*MODIFICATION OF CONSONANT SPEECH-SOUND
ARTICULATION IN YOUNG CHILDREN¹*

JAMES M. JOHNSTON AND GWENDOLYN T. JOHNSTON

GEORGIA STATE UNIVERSITY AND EMORY UNIVERSITY

A series of three experiments was performed in a classroom setting with small groups of young children with severe articulation problems. Variations on a basic token reinforcement procedure were demonstrated in each experiment. A combined multiple baseline/reversal design showed effective experimenter control of rates of correct and incorrect consonant sound articulation in all cases. In addition, the data in each experiment showed the problems of obtaining stimulus generalization of the high rates of correct articulation to non-training settings. The third experiment demonstrated a procedure for producing such generalization by making each child a discriminative stimulus for correct articulation by the other child, thus maintaining high levels of correct articulation for each child when in the presence of the other.

Since the publication of Skinner's major work (1957), applications of principles of behavior have been extended to the control of different classes of human verbal behavior (Issacs, Thomas, and Goldiamond, 1965; Reynolds and Risley, 1968; Barton, 1970), shaping verbal behavior (Hingtgen and Trost, 1966; Risley and Wolf, 1967), increasing the use of certain categories of verbal responses (Baer, Peterson, and Sherman, 1967; Hart and Risley, 1968; Guess, Sailor, Rutherford, and Baer, 1968; Risley and Reynolds, 1970; Wheeler and Sulzer, 1970), and manipulation of stuttering behavior (Flanagan, Goldiamond, and Azrin, 1958, 1959; Siegel and Martin, 1965*a*, 1965*b*; Goldiamond, 1965; Martin and Siegel, 1966*a*, 1966*b*; Quist and Martin, 1967; Azrin, Jones, and Flye, 1968; Jones and Azrin, 1969; Siegel, Lenske, and Broen, 1969).

Although speech therapists spend more time correcting poor articulation than on any other type of speech problem (Sloane and MacAulay, 1968), applications to the control of articulation

of phonemes have been less numerous. Both Holland and Mathews (1968) and McDearmon (1968) developed and tested programs for training discriminative responding to auditory stimuli. A study by Mowrer, Baker, and Schutz (1968) used a program that shaped the correct articulation response by successive approximations and gradually developed generalization of correct responding to a larger vocabulary of more complex words. Brady, Commons, and Hochberg (*unpublished*) reinforced correct responses to auditory discrimination tasks in single words and phrases (with teacher praise) and then demonstrated maintenance of those levels of correct responding in a fluent speech situation.

The present experiments were designed to serve three major functions. First, one purpose was to extend techniques of behavior analysis to demonstrate three different ways of training high rates of correct and low rates of incorrect consonant speech-sound articulation in young children with severe articulation problems. Secondly, since a common complaint of teachers and speech therapists concerns the demands on their time and skills of the requirements of behavioral techniques, all work was performed in a small group, classroom setting with recording and consequence by a regular teacher and

¹Funded through Title VI-A Florida Department of Education, Exceptional Children's Program. Reprints may be obtained from James Johnston, Dept. of Psychology, Georgia State University, 33 Gilmer St. S.E., Atlanta, Georgia 30303.

speech therapist so as to demonstrate the practical feasibility of the procedures. Finally, the purpose was to demonstrate empirically the problem of obtaining generalization of responding developed in an experimental or training situation to non-training settings and to offer evidence on one tactic for obtaining stimulus generalization.

GENERAL PROCEDURE

Experiments I and II were conducted concurrently; Experiment III at a later date. Another study, part of an experiment (not reported here) similar to Experiment III was conducted at the same time as the first two experiments and constituted part of the stimulus situation for those two groups.

A 3-hr school day was divided into blocks of time in which teacher-directed activity periods (15 min) alternated with undirected "free-play" periods (originally 15 min but later changed to 10 min).

During activity periods, the children sat with the teacher at a table or on a mat. There were three kinds of activities (storytelling, lessons from the Peabody Language Developments Kits, and children's card games), all designed solely to obtain high rates of natural (not teacher-elicited) verbal behavior from the children and a minimum of verbalizations from the teacher.

