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THE EFFECTS OF VERBAL ELABORATIONS AND SOCIAL REINFORCEMENT ON CHILDREN'S PERFORMANCE IN A SIMPLE DISCRIMINATION TASK

The University of Arizona PH.D. 1982

THE EFFECTS OF VERBAL ELABORATIONS AND SOCIAL REINFORCEMENT ON CHILDREN'S PERFORMANCE IN A SIMPLE DISCRIMINATION TASK

by

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A Dissertation Submitted to the Faculty of the

DEPARTMENT OF SPECIAL EDUCATION

In Partial Fulfillment of the Requirements

For the Degree of

DOCTOR OF PHILOSOPHY

In the Graduate College

THE UNIVERSITY OF ARIZONA

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THE UNIVERSITY OF ARIZONA
GRADUATE COLLEGE

As members of the Final Examination Committee, we certify that we have read the dissertation prepared by MICHAEL JOHN MANOS

entitled THE EFFECTS OF VERBAL ELABORATIONS AND SOCIAL REINFORCEMENT ON CHILDREN'S PERFORMANCE IN A SIMPLE DISCRIMINATION TASK

and recommend that it be accepted as fulfilling the dissertation requirement for the Degree of DOCTOR OF PHILOSOPHY.

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Final approval and acceptance of this dissertation is contingent upon the candidate's submission of the final copy of the dissertation to the Graduate College.

I hereby certify that I have read this dissertation prepared under my direction and recommend that it be accepted as fulfilling the dissertation requirement.

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STATEMENT BY AUTHOR

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SIGNED: Michael J. Mauro

DEDICATION

To John and Viola for lifelong

unconditional support

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ABSTRACT

In this study, six educationally disadvantaged children were taught beginning letter sounds under two teaching conditions. After a baseline of no intervention, a single subject alternating treatments design was used to compare contingent elaborations and token reinforcement within children. Performance between treatments was analyzed in terms of cumulative number of letter sounds learned, total number of letter sounds learned, and maintenance of learning. Token probes were implemented to ascertain whether tokens remained functionally reinforcing over the course of the study. Five children responded to treatment over baseline. Three of these, characterized by above average Wepman auditory discrimination scores, performed better under elaborations until the final third of the study when differential performance between treatments was less pronounced. Remaining subjects, characterized by below average auditory discrimination, showed similar learning under both treatments or, as in the case of one child, no learning. No differences in maintenance were observed. Implications for the classroom and suggestions for further research were discussed.

CHAPTER 1

INTRODUCTION

The scientific approach to research applied to classroom teaching procedures is receiving increased attention. Becker (1972) suggests that the goal of this application is to provide support for teaching practices which prove effective so as to help perpetuate good practices (i.e., those resulting in an acceptable level of learning) and eliminate poor practices (i.e., those resulting in an unacceptable level of learning). Classroom research can also point the way to new and innovative methods of teaching that will streamline classroom routines and make teaching a more efficient and rewarding process for both teacher and learner.

Some of the teaching procedures commonly used in classrooms have not been rigorously investigated. Consequently, their effectiveness is unsubstantiated. A very common classroom practice is that of elaborating on children's responses as new material is learned. Although it is frequently used, elaborating may not be as definitive an aid to learning as its popularity implies.

Interest in analyzing and describing teacher verbal behavior such as elaborations is quite evident in the literature (Berliner and Rosenshine, 1977; Flanders, 1965, 1970; Good, Biddle, and Brophy, 1975). Investigations of the functional relationships between specific teacher

verbal behaviors and specific student behaviors also appear in the literature, but are not as widely discussed (Brophy, 1979; O'Leary and O'Leary, 1976).

Background of the Problem

A discussion of the background of the problem centers on two major issues. The first involves studies of teacher behavior in applied settings. Most research on the effects of teacher behavior is correlational (Brophy, 1979; Land and Smith, 1979), and more studies using experimental designs to establish cause and effect relationships are needed in classroom research. According to Land and Smith (1979), more frequent use of low inference measures (e.g., direct observation of teacher behavior) and greater specification of classroom variables are needed. Gordon and Jester (1972) also identified the need to define the functional variables in teacher-child verbal exchanges. These authors suggest that drawing inferences about general classes of teacher behavior and child responses is less desirable than analyses of functional relationships with clearly specified variables.

The second issue is succinctly expressed by Berliner and Rosenshine (1977, p. 392): "Many studies of the acquisition of knowledge in the classroom count or rate behavior and do not deal with the crucial question of appropriateness of teacher behavior, a qualitative dimension with which it is difficult to come to grips." Teachers behave with the goal of improving student performance. Analyses of teacher behavior in applied settings may provide evidence to help determine what

appropriate behavior is by showing how the teacher's actions influence a student's knowledge and skill acquisition.

Review of the Literature

Teacher verbal behavior constitutes the major portion of classroom activity (Flanders, 1961). From his analyses of classroom interactions, Flanders cited the "Rule of Two Thirds"--talking occurs during two-thirds of the time spent in a classroom and, of that time, the chances are two out of three that it is the teacher who is doing the talking. When the teacher is talking, two-thirds of the time he or she will be expressing personal opinions, quoting facts, giving directions, or responding to student behavior and misbehavior. Considering the high frequency of teacher verbal behavior, surprisingly little attention has been given to the functional relationship between teachers' verbal behavior and children's learning (Blank, Rose, and Berlin, 1978; Gordon and Jester, 1972).

The review of the literature presented here on the effects of teacher verbal elaborations on children's learning deals with three major areas of research:

1. Studies of different categories of teacher verbal behavior;
2. Studies of the impact of teacher verbal behavior; and
3. Studies of teacher elaborations contingent on responses.

Categories of Teacher Verbal Behavior

Several analyses of teaching style and teacher behavior in the classroom have been attempted. Most studies of teaching styles have

investigated the type and orientation of teachers' verbal behaviors by classifying and categorizing teacher statements. This section reviews several of these classification systems.

Early classification systems were made by Flanders (1965), who suggested that teachers made statements to (a) clarify children's feelings constructively, (b) praise or encourage, (c) clarify, develop or make use of ideas suggested by students, (d) ask questions, (e) lecture, (f) give directions, and (g) criticize student behavior. Flanders' system was offered as a framework within which teachers' verbal behavior could be investigated.

Braun, Holzman, and Lasher (1969) reviewed the literature on teaching styles and teacher-child interactions and then developed a method of describing what a teacher of young children does. They were interested in isolating teachers' characteristic ways of responding to children. Teacher verbalizations were a major part of the analysis. Braun et al. concluded that teachers most often initiated comments that (a) stated personal ideas and feelings, (b) introduced new ideas or material, or (c) expanded or added some information about which children had not specifically asked. These types of responses occurred twice as often as teachers' requests for compliance.

The verbal components of feedback to children's responses also plays an important role in the analysis of teacher talking. Leathers (1979) identified seven factors or qualities inherent in feedback that varied from teacher to teacher and which were assumed to affect children's responses differentially. The factors were: (a) the

comprehensibility of feedback; (b) the objectivity of the teacher providing feedback; (c) the continuity or consistency of verbal feedback repeatedly given; (d) the involvement of the teacher with the child; (e) the conciseness or length of verbal statements; (f) the deliberativeness with which feedback was presented; and (g) the relevancy of teachers' comments. Leathers concluded that it is necessary to investigate not only the frequency of verbalizations in communication, but also the kinds of information transmitted and the effect of various kinds of information on the behavior of individuals.

More recently, Clark (1979) examined verbal teaching style with respect to structuring (i.e., telling students what will happen next and discussing the material to be used), soliciting (i.e., making statements that prompt students to investigate material), and reacting (i.e., praising, criticizing, waiting, correcting, prompting, or redirecting). Results indicated that when teachers used low levels of antecedent soliciting along with high levels of structuring and high levels of reacting, students in a sixth grade ecology class achieved significantly more than when low structuring and low reaction were used.

Summary. Studies of teacher verbal behavior indicate that teachers talk frequently. This verbal behavior may be classified, according to an operant analysis, into (a) antecedent stimulus events such as giving directions, expressing personal views or asking questions, and (b) consequent stimulus events such as praising, criticizing, or explaining. Categorizing teacher verbal behavior in this way

provides a means of focusing on the functional relationships in the interaction of teacher verbal behavior with student learning.

Impact of Teacher Verbal Behavior

Berliner and Rosenshine (1977, p. 381) suggested that "It is no longer acceptable to take seriously those who minimize the effect a teacher has on students' acquisition of knowledge." Teachers do make a difference. Although attempts have been made to develop "teacher-proof" curricula, overwhelming evidence indicates that certain teachers facilitate more learning than others (Berliner and Rosenshine, 1977; Brophy, 1979; Good, 1979). Specific teacher behaviors such as verbal behavior can have specifically identifiable effects on children's performance in the classroom. Teacher verbal responses may have differential effects on student task-oriented responses (Risley and Twardosz, 1976; Umbreit et al., in press). In particular, teacher verbal behavior in the forms of (a) attention, punishment, and expansion, (b) instructions, and (c) questioning can have effects.

The effects of teacher attention, usually operationalized in some form of verbal praise or words of encouragement, are well documented (Becker et al., 1967; Madsen, Becker, and Thomas, 1968; O'Leary and O'Leary, 1976). Punishment, frequently operationalized in verbal behavior such as reprimands, also has a powerful effect on student activity in the classroom (Kounin, 1970; O'Leary and O'Leary, 1976). The use of expansions--the repetition of what a child has said corrected into well-formed adult English (Newport, Gleitman, and Gleitman, 1977)--has been recommended for parents to encourage language

development in normal children (Moog, 1979) and in language delayed handicapped children (McGehee, 1980; Miller and Yoder, 1974).

Antecedent teacher verbal behaviors in the form of instructions also have been studied. O'Leary and O'Leary (1976) reviewed a variety of classroom instructional techniques and emphasized the need for analysis of their effects on children's learning. Good (1979) pointed out the various strengths in using elaborations or explanations as antecedents to task orientation in a pattern of instruction he called "direct instruction." Good suggested that explanations may hold different functions for different students.

Questioning is another method commonly used by teachers. Hudgins, Dorman, and Harris (1979) studied the effects of strategically placed verbal questions. Subjects were 166 fourth, fifth, and sixth graders. These students scored higher on recall of written stories when questions were interspersed with reading passages and asked after a passage was read rather than asked prior to when a passage was read. The results suggest that interrogatives as consequent elaborations may be more effective than interrogatives as antecedents. Similar findings were obtained by Turnure, Buium, and Thurlow (1976) and Buium and Turnure (1977). These researchers found that teacher administered interrogative elaborations were far superior in facilitating paired-associate learning with young children than simple labeling, sentence generation, or sentence repetition.

Summary. Studies suggest that teacher behavior influences learner behavior and that teacher verbal behavior has an impact on

student responses. The influence of antecedent and consequent verbal stimuli in the form of praise, punishment, expansions, instructions, and questioning has been briefly discussed. The next section examines the role of verbal elaborations in strengthening task responses.

Elaborations as Response Contingencies

Explaining things to children or elaborating on the responses children give in learning situations is a common teaching practice. The practice has its roots in cognitive approaches to learning and is believed to enhance learning. Through elaborations, new material can be related to or connected with ideas and information in other areas of study for the learner. New material can also be incorporated into material the learner already possesses (Ausubel, 1968).

Reviewing and elaborating in the development portion of a lesson is thought to be significantly related to classroom learning gains (Anderson, Evertson, and Brophy, 1979; Brophy, 1979). Elaborative teaching styles have been found to influence children in various ways. Stecher (1976), using Flanders' categories of teacher verbal behavior, found that teachers who (a) expressed affect, (b) praised learners, (c) extended student ideas by repeating, questioning, clarifying, or developing, and (d) presented new ideas to classes, had students who communicated in a more elaborative style, i.e., they easily acknowledged themselves and others, showed perception of others' points of view, and made referential statements about objects within and without the classroom.

