and language training with aphasic children. Lovaas et al. (1966) and Hewett (1966) demonstrated that operant procedures can be used to establish elementary speech by autistic children. Finally, Wolf, Risley, and Mees (1964) and Risley and Wolf (1967) demonstrated that the verbal behavior of severely retarded children can be modified by operant techniques.

In the area of hearing, operant procedures have been developed which train severely retarded children to respond to changes in auditory stimuli. These procedures have then been used to evaluate the hearing characteristics of retarded children (Bricker and Bricker, 1969; Fulton and Spradlin, in press, a and b; Lloyd, Spradlin, and Reid, 1968; Spradlin, Locke, and Fulton, 1969).

The six studies in this monograph are within the framework of a functional analysis of behavior. The studies vary in their procedures; yet each is based on the application of Skinner's three-term contingency: stimulus–response–reinforcement. The first two were laboratory studies to evaluate the effect of certain consequences and contingencies on the rate of verbal behavior. The basic data were the rate of vocalization as recorded by a voice-operated relay. Reinforcement was automatically programmed. The advantages of automated procedures have been discussed previously by Lindsley (1964). The chief advantages of automatic recording are convenience and the elimination of recorder bias. The advantages of automatic programming are obvious. First, even when the criteria for reinforcement delivery are within human capabilities, there is always a chance for an error; and, second, some contingencies, such as those described by Bradford in Chapter III, could not be reliably determined by a human experimenter.

However, automation has distinct limitations. It is expensive, and in some cases it restricts the range of verbal behavior which can be studied. For example, the expense involved in automating the last four studies of this monograph was beyond the resources of the investigators. Moreover, instrumentation of studies such as those by McLean, Hall, McReynolds, and Galloway and Sulzbacher may be beyond our present technological sophistication.

The first two studies were concerned with the effects of rather limited variables on responses which could be automatically recorded. The procedures probably cannot be transferred immediately to most clinical situations. However, the studies by McLean, Hall, McReynolds, and Galloway and Sulzbacher involved settings and procedures which might be readily used by any speech clinician. In a sense, the six studies are a demonstration of the variety of experiments which have been generated within the framework of a functional analysis of behavior.

Reinforcement

Five of the six studies involved direct modification of verbal behavior through presentation of reinforcement. However, when one looks closely at the reinforcers used, they bear little relationship to the reinforcers typically used in lower animal studies (unconditioned reinforcers such as food, water, or sexual activity). Moreover, they bear little relationship to each other, with the exception that each reinforcing event (when contingent on members of a response class) increased the frequency of occurrence of members of that response class. They are defined as reinforcement only because they increase the frequency of responses on which they are contingent. This definition is in line with Skinner's general definition of reinforcement. However, since reinforcement theory has

its roots in laboratories for lower animals, reinforcement is most frequently conceptualized in terms of primary and secondary (or conditioned) reinforcement terms. It is often assumed that such reinforcers as food, water, and sex are primary reinforcers not requiring association with other events, and that attention, smiles, and vocal sounds are conditioned reinforcers which achieve their reinforcing properties only because they have been discriminative stimuli for the delivery of primary reinforcers. There are considerable data indicating that this conceptualization is not totally accurate even for animals (Butler, 1953; Olds and Milner, 1954; Harlow, 1958). Furthermore, Fantz (1963) has demonstrated that certain shapes and patterns control the visual responses of infants more readily than do others. If one assumes that patterned stimuli which control looking responses are reinforcing, perhaps at least some of the variables involved in the development of attention as a reinforcer may not depend on association with the "primary reinforcers."

In human behavior, various events serve as reinforcers for selected persons. These are often remote from the primary reinforcers of food, water, sex, and reduction of "unconditioned aversive stimuli." One can, of course, through the use of creative "logic," demonstrate after the fact how all of these have been derived from primary reinforcers. This reasoning is, however, after the fact. If one observes humans and other higher animals (primates) one finds that a chief characteristic is the degree to which they can be reinforced by events remote from primary reinforcers. Perhaps this partly explains the extremely varied behavioral repertoires of these organisms.