The particular activities used were experimentally unimportant except that they served to maintain a high level of natural verbalizations from the other children. However, the teacher always sat with the children and supervised the activity and the verbalizations in an attempt to maintain a great deal of conversation and to ensure that each child had his chance to talk. The teachers were initially instructed and frequently reminded to keep their own verbalizations to a minimum.

In play periods, the children were usually given a choice of two or more typical preschool or elementary activities that would be normally regarded as recreational. These activities in-

cluded playing with blocks, cars, trains, dolls, toy houses, puppets and other toys; playing table games; working with clay, pipe cleaners, and paper; and playing improvised games. During these play activities, the teacher stood or sat in the background to record speech sounds and interfered as little as possible.

All activity and play periods ended and began with a bell, and there was a 2-min break to allow the groups and teachers to switch materials and positions. Activity and play periods were held in opposite sides of two large rooms connected by a partially closed folding wall; thus, groups from the two other concurrent experiments were always either in an activity or play period nearby. Except when behavior during play periods involved experimental consequence, each group sometimes shared a play period with another group.

A single consonant speech sound was selected for each child as the behavior to be studied. In every case, it was a sound with which individual or group therapy procedures had been employed during the previous nine months but which was not being correctly articulated outside of the speech therapy setting or, in some cases, in the therapy situation itself. Thus, the correct articulation of each child's sound was in his repertoire, but at a very low rate.

All correct and incorrect emissions of each child's sound in fluent speech during all activity periods and two play periods each daily session were counted by the teacher on manual counters mounted on a small board. The diversity of activities in play periods made it necessary for the teacher usually to observe only two children at a time each play period. The decision of whom to observe was made by the teacher immediately before the play period started; however, each child was observed during two play periods each day.

The complexity of the repertoire of behaviors required of the teachers (managing the children, handling the activity and materials, and counting separately all correct and incorrect emissions of a sound for each child in fluent speech)

necessitated a brief period of training with additional children before the study was initiated. During the initial baseline phase, the teachers switched groups on a variable schedule every day. However, at the beginning of the first experimental manipulation each teacher was assigned to a particular experiment for the remainder of the program.

It was not feasible under the circumstances to assess the accuracy of the teachers' recording with the desired degree of sophistication. Reliability measures of the teachers' recording in Experiment I and II were made by having a qualified speech therapist serve as observer on six separate sessions throughout the program. The therapist observed a different group each period on a predetermined schedule so that at the end of the studies, there were a number of observations of each possible teacher-group-activity combination. Available audio-visual aids would not adequately record the emission of the speech sounds, and the therapist-observer had to sit immediately behind and beside the teacher in order to receive accurately the same auditory and visual cues necessary to judge the correctness of speech sounds. The therapist-observer was frequently instructed to use the prearranged criteria for each sound and to attempt to make her judgements independently of those of the teachers.

The per cent agreement on correct and incorrect emissions between the observer and the experimenters of Experiment I and II was computed for each experimenter by dividing the larger number of observations into the smaller number. The experimenter for Experiment I (and also Experiment III) was a trained and experienced speech therapist, and the per cent agreement with the speech therapist-observer was 93.6% for correct speech sound articulation and 91.4% for incorrect sound emissions. Agreement between the observer and the experimenter of Experiment II (a kindergarten teacher) was 84.7% for correct sounds and 81.8% for incorrect sounds. It should be noted that speech sounds (particularly in this study) constantly

change along a continuous dimension from correct to incorrect articulation and the discriminatory responses that were required of the experimenters had to be made on the basis of extremely subtle visual and auditory stimuli. Studies cited by McDonald (1964) indicated that experienced speech clinicians averaged only 80% agreement in judging the correctness of articulation responses in children.

EXPERIMENT I

Subjects

This experiment was conducted with three boys and two girls, all 6 yr old. These children each had very low operant rates of correctly articulating two or more consonant speech sounds in educational settings and would normally be termed as having severe articulation problems. They all had received individual speech therapy for varying periods of time during the nine months before the study. During this earlier therapy, the correct pronunciation of the consonant speech sound used in the study had been successfully shaped, but according to teacher reports and observations by the speech therapist, had been maintained (at moderate rates) only in the presence of the speech therapist. Thus, the operant under study was already in the repertoire of each child to varying degrees, but at very low rates. One child was dropped from the experiment due to illness and another child (data not presented) completed the study with frequent absences due to illness.