Thompson and Nesselroad (1971) found that the quantity of teachers' verbalizations had a significant positive effect on Headstart children's WPPSI, PPVT, and ITPA scores. Lorentz, Creamer, and Coker (1978) found that, when teachers elaborated and discussed student responses, fifth and sixth grade students of high socioeconomic status made greater reading gains. A conclusion reached in both studies was that what is heard is not as important as how much is heard in children's acquisition of language. The same argument is presented by Newport, Gleitman, and Gleitman (1977). They found that one to three year old children responded in compliance to the quantity of commands given by their mothers rather than to the quality of the commands. Finally, Smothergill (1971) found that preschool teachers who had elaborative teaching styles (i.e., they provided additional information for tasks, supported children, and elicited comments from children) had students who talked about activities in the classroom more frequently than did the students of teachers who had a nonelaborative style.

Umbreit et al. (in press) have recently questioned the practice of elaborating.

> Do verbal elaborations consequent to a child's response enhance learning? Consider the following example. A teacher asks a child, "What's the color of grass?" and the child says, "Green." The teacher says, "Yes, the grass is green. It is one of nature's most beautiful colors and always reminds me of the outdoors, the forests, valleys, and great plains."
>
> . . . . If you would merely say, after a correct response, something like, "Yes, that's right," such a comment may be just as effective as anything else you might say.

Very little attention has been given to comparing the effects of elaborating with other teaching methods. Smothergill, Olson, and Moore (1968) investigated the effects of elaborative teacher statements and noninformation supportive statements on several variables in a group of normal preschool children. Results indicated that an elaborative teaching style aided the children's problem-solving abilities, whereas a nonelaborative style produced a greater frequency of child-initiated utterances. However, nothing definitive regarding the effects of elaborative or nonelaborative teaching styles could be concluded.

In a related study, McGehee (1980) investigated the effects of expansions and labeled praise on spontaneous utterances of four language-delayed preschool children. Though subject variability was very high from day to day, McGehee concluded that the expansion condition yielded a greater number of child initiated utterances than did the labeled praise condition.

Kounin (1970), in analyzing teacher verbal "desist" statements and the "ripple effect" of such statements on kindergarten children's misbehavior, also discussed examples of teachers who verbally elaborate and expand on the efforts children make in learning rhyming words within small groups. Kounin suggested that such an elaborative style should enhance children's learning. However, no empirical evidence was given to support the statement.

An example of different therapist feedback styles can be found in analogue psychotherapy research. Thomas (1976) exposed 30 female undergraduates who volunteered for short term psychotherapy to two

conditions of feedback. Therapists in the first experimental condition gave one word verbal reinforcement (VR) in response to subjects' positive self-statements. Therapists in the second experimental condition gave lengthy information feedback (IF) in response to each positive self-statement. Pre- and post-measures of self-concept and social skills ratings were taken. Results of the study were somewhat equivocal. Both VR and IF had a positive impact on subjects' self-concept and social skills ratings.

Several studies have focused on teaching children to self-elaborate as a way to improve memory, discrimination, or language acquisition. Lee and Lehane (1977) taught 120 normal second graders to use sentence elaborations as a mnemonic device in learning paired-associate words. This type of elaborating training was found to be superior to verbal praise and information feedback on paired associate learning and on tasks involving transfer of learning. Vogel (1979) improved kindergarten children's correct discriminations of line drawings and mirror images of line drawings by inducing subjects to (a) give detailed verbal descriptions of the drawings, (b) specify a difference between characteristics of the child's side versus the experimenter's side of the picture, or (c) do both. All three strategies were equally effective. However, improved performance was not maintained one week later. Lahey (1971) taught elaboration of description to Headstart children in small group sessions. Lahey asked children in each of two groups of children to describe the contents of a box of toys. Then, he described the contents. In one group, Lahey used descriptive adjectives, whereas in the second

group he did not. Children exposed to Lahey's descriptions increased their use of adjectives, whereas children not exposed to descriptive adjectives remained at their initial level. Lahey concluded that simple modeling was a factor influencing children's gains.

Summary. Elaborations as consequent events to responses can enhance learning whether they are administered by the teacher, by mothers, or self-initiated by the child. Analyses of language acquisition, of elaborative training techniques, and of various types of feedback indicate some support for the use of elaborations, but conditions under which elaborations are functional as reinforcers are not fully understood. Little is known, for example, about the relationship of consequent verbal elaborations to behavior in general. Even less is understood about the functional relationship between specific teacher verbal elaborations and specific children's responses. An applied behavior analysis of these variables could provide important empirical information that has implications for classroom instruction.

Statement of the Problem

The purpose of this study was to compare the effects of two types of response contingencies, teacher verbal elaborations and token reinforcement, on children's learning. Specifically, the purpose was twofold: first, to determine whether or not verbal elaborations and token reinforcement as consequent events affect young children's rate of learning blends, digraphs, and consonant sounds; second, to compare verbal elaborations and token reinforcement, both as consequent events, within the same learning context.

The dependent variable, children's learning, was the cumulative number of letter sounds discriminated by the child. The independent variables were the consequent events of (a) elaborations and (b) token reinforcement. Elaborations were defined, in general, as any extended verbal explanations following a response which added additional information to the task situation or associated task responses with other ideas, concepts, or examples. Token reinforcement was defined as the presentation of tokens (e.g., money, chips) following the occurrence of desired behavior. Generally, tokens could be exchanged for a variety of back-up activities, objects, play, or toys (Bellack and Hersen, 1978). Elaborations and token reinforcement are defined more specifically in the Procedures section.

This study addressed the following questions:

1. In a simple discrimination task, do the teacher's verbal elaborations made contingent upon children's correct discriminations facilitate those discriminations?
2. In a simple discrimination task, do tokens made contingent upon children's correct discriminations facilitate those discriminations?
3. How do elaborations and tokens compare in terms of their effect on the frequency of children's correct discriminations?
4. How do elaborations and tokens compare in terms of their effect on maintenance of learned discriminations?

Answers to these questions were sought through the study of individual children using a single-subject design known as an Alternating Treatments Design (Barlow and Hayes, 1979) or Multielement Baseline Design (Ulman and Sulzer-Azaroff, 1975). The Alternating Treatments Design (ATD) allows the comparison of two treatments within a single subject with repeated measurement of behavior as treatments are alternated in a counterbalanced or randomized order, independent of behavior changes. Experimental control is demonstrated when a particular pattern of responding emerges under each of the experimental conditions, and each pattern remains unique to that experimental condition.

Pilot Studies

To answer several procedural questions and to identify parameters of the proposed study, three pilot studies were conducted. The first study addressed attention as a confounding variable. Would an elaboration condition be reinforcing because it took longer to administer, thus providing the child with longer periods of teacher attention? Results on four children seen daily for four weeks indicated differential attention was not a factor. The elaborations and reinforcement conditions were administered in very nearly equal amounts of time. A further consideration in the study was to establish an appropriate criterion level. Based on experience in the first pilot study, a criterion level of five out of five correct responses in nonconsecutive trials within single sessions was established. This criterion level was thought to be appropriate because it appeared to enhance maintenance

of learning. Various other procedural details such as the optimal number of trials per session, methods of recording data, and the amount of time required for each session were also determined. The final problem resolved in the first pilot study was the operational definition of elaborations. The definition is described below in the Procedures section.

A second pilot study was conducted to evaluate picture vocabulary cards as stimuli for learning tasks. Children quickly and easily identified picture cards regardless of consequences. Therefore, picture cards were discarded. Tasks involving consonant and vowel sounds were tested in a third pilot study. These stimuli were of sufficient difficulty and because of this, were accepted as appropriate for the current investigation.

Results of the pilot studies are tentative at best as changes in presentation were made periodically. Nevertheless, several trends in data indicated that, in all conditions, the number of correct responses gradually lessened. This was taken as evidence for satiation to consequent stimuli, and a decision was made to modify the form of the elaborations and the contingent praise condition. Rather than using abstract elaborations (e.g., "Yes, a 'house' is where people live, it has windows, and you can sleep in a house"), elaborations were given which directly related to the stimulus being taught (e.g., "Yes, 'house' begins with h like happy, home, or hat"). Also, instead of using praise alone, praise was paired with token reinforcement.

CHAPTER 2

METHOD

This chapter describes: (a) the subjects, (b) materials used, (c) research procedures, and (d) the method of data collection, reliability, and data analysis.

Subjects

The subjects were children in the morning kindergarten class at Wetmore Elementary School in Amphitheater School District, Tucson, Arizona. The children were in a classroom supported by Title I funds for disadvantaged children.

Six children were selected for the study based on their performance on the criterion-referenced Continuous Uniform Evaluation System (CUES), which is given to each kindergarten child during each school year (see Appendix A). The children performed in the lower quartile of their particular age group, were considered educationally at-risk, and were eligible for federally funded enrichment programs under Title I guidelines. Children identified for Title I typically are unable to identify their first name when it is seen in print, do not identify basic colors accurately, do not count to ten, and do not correctly identify small or capital letters of the alphabet. Subjects were also given the Wepman Test of Auditory Discrimination, Form II. The Wepman test was administered to better account for possible

variability in performance between subjects. It was not used as a screening device. The children appeared to have normal vision and hearing, based on vision and hearing screening procedures (see Table 1).

In addition to involvement in the proposed study, all subjects participated in daily kindergarten instruction and, as part of the Title I program, received small group academic instruction with parent volunteers for one-half hour each week. The daily instruction and small group activity did not duplicate the training provided in the experimental manipulation of elaborations and token contingencies.

The six subjects were randomly chosen from a group of 12 Title I children. Parental permission was obtained for the three boys and three girls selected for investigation, and The University of Arizona and the Amphitheater School District policies on human subjects were followed.

Three of the children, Curt, Liza, and Beth, were six-year-old children of normal intelligence who progressed at an average rate in kindergarten at Wetmore Elementary School. They were identified as Title I children based on an initial screening at the beginning of the school year. Parent(s) of each child were contacted for participation in the federally funded Kindergarten Involved Parents (KIP) program. The KIP program provided instruction for parents on how to teach their own children. Only Liza's mother regularly attended weekly KIP sessions. All three children did master the reading, writing, and math skills as measured by the CUES, and all three children were recommended for promotion to first grade. Beth's auditory discrimination skills,

Table 1. Summary of child characteristics

	CA	Wepman Score	Wepman Rating	Norm	CUES Reading	CUES Writing	CUES Math	Vision	Hearing	Teacher's Rating of Child's Progress
Curt	6-1	25	0	Average	M	M	M	N	N	Average
Liza	6-3	25	0	Average	M	M	M	N	N	Average
Beth	6-3	27	+1	Above Average	M	M	M	N	N	Average
Kate	6-4	11	-2	Below Adequacy Threshold	X	X	M	N	N	Below Average
Butch	6-0	15	-2	Below Adequach Threshold	X	X	M	N	N	Below Average
Mickey	6-1	21	-1	Below Average	X	X	X	N	N	Well Below Average

M = mastered; at or above 75% criterion level
X = not mastered; below 75% criterion level
N = normal

as measured by the Wepman Test of Auditory Discrimination, were above average for her age group. Curt and Liza scored in the average range. These data are also summarized in Table 1.

Kate and Butch were six-year-old children of normal intelligence who progressed at a below average rate in kindergarten. They were identified as Title I target children and their parents were contacted for involvement in KIP. Neither parent attended any KIP sessions. Both children mastered the math component of the CUES test but did not master reading and writing skills. Additional remedial instruction was recommended and this instruction was provided for Butch. Kate left the district before remediation began. Butch was recommended for promotion to first grade. Both children's Wepman scores showed auditory discrimination well below the threshold level of adequacy. Kate's score was especially low.

Mickey was a six-year-old child of normal intelligence whose progress was markedly below the average rate for children in his kindergarten class. Mickey's teacher observed that he seemed developmentally immature to other children in that his activity level was higher than others and his attention span shorter. Mickey's mother was contacted for participation in KIP, and she attended two sessions. Mickey did not master any of the skill areas on the CUES. His teacher recommended he be retained in kindergarten for another year, and he was referred for psychological testing. Mickey's Wepman score indicated below average auditory discrimination for children in his age group.