The studies included in this monograph illustrate that a wide range of events can be used to increase the verbal responses of human subjects. Some of the reinforcers used were a pretty girl on a television screen, money, food, and allowing a child to draw with a pen. Only one of these—food—involved "primary" reinforcement.

The results of the studies raise intriguing research questions. Yoder found that the presentation of a picture of an approving pretty girl was a positive reinforcer for adolescent retarded males. Would this same result have been obtained if the approving person had been a male, an older woman, or a peer? Moreover, would a frowning, disapproving person have served as a punisher? Would adolescent girls have responded in the same manner, or would it take a smiling, approving young male to control their behavior? The work of Stevenson (1962) with normal children suggests that such assembly variables do affect the reinforcing properties of an audience.

Both Yoder's and Bradford's chapters deal with the effects of specific consequences and contingencies on verbal behavior. However, it is quite likely that the consequences and contingencies which control speech in natural situations are far more subtle and transitory than those described in this monograph. The delivery of a penny or the removal of an audience is rarely contingent on a response. However, such responses as, "That's right," "I understand," "I didn't know that," or "That reminds me," occur in nearly every conversation and it is likely that these serve as reinforcers for much verbal behavior. Moreover, it is

likely that any one of these responses loses its reinforcing value with frequent occurrence. This is especially true with normal adults. If a person says, "That's fine," too frequently we begin to doubt his sincerity. In other words, this ordinarily reinforcing event may become neutral or aversive. Studies of the effects of such momentary contingencies are complex; however, they lead to a greater understanding of the reinforcers involved in natural speech.

The comments relative to the reinforcers in normal conversation do not detract from the fact that speech can be modified by "non-natural" reinforcers. Such reinforcers as those used in the studies by Bradford, McLean, Hall, and McReynolds can be used to reinforce the child in speech therapy. Moreover, such reinforcers may be necessary to establish verbal responses in some young children. The McReynolds study demonstrates that once the response is established, it is possible to maintain it on social reinforcers. An additional benefit from the use of "non-natural" reinforcers (e.g., food or money in a speech therapy situation) is that children do not "forget" to come to therapy, but frequently come early and are in no hurry to leave.

When reinforcement principles are used in speech therapy, it is important to recognize that reinforcement is defined empirically. That is, an event is a positive reinforcer only if it serves to increase the frequency of a response. Moreover, reinforcers may lose their potency with repeated use. For this reason the clinician must be extremely sensitive to the behavior of the child and must introduce new reinforcers accordingly. Good clinicians have always done this, most frequently expressing it in terms of "being sensitive to the needs of the child."

Decelerating Inappropriate Behavior

The clinician frequently encounters children who exhibit behavior which interferes with the development of desired speech behavior. Sometimes the behavior will be appropriate in other situations, or at reduced rates. Occasionally, however, it will be behavior which has little utility in a natural community. Such was the case of the jargon from the child studied by Galloway and Sulzbacher. Any complete analysis of training would be remiss if it did not suggest ways of decelerating such behavior. There are several procedures for reducing the frequency of undesirable behavior. An often-suggested procedure is extinction, or merely making sure that no reinforcement is delivered for such behavior. This procedure is difficult with vocal behavior, since vocal behavior once established may be maintained on weak reinforcers, as was demonstrated in the McReynolds study. Moreover, if the behavior was developed on intermittent reinforcement, it may resist extinction. A second procedure involves the positive reinforcement of incompatible behavior. For example, Galloway and Sulzbacher might simply have reinforced the child for periods of silence. Practical limitations sometimes preclude this luxury of time. In such a case, it may be most efficient simply to punish the response each time it occurs. Galloway and Sulzbacher first tried time-out from reinforcement as their decelerating consequence. This procedure is often effective. However, they found that

the time-out procedure did not reduce jargon to satisfactory levels, so they introduced an alternative decelerating consequence, *shh*, which reduced the jargon to acceptable levels. Once again, the effect of a consequence was demonstrated to be an empirical matter.

