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ABSTRACT

The project purpose was to develop and field test a program of instruction for young deaf children which could be used in existing classrooms. The main program contained two areas of instruction in written language: verb vocabulary at a high level of generalization and sentence structure. The program materials were field tested with 78 children in the preparatory levels of three schools. The only criterion for admission to the sample was a simple test of minimum word recognition ability. Subjects ranged from 5 to 10 years of age, and from three and one-half to 10 1/2 years on psychometric scores. Three validation criteria, one final performance criterion and two measures of gain, were applied in 28 instances to the pretest and posttest data from the sample groups. The criteria were met in 21 instances. Of the 78 children, 77% achieved mastery in verb vocabulary, and 83% in sentences. Each of the sample groups evidenced statistically significant learning in all areas of instruction. The mean time required for the program was 4.7 hours. It was concluded that the program represented a very effective, as well as an efficient, method of teaching written language to young deaf children. (Author)

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FINAL REPORT
Project No. 5-0394
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DEVELOPMENT AND EVALUATION OF PROGRAMMED INSTRUCTION IN THE TEACHING OF VERBS TO DEAF CHILDREN IN THE PRIMARY GRADES

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U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

Office of Education
Bureau of Research

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DEVELOPMENT AND EVALUATION OF PROGRAMMED INSTRUCTION IN THE TEACHING OF VERBS TO DEAF CHILDREN IN THE PRIMARY GRADES

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March 1970

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SUMMARY

The educational retardation of deaf children is a source of constant concern to their parents and teachers and to others interested in their future vocational and social adjustment. The present project is one of many endeavors directed toward practical solutions for the problems involved in educating deaf children. The purpose of the project was to develop and field test a program of instruction for young deaf children which could be used in existing classrooms. The goals of the Program were (1) to develop materials appropriate for children as soon as minimal word recognition skill has been acquired; (2) to provide instruction in content areas of written language which are difficult to teach; and (3) to achieve a high level of generalization of verbal concepts. The specific goal was to bring the students to mastery of written language at the recognition level--a sub-goal which leads to the acquisition of receptive and expressive language at the recall level. The terminal behavior selected to represent the achievement of the specific goal was a multiple-choice recognition response, specified by means of validation tests in each area of instruction.

The main Program consisted of two areas of instruction in written language--verb vocabulary at a high level of generalization and sentence structure. A third area, noun vocabulary, was provided in a supplementary Program for students who needed instruction in the noun vocabulary prerequisite to the sentence portions of the main Program. For the purpose of administering the Program, a simple method of presentation, including an inexpensive reinforcing device, was developed.

After extensive trial and revision of the Program materials, the final form was field tested with 78 children in the preparatory levels of two state residential schools and one private day school in the southeastern area. Level I at each of the three schools and Level II in one of the state schools comprised the four sample groups. Within these groups a satisfactory score on a simple test of minimum word recognition ability was the only criterion for admission to the sample. The subjects ranged from five years of age at Level I to ten years at Level II and from three and one-half to ten and one-half years in related psychometric age scores.

During field testing two major problems involving materials arose. Because of delays in obtaining printed materials, student use

of the Program was interrupted at various points. In the initial sets of the Program an unsatisfactory procedure, used in a portion of the frames, led to confusion for many children. A solution to this problem was found, and materials for later sets of the Program were modified to accommodate the new procedure.

The effectiveness of the Program was evaluated by validation pretest and posttest measures in each of the three areas of instruction. Three validation criteria--one final performance criterion and two measures of gain--were applied to the test results for each of the four sample groups. The final performance criterion selected was 80/90--80% of the validation subjects achieving a mastery score of 90% on the Program posttests. Meeting this standard was the only aim for the supplementary Program in nouns. The McGuigan gain ratio compares the actual gain with the possible gain. Blake's measure of gain is a more rigorous standard which penalizes the programmer for students' preknowledge of the program content.

With one exception, the Level II sample group met the criteria in all areas of instruction. Because of high pretest scores in sentences, Blake's criterion was missed by a very narrow margin. The McGuigan gain ratio was exceeded by all four groups in both areas in which it was applied.

The notable exceptions to acceptable performance occurred with respect to the mastery criterion and Blake's criterion for the three Level I sample groups. In the area of verb vocabulary the mastery criterion was met by only two groups; however, Blake's criterion was attained by all three groups. For sentences the mastery criterion was met by two groups and Blake's criterion by only one. Two of the three groups met the 80/90 mastery criterion for nouns.