Procedure

In Phase I (baseline), the children were simply told they were in summer school, and no mention was made about "speech". The teachers counted correct and incorrect speech sounds for each child with no programmed consequences other than the click of the counters. The children rarely asked about the counters or what the teacher was doing.

At the beginning of Phase 2, the teacher announced to the children before each activity that

she was counting their correct and incorrect speech sounds. Each child was told what his sound was, and examples of that sound in words were presented. Each time a child said his speech sound correctly he earned a mark or sticker or dot, which was placed on his daily histogram-type chart with a single vertical column for each of the daily activities. A board displaying all four charts was kept next to the table during the activity and was frequently referred to. If a child earned enough stickers to go above an individually set daily criterion line drawn at some level on the column, he was allowed to choose his activity in the following play time. If he failed to earn enough stickers to go above his "line", he sat in a timeout chair for the duration of the following play time until the next activity.

Actually, few timeout contingencies were administered. The criteria levels were set by each teacher before each activity. They were continually raised (and never lowered) in each activity (or play period in Phase 3), but the desired criteria levels were adjusted gradually in successive steps so that failure of the child to meet a criterion was unlikely.

The contingencies were announced more frequently at first, and teacher praise was intermittently given for correct sound productions. All incorrect emissions of each child's speech sounds were corrected by the teacher. The form of this correction varied somewhat, but usually involved the teacher saying: "No, Johnny, fish not *pish*." One of the activities each day was followed by a snack at which all children received juice, but cookies and other edibles were earned by criterion performance.

Throughout Phases 1 and 2, the teacher, unobtrusively recorded correct and incorrect sound productions during play periods; however, there were no programmed consequences. This allowed the play periods to provide multiple baseline function for comparison with the activity period procedures.

In Phase 3, a reversal manipulation was made in which baseline conditions were reinstated for activity periods and experimental conditions

were concurrently begun for play periods. The appropriate number of stickers produced in play time earned a cookie or other snack immediately following the play period. During this phase, the teacher had to interact somewhat more often than during the previous play time, but this was still a time of non-directed play with minimal teacher verbalizations.

RESULTS

The effects of these procedures may be seen in Figure 1, which shows the overall rates of correct and incorrect productions of each child's consonant speech sounds as a function of daily sessions for all activity periods and for two play periods. The graphs for each subject are shown side by side, with activity period data on the left and play period data on the right.

Figure 1 shows highly similar performance for all subjects in each of the phases. In the original baseline phase, all subjects show stable rates of both correct and incorrect responding in both activity and play periods, with very low correct response rates. Following the onset of reinforcement procedures in activity periods, all exhibit an immediate and steady increase in rates of correctly articulating their consonant sound and a steady decrease in incorrect response rates, to the extent that at the end of Phase 2, the levels of correct and incorrect responding are the reverse of that observed in baseline data. The concurrent continuation of baseline conditions in play periods produced little or no change in response rates until the latter part of the phase, when some increase in correct and decrease in incorrect rates may be seen. In the final manipulation, the return to baseline procedures in activity periods produced moderate (Subject 1C) to large increases in rates of incorrect responding and decreases in rates of correct responding. The simultaneous initiation of reinforcement procedures in play periods yielded dramatic increases in rates of saying sounds correctly and slight decreases in the incorrect response rates of Subjects 1A and 1C.

Fig. 1. Number of correct and incorrect speech sounds per minute for all subjects in Experiment I. Each point represents the overall rates correct and incorrect for all activity or play periods in each daily session.

DISCUSSION

In Experiment I, the stringent requirements of a multiple baseline design allow the clear conclusion that the changes in the children's rates of correctly and incorrectly saying their speech sounds were the result of the described reinforcement procedures. This type of research design also permits an analysis of the degree of stimulus generalization that occurred. It must be remembered that most of what would normally be considered relevant variables were arranged so as to maximize the generalization of response

rates obtained by the reinforcement procedures to settings in which experimental reinforcement was absent. In Phase 2 of play periods and Phase 3 of activity periods, when no reinforcement was administered, the same physical setting, peers, and teachers were present as existed during training conditions. This should have increased the probability of observing a high degree of stimulus generalization. Instead, only minor decreases in incorrect and increases in correct response rates were observed in these two instances. Clearly, in this situation simply maintaining the presence of certain stimuli in non-reinforcement conditions was not sufficient to

obtain an even moderate degree of generalization.