Materials

The experiment was conducted in a library conference room adjacent to the classroom. Subjects were seated at a juvenile table across from the experimenter. A set of printed 4-inch by 4-inch laminated alphabet cards with upper and lower case letters printed on each card was organized for presentation in sequence with 259 picture cards of objects whose names began with the letter sounds to be taught. The number of letters in each picture card name averaged about four to six letters. The set of letters and picture cards was printed by Ideal School Supply Company. Small colored chips were used as tokens. A list of the back-up reinforcers used is included in Appendix B. A large 24-inch by 36-inch sheet of oaktag with dates and children's names was used as an attendance chart. A total of 240 "Scratch and Sniff" stickers in a variety of fragrances was available to mark off the days. An audio tape recorder and microphone were used to tape all weekly sessions for reliability assessment. The findings on reliability are discussed in the section on Data Collection below.

Research Procedures

There were two sessions a day, one in the morning and one in the afternoon. All sessions were held in the library conference room. Children visited the room before data collection began to familiarize themselves with the situation.

To begin initial sessions, the experimenter greeted each child in the classroom and walked with each child to the conference room. When children became familiar with the routine, they conducted

themselves back and forth alone. The order of experimental presentations to children was kept constant (i.e., each child was seen at the same time of the morning and afternoon on each day).

The study consisted of two phases, a baseline phase and a treatment phase. The baseline phase was conducted to provide information on the chance occurrence of current responses. Baseline continued for five sessions when stability was noted. Stability was defined as a minimum of three data points with five percent or less variability between points (Hersen and Barlow, 1976).

The treatment phase followed baseline. In this phase, elaborations and token contingencies were alternated within daily sessions of 20 trials with 10 trials per treatment. To control for multiple treatment interference, the order of presentation of treatments was randomly assigned to each group of 10 trials with equal numbers of elaborations and token conditions apportioned over the total number of sessions. The order of presentation is illustrated in Table 2. In addition, at the beginning of daily sessions and when a change in treatment within sessions was forthcoming, each subject was informed which condition would be administered (e.g., "To help you learn these letters, you are going to have the chance to earn chips," or "This time you will not earn chips, but I'll help you learn these new letters by giving you examples.") and the box of tokens and individual receptacles bearing the child's name were presented or removed. This procedure was implemented to control for carry over effects. The treatment phase continued for a total of 32 sessions.

Table 2. Alternating treatments design and order of presentation for each subject

Trials	Sessions														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1-10	T	T	T	E	T	T	T	T	E	E	E	E	E	E	T
11-20	E	T	T	T	E	E	E	T	T	E	E	T	E	E	E
	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1-10	E	E	T	E	E	E	T	T	T	T	T	E	T	T	E
11-20	T	T	E	T	E	T	T	E	E	T	E	E	T	E	T

E = Elaborations condition
T = Tokens condition

Baseline

During baseline the experimenter presented three letters one at a time, gave the sound each letter represented, and for each letter gave one sample word beginning with the sound to be taught. The three letter cards consisted of two target letters and one distractor. The experimenter modeled the procedure for each child in the first session only. The three letter cards were placed in a row on the table before the child. The experimenter showed a picture of an object beginning with one of the consonant sounds by placing that picture on the table about four inches above the center letter card. Pictures were drawn from a pool of ten different pictures. The pool consisted of two sets of five pictures, each of which began with the sound of one of the target letters. The child was asked to say aloud what the picture was and then point to the letter with which the picture began. The experimenter corrected any wrong names the child attached to the picture card. If the child pointed to the correct letter, the experimenter offered no response. If the child pointed to an incorrect letter, the experimenter went through a correction procedure (i.e., "No, this is the letter. Now you point to it."). If the experimenter was uncertain about which card the child pointed to, he asked the child to point again until the child's choice was made clear. Pilot work suggested that the experimenter needed to stare at a neutral point of the table so as not to inadvertently indicate the correct letter to the child. Also, the experimenter changed the order of the letters so the child would not respond to the position of the stimulus cards.

Treatment

The treatment phase consisted of two conditions--elaborations and contingent tokens. When the baseline phase was completed, the experimenter said to the child, "Now I'm going to help you learn these letters. Sometimes I'll give you examples when you're correct and sometimes you'll earn tokens to buy something you like." The procedures outlined in baseline were followed except that, in elaborations, rather than giving no response to the child's correct answer, the experimenter elaborated by giving the child three other words that began with the same sound (e.g., "Yes, boy begins with b, banana begins with b, and badger also begins with b."). The experimenter followed the correction procedure described above when the child gave an incorrect response.

In the tokens condition, each child earned a token paired with praise for each correct response (see Appendices B and C). A pool or menu of back-up social reinforcers was available and the child chose items by reaching into a "Mystery Bag." Tokens were exchanged for back-up reinforcers when the appropriate number of tokens had been earned. As in the elaboration condition, the correction procedure was followed for incorrect responses (see Appendix D). To ensure that the token system was functionally reinforcing, the presentation of tokens was made contingent on an unrelated low frequency task (i.e., marble drops). These token probes were taken prior to treatment, in the middle of treatment, and at the end of treatment. Children were asked to place marbles in a cup and the number of marbles was counted after a 30-second period. Three trials of a token contingency (one token for three

marbles) were initiated following three no token baseline trials. The 30-second trials were kept brief to prevent satiation on the tokens.

Several additional procedures were characteristic of the treatment phases. Each condition was designated a pool of consonant sounds, blends, and digraphs randomly chosen from a list of sounds normally taught in prereading instruction (Harris and Sipay, 1980) and with which the children were unfamiliar (as determined through pretesting; see Appendix E). A letter was presented in nonconsecutive trials until the child correctly identified its sound five out of five times within a single session. The five out of five correct responses constituted criterion performance. The letter was then withdrawn, and a new letter from the appropriate pool was added to the trials. Maintenance or temporal generality of learning was determined in additional trials at the end of each ten sessions, one trial for each word learned during the week (see Appendix F). Contingencies in these trials were the same as in baseline. To reinforce children's attendance at sessions, a large chart was kept in the conference room. For each day attended, children had the opportunity to place a "Scratch and Sniff" sticker on the appropriate space next to their name. All children attended the required sessions.

Data Collection

Each response by each subject was recorded. A correct response was indicated when a child placed his or her finger on the correct letter card. If a child gave a wrong response but then self-corrected, the response was counted as correct.

In addition to recording children's responses, the experimenter's behavior was also monitored to ensure consistent presentation of elaborations and tokens. In twice weekly checks, two observers reviewed audiotaped sessions to ensure that the operational definition and application of elaborations and token reinforcement were being administered uniformly. Sample data sheets are provided in Appendix G.

Interobserver Reliability

Interobserver reliability was calculated for the frequency of subjects' correct responses across all phases of the study twice each week in reliability checks. An impartial observer viewed sessions and recorded data on the number of correct and incorrect responses by each child. These data were compared to data recorded by the experimenter. Two observers also rated the consistency of the experimenter's behavior in (a) administering elaborations and (b) administering token reinforcement. Refer to Appendix D for the procedure for instruction in both the elaboration and tokens conditions. Reliability checks of subjects and experimenter were randomly assigned over the days of the week.

Reliability for subjects is presented in a two-by-two table showing the number of correct-incorrect responses within each group of ten trials. The percentage agreement was calculated using the formula:

$$\frac{\text{number of agreements}}{\text{number of agreements + number of disagreements}} \times 100$$

Reliability of data gathered on experimenter behavior was similarly analyzed. Two-by-two tables were constructed for the occurrence-nonoccurrence of operationally defined behavior in administering elaboration and token reinforcement. Percentage agreement was computed. All reliability measures are presented in Table 3.

The use of percentage agreement in determining reliability has recently been questioned in that it may be insensitive to observer bias or misrepresent observer competence (Hartmann, 1977; Hawkins and Dotson, 1975; Kratochwill and Wetzel, 1977; Yelton, Wildman, and Erickson, 1977). However, the ease of observing behaviors in this study (e.g., child touching a letter card with a finger or hand) obviates the criticisms raised.

Data Analysis

To illustrate the functional relationship between the frequency of correct responses and the two alternated treatment conditions and to show any differences in maintenance of learned responses, data from baseline and experimental conditions were plotted graphically. Graphic representation of these data reflects levels of change in experimental conditions. Graphs are displayed in Chapter 3.

Statistical methods for data analysis have recently been applied to single N studies (Edgington, 1980; Kazdin, 1976; Kratochwill and Levin, 1980), and they are applied here in modified form. A nonparametric basic randomization test (Levin, Marascuilo, and Hubert, 1978) in modified form was used here as a descriptive statistic to show the distribution and probability levels of the cumulative learning rates

Table 3. Two-by-two tables and percentage agreement for combined child responses (I) and for experimenter responses (II)

I. CHILD RESPONSES

Observer 1

Observer 2	Correct	Incorrect
	Agree	Disagree
Correct	288	1
	Disagree	Agree
Incorrect	3	158

Percentage agreement = 99.1%

11.7% of trials observed

II. EXPERIMENTER RESPONSES

Observer 1

A.

Observer 2	Correct	Incorrect
	Agree	Disagree
Correct	1249	3
	Disagree	Agree
Incorrect	1	12

Percentage agreement = 99.7%

32.9% of trials observed

B. % of time correct experimenter responses were administered:

$$\frac{\#\text{ correct responses}}{\#\text{ total responses}} \times 100 = 98.3\%$$

associated with each condition in each third of the study. Additionally, t tests were applied to the total responses in the token probes. Though t tests used with time series data have been criticized for violation of the assumption of independence of observations (Kazdin, 1976), Gentile, Roden, and Klein (1972) recommended combining points across phases of a study to disrupt this autocorrelation effect. Although this practice also has been criticized by Kazdin and others, it has been employed here as an accessory descripter for the token probes. However, a visual analysis of the data is the primary source of information in establishing proof of functional relationships between variables in an applied behavior analysis (Michael, 1974; Parsonson and Baer, 1978).

CHAPTER 3

RESULTS

The results are presented in three sections: (a) data on Curt, Liza, and Beth are presented together, (b) data on Kate and Butch are presented together, and (c) data on Mickey are presented. These sections are based on the data for subjects who performed similarly on the Wepman Test of Auditory Discrimination and on the Continuous Uniform Evaluation System (CUES) for kindergarten children. For Curt, Liza, and Beth, Wepman scores indicated average or above average auditory discrimination and CUES scores showed average school progress. Therefore, these three children are presented together in Section I. For Kate and Butch, Wepman scores were well below the threshold level of adequacy and the CUES scores were below average. Therefore, these two children are presented in Section II. For Mickey, the Wepman score indicated questionable auditory discrimination and the CUES score indicated practically no academic gains made over the school year. Therefore, data for Mickey are presented separately in Section III.