The validation criteria were applied in 28 instances to the data from the four sample groups. The Program met the standards in 21 instances. Of the total sample of 78 children, 77% achieved mastery in verb vocabulary, 81% in nouns, and 83% in sentences. Application of the sign test to the pretest and posttest scores showed significant learning by each of the four sample groups in all areas of instruction.

For the main Program the estimated average time for the 29 Level II children was 224 minutes; the 49 Level I children spent approximately 317 minutes. For the 47 children who took the entire supplementary Program the average estimated time was 63 minutes. The 11 children who needed only a portion of this Program averaged approximately 28 minutes. Additional time required for related activities, such as distribution of materials in the classroom and testing, was estimated at 210 minutes per child. It is estimated that the slowest

child spent approximately 14 hours in all Program activities.

From these results it was concluded that, although the validation criteria were not met in all instances, nonetheless the Program potentially represents a very effective as well as an efficient method of teaching written language to young deaf children.

It was recommended that, with the correction of the two major problems associated with the first field testing, the Program be field tested again. Further revision was recommended if the Program should fail to meet the specified criteria in the second field testing. Upon the attainment of rigorous validation standards, it was recommended that the Program be disseminated to schools for the deaf and that additional materials utilizing the same methods be developed.

INTRODUCTION

The educational retardation of deaf children is a source of constant concern to their parents and teachers and to others interested in their future vocational and social adjustment. However, the recent surge of activity directed toward practical solutions for the educational problems of deaf children allows us to be optimistic regarding the future. "The U. S. Office of Education is committed to improving the education of handicapped children. Such a commitment requires a major emphasis on the development, field testing and dissemination of instructional materials" (7). The present project is one of many endeavors emerging from this commitment. Programmed instruction was chosen as the area for exploration and demonstration.

(1.10) Relevant Background

In recent years programmed instruction has become widely accepted in general education and in industrial training. At the time the present project was conceived, the literature regarding this subject with the deaf was limited but nonetheless indicated that programming could be used effectively in teaching language to deaf children. Fehr (4) programmed the indefinite article and Falconer (3) developed a program for teaching sight reading vocabulary to deaf children. In both studies it was demonstrated that learning had taken place. In comparing two groups of deaf children, one which received teacher directed instruction and the other which received programmed instruction, Stuckless and Birch (12) found no difference in the amount of learning by the two student groups. However, the teacher directed group consumed twice as much time.

(1.20) Characteristics of Programmed Instruction

It has been demonstrated (6) that behavior can be shaped by immediate reinforcement of responses which approach desired goals--that by introducing successive directional increments toward those goals, one can lead a student to a specified type and level of behavior. Programmed instruction can implement principles of learning associated with the shaping of behavior (2) which are difficult to apply in a

conventional classroom situation. It provides a setting for the following:

1. Immediate reinforcement

2. Active responses from the student

3. Reduction in learning errors

4. Logical sequencing of learning steps

5. Individual learning pace

6. Efficient use of time

A well designed program provides a sequence of learning steps which lead the student from the basal level (the level at which he can already perform) to a clearly specified goal (terminal behavior). At each step a stimulus is presented, a response is required from the student and immediate feedback (reinforcement) for the response is supplied without delays between components of the step. Furthermore, the student can proceed from one learning step to the next through an entire sequence at his own rate of speed. With the correction of errors at each step provided by feedback, materials can be logically sequenced--the accomplishment of one step providing the base for the next one. In this way independent activities can be utilized in the teaching of new material--not for drill only. Correction of errors can prevent the practice of errors but does not prevent their occurrence the first time. Carefully designed learning steps and controlled sequencing of steps can greatly reduce the occurrence of errors which lead to erroneous associations.

(1.30) Characteristics of Conventional Methods

In the conventional classroom setting it is difficult for the teacher to apply such learning principles. For many group activities the teacher simply presents a series of stimuli without requiring overt responses and without providing reinforcement. In group presentations in which responses are required and reinforcement provided, the teacher must deal with the children one at a time at some point in the learning step. As a result delays occur between the stimulus and the response or between the response and feedback. In either case, delays which interfere with the shaping of behavior are introduced at some point in the learning step. The time spent in waiting for others to perform is wasted and frequently attention is lost. Furthermore, in any situation which stimuli are presented to the group as a whole,

the pace of instruction is not likely to be appropriate for all members of the group. If the level of difficulty is geared to the slowest child, the pace is wasteful for all others.