EXPERIMENT II

This experiment was designed to demonstrate a second technique for training proper emission of consonant speech sounds. A common strategy for training such responding in young children is first to teach the child to respond discriminatively to correct and incorrect sounds produced by others. These manipulations were intended to show that this step is unnecessary by training discriminative responding (counting) to correct sound emissions in the child's own fluent speech while he was engaged in normal verbal activities and by using this counting response to increase correct and to decrease incorrect rates of saying his consonant sound. The manipulations were also designed to provide additional evidence of the degree of stimulus generalization occurring under these conditions.

Subjects

Two girls and three boys, 6 and 7 yr of age, served. One boy was dropped from the study early in the second phase because he progressed very slowly with respect to the other children. His slow progress resulted in excessive teacher time and verbalizations spent with him (thus, less time with and verbalizations from the other children) and caused considerable disruption with the other children (who continually corrected and chastized him). As in Experiment I, these children had received speech training within the previous nine months and had then been shaped to articulate correctly the speech sound used for them in the study. However, their articulation problems again would normally be termed severe.

Procedure

The procedures of Experiment I were repeated, with the following exceptions. The sequence of experimental conditions was ABB in activity periods and AAB in play periods. In

other words, conditions were the same as in Experiment I except that there was no return to baseline in Phase 3 of activity periods.

At the beginning of the second phase in activity periods, each child was given a manual counter (Lafayette #99T9030) that produced an audible click when the lever was depressed. During the first few sessions, the teacher shaped each child to click the counter immediately after correctly articulating his speech sound in normal speech.

To obtain this behavior, the teacher initially verbally described the desired response. At first, each time a child emitted his sound correctly, the teacher verbally reminded him to count it; the child was immediately given a sticker on his chart for the correct counting response. The teacher gradually diminished the verbal cues and then slowly decreased her use of other cues, such as looking at the child, pausing, and moving her hand toward her own counters. Each completed counting response was reinforced with the presentation of a sticker on the child's chart. As the teacher cues were withdrawn, latency requirements for the child's counting response were decreased so that a correct counting response had to occur approximately 1 to 2 sec after the sound (and before the teacher's own counting response). Once these procedures were terminated (in different sessions for different children), the teacher attempted to give no cues to a child to assist in counting. This requirement meant that the teacher's own counting of the child's sounds had to be delayed until the child had counted or until the teacher-determined deadline had passed. Often, the teacher waited until another child was talking before counting the previous child's sounds. After this fading procedure was over, any correct sounds not counted by the child were ignored by the teacher, but all incorrect sounds were still corrected.

RESULTS

When the number of correct consonant sounds counted by each child is expressed in

terms of the per cent of the total correct sound emissions in activity and play periods across experimental sessions, the data show that these 6- and 7-yr-old children counted their correct sound productions in fluent speech while engaged in an activity with a degree of accuracy ranging from medians of 87 to 93% of possible correct sounds. Although the number of times each child counted an incorrect sound was not recorded, it was estimated to have been consistently very low. It was interesting to note that initially, counting an incorrect sound often resulted in the child asking the teacher if he could clear his counter and reset the proper number. To avoid any possible reinforcing consequences of manipulating the counters, the teacher announced that anyone who accidentally depressed the lever or who counted an incorrect sound would not be allowed to reset the counter to correct the error. There were indications that this procedure facilitated the acquisition of correct counting responses.

During Phase 2 in activity periods, the children were free to take their counters to the following play periods and count their sounds, but this did not occur. However, when counting was consequated in play periods (Phase 3), it occurred with the same accuracy obtained when it was reinforced in activity periods.