Section I--Findings on Curt, Liza, and Beth

Curt

Figure 1 and Table 4 show the effects of contingent elaborations and contingent tokens for Curt. Figure 1 indicates that Curt performed

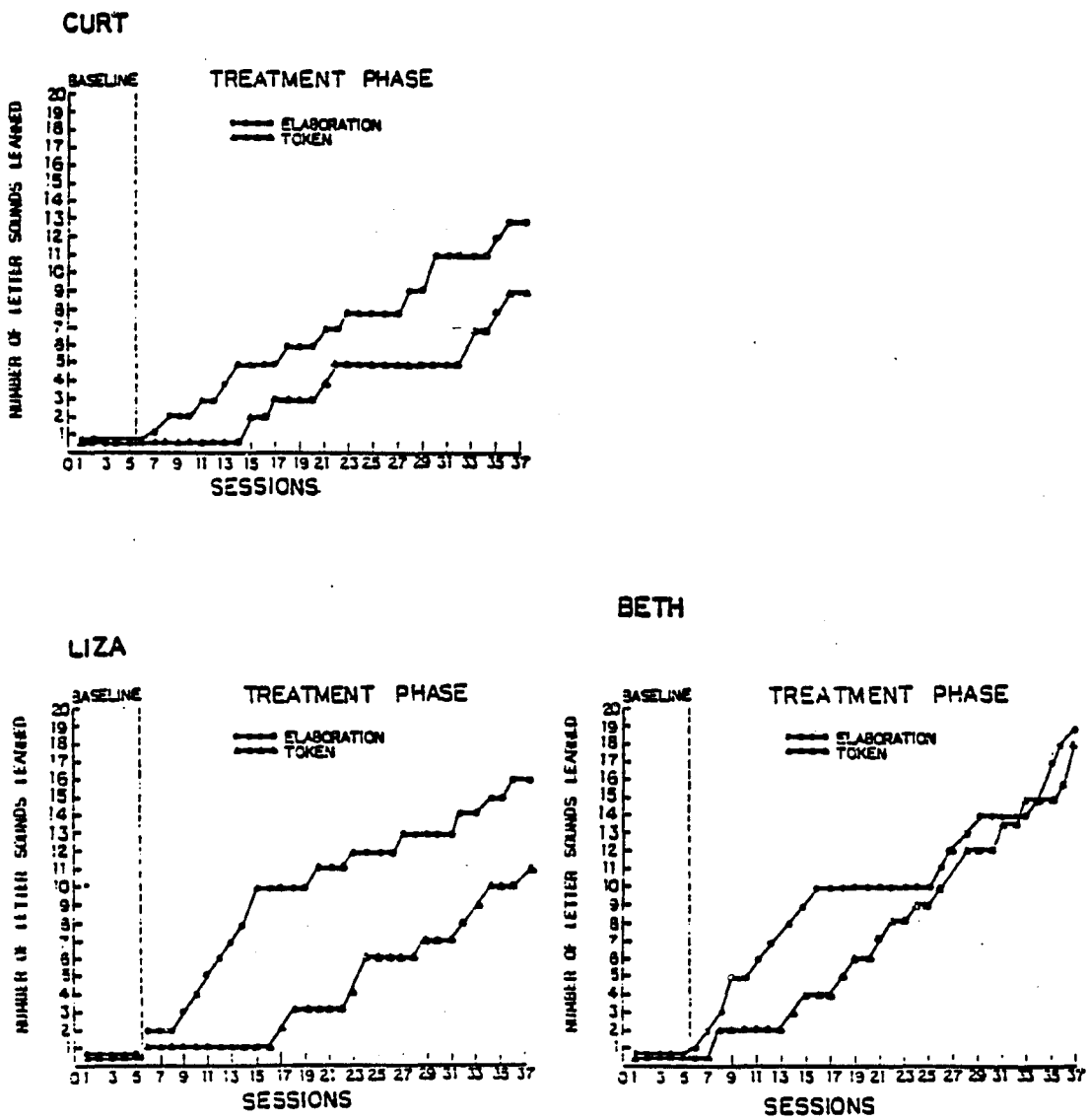

Figure 1. Cumulative number of letter sounds learned in baseline and treatment phase for Curt, Liza, and Beth. Paired conditions in the treatment phase consist of elaboration and token contingencies.

Table 4. Cumulative sounds learned per session in each third of the study for Curt. The Type I probability level of the largest (1.29) permutation (6!/3!3!) associated with elaborations and the smallest (1.71) permutation associated with tokens is $p = .05$.

Session	Cumulative Sounds/Session Elaborations Condition	Tokens Condition
15	.50	.20
26	.38	.23
37	.41	.28
Total	1.29 $p = .05$	.71 $p = .05$

better in cumulative number of letter sounds learned in the elaborations condition than in the tokens condition. In addition, Curt appeared to learn at a consistent rate with elaborations, learning a letter sound about every two to three sessions. However, in the token condition, his performance was more irregular, showing two periods of no learning (sessions 6-14 and 22-32) interspersed with two periods of rapid learning (sessions 15-22 and 32-37).

In Table 4 the treatment sessions were divided into thirds and rate of learning was calculated at each of three points. Visual inspection shows that cumulative learning rate (i.e., letter sounds per session) was higher in each third under the elaborations condition than under the tokens condition. A basic randomization test was applied to the totals. The Type I error probability of the highest score being

associated with elaborations and the lowest score being associated with tokens is $p = .05$ (Levin, Marascuilo, and Hubert, 1978; see Appendix H).

Table 5 presents the results of probes on the functionality of the tokens. These probes were conducted to indicate any major changes in the reinforcing strength of the token system prior to the study, at the midpoint of the study, and at the end of the study.

Table 5. Total number of responses in noncontingent baseline and contingent token probes over three 30-second intervals in initial, mid, and final sessions for Curt. Means are significant at $p =< .05$ (df = 16).

	Number of Marble Drops	
	Baseline	Tokens
Initial	13	17
	17	21
	13	20
Mid	10	17
	14	22
	15	22
Final	16	19
	16	19
	16	22
Total	130	179
Mean	14.4	19.9

Combining each baseline and each token phase of three probes (Gentile, Rodin, and Klein, 1972) showed that the token contingency resulted in a significant increase in number of responses over baseline ($p < .05$, $df = 16$). Data in each separate probe show increases in responses in the token contingency over baseline. Because of the limitation of applying significance tests only over the total responses in each condition, one cannot determine whether the changes in each period were statistically significant.

Maintenance of learning, checked after trial 16, trial 26, and trial 32, is presented in Figure 2. In the first maintenance check, Curt recalled all letter sounds in both the elaborations and tokens condition. He recalled all but one sound in both the second and third checks.

Liza

Data on the effects of contingent elaborations and tokens for Liza are presented in Figure 1 and Table 6. Figure 1 shows superior cumulative performance in the elaborations condition with some evident variability. Liza learned at a rapid rate in the first ten sessions of elaborations, learning about one letter sound in each session. After this initial performance, her learning rate decreased. In the tokens condition she showed no learning from session 7 to 16, and then a rapid rate of learning, especially from session 32 to 37. Table 6 also indicates a higher cumulative response rate with elaborations in each third of the study and overall (see Appendix H).

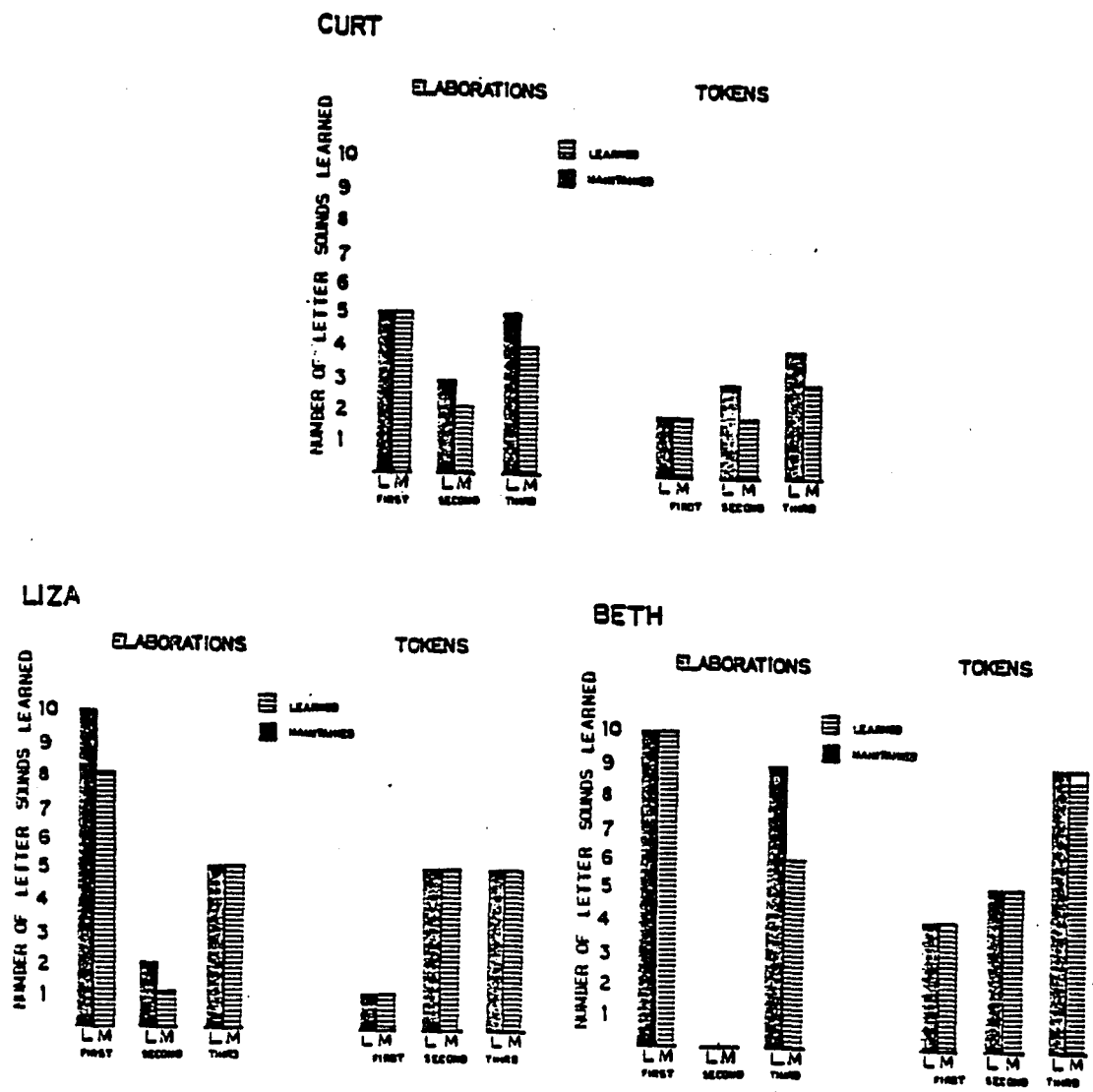

Figure 2. Number of letter sounds learned (L) and number of letter sounds maintained (M) in elaboration and token contingencies for Curt, Liza, and Beth over three maintenance checks

Table 6. Cumulative sounds learned per session in each third of the study for Liza. The Type I probability level of the largest (2.10) permutation (6!/3!3!) associated with elaborations and the smallest (.73) permutation associated with tokens is $p = .05$.

Session	Cumulative Sounds/Session: Elaborations Condition	Tokens Condition
15	1.0	.10
26	.57	.29
37	.53	.34
Total	2.10 $p = .05$	.73 $p = .05$

Table 7 presents data on the token probes. The token condition significantly increased responses over baseline ($p < .05$, $df = 16$). Tokens also increased marble drop responses in each of the three probes with a small magnitude of effect within each probe. However, significance tests can be applied only to the combined total responses.

Data on the maintenance of learning (Figure 2) indicates that Liza recalled eight of the ten letter sounds learned in the first elaboration maintenance check (after trial 16), one of two letters learned in the second check (after trial 26), and all five letters learned in the third check (after session 32). She recalled all of the letters learned in each of the tokens maintenance checks.

Table 7. Total number of responses in noncontingent baseline and contingent token probes over three 30-second intervals in initial, mid, and final sessions for Liza. Means are significant at p =<.05 (df = 16).

	Number of Marble Drops	
	Baseline	Tokens
Initial	3	17
	7	15
	8	14
Mid	12	12
	13	21
	13	18
Final	6	16
	8	19
	8	19
Total	78	151
Mean	8.7	16.8

Beth

Data on Beth's performance under the elaborations and tokens condition are displayed in Figure 1 and Table 8. Figure 1 indicates that Beth learned more quickly in initial sessions under the elaboration condition until session 26, when learning in both conditions appeared to be fairly equal. Variability was greater in the elaborations condition, i.e., from sessions 6 to 15 and sessions 26 to 37, Beth learned about one letter sound in each session, but from sessions 16 to 25, no letter sounds were learned. Under the token condition, learning was more consistent throughout the study.

Table 8. Cumulative sounds learned per session in each third of the study for Beth. The Type I probability level of the largest (2.1) permutation (6!/3!3!) associated with elaborations and the smallest (1.43) permutation associated with tokens is $p = .05$.