Speech therapy often involves the shift or extension of stimulus control over already established speech behavior. The extension of stimulus control of speech is best illustrated by McLean's study. Although it may seem that the behavior of McLean's subjects was shaped, this is not correct. The subjects exhibited the desired behavior under certain stimulus conditions, i.e., when an echoic response was required. They did not emit the correct articulatory responses in the presence of other stimuli (pictures, printed words, intraverbal stimuli). McLean's task was to extend stimulus control to these other appropriate stimuli. His procedure was to reinforce the desired response as an echoic response until it was highly probable, and then to pair the echoic stimulus with a picture stimulus, continuing to reinforce desired responses until they were given in almost 100% of the trials. Then he withdrew the echoic stimulus and reinforced the subject for making the desired response to the picture alone. The picture was then paired with printed words and the procedure was continued until control could be shifted to the printed word alone. These same procedures were then used to establish intraverbal control (i.e., correct responses to such verbal stimuli as, "Wool is produced by [sheep].").

Extending stimulus control in the training of articulation requires increasing the probability of the desired responses while reducing the probability of the undesired response. The probability of the desired response is increased by presenting an echoic stimulus and reinforcing it. One may ask why McLean's first step did not involve pairing the echoic and the picture stimulus. McLean's procedure of first increasing the strength of the desired response under echoic stimuli was used because the typical response to the picture was the undesired response. Presenting the echoic stimulus first increased the strength of the desired response, thus making it more likely that it would be emitted in the presence of the more complex stimuli consisting of both the echoic and picture stimuli.

While McLean's procedure was effective, laboratory evidence (Sidman and Stoddard, 1967; Stoddard and Sidman, 1967; Terrace, 1963a, 1963b) indicates that it is more effective to gradually fade in the picture stimulus and then gradually fade out the echoic stimuli. This procedure can be replicated in the shift from picture to printed word and from printed word to the intraverbal stimulus. The fading procedures allow for nearly errorless learning and decrease the probability that previously formed discriminations will be disturbed. In other words, fading decreases the chances that the responses under echoic control will be disturbed when the responses are shifted to picture control.

The use of fading as described in the study by Hall more nearly illustrates the ideal stimulus extension procedure and clearly demonstrates that such pro-

cedures can be used in a clinical situation with a child with verbal disturbances more severe than simple articulation problems.

While much of the work on extension of stimulus control has involved within-modality shift of stimulus control, McLean's study, as well as the clinical observations by Hall, clearly demonstrate that control can be extended from auditory to visual stimuli. McLean's data indicate that progressive extension of stimulus control is more easily established each time the control is extended to an additional stimulus. Once control has been established with two stimuli, a third can be added in fewer trials than it took to add the second. This same phenomenon is found in simple discrimination and imitation learning.

Extension of stimulus control seems basic to at least one type of concept formation. For example, if a child says, "book" in the presence of only one specific book, we would probably say that he did not have the "concept" of book; however, if he names many books with the label "book," we would likely say that he has the concept of book. Natural concept learning, though, involves far more than response to a visual stimulus. If a child could say "cat" to all the cats that walked by, but could not respond to a question such as "What has four legs, a long furry tail, and goes meow?" we would consider his conceptual development inadequate. Therefore, we would extend stimulus control to the question before we would say that he has a "complete concept" of cat.

Bricker and Bricker (in press), Guess et al. (1968), and Guess (1969) have shown that the systematic use of operant principles can be useful in vocabulary development and the acquisition of linguistic rules.

Carry-Over or Generalization

Carry-over, or generalization of correct speech outside the clinic, is an important problem for speech clinicians. The problem is a complex case of extension or shift of stimulus control and should be accomplished in much the same manner that extension is accomplished within the clinic. McLean suggests that the repeated extension of stimulus control within the clinic increases the chances that correct articulations will be generalized outside the clinic. The data are not presently available to support this notion, but it is certainly plausible since McLean did discover that each new shift or extension of stimulus control was established with greater ease than the previous one.