Figure 2 shows the number of correct and incorrect sound emissions per minute in activity and play periods as a function of daily sessions for all subjects (Subject 2C withdrew from the study early in the third phase because her family moved out of town). The pattern of the rates of correct and incorrect sound emissions in each phase shows considerable similarity to those in Experiment I. It should be noted that in all cases at the beginning of Phase 2 in activity periods there was an immediate decrease in the rate of incorrect sounds while only a slight increase in correct rates. This change resulted in a decrease in the overall production of the speech sound, suggesting an overall decrease in the rate of verbalizations. Then, more gradually than in Experiment I, the rate of incorrect sounds decreased

still further while the rate of correct sounds increased to a point higher than incorrect sound rates in the baseline phase. This change coincided with the final acquisition sessions. After the acquisition procedures were terminated, each child showed further increases in correct and decreases in incorrect response rates. In Phase 3 in activity periods, still greater increases in rates of correct sounds were obtained along with some increase in rates of incorrect sounds for Subjects 2A, 2B, and 2C.

Graphs of the individual response rates in play periods show fairly stable baseline response rates in the first two phases except for a slight increase in correct rates of sound articulation toward the end of Phase 2. Introduction of the experimental conditions in the play periods resulted in immediate increases in correct response rates and generally small decreases in incorrect response rates. In Subjects 2A, 2B, and 2C, this resulted in an increase in the overall rate of each child's speech sounds, thus suggesting an increase in the overall level of verbalizations. Proportionately, the number of incorrect sounds showed a decrease from the previous phases.

DISCUSSION

As with Experiment I, the design of this manipulation allowed the clear conclusion from the data that the reinforcement procedures for correct self-counting responses produced a high degree of control over correct and incorrect sound emissions. Furthermore, it does not seem that teaching auditory discrimination of the consonant sounds of a model would be a necessary prerequisite to teaching the child to monitor his own sounds.

An analysis of the degree of stimulus generalization obtained in non-reinforcement settings is again useful. Not only did the children not count unless reinforced, little change (if any) in the high incorrect and low correct response rates was observed between Phase 1 and Phase 2 in play periods. This was in spite of the fact that in the alternative activity periods during Phase

Fig. 2. Number of correct and incorrect speech sounds per minute for all subjects in Experiment II. Each point represents the overall rates correct and incorrect for all activity or play periods in each daily session.

2, the children were emitting mostly correct consonant sounds in the presence of the same peers, teachers, and general stimulus setting as were present in play periods.

EXPERIMENT III-A

The purposes of this experiment were to (1) demonstrate a third technique for training cor-

rect consonant sound usage by teaching two children to respond discriminatively to the correct and incorrect speech sounds of each other, (2) to measure the effect of this monitoring by the other child on their own rates of correct and incorrect sounds, and (3) to examine the effects of establishing each child as a discriminative stimulus to the other child for the monitoring of the other's speech sounds on the degree of stimulus generalization obtained under non-reinforcement conditions.

Subjects

Two girls, 8 yr of age, who met the same criteria as the subjects in Experiments I and II, served.

Procedure

Again, the procedures in this study were identical to those in Experiment I with the following exceptions: the sequence of experimental conditions was ABA in activity periods and AAB in play periods, the same experimenter was used throughout all phases, and the data were collected in one 15-min period followed by one 10-min play period. Unfortunately, no data were recorded during Phase 1 in play periods.

For sessions 11 through 14 at the beginning of the experimental conditions in the activity periods, each child was trained to monitor the correct and incorrect speech sounds of the other. The procedures used were similar to those of Experiment II, in that initially, verbal prompting by the teacher was combined with physical cues to obtain the desired behaviors. Over a period of four sessions, these cues were gradually faded out and were not used again after training was completed. A monitoring response meeting the criterion for reinforcement with a sticker on the child's chart was defined as (1) saying to the other child within 1 to 2 sec of his articulating his speech sound incorrectly: "You said fish wrong", or "That was a bad /f/ in fish", or (2) saying to the other child within 1 to 2 sec of his pronouncing his speech sound correctly: "That

was a good /s/ sound", or "You said snake right that time". The exact phrase used varied somewhat because of the spontaneity of the subject's verbalizations, but the basic components of 1-2-sec latency, speaking to the other child, (not the teacher), and saying the word containing the speech sound had to be present to define a monitoring response. Either kind of monitoring response produced a sticker for the monitoring child that was placed on his chart. The teacher did not deliver any scheduled consequences for correct or incorrect speech sounds. The number of monitors of correct and incorrect sounds and all emissions of correct and incorrect sounds was recorded for each child by the teacher.