Session	Cumulative Sounds/Session Elaborations Condition	Tokens Condition
15	1.00	.40
26	.52	.47
37	.59	.56
Total	2.11 $p = .05$	1.43 $p = .05$

Table 8 shows Beth's rate of learning in each third of the study. Although elaborations strengthened learning to a greater degree overall ($p = .05$), visual inspection shows that differences between conditions diminished toward the final sessions (see Appendix H).

Data for token probes are given in Table 9. Combined token contingencies significantly strengthened marble drop responses over baseline ($p = <.05$, $df = 16$). Visual inspection shows increases with tokens in each probe with weak effects over baseline.

Table 9. Total number of responses in noncontingent baseline and contingent token probes over three 30-second intervals in initial, mid, and final sessions for Beth. Means are significant at $p =< .05$ ($df = 16$).

	Number of Marble Drops	
	Baseline	Tokens
Initial	14	20
	14	23
	14	18
Mid	16	23
	15	23
	15	23
Final	18	24
	20	25
	20	24
Total	146	203
Mean	16.2	22.6

Figure 2 provides maintenance check data. Beth recalled ten of the ten letter sounds learned in the first elaborations check and six of the nine sounds learned in the third elaborations check. No letter sounds were learned in the second portion of the study. Beth recalled all letter sounds learned in all three of the tokens maintenance checks.

Summary

All three subjects discussed in Section I learned more letter sounds in the elaborations condition than in the tokens condition.

Variability was not solely confined to one condition, but occurred in the tokens condition for Curt, in the elaboration condition for Beth, and in both conditions for Liza. Token probes showed that the rate of marble drop responses was higher under the token contingency for all children, but that the effects were weak. Maintenance appeared fairly similar in both conditions for all children.

Section II--Findings on Kate and Butch

This section presents the data on Kate and Butch. These children scored low on the Wepman Test of Auditory Discrimination and their academic performance was below average.

Kate

Figure 3 shows the treatment effects on number of letter sounds learned by Kate in the elaboration and token conditions. Both treatment conditions differed from baseline, although the treatment conditions were not clearly different from one another. A slightly increasing trend is apparent in the tokens condition from session 28 to 37. Number of letters learned increased in the tokens condition in the final third of the study (Table 10). However, the total rate did not favor either condition (p =.10; see Appendix H).

Kate's responses to the token probes are presented in Table 11. Combined responses in the token contingency were significantly greater than combined responses in baseline (p <.05, df = 16). In each separate probe, tokens showed a consistent though weak effect in strengthening responses.

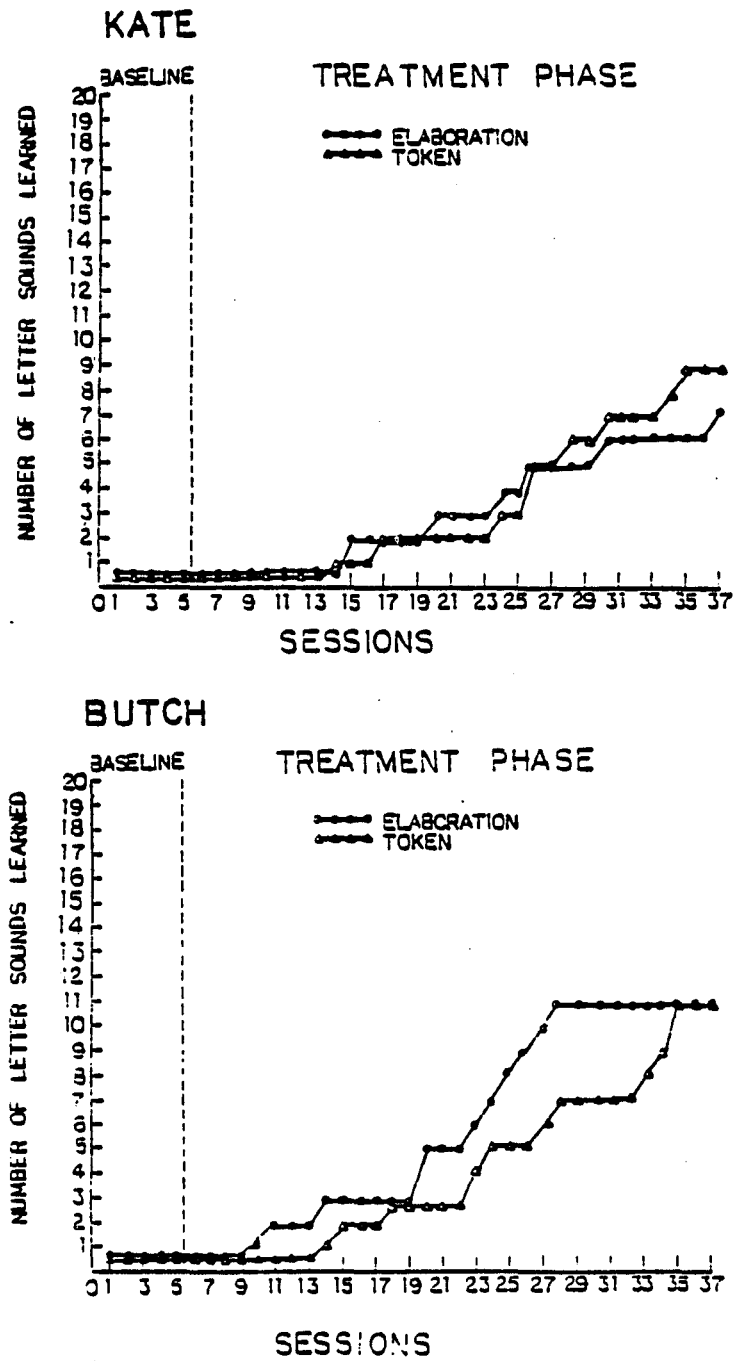

Figure 3. Cumulative number of letter sounds learned in baseline and treatment phase for Kate and Butch. Paired conditions in the treatment phase consist of elaboration and token contingencies.

Table 10. Cumulative sounds learned per session in each third of the study for Kate. The Type I probability level of the largest (.74) permutation (6!/3!3!) associated with elaborations and the smallest (.52) permutation associated with tokens is $p = .10$.

Session	Cumulative Sounds/Session Elaborations Condition	Tokens Condition
15	.20	.10
26	.23	.23
37	.22	.28
Total*	.65 $p = .10$	.61 $p = .10$

*Totals fall in the middle of the ranked distribution and are not the highest and lowest scores of all permutations.

Table 11. Total number of responses in noncontingent baseline and contingent token probes over three 30-second intervals in initial, mid, and final sessions for Kate. Means are significant at p =<.05 (df = 16)

	Number of Marble Drops	
	Baseline	Tokens
Initial	14	17
	19	23
	20	25
Mid	8	23
	12	24
	16	22
Final	13	21
	10	21
	9	17
Total	121	193
Mean	13.4	21.4

Data on maintenance of letter sounds learned is presented in Figure 4. Kate recalled one of the two letter sounds learned in both the first and second elaboration checks, and two of the three sounds learned in the third elaboration check. She correctly identified all letter sounds in the first two tokens maintenance checks, and five of the six letter sounds learned in the third check.

Butch

The effects of treatments for Butch are presented in Figure 3. Butch learned more letter sounds in the elaboration condition during

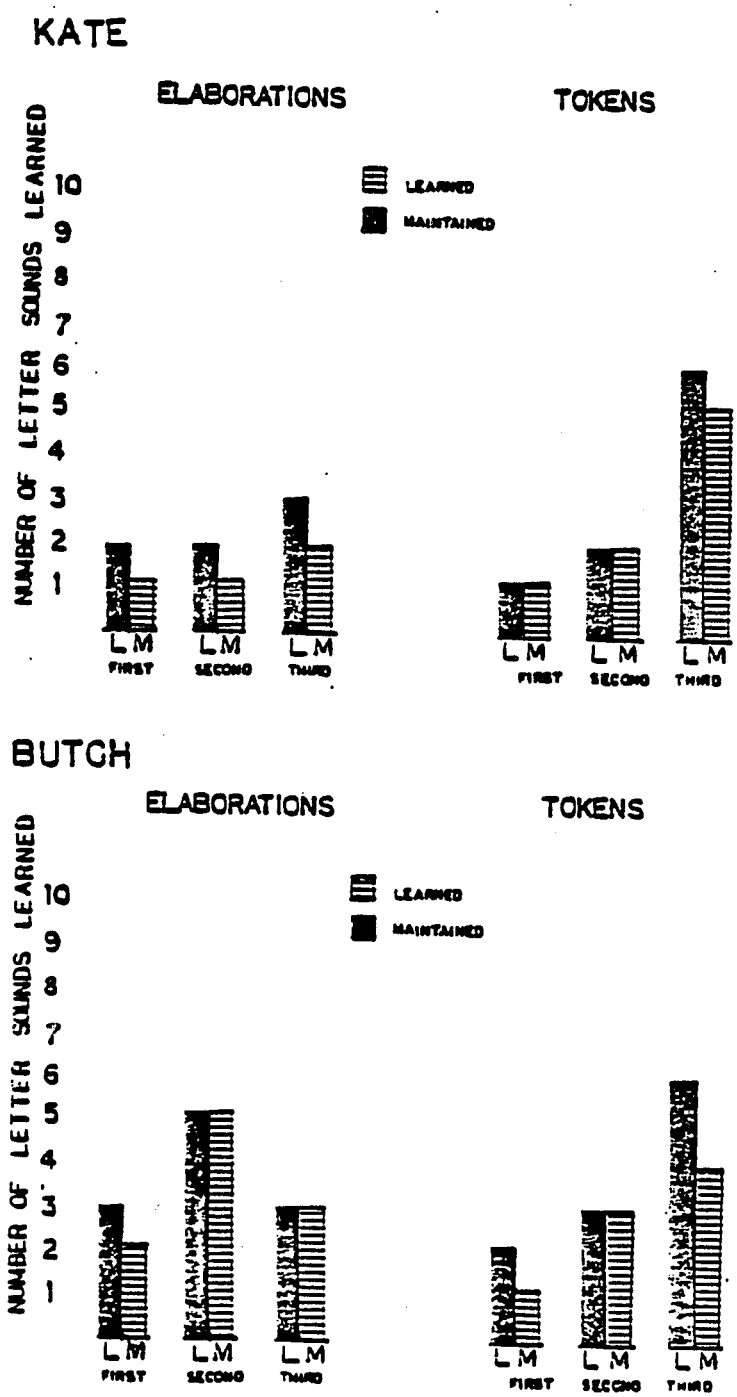

Figure 4. Number of letter sounds learned (L) and number of letter sounds maintained (M) in elaboration and token contingencies for Kate and Butch over three maintenance checks

the beginning and middle sessions of the study (sessions 9 to 14 and 19 to 28), but learned more letter sounds in the tokens condition at the end of the study (sessions 32 to 37). Table 12 gives the cumulative learning rate in each third of the study. It does not show a definitive overall advantage in elaborations (see Appendix H). Also, by the final session, the total number of letter sounds learned (11) was the same in both conditions (see Figure 3). Variability is evident in both conditions and is characterized by periods of rapid learning followed by periods of no learning.

Table 12. Cumulative sounds learned per session in each third of the study for Butch. The Type I probability level of the largest (1.10) permutation (6¦/3!3!) associated with elaborations and the smallest (.73) permutation associated with tokens is $\underline{p} = .10$.

Session	Cumulative Sounds/Session Elaborations Condition	Tokens Condition
15	.30	.20
26	.42	.23
37	.34	.34
Total*	1.05 $\underline{p} = .10$	.77 $\underline{p} = .10$

*Totals do not fall at the extreme ends of the ranked distribution and are not the highest and lowest scores of all permutations.

Token probes are presented in Table 13. There was a significant difference between total responses in baseline and total responses in the token condition ($p < .05$, $df = 16$). Within each individual probe, responses increased with tokens, although the token condition showed a weak effect.

Table 13. Total number of responses in noncontingent baseline and contingent token probes over three 30-second intervals in initial, mid, and final sessions for Butch. Means are significant at $p = < .05$ ($df = 16$).