Carry-over might be increased by bringing members of the child's family into the speech clinic toward the end of training. Since members of the child's immediate family are probably significant controlling stimuli for the incorrect responses, an increase in the probability of correct responses in their presence can be accomplished by transferring the control of the clinic room and the clinician to the child's immediate family. Moreover, such a procedure might increase the chances that the immediate family would reinforce correct speech.

Clinicians have been well aware of the problem of shift of stimulus control outside the clinic and have developed procedures for increasing the chances of carry-over. Van Riper's (1963) "good speech chair" is one of these. The notion

is that a child has a special chair in which he practices speech at home. This is probably partially effective because in practicing speech in a special chair, the child is more likely to emit correct responses; and, since the chair is in the home of the family, control of proper speech may be shifted from the chair to members of the family. A speech wristwatch might be an equally effective transfer device. During the final stages of training in the clinic, the child would be given a special wristwatch to wear while working on speech. Later, the child would be allowed to take the watch home. He would wear it only when he was practicing good speech. At first, practice sessions would be short and confined to an artificial setting. However, after a while the child might be allowed to wear the wristwatch at the dinner table. This would provide a controlled context in which the parents could observe and reinforce correct speech. The child would have to remove the watch if his speech deteriorated at any time. Such a procedure, of course, provides portable stimulus control and would be reinforcing for most children. Moreover, the duration of the time the child wears the watch would be gradually increased. One should remember, however, that the aim is to extend the control of articulate speech to members of the family, peers, and members of the community. The wristwatch is, at best, an aid in achieving such carry-over.

Another technique to enhance shift of stimulus control from the clinic to the home is the gradual shift from continuous to intermittent reinforcement. An intermittent schedule is provided in the natural environment. In most of the studies reported here, the reinforcement was delivered on a continuous schedule. Behavior established on such a schedule extinguishes rapidly. Thus, if speech behavior is to remain strong in the face of relatively infrequent reinforcement in the community, the clinician should thin out the schedule within the clinical setting before finishing the therapy, as Hall did in Chapter V.

Reinforcement develops stimulus properties (Spradlin, Girardeau, and Hom, 1966). That is, the clinician who reinforces behavior with tokens, pennies, or candy may accidentally establish tokens, pennies, or candy as controlling stimuli so that the child will respond appropriately when the reinforcement is present. For this reason, if one can establish appropriate speech and maintain it under social reinforcement conditions, there may be a greater chance of shift of stimulus control to the natural environment. Moreover, if one uses a wide variety of objects, events, and activities (such as Hall did in his training sessions) transfer most likely will be accomplished rapidly.

Speech presents special problems in analysis since it is subject to complex, multiple controlling variables. Usually the discriminative stimuli involve a complex set of events including at least an audience and an auditory stimulus—namely, the listener's last utterance. In other communication situations, other visual, tactile, kinesthetic, gustatory, or olfactory stimuli are usually included. In addition to the fact that the discriminative stimuli controlling speech are multiple, the stimuli often have multiple functions serving both as discriminative stimuli for the speaker's responses to follow and as reinforcers for his previous

responses. It is, of course, well known that discriminative stimuli also function as reinforcers. However, the dual role is much more compelling in a two-person situation in which each person's response reinforces the other person's response, as well as being the occasion for subsequent responses. The fact that the stimuli associated with the listener have strong reinforcing and discriminative functions leads to some interesting research design problems. For example, a study by Flanagan and Rolland[1] demonstrated that when projected pictures occurred contingent on the verbal behavior of young retardates, rate of vocalization increased. When the pictures were not presented when the child vocalized, vocalization decreased. This would suggest that the slides were reinforcing and that nondelivery resulted in a decrease of response. However, the investigators then presented the pictures independent of the child's vocalization. The vocalization rate increased. Thus, the pictures increased the rate of vocalization whether or not their presentation was contingent. It seems likely that the discriminative properties of the pictures were the primary factor in the increase of vocalization rates.