RESULTS

Figure 3 shows that the monitoring by the other child clearly controlled correct and incorrect response rates in patterns quite similar to those seen in Experiments I and II. Child 3A (top) monitored the correct and incorrect sounds of Child 3B (bottom) with medians of 97.8% and 100% accuracy in Phase 2 and medians of 81% and 57.5% accuracy in Phase 3 when monitoring was no longer reinforced. Child 3B monitored the correct and incorrect sounds of Child 3A with medians of 94% and 100% accuracy in the reinforcement phase and with medians of 47.5% and 0% in Phase 3. Of particular note is the fact that in Phase 3 of activity periods, when monitoring responses were no longer being reinforced, each child continued to monitor (although with reduced accuracy) and that this monitoring maintained some control of each child's correct and incorrect response rates.

The lack of data in Phase 1 of play periods did not allow a comparison of response rates before and during peer reinforcement procedures. Therefore, it was not possible to draw any conclusions about the discriminative stimulus effects of the presence of each child on the other's speech sound rates.

Fig. 3. Number of correct and incorrect speech sounds for both subjects in Experiment III-a. Each point represents the overall rates correct and incorrect for all activity or play periods in each daily session.

EXPERIMENT III-B

Since it was not clear from Experiment III-a that each child was a discriminative stimulus for the monitoring of sounds by the other child, a further manipulation was performed.

Subjects

The same children from Experiment III-a were used.

Procedure

The basic procedures used in Experiment III-a were repeated, but the sequence of experimental phases was BAA in activity periods and ABB in play periods.

After the first phase, monitoring responses were no longer reinforced in activity periods but were now reinforced in play periods. After stable

responding had been observed in this double reversal of conditions, two classmates of the two experimental children were brought into the activity periods. These new children had had no experience with this situation of the experimenter, and they had no articulation problems. For five sessions, Subjects 3A and 3B were separately paired with one of the new children (always the same one) during the usual activity period (where responses were no longer being reinforced). The activity periods for each pair were held simultaneously in the same room. The experimental subjects sat with their backs to each other at opposite ends of a large table, and there was no evidence that the presence of either pair affected the other. The experimenter recorded sounds and monitoring responses for the experimental subjects on paper, in an attempt not to disturb the non-experimental subjects

with the sound of manual counters. The new children left immediately after the activity period and the experimental children promptly began the usual play periods together (where monitoring responses were now reinforced).

In the final experimental phase, conditions were identical to those existing before the new children were introduced.

RESULTS

Figures 4 and 5 show the results of these manipulations for Subjects 3A and 3B, respectively. The same pattern of correct and incorrect responding by each child relative to the monitoring of his peer observed in Experiment III-a is clearly shown. Again, monitoring of sounds by each child occurred in activity periods when it was not being reinforced by the teacher, but

occurred only on a total of three days with poor accuracy during non-reinforcement in Phase 1 of play periods.

It may be seen that the pairing of a new child with each subject in the latter part of Phase 2 in activity periods had consistent effects on the responses of the subjects. Child 3A, who during this entire experiment made only two incorrect responses when paired with Child 3B, now said some sounds incorrectly on four of the five days she was paired with the new child. While the difference is small, the high degree of stability makes the change notable. Child 3B showed large and consistent increases in incorrect and decreases in correct response rates in the presence of the new child compared to when she was paired with Child 3A. That this change in response rates was due to the new child and not the absence of monitoring may be seen by com-

Figure 4. Top: each point represents the per cent of the total speech sounds emitted by Subject 3B, which were monitored by Subject 3A. Bottom: each point represents the overall speech sounds per minute in each daily session for Subject 3A.

Fig. 5. Top: each point represents the per cent of the total speech sounds emitted by Subject 3A, which were monitored by Subject 3B. Bottom: each point represents the overall speech sounds per minute in each daily session for Subject 3B.

paring these data with those seen in Phase 1 of play periods (where almost no monitoring occurred but where the two experimental children were together). The conclusion that the two children were discriminative stimuli for low rates of incorrect and high rates of correct responding in the other child is clearly justified.