	Number of Marble Drops	
	Baseline	Tokens
Initial	19	21
	11	20
	18	23
Mid	14	13
	7	15
	9	18
Final	16	25
	21	20
	15	25
Total	130	180
Mean	14.4	20.0

Data on maintenance for Butch is shown in Figure 4. He recalled two of three letter sounds learned in the first elaborations check and all of the letter sounds learned in the second and third elaboration checks. In the tokens maintenance checks, Butch recalled one of the two letter sounds learned in the first check, all three letter sounds learned in the second check, and four of the six letter sounds learned in the third check.

Summary

The performances of both subjects in Section II was somewhat equivocal. The token condition appeared somewhat stronger for Kate, whereas elaborations appeared somewhat stronger for Butch. Variability in learning rate was evident in the tokens conditions for Kate and in both conditions for Butch. Probes showed that tokens only slightly strengthened responses for both children. Kate maintained learning somewhat better in the tokens condition, whereas Butch maintained learning slightly better in elaborations.

Section III--Findings on Mickey

This final section presents the results of Mickey's performance. Mickey's auditory discrimination score was marginal and his academic gains during the school year were extremely low, so much so that his teacher recommended retention in kindergarten.

Results of token probes are shown in Table 14. The token contingency was significantly greater overall than the nontoken condition ($p < .05$, $df = 16$). In each probe, responses showed slight increases over baseline.

Table 14. Total number of responses in noncontingent baseline and contingent token probes over three 30-second intervals in initial, mid, and final sessions for Mickey. Means are significant at $p =< .05$ ($df = 16$).

	Number of Marble Drops	
	Baseline	Tokens
Initial	9	14
	13	20
	16	17
Mid	13	19
	13	22
	18	19
Final	8	24
	12	18
	12	15
Total	114	168
Mean	12.7	18.7

No graphs are presented for Mickey because he did not reach criterion on any letter sounds in either condition and his performance did not differ from baseline in the treatment phase of the study. Neither contingency strengthened his responses within the 32 sessions of treatment.

CHAPTER 4

DISCUSSION

The purpose of this study was to investigate the differential effects of two types of contingencies, teacher verbal elaborations and token reinforcement, on children's discrimination learning. This chapter provides: (a) a discussion of the various forms of contingent elaborations and token contingencies in the teaching process; (b) comments on the experimental design; (c) interpretation of results in the context of four questions raised in the introduction; (d) limitations; (e) comparisons of findings with other studies; (f) implications for teaching; and (g) recommendations for further research.

Elaborations and Tokens as Consequent Stimuli

Various forms of elaborations can have a desirable effect on children's behavior when they are used appropriately. If, for example, a teacher's purpose is to teach a child to recognize the word "house" from a vocabulary card, she would do best to use elaborations that point out distinct characteristics such as the order of letters in the word or its entire configuration. The child is unlikely to identify the word readily if, upon presentation of the stimulus card, she says to the child, "Yes, that's 'house'. A house has windows and doors and families usually live in houses."

Elaborations in teaching take on at least four forms. One form of elaboration is concept elaboration. When a teacher talks about the characteristics that make a certain stimulus belong to a class of stimuli, all of which may be different but all of which share certain common characteristics, she is using concept elaboration. A teacher may point out to children that all integers represent groups with a defined number of objects in each group; the integer "one" has one object, the integer "two" has two objects, and so on. The teacher's purpose in using concept elaborations is to show how various stimuli, although they are different, also have qualities in common which make them belong together.

A second type of elaboration is associated with language development and is called an expansion. An expansion is a comment given in response to a child's utterance that contains the exact words and word order of the child's utterance and includes syntactic information such as the addition of a verb or an adjective. A child may say, "Look, dog" and the teacher may comment, "Yes, look at the big dog." The teacher's aim in expanding is to develop the child's use of language.

A third form of elaboration is self-initiated elaboration. A child may elaborate to himself through cues or prompts provided by the teacher, in imitation of the teacher's modeled verbal behavior, or as a result of specific training in self-instruction. Self-initiated elaborations are apparent in a child's directions to himself when spelling words. For example, he may say, "i before e except after c" to help him spell the word "receive" on a spelling test. Self-instruction has the function of cueing or prompting behavior which is likely to be reinforced.

Finally, elaborations are used in discrimination training. These are referred to here as discriminative elaborations. Discriminative elaborations serve the specific function of emphasizing the salient auditory, visual, or tactile characteristics of a particular stimulus to be learned. For example, a teacher may point out the "snowman" look of the number eight (8) and explain how the shape of the number eight differs from the shape of all other numbers. The teacher's purpose in using discriminative elaborations is to enable a child to distinguish a certain stimulus from all other stimuli and to teach the child that the stimulus has certain specific functions.

The present study employed discriminative elaborations as a consequence to children's correct responses in identifying letters associated with speech sounds. Only this form of elaborations pertains to findings in this study.

Tokens are discussed extensively in the literature and are only briefly reviewed here. Token systems can be an efficient means of dispensing contingent reinforcement to strengthen behavior. The functional relationship between a token economy and a specific behavior depends upon the mode of presentation of tokens and on the varying back-up reinforcers which students can purchase with tokens. Token system contingencies can be applied to all manners of behavior in numerous settings and over a multitude of exchange modes and schedules of reinforcement. Token systems also can have an almost limitless variety of back-up reinforcers. In the present study, a token economy was applied to correct identification of letter sounds on a continuous reinforcement

schedule in a teaching situation. The back-up reinforcers were social praise and recognition by the children's teachers, parents, and peers. The study addresses only this form of token contingency.

Design Strengths and Weaknesses

The advantages of the ATD in educational research have been described thoroughly by Barlow and Hayes (1979) and Ulman and Sulzer-Azaroff (1975). These advantages include nonreversibility, termination of manipulation as soon as experimental control is established, use with behaviors typically yielding unstable baselines (e.g., skill acquisition), uses in the study of complex behaviors, acceptance by school personnel, quick comparison of treatments, and elegant control for threats to internal validity.

Disadvantages are also evident. Barlow and Hayes discussed the problems of multiple treatment interference brought about by one treatment following another. Multiple treatment interference includes (a) carryover effects--"the influence of one treatment on an adjacent treatment, irrespective of overall sequencing" (Barlow and Hayes, 1979, p. 204); (b) sequential confounding--the confounding of effects of one of the treatments because it has repeatedly followed a prior treatment; and (c) alternation effects--the juxtaposition of two treatments together creating a more powerful effect than either treatment alone. A recent study by Shapiro, Kazdin, and McGonigle (in press) confirms the influence of multiple treatment interference on the dependent measure in an ATD. Several factors including the spacing of time periods, the interventions being compared, and the behaviors being evaluated may

contribute to multiple treatment interference. In the present study, carryover from elaborations to tokens did appear to occur when children initially repeated sounds only in the elaboration condition but later repeated sounds in both conditions. Other forms of multiple treatment interference in the present study can only be surmised. To better ascertain these effects and to add strength to treatment effects, the baseline condition could be extended across all sessions and subjects' performances could be compared to it. In the present study, some learning may have taken place in baseline. This would explain why Liza and Beth learned letters in the first session of treatment. Baseline could have been assigned its own set of letters and carried out throughout the entire intervention.

Interpretation of Results in the Context of Four Questions

Four questions were raised in the introduction:

1. In a simple discrimination task, do the teacher's verbal elaborations made contingent upon children's correct discriminations facilitate those discriminations?
2. In a simple discrimination task, do tokens made contingent upon children's correct discriminations facilitate those discriminations?
3. How do elaborations and tokens compare in terms of their effect on the frequency of children's correct discriminations?
4. How do elaborations and tokens compare in terms of their effect on maintenance of learned discriminations?

Five children are discussed in the context of these questions and one child is discussed separately. A summary is included.

Effects of Elaborations

The overall results of this study for Curt, Liza, and Beth indicate that elaborations as a consequence to correct responses strengthened correct responding on a discrimination task. Although the performances by Beth and Liza were somewhat variable, the elaborations condition did appear to contribute to the acquisition of letter sounds.

Results for Kate and Butch showed a slow but clear effect in the elaborations condition. Whereas Kate performed at a fairly consistent rate, Butch's performance was more variable. The initial reinforcing effect of elaborations weakened as both children appeared to satiate on elaborations in the last third of the study. This occurred to a greater degree for Butch.

Effects of Tokens

A token contingency backed by social reinforcers facilitated learning for Curt, Liza, and Beth. In the token condition, children learned more letter sounds than in the baseline condition, especially in the latter third of the study. At about session 30, all three children appeared to accelerate in learning rate in the token condition. This apparent strengthening of the token contingency was not readily accounted for by a sudden change in the token system itself because no concomitant change was evident in the token probes.

In the token contingency, Kate and Butch learned letter sounds in a similar pattern across the treatment sessions. Learning of letter

sounds began at the same time (session 14) and progressed at a fairly slow rate until the final third of the study. At this point, the rate at which letter sounds were learned increased in the tokens condition. The rate increase does not appear to be due to a change in the status of the token system because no accompanying change in the functional strength of tokens was observed in the token probes.

Comparative Effects of Elaborations and Tokens on Discriminations

A comparison of the effects of the elaboration and token conditions shows that, over the entire course of the study, elaborating resulted in more letter sounds learned for Curt, Liza, and Beth. For Curt and Liza, elaborating was clearly superior to tokens over all sessions. For Beth, however, elaborating distinctly surpassed tokens only in the first two-thirds of the study; in the last third, tokens and elaborations were fairly equal in strength. The apparent strength of elaborations for all three children may be due in part to their average or above average auditory discrimination skills, an obvious advantage in learning sound-symbol relationships.

There was no compelling evidence that either elaborations or tokens were superior in strengthening learning for Kate and Butch. Although Kate performed better in the tokens condition in the last third of the study, and Butch performed better in the elaborations condition in the first two-thirds of the study but better under tokens in the last third, distinctions between treatments are equivocal. The lack of clear difference between performances in the two treatment conditions may be related to each child's below average auditory

discrimination skills. Also, the apparent satiation on elaborations and strengthened reinforcing value of tokens discussed above was evident in other observations. For instance, during the latter sessions in the elaborations condition, Kate would complain that her eyes hurt and would place her feet on the table or crawl on the floor. When tokens were announced, her eye troubles disappeared and she sat up straight.

Comparative Effects of Elaborations and Tokens on Maintenance

There was no strong evidence showing differential effects of conditions on maintenance for any of the children. Curt recalled about the same number of letters in both conditions. Liza, Beth, and Kate maintained letters better in the tokens condition, but the difference between conditions was quite small and subsequently is not easily attributable to treatment effects. Butch maintained learning slightly better in the elaborations condition, but again, the difference between treatments was small and may not be due to experimental effects. Maintenance performance, then, is not seen to be definitively stronger in one condition over the other.

Discussion of Mickey

Mickey learned no letter sounds in either condition over the entire course of the study. He appeared to respond correctly more frequently in the elaborations condition in the beginning of the study and more frequently with tokens toward the end of the study, but he did not reach criterion on any of the letter sounds. Mickey's responses seemed to be random attempts at correct identifications. Although he

expressed delight at the opportunity to earn tokens, the token contingency was not functionally reinforcing in treatment. However, tokens did strengthen Mickey's marble drop behavior.

Mickey's marginal auditory discrimination scores and his extremely low academic functioning, those characteristics which distinguished him from other children in the study, may have been factors in his poor performance.

Summary

Four children (Curt, Liza, Beth, and Butch) showed superior performance with elaborations in about the initial two-thirds of the treatment phase. One child, Kate, performed about the same in both experimental conditions. Another child, Mickey, did not learn any letter sounds in either condition. All five of the children who learned letter sounds showed accelerated learning rates in the tokens condition in about the final third of the treatment phase. A probable explanation for the initial strength of elaborating is that it performed a cueing or prompting function for each child. As the teacher repeated the letter sound, the child began to discriminate that sound from other sounds on the next discrimination opportunity. The teacher's consequent elaboration actually acted as an antecedent stimulus for the child's next response.