If the researcher runs the risk of placing too much emphasis on reinforcing properties, the layman focuses too much on the discriminative properties of speech. For example, an adult may call out a child's name and command the child to stop engaging in a given activity. It may soon become apparent that the rate of engaging in the activity is increased—not decreased—by the vocal behavior of the adult. In such cases, it is obvious that the commands do not have controlling properties, but are functioning as reinforcers for the child's activity.

The events which determine whether or not a given social response to verbal behavior is reinforcing are extremely subtle. For example, eye contact coupled with a slight smile and verbal remarks may serve to reinforce behavior. Or perhaps eye contact has reinforcing and discriminative properties only under special conditions, such as when there is a rather abrupt change in eye direction. That is, perhaps it is only the momentary establishment of eye contact which controls behavior, rather than the endurance of eye contact.

Speech Therapy of the Future

The development of effective speech correction procedures based on principles derived from the experimental analysis of speech will be gradual. The first basic change will be an improvement in the way individual clinicians organize their therapy sessions. The clinician will do a more careful analysis of the child's speech and will try to pinpoint exactly what aspects of speech are to be changed. He will devise convenient ways of recording change in speech response, and there will be a careful analysis of possible reinforcers for the child. Something like Addison and Homme's (1966) reinforcing event menu will probably become a standard part of therapy programs. Clinicians also will

[1]Personal communication to the authors.

become acquainted with the importance of timing of reinforcement delivery and they will react more quickly (even spontaneously) when the child makes a desired speech response. They will also recognize that once a desired speech response is established, reinforcement can be gradually reduced until the behavior is being maintained by occasional reinforcement.

A special emphasis will be placed on principles of stimulus control. Clinicians will become extremely sensitive to the principle involved in shift of stimulus control, such as was illustrated in McLean's and Hall's papers. They will seek ways to evoke correct responses and to develop procedures to insure that they are shifted to the stimuli provided in the community. The principles of stimulus shift no doubt will lead to effective carry-over procedures.

In short, the clinician will develop specific goals and powerful tools for achieving these goals. Nevertheless, certain problems will still be prevalent. First, it will be impossible to treat all children with speech problems by individual therapy, and, second, even trained clinicians will vary in their effectiveness in programming stimuli and reinforcers.

Simultaneously with the change in individual therapy will come the development of machines to serve as clinicians. Researchers are already beginning to develop voice-operated machines that discriminate certain aspects of duration, intensity, and pitch (Bruiten and Lane, 1965). Coupled with the computer, it may be a relatively simple matter to determine whether a child's speech meets community requirements. A variety of machine-delivered reinforcers will be used. Initially in speech training, nonsocial reinforcers such as money or food may be used. Unlike the clinician, the machine will accurately deliver reinforcements on whatever schedule is deemed most desirable at a given stage of therapy. At a later stage social reinforcers may be programmed. Yoder's technique provides an ideal model for this. But video reinforcers need not be confined to a single person. Pictures of mothers, fathers, brothers, and sisters can be taped and presented when most appropriate. During tape therapy, the mother would not inadvertently reinforce incorrect responses and the father would not become impatient when Johnny's responses did not meet his expectations. More predictable systems for presenting stimuli to evoke specific articulation responses will be automatically programmed and response learning will be efficient, rapid, and painless.

What about the speech clinician? This role will change dramatically. The clinician will develop more precise diagnostic techniques, will design precise clinician-presented and machine programs, will evaluate these programs, and will revise them so that they are effective. In every situation, the clinician will be extremely sensitive to the use of individualized consequences. The clinician will also develop individual programs to be used in the home and work more closely with the family in making the programs work. In short, the image of the speech clinician will continue to improve as clinicians become more aware of the behavioral principles involved in effective speech modification programs. The future looks bright, indeed, for those children and adults who need speech and hearing therapy.

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