DISCUSSION

Experiment III demonstrated another successful technique for training the correct usage of speech sounds based on reinforcement principles. However, unlike Experiments I and II, a considerable degree of stimulus generalization may be observed here. The subjects monitored their peer's sounds in activity periods even when they did not receive reinforcers for doing so and this controlled responding in the child monitored.

Furthermore, it might be expected that had an extinction phase followed a phase of reinforcement for monitoring in play periods, a similar degree of monitoring along with its effects would have been seen. (The first phase of Experiment III-b is not such a case because it followed Phase 3 of Experiment III-a two months later.)

GENERAL DISCUSSION

Each of the experiments successfully showed a practical means for training correct usage of speech sounds. While the setting and reinforcers were the same in all three experiments, only in Experiment I were articulation responses directly reinforced by the teacher. However, reinforcing counting of one's own correct sounds and reinforcing monitoring of one's peers correct sounds both produced the same degree of control over

saying correct and incorrect speech sounds as observed in Experiment I.

The practical feasibility of these procedures for speech therapists and classroom teachers is demonstrated by the fact that all work was performed under standard classroom conditions by a speech therapist and a kindergarten teacher with only a few hours practice. These experimenters successfully managed up to five young children, handled activity materials, and counted all correct and incorrect emissions of five different consonant sounds in fluent speech, all simultaneously. Of course, practical application of these techniques would not require such extensive data collection.

Experiments I and II pointed out the lack of stimulus generalization from training to non-training conditions, in spite of the fact that the environment was arranged to maximize the probability of obtaining appropriate responding under non-reinforcement conditions. One technique of obtaining generalization of responding to non-experimental stimuli is to establish as a discriminative stimulus for appropriate responding a stimulus that is present in the non-experimental settings of interest. One stimulus always present in both small group training situations and in all other educational settings is another child. Thus, in Experiments III-a and III-b each child was established as a discriminative stimulus setting the occasion for appropriate responding by the other child, which would then be reinforced. This did produce a high degree of control over responding, both when monitoring was occurring for only a moderate proportion of possible responses and when monitoring was hardly occurring at all.

Circumstances at the time of the study did not permit extension of this project into the classroom of these two children. However, for purposes of shaping and maintaining generalization of responding to non-experimental stimulus situations, there seems to be considerable value in establishing peers as discriminative stimuli for occasion-appropriate responding and contingent peer-delivered reinforcement.

Future investigations should explore such problems as different means of establishing one child as a discriminative stimulus for the reinforcement of certain behaviors of other children, variables controlling the maintenance and power of the discriminative properties, and possible applications to classroom and clinical problems.

REFERENCES

- Azrin, N., Jones, R. J., and Flye, Barbara. A synchronization exhibit and its application to stuttering by a portable apparatus. *Journal of Applied Behavioral Analysis*, 1968, 1, 283-295.
- Baer, D. M., Peterson, R. F., and Sherman, J. A. The development of imitation by reinforcing behavioral similarity to a model. *Journal of Experimental Analysis of Behavior*, 1967, 10, 405-416.
- Barton, Elizabeth. Inappropriate speech in a severely retarded child: a case study in language conditioning and generalization. *Journal of Applied Behavior Analysis*, 1970, 3, 299-307.
- Brady, G. Y., Commons, M. L., and Hochberg, Ruth. *Speech sound acquisition and resultant carry over to conversation using behavior analysis techniques applied in a speech therapy class*. Unpublished paper presented at Western Psychological Association, 1969.
- Flanagan, B., Goldiamond, I., and Azrin, N. Operant stuttering: the control of stuttering behavior through response-contingent consequences. *Journal of Experimental Analysis of Behavior*, 1958, 1, 173-177.
- Flanagan, B., Goldiamond, I., and Azrin, N. Instatement of stuttering in normal fluent individuals through operant procedures. *Science*, 1959, 130, 979-981.
- Goldiamond, I. Stuttering and fluency as manipulable operant response classes. In L. Ullman and L. Krasner, Eds. *Case studies in behavior modification*. New York: Holt, Rinehart, and Winston, 1965.
- Guess, D., Sailor, W., Rutherford, G., and Baer, D. M. An experimental analysis of linguistic development: the productive use of the plural morpheme. *Journal of Applied Behavioral Analysis*, 1968, 1, 297-306.
- Hart, Betty and Risley, T. R. Establishing use of descriptive adjectives in the spontaneous speech of disadvantaged preschool children. *Journal of Applied Behavioral Analysis*, 1968, 1, 109-120.
- Hingtgen, J. N. and Trost, F. C. Shaping cooperative responses in early childhood schizophrenics: II. Reinforcement of mutual physical contact and vocal responses. In R. Ulrich, T. Stachnik, and J. Mabry. (Eds.), *Control of human behavior*. Glenview, Ill.: Scott, Foresman and Co., 1966, Pp. 110-113.