A probable explanation for the accelerated rates in tokens is that children imitated the teacher's elaborative verbal behavior. This is supported by observations of the strategies children used in identifying letter sounds. Children were observed to repeat the words and

sounds the teacher had given in elaborating. For instance, the teacher elaborated on the blend "bl" by repeating the words "blue," "blank," and "blip." The next time the "bl" stimulus appeared, children often repeated "blue," "blank," and "blip" before pointing to the stimulus card. Children appeared to be guiding or instructing themselves.

In the initial sessions, repetitive self-instruction seemed to occur only in the elaboration condition. In later sessions, self-instruction also occurred in the tokens condition in which no teacher elaborations were present. A transfer effect from one treatment to another may have occurred.

In addition to self-instruction, latency of responding seemed to increase from the beginning sessions to the final sessions and from the elaborations condition to the tokens condition. In repeating sounds to themselves, children took longer to respond.

Limitations

Three limitations in this study must be taken into account in interpreting and generalizing the results. The first limitation concerns the generalization of results to other subjects. One cannot be sure what caused variability in the children's performances in both conditions. Differences in auditory discrimination and academic achievement may not have been the sole factors that created variability. Children may have had other characteristics in common as well. Age, socioeconomic status, and ethnic background also may influence performance. Therefore, further study across a wider range of subjects is needed to determine what other conditions are functional.

A second limitation is associated with the token probes. The token probes indicated the continuous strength of tokens across all sessions of the study. However, the probes were of very brief duration (30 seconds) and appeared intrinsically reinforcing to children. Consequently they may have been insensitive to changes in magnitude of the reinforcing strength of the tokens. If children found that putting marbles in a cup for a short time was attractive in itself, then the tokens may have dramatically increased in functional strength. However, the token probes were too unsophisticated to detect this increase. Probes were intended to be of short duration to guard against satiation. In retrospect, it appears that the probes could have been longer without weakening the functional strength of tokens.

A third limitation may be in the assignment of letters to each condition. Though stimulus letters were randomly drawn, some letters, such as b or m, may have been intrinsically easier to learn than others, such as g or y. This difference could have resulted in quicker or slower learning taking place in different conditions at different times. It may also account for some within-subject variability. However, it is not likely that it accounted for the trends observed over all subjects because children learned different letters at different times. To control for this possible source of variability, in future studies letters could be counterbalanced across children after they were randomly assigned to treatments.

Summary and Implications for the Classroom

Without replication, the results of this experiment may only be accepted with reservation, regardless of the consistency of results observed across subjects. Nevertheless, several implications drawn for the classroom may be suggested. Currently, teachers are actively dealing with the problem of how children best acquire knowledge and skills and with the problem determining the conditions that best maintain the performance of acquired knowledge and skills. The present study appears to offer some guidelines for the acquisition and maintenance of learning letter sounds. Discriminative elaborations, through the constant repetition of a sound, may be used initially to teach children the sounds that go with letters or other similar discrimination tasks. As a child acquires the sound-symbol relationship, performance may be strengthened in practice sessions under a token contingency. The back-ups for the token economy in the present study are readily adaptable to the classroom because they are easily dispensed and do not appear to lose strength over a number of training sessions.

The cueing or prompting function of discriminative elaborations suggests that training a child in a strategy of learning, such as self-instruction, may enhance acquisition of sound-symbol relationships. Extending the discriminative elaboration from the teacher to the child by teaching the child to repeat a sound before responding may enhance acquisition.

Discriminative elaborations may serve a similar function in other classroom instruction. In teaching shapes to children, for

example, the teacher may point out the particular configurations of various shapes. The roundness of a circle or the long and short sides of a rectangle may be elaborated repeatedly. Discriminative elaborations may be used in a similar fashion with numbers, letter identifications, or whole word identifications.

Teachers rarely present information in isolated bits. They almost always convey information in meaningful contexts. No one teacher behavior is likely to have a profound impact on students. Therefore, elaborations used in conjunction with other behaviors and in other contexts are recommended.

Comparison to Other Studies

The results of the present study parallel the results of other studies of the effects of elaborations on learning. Turnure, Buium, and Thurlow (1976), Buium and Turnure (1977), Taylor, Josberger, and Knowlton (1972), and Lee and Lehane (1977) all found elaborations to be effective in paired-associate learning across several groups of children and over several kinds of elaborations including self-generated sentence elaborations (Taylor et al., 1972). Elaborations have also been found to strengthen language development in children when mothers used expansions (Hovell, Schumaker, and Sherman, 1978) and when teachers use elaborative styles (Smothergill, 1971; Stecher, 1976; Lorentz, Creamer, and Coker, 1978; McGehee, 1980). Elaborations were found to strengthen other behaviors such as standardized test scores (Thompson and Nesselroad, 1971) and responses to directives given by mothers (Newport et al., 1977). However, no studies compared the effects of teacher administered

verbal discriminative elaborations with functional token reinforcement. Lee and Lehane did compare sentence elaborations with feedback and praise, but a question remains in that study as to whether or not verbal praise was functionally reinforcing throughout. Additionally, Lee and Lehane did not control for attention in their investigation. Children may have been responding to the increased contact they had with the experimenter under elaborations. Attentional factors may also have confounded the Hovell et al. study.

Several incidental child responses observed in the present study also occurred in other studies. For example, children self-verbalized in paired-associate learning in the Taylor et al. study even though they were not instructed to do so. Similarly, children subvocally repeated sounds in the present study. Bender (1975) reported that latency increased between the time the stimulus was presented and a response was given. This phenomenon was also noted in the present study. Finally, Bender and Smothergill reported apparent modeling effects by teachers. This also was a possible factor in the present research.

Further Research

The present study suggests several avenues for research. With the modifications in design already proposed, the effect of verbal elaborations and tokens should be compared in subjects of varying ages, intelligence, socioeconomic status, and cultures. With further replication and similarity of results across replications, the functional relationship of elaborations as consequent events to learning will be more clearly understood. Efforts should also be made to compare the

effects of elaborations as consequent events with elaborations as antecedent events in learning. The Hovell et al. (1978) study attempted to examine this issue within the framework of language development in young children, but Hovell's study has several methodological problems and does not relate specifically to classroom learning.

Research identifying the conditions under which discriminative elaborations and concept elaborations result in optimal learning may provide useful information. Research investigating the effects of elaborations consequent to children's incorrect responses may also be productive. Study in this area would throw light on how an effective correctional procedure might be devised and adjusted to various kinds of learning tasks. Finally, this study lends itself well to design analyses of the ATD. Modifications in the period of alternation, which were quite short in this study, may yield differential results and shed some light on multiple treatment interference.

APPENDIX A

KINDERGARTEN CONTINUOUS UNIFORM

EVALUATION SYSTEM

Summary and Recommendations for Implementation of CUES Testing

In the development of criterion-reference tests for the areas of reading, mathematics and communications, Amphitheater School District contracted with EESI to develop the tests and provide a reliability analysis of the test and re-test data. This data was obtained from the administration on two occasions of these tests to K through 9th grade students. The major findings produced by this analysis are:

- Virtually all tests in the three content domains possess satisfactory reliability as gauged by test/re-test stability and internal consistency.

- Virtually all tests in the three content domains are composed of items possessing a level of difficulty consistent with the purposes of the test developer.

On the whole, the Amphitheater School District's criterion-reference tests possess reliability sufficient to be used as instruments for evaluating pupil performance and instructional effectiveness. Findings obtained in this study lead to the following recommendations:

- For those few tests containing a large percentage of items having a high student failure rate, efforts should be aimed at item revision or deletion. Successful efforts would yield both higher test reliability and test validity.

- In a few instances test length appeared excessive. In these instances items in the latter portion of the tests were responded to in random fashion. Therefore, although test length is directly related to test reliability, in this case reduction of test length will increase test reliability.

It is important to note that these recommendations apply to only a few of the many tests developed. Amphitheater School District has achieved a high degree of success in developing a wide range of

tests for three major content areas. Taken as a whole, the tests possess satisfactory reliability and item characteristics to meet the goals for which the tests were developed.

Executive Summary

Because of a concern with evaluating pupil academic achievement and instructional effectiveness, Amphitheater School District contracted with Educational Evaluation Systems, Inc. (EESI) to develop a series of criterion-reference tests for the areas of reading, mathematics and communication. These tests covered the grade range of K-9. To assist in this development, the school district also contracted with EESI to provide a reliability analysis of data obtained by the district from the administration of the tests on two occasions.

The major findings derived from this analysis are:

.Virtually all tests for the three content domains possessed satisfactory reliability as gauged by test/re-test stability and internal consistency

and

.Virtually all tests for the three content domains are comprised of items possessing a level of difficulty consistent with the purposes of the test developers.

On the whole, the criterion-reference tests developed for Amphitheater School District possess reliability levels quite adequate for the evaluation of pupil performance and instructional effectiveness.

The following recommendations stem from the findings of the analysis:

.For those few tests consisting of a comparatively large percentage of items having a high student failure rate, efforts should be aimed at item revision or deletion, or inclusion of appropriate instruction of the proper grade level. Success in these efforts would yield both higher test reliability and validity

and

.In a few instances test length appeared excessive. This was evidenced by a random response to alternative items appearing toward the end of the test. Reduction of the length of these few tests would enhance test reliability.

It is important to note that these recommendations apply to only a few of the many tests developed for the district. Again, taken as a whole, the tests possess satisfactory reliability and item characteristics to accomplish the goals for which the tests were developed.

APPENDIX B

SYSTEM OF PRESENTATION OF BACK-UP REINFORCERS FOR TOKEN CONTINGENCY

Step 1: Child earns 15 tokens.

Step 2: Child cashes in tokens to obtain reach into "Mystery Bag" which contains assorted stickers and emblems: ("Scratch and Sniff," Smiley Faces, Stars, Medals, etc.).

Step 3: Child chooses to place sticker or emblem on a classroom chart, a colored oaktag bookmark, an award notice to be signed by the teacher and sent home, or on an index card attached to the child's chair.

Step 4: Child's accomplishment is announced to the class by the classroom teacher.

APPENDIX C

SAMPLE LIST OF SOCIAL REINFORCERS

"You did a great job on that one."

"Wonderful. You really know those."

"Great. It looks like you've got it."

"That's a boy/girl."

"You sure are doing well."

"Way to go, (child's name)."

"That's exactly how to answer that one."

"Hey, you're really catching on."

"Super job."

"Good (child's name). Now you've got it."

"Very good, (child's name). You are really working hard."

"That's it. Great work."

"That certainly is the way to do it."

"My goodness, how impressive."

"It looks like you're really putting a lot of work in this."

"You are really outdoing yourself today, (child's name)."

"You make it look easy."

"Now you've figured it out."

"Now you've got the hang of it."

"Good for you. Exactly right."

APPENDIX D

PROCEDURE FOR INSTRUCTION IN

ELABORATIONS AND TOKENS CONDITION

Objective: Child will point to target letter.

Criterion: Five correct responses to target letter in five nonconsecutive opportunities.

Materials: Three printed target letter cards (small letters), five object picture cards for each letter (15 total) with picture name beginning with target letter (e.g., B, b - butterfly).

Teaching procedure:

1. Antecedent events

   a. Gain child's attention. "(child's name), look."
   b. Place first target letter card before child.
   c. Say, "This is the letter (target letter). It makes a ('sound') sound like you hear at the beginning of 'sample word beginning with the target letter sound'."
   d. Place second target letter card before child.
   e. Say, "Here is another letter, (child's name). It is the letter (target letter). It makes a ('sound') sound like you hear at the beginning of ('sample word')."
   f. Place third target letter card before child.
   g. Say, "Here is the last letter, (child's name). It is the letter (target letter). It makes a ('sound') sound like you hear at the beginning of ('sample word')."

   Behavior

   a. Show a picture card.
   b. Say, "(Child's name), what is this?"
   c. If child gives incorrect name, follow picture correction procedure. Say, "No, this is a ('correct picture name'). Now you say it."
   d. Say, "Point to the letter you hear at the beginning of the word."

e. Child places finger or hand on correct letter card.

(1) If child points to incorrect card, follow letter correction procedure. Say, "No, ('picture word') begins with the letter ('target letter')." Point to letter. "Now you point to it."
(2) Child places finger or hand on correct letter.