In many group settings, the learning activity is actually conducted on an individual basis. As each child takes his turn, the teacher presents a stimulus, requires a response from him and supplies reinforcement. Although there may be no delays within the learning step, the waiting time is even greater than with group presentation of stimuli.

In individual activities, commonly known as seatwork, the child may progress through a series of items at his own rate without delay between stimulus and response. However, there is usually long delay between response and feedback while the child waits for his teacher to correct his paper. This delay not only interferes with the sequence of events in a learning step; it also allows the child to practice his mistakes. Furthermore, design of sequential materials, when correction does not occur at each step, is difficult because one cannot assume the accomplishment of previous steps in designing subsequent ones.

(1.40) Combining Programmed Instruction with Teacher Directed Activities

It is not possible at the present time to estimate the amount of time the deaf child in a typical classroom situation spends waiting or to estimate the extent of interference with learning caused by delays. We do not suggest that this waiting time could be completely eliminated in the near future or that all group activities should be abandoned even if this were possible. However, we feel that the waste of student time could be substantially reduced and teaching effectiveness greatly increased through the combined use of programmed instruction and teacher directed activities.

Although a great deal of the deaf child's learning is necessarily subject to the personal control of the teacher, many of the conventional learning activities could be replaced by programmed instruction, thus providing individual attention without the loss of time spent waiting. In addition, a greater degree of self-reliance could be developed through the reduction in the amount of teacher support necessary. Activities requiring the supervision of the teacher could be conducted in smaller, more homogeneous groups so that children would spend less time waiting while others perform, and the pace of the smaller group would be more compatible with that of the individual members. In the total learning situation a far greater number of learning responses could be

elicited and the teacher's professional skill could be utilized more effectively.

(1.50) Advances in Educational Media

It is encouraging to note that recent advances in educational media are being brought to bear on the problems involved in educating deaf children--both in programmed instruction and in teacher directed instruction. As with advances in any field, there are problems arising which impede the widespread application of newly developed media especially that which is complex and costly. In addition to the expense of purchasing equipment and the accompanying materials, few existing classrooms have the space or wiring to accommodate the equipment necessary. It is hoped that the development of effective instructional materials in all types of media for the deaf will continue at an even more rapid rate. While the use of complex equipment may be essential in some areas, it would appear that the application of the principles of modern learning theory through simple and inexpensive program devices could facilitate learning for deaf children. Certainly development of such methods and materials should not be neglected.

In order to explore the utilization of inexpensive media in programming abstract language terms (classificatory nouns) for deaf children, a pilot study (5) was conducted at the Atlanta Speech School. The program developed for this purpose was presented in a programmed text with accompanying answer sheets. It was administered to a small group of deaf children between the ages of seven and nine and to a similar group of normal children. The educational retardation of the deaf children demonstrated on a pretest was no longer evidenced on the posttest. Although programmed instruction appeared to have potential as an effective and efficient method of teaching language to deaf children, programs available for classroom use at the time the present project was initiated were limited in number and scope.

(1.60) Description of the Project

(1.61) Purpose and Goals. On the basis of results of the pilot study, it was decided to explore more extensively the application of programmed instruction to the teaching of written language for deaf children. The specific purpose of the project was to develop and field test a program of vocabulary development and sentence structure. The goals of the Program were as follows:

1. To devise materials appropriate for young deaf children with minimal word recognition skill

2. To provide instruction in content areas of written language which are difficult to teach

3. To achieve a high level of generalization of verbal concepts

With regard to the third goal, it has been shown (8, 9, 13) that deaf children function at lower levels of generalization than do hearing children. However, the results of the pilot study (5) indicate that this deficiency is amenable to teaching. Development of a high level of generalization was to be a major consideration throughout the development of the Program. A large number of examples would be needed for each element (shade of meaning), and elements must be carefully ordered to facilitate the perception of the common characteristic from one example to the next in the sequence. In order to prevent the association of the verbal symbol with a narrow concept--or a completely erroneous one, a sequence of frames designed to develop generalization would be presented before the introduction of the printed symbol. Each of the various elements--demonstrated with different examples--would then be associated with the printed symbol.

(1.62) Criteria for Goal Achievement. At the time the Program goals were being formulated, language teaching was envisioned as consisting of three phases:

1. Initial concept development

2. Association of the verbal symbol with that concept at the recognition-response level

3. Receptive and expressive use of the verbal symbol at the recall-response level

It was not the aim of the Program to attain the third goal, language usage at the recall level, but to bring the student to mastery of the second phase--a sub-goal leading toward the third goal. By providing the instruction for the first two phases at a high level of generalization, the Program enables the teacher to concentrate her time and energies toward instruction in the third phase. Furthermore, if the first two phases are thoroughly established, the development of the third phase is greatly facilitated.