- Holland, A. and Mathews, J. Application of teaching machine concepts to speech pathology and audiology. In H. N. Sloane and Barbara MacAulay (Eds.). *Operant procedures in remedial speech and language training*. New York: Houghton-Mifflin Co., 1968, Pp. 159-281.
- Issacs, W., Thoman, J., and Goldiamond, I. Application of operant conditioning to reinstate verbal behavior in psychotics. In L. Ullman and L. Krasner (Eds.) *Case studies in behavior modification*. New York: Holt, Rinehart, and Winston, 1965, Pp. 69-73.
- Jones, R. J. and Azrin, N. H. Behavioral engineering: stuttering as a function of stimulus duration during speech synchronization. *Journal of Applied Behavioral Analysis*, 1969, 2, 223-229.
- McDearmon, J. Programmed learning instruction in phonics. In H. N. Sloane and Barbara MacAulay (Eds.). *Operant procedures in remedial speech and language training*. New York: Houghton-Mifflin Co., 1968, Pp. 282-295.
- McDonald, E. T. *Articulation testing and treatment: a sensory motor approach*. Pittsburgh: Stanu House, 1964.
- Martin, R. R. and Siegel, G. M. The effects of response-contingent shock on stuttering. *Journal of Speech and Hearing Research*, 1966, 9, 340-352. (a)
- Martin, R. R. and Siegel, G. M. The effects of simultaneously punishing stuttering and rewarding fluency. *Journal of Speech and Hearing Research*, 1966, 9, 466-475. (b)
- Mowrer, D. E., Baker, R. L., and Schutz, R. E. Operant procedures in the control of speech articulation. In H. N. Sloane and Barbara MacAulay (Eds.), *Operant procedures in remedial speech and language training*. New York: Houghton-Mifflin Co., 1968, Pp.
- Quist, R. W. and Martin, R. R. The effect of response-contingent verbal punishment on stuttering. *Journal of Speech and Hearing Research*, 1967, 10, 795-800.
- Reynolds, Nancy and Risley, T. R. The role of social and material reinforcers in increasing talking of a disadvantaged preschool child. *Journal of Applied Behavioral Analysis*, 1968, 1, 253-262.
- Risley, T. R. and Reynolds, Nancy. Emphasis as a prompt for verbal imitation. *Journal of Applied Behavior Analysis*, 1970, 3, 185-190.
- Risley, T. R. and Wolf, M. Establishing functional speech in echolalic children. *Behavior Research and Therapy*, 1967, 5, 73-88.
- Siegel, G. M. and Martin, R. R. Experimental modification of disfluency in normal speakers. *Journal of Speech and Hearing Research*, 1965, 8, 235-244. (a)
- Siegel, G. M. and Martin, R. R. Verbal punishment of disfluencies in normal speakers. *Journal of Speech and Hearing Research*, 1965, 8, 246-251. (b)
- Siegel, G. M., Lenske, J., and Broen, P. Suppression of normal speech disfluencies through response cost. *Journal of Applied Behavioral Analysis*, 1969, 2, 265-276.
- Skinner, B. F. *Verbal behavior*. New York: Appleton-Century-Crofts, 1957.
- Sloane, H. M. and MacAulay, Barbara (Eds.) *Operant procedures in remedial speech and language training*. New York: Houghton-Mifflin Co., 1968.
- Wheeler, A. J. and Sulzer, Beth. Operant training and generalization of a verbal response form in a speech-deficient child. *Journal of Applied Behavior Analysis*, 1970, 3, 139-147.

Received 4 August 1970.

(Revised 6 March 1972.)