3. Consequent events to correct letter response

a. Elaboration

(1) Say, "Yes, you hear ('target letter') at the beginning of ('picture word'). You also hear ('target letter') at the beginning of ('sample word 1'), before the word ('sample word 2'), and you hear ('target letter') at the beginning of ('sample word 3')."
(2) Rearrange order of letter cards.
(3) Present next picture card.

b. Token reinforcement

(1) Say, "Yes, you did very well on that one. Good for you. I think that's a great job."
(2) Present token.
(3) Rearrange letter cards.
(4) Present next picture card.

Note: Social praise may vary in content but not in number. Various combinations of three supportive comments may be given.

4. Consequent events to incorrect letter response

a. Correction procedure
b. Rearrange letter cards
c. Present next picture card.

Procedure of Token Reinforcement

1. At the commencement of the treatment phase, each child was shown the Menu of Reinforcers. The list was discussed and the "price" in tokens was explained.

2. A small cup with the child's name printed clearly on it was given to the child and used to store tokens.

3. During the tokens condition of the treatment phase, each child received one token for every correct response given in the task situation. Tokens were placed in the child's cup.

4. Children "cashed in" tokens on any day of the week provided all sessions for the day had been completed.

5. Back-up reinforcers on the Menu were approved by parents and teacher.

APPENDIX E

PROCEDURE FOR SELECTION OF CONSONANT SOUNDS AND RANDOM ASSIGNMENT OF TARGET LETTERS TO ELABORATIONS AND TOKENS CONDITION

Procedure for Selection of Consonants and Short Vowels, for Elaborations and Tokens Conditions and for Individual Subjects

1. A pool of 40 consonants, blends, and digraphs were selected from a list in Harris and Sipay (1980). These letters are characteristic of those taught in pre-primary and primary skills.

2. Letter cards, printed by Ideal, were selected for use.

3. Each letter card was paired with a picture of an object. The name of each object began with the letter of the card with which it was paired.

4. All 40 cards were assigned to the two treatment conditions, 20 cards in each, through split-half randomization.

5. Each child was assessed on knowledge of cards. If a child recognized the sound a letter or card made, the card was withdrawn from the child's pool of words.

6. Cards were presented in the same order for each child. Cards were assigned to each child in random order.

7. After random card assignment to each child, each card was designated five pictures of objects, each object name beginning with the same letter as the card to which it was designated.

Random Assignment of Target Letters to Treatment

Elaborations

b	p	z	bl	gl
d	r	k	cl	gr
j	s	ch	fl	pl
m	t	th	fr	pr

Token Reinforcement

c	l	y	cr	sm
f	n	wh	dr	sn
g	w	sh	sk	sp
h	v	br	sl	st

APPENDIX F

WEEKLY MAINTENANCE CHECK PROCEDURES

Materials: Target letters learned during week and one picture card for each target letter.

Procedure:

a. Conduct maintenance check after final trial on the last full day of the week.
b. Place one learned target letter card and two distractors before child.
c. Show picture card of object beginning with letter sound child has learned.
d. Say, "(Child's name), look, what is this?"
e. Child gives correct name
    1. If child gives incorrect name, follow Picture Correction Procedure.
    2. Child gives correct name.
f. Say, "(Child's name), point to the letter you hear at the beginning of the word."
g. Child places finger or hand on letter card.
h. Record response.
i. Remove letter cards and picture.
j. Repeat procedure placing next learned target letter card with two distractors before child.

Note: Provide no response as a consequence to child's choice of letter card.

APPENDIX G

DATA RECORDING SHEETS

Data Sheet--Child Responses

Child's Name: _____

Date: _____

Observer: _____

Response code:

= response within limits of operational definition

= response not within limits of operational definition

Target letters _____ _____ _____ Condition: Circle One E R

Letter Presentations	Response	Letter Presentations	Response
1.		6.	
2.		7.	
3.		8.	
4.		9.	
5.		10.	

Target letters _____ _____ _____ Condition Circle One E R

Letter Presentations	Response	Letter Presentations	Response
1.		6.	
2.		7.	
3.		8.	
4.		9.	
5.		10.	

Data Sheet--Experimenter Responses

Date:_____

Observer:_____

Response code:

= response within limits of operational definition

= response not within limits of operational definition

Condition: Circle One E R

Trial		Trial	
1.	_____	6.	_____
2.	_____	7.	_____
3.	_____	8.	_____
4.	_____	9.	_____
5.	_____	10.	_____

Condition: Circle One E R

Trial		Trial	
1.	_____	6.	_____
2.	_____	7.	_____
3.	_____	8.	_____
4.	_____	9.	_____
5.	_____	10.	_____

Weekly Maintenance Check Data Sheet

Child's Name: _____

Date: _____

Response code:

= correct

= incorrect

Letters Learned to Criterion	Picture Presented	Response
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

APPENDIX H

TABLES OF PERMUTATIONS AND DISTRIBUTIONS FOR BASIC RANDOMIZATION TEST

Table H1. All possible permutations (6!/3!3!) and sums of learning rates in each third of the treatments phase (elaborations and tokens) for Curt

	Learning Rates						
	Elaborations			Tokens			
Permutation	.50	.38	.41	.20	.23	.28	Sums
1	.50	.38	.41				1.29
2	.50	.38	.20				1.08
3	.50	.38	.23				1.11
4	.50	.38	.28				1.16
5	.50	.41	.20				1.11
6	.50	.41	.23				1.14
7	.50	.41	.28				1.19
8	.50	.20	.23				.93
9	.50	.20	.28				.98
10	.50	.23	.28				1.01
11	.38	.41	.20				.99
12	.38	.41	.23				1.02
13	.38	.41	.28				1.07
14	.38	.20	.23				.81
15	.38	.20	.28				.86
16	.38	.23	.28				.89
17	.41	.20	.23				.84
18	.41	.20	.28				.89
19	.41	.23	.28				.92
20	.20	.23	.28				.71

Table H2. Probability distribution representing the 20 permutations of Table H1 for Curt

Ranked Sums	Probability
.71 (T)	.05
.81	.05
.84	.05
.86	.05
.89	.10
.92	.05
.93	.05
.98	.05
.99	.05
1.01	.05
1.02	.05
1.07	.05
1.08	.05
1.11	.10
1.14	.05
1.16	.05
1.19	.05
1.29 (E)	.05

(T) = summed score for tokens performance
(E) = summed score for elaborations performance

Table H3. All possible permutations (6!/3!3!) and sums of learning rates in each third of the treatments phase (elaborations and tokens) for Liza

	Learning Rates						
	Elaborations			Tokens			
Permutation	.50	.38	.41	.20	.23	.28	Sums
1			1.00	.57	.53		2.10
2			1.00	.57	.10		1.67
3			1.00	.57	.29		1.86
4			1.00	.57	.39		1.91
5			1.00	.53	.10		1.63
6			1.00	.53	.29		1.82
7			1.00	.53	.34		1.87
8			1.00	.10	.29		1.39
9			1.00	.10	.34		1.44
10			1.00	.29	.34		1.63
11			.57	.53	.10		1.20
12			.57	.53	.29		1.39
13			.57	.53	.34		1.44
14			.57	.10	.29		.96
15			.57	.10	.34		1.01
16			.57	.29	.34		1.20
17			.53	.10	.29		.92
18			.53	.10	.34		.97
19			.53	.29	.34		1.16
20			.10	.29	.34		.73

Table H4. Probability distribution representing the 20 permutations of Table H3 for Liza

Ranked Sums	Probability
.73 (T)	.05
.92	.05
.96	.05
.97	.05
1.01	.05
1.16	.05
1.20	.10
1.39	.10
1.44	.10
1.63	.10
1.67	.05
1.82	.05
1.86	.05
1.87	.05
1.91	.05
2.10 (E)	.05

(T) = summed score for tokens performance
(E) = summed score for elaborations performance

Table H5. All possible permutations (6!/3!3!) and sums of learning rates in each third of the treatments phase (elaborations and tokens) for Beth

	Learning Rates						
	Elaborations			Tokens			
Permutation	.50	.38	.41	.20	.23	.28	Sums
1			1.00	.52	.59		2.11
2			1.00	.52	.40		1.92
3			1.00	.52	.47		1.99
4			1.00	.52	.56		2.08
5			1.00	.59	.40		1.99
6			1.00	.59	.47		2.06
7			1.00	.59	.56		2.15
8			1.00	.40	.47		1.87
9			1.00	.40	.56		1.96
10			1.00	.47	.56		2.03
11			.52	.59	.40		1.51
12			.52	.59	.47		1.58
13			.52	.59	.56		1.67
14			.52	.40	.47		1.39
15			.52	.40	.56		1.48
16			.52	.47	.56		1.55
17			.59	.40	.47		1.46
18			.59	.40	.56		1.55
19			.59	.47	.56		1.62
20			.40	.47	.56		1.43

Table H6. Probability distribution representing the 20 permutations of Table H5 for Beth

Ranked Sums	Probability
1.39	.05
1.43 (T)	.05
1.46	.05
1.48	.05
1.51	.05
1.55	.10
1.58	.05
1.62	.05
1.67	.05
1.87	.05
1.92	.05
1.96	.05
1.99	.10
2.03	.05
2.06	.05
2.08	.05
2.11 (E)	.05
2.15	.05

(T) = summed score for tokens performance
(E) = summed score for elaborations performance

Table H7. All possible permutations (6!/3!3!) and sums of learning rates in each third of the treatments phase (elaborations and tokens) for Kate

	Learning Rates						
	Elaborations			Tokens			
Permutation	.20	.23	.22	.10	.23	.28	Sums
1	.20	.23	.22				.65
2	.20	.23	.10				.53
3	.20	.23	.23				.66
4	.20	.23	.28				.71
5	.20	.22	.10				.52
6	.20	.22	.23				.65
7	.20	.22	.28				.70
8	.20	.10	.23				.53
9	.20	.10	.28				.58
10	.20	.23	.28				.71
11	.23	.22	.10				.55
12	.23	.22	.23				.68
13	.23	.22	.28				.73
14	.23	.10	.23				.56
15	.23	.10	.28				.61
16	.23	.23	.28				.74
17	.22	.10	.23				.55
18	.22	.10	.28				.60
19	.22	.23	.28				.73
20	.10	.23	.28				.61

Table H8. Probability distribution representing the 20 permutations of Table H7 for Kate

Ranked Sums	Probability
.52	.05
.53	.10
.55	.10
.56	.05
.58	.05
.60	.05
.61 (T)	.10
.65 (E)	.10
.66	.05
.68	.05
.70	.05
.71	.10
.73	.10
.74	.05

(T) = summed score for tokens performance
(E) = summed score for elaborations performance

Table H9. All possible permutations (6!/3!3!) and sums of learning rates in each third of the treatments phase (elaborations and tokens) for Butch

	Learning Rates						
	Elaborations			Tokens			
Permutation	.30	.42	.34	.20	.23	.34	Sums
1	.30	.42	.34				1.06
2	.30	.42	.20				.92
3	.30	.42	.23				.95
4	.30	.42	.34				1.06
5	.30	.34	.20				.84
6	.30	.34	.23				.87
7	.30	.34	.34				.98
8	.30	.20	.23				.73
9	.30	.20	.34				.84
10	.30	.23	.34				.87
11	.42	.34	.20				.96
12	.42	.34	.23				.99
13	.42	.34	.34				1.10
14	.42	.20	.23				.85
15	.42	.20	.34				.96
16	.42	.23	.34				.99
17	.34	.20	.23				.77
18	.34	.20	.34				.88
19	.34	.23	.34				.91
20	.20	.23	.34				.77

Table H10. Probability distribution representing the 20 permutations of Table H9 for Butch

Ranked Sums	Probability
.73	.05
.77 (T)	.10
.84	.10
.85	.05
.87	.01
.88	.05
.91	.05
.92	.05
.95	.05
.96	.10
.98	.05
.99	.10
1.06 (E)	.10
1.10	.05

(T) = summed score for tokens performance
(E) = summed score for elaborations performance

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