A great deal of consideration was given to the selection of terminal behavior--the behavior which serves as evidence that the instructional goals have been attained. The type of behavior selected was a multiple-choice recognition response. In the construction of validation

tests utilizing this response mode, the level of generalization was measured by including items for all elements taught for each word. In addition, specific examples used in the test were different from those used in the Program frames.

The level of behavior selected as the goal for the Program students was 90% mastery rather than the traditional 70% or 75% passing level. The rational for this criterion is two-fold. First, the allocation of student time for instruction assumes that the content of that instruction is worthwhile. Second, almost universally the learning of young children serves as the foundation for future learning. If the foundation at any point is not thoroughly established, the effect of an inadequate background is compounded in subsequent learning.

(1.63) Requirements for the Method of Presentation. Physical requirements for the method of presenting the Program were established as follows:

1. The method of presentation must first fulfill the requirements for administering the teaching sequence effectively and efficiently. It must be flexible enough to accommodate any variation in frame format which might be needed.

2. The device must be simple for students to operate and for teachers to maintain. The possibility of jamming must be virtually eliminated.

3. Both the original purchase price of the device and maintenance costs must be low in comparison to most teaching machines. It must permit the presentation of reusable materials.

4. The students must be able to use the Program in their usual setting for individual work and classroom storage requirements must be minimal. The device must house its own power supply, if required.

(1.64) Development of the Program. After the formulation of specific instructional goals and presentation requirements, the following steps remained: (1) design of a model lesson plan, (2) construction of trial materials, (3) trial and revision of materials, and (4) development of a suitable method of presentation. When, after extensive trial and revision, a program of instruction appears to have reached an acceptable level of effectiveness, it must be field tested with an appropriate sample.

PROCEDURE

In order for the Program to have the best potential for early and lasting effects upon education, it was decided that the target population would be children in the primary levels of schools for the deaf. The overall development of the Program included:

(2.10) Selection of subjects

(2.20) Selection of content

(2.30) Specification of terminal behavior

(2.40) Design and preparation of materials

(2.50) Trial and revision of materials

(2.60) Determination of initial behavior

(2.70) Development of the teaching machine

(2.80) Collection of data for validation

(2.10) Selection of Subjects

Children in the preparatory levels in two state residential schools and one private day school in Georgia and North Carolina were used in the validation phase of the project; only children in one state school were used during the trial and revision phase.

(2.11) Trial and Revision Subjects. Small groups of children were needed from time to time for the purpose of testing and revising material as it was being developed. The supervisors were asked to select children who, in their judgment, were representative of the range of achievement to be found in the particular level for which materials were being developed.

(2.12) Validation Subjects. When a program appears to have reached an acceptable level of effectiveness, it must be tested under appropriate classroom conditions for the purpose of validation; thus, when extensive trial and revision appeared to have brought the project

materials to an acceptable level, a sample for validation was required. Within the two state schools the academic levels containing the youngest children were selected. Comparable subjects were selected from the day school. In subsequent discussions of the subjects there will be reference to children in Level I, Level II or Level III. The reader must be aware that these may not be comparable in age from school to school; for example, the day school admits children to nursery classes at three and one-half years of age, one state school admits children to Preparatory Level I at five years of age and the other admits to Preparatory Level I at six years of age.

There was a total of 78 children who met the admission criteria established for validation subjects, discussed in detail in (2.83) Selection of Subjects. They were distributed as follows: 63% Level I and 37% Level II; 54% male and 46% female; approximately 86% Caucasian and 14% Negro.

(2.20) Selection of Content

As originally envisioned, instructional materials would have encompassed two areas. The first area would consist of a nucleus of verb vocabulary, for which the concept can be demonstrated with a picture alone, and simple sentence structure. These would provide a base for the future teaching of more difficult concepts which require the use of a sentence as well as a picture for demonstration of the concept.

The second area would consist of verb vocabulary and language structure which require a sentence in addition to pictures for the demonstration of the concept, e.g., such verbs as have and is and language structure such as tense and negation. Trial materials for tense and negation were devised and tried to a limited extent, but it did not appear that a satisfactory level of effectiveness could be achieved within the time limitations of the project. Therefore, it was decided to concentrate the major effort of the present project in the first area.

The Program Unit devised for this area had as its primary goal teaching--at a high level of generalization--the verb vocabulary to be utilized in the development of sentence structure. An additional goal was the development of an understanding of the relationship between the verb and other parts of the sentence. In order to develop the Program Unit, a series of trials was conducted to identify a strategy for structuring content into a workable framework. As a result of these trials the Unit was organized into five subdivisions, hereafter

referred to as Sets One, Two, Three, Four* and supplementary Subject Noun Program. Set One consisted of verb vocabulary and sentence sequences, which together with the supplementary Subject Noun Program, was presented in the following order:

(2.21) Four verb vocabulary words, each including a variety of elements

(2.22) A supplementary program of eleven subject nouns

(2.23) A sentence structure sequence

Sets Two, Three and Four contained the following:

(2.21) Four verb vocabulary words, each including a variety of elements

(2.23) A sentence structure sequence

(2.24) Review

(2.21) Verb Vocabulary. The first consideration in selection of the verb vocabulary within a given Set was suitability for use in developing sentence structure. Verbs were selected whose actions could be performed by many of the same subjects and received by many of the same objects. Careful selection of both nouns and verbs permitted the presentation of many simple sentences with a relatively small vocabulary.

The present progressive tense was elected for use in the sentence structure portions of the Unit; therefore, verbs chosen must lend themselves to presentation in that tense. In addition, verbs in the Program Unit were selected to provide the basic vocabulary for the later teaching of verb tense; therefore, attention was given to the distribution of verbs, with regard to tense characteristics. There was a need to include regular verbs which retain the root form when tense is shifted and irregular verbs where the change in tense alters the root word but maintains a recognizable form.

The second consideration was the predicted familiarity with the concept of each verb. At least one element of each concept had to be within the presumed experience of all the children. The degree of competition among the verbs within each Set was also an important factor in vocabulary selection. It was important that the words be noncompetitive with regard to both concept and configuration. Another

*As will be explained in (2.872) Classroom Participation, Set Four was not validated.

aspect given attention was the ease with which each concept could be demonstrated with pictures. It should be noted that this is not synonymous with the degree of artistic skill required.

(2.22) Subject Noun Vocabulary. For those children who did not have the prerequisite noun vocabulary for the sentence structure sequence, the supplementary Subject Noun Program was devised. These nouns were selected on the basis of their usefulness in permitting the presentation of all the verb elements in simple sentences with a relatively small vocabulary. The children's probable familiarity with the concept of each noun was considered equally important. Some degree of competition among words was unavoidable but, since nouns are generally considered to be less difficult for deaf children than verbs, there was less concern regarding competition among nouns. Portraying the concept graphically was not a problem.

(2.23) Sentence Structure Sequence. As soon as minimal vocabulary had been taught, verbs were combined with nouns in simple sentences. In Set One, following the vocabulary portions of the Program, the relationship of the verb to the subject was developed. Following the vocabulary sections of Sets Two and Three, subject-verb sentence structure was reviewed incorporating the cumulative vocabulary. Later sections of Set Three provided instruction in the relationship of the verb to the object, using the total vocabulary of the first three Sets.

Since single pictures of on-going activities were to be used, the present progressive was selected as the appropriate verb tense for sentence structure portions of the Program.

(2.24) Review. Sets Two, Three and Four contained sections which reviewed previous material (vocabulary and sentence structure), integrating new material with that of the preceding sets. A detailed outline of the content of the Program Unit appears in Appendix A.

(2.30) Specification of Terminal Behavior

Terminal behavior is the behavior expected of the student when he has completed a program--the behavior which is accepted as evidence that the goals of the program have been attained. It is usually specified by means of a criterion or validation test.

A multiple-choice recognition response was selected as the behavior which would serve as evidence that the goals of the Program

Unit had been attained. Validation tests were developed for the following:

(2.31) Verb vocabulary

(2.32) Noun vocabulary

(2.33) Sentence structure

(2.31) Verb Vocabulary Tests. A 54-item test covering the verb content of the Unit of four Sets was constructed to serve as the primary validation instrument. Each item presents the student with a picture portraying a certain concept; his task is to select the appropriate word from among competing alternatives. Alternatives were drawn from the vocabulary content of the entire Unit. Generalization was a primary goal of the project; therefore, two steps were taken to assure its accomplishment:

1. To prevent the student from responding on the basis of rote memory of specific frames from the Program, pictures appearing in the test were not used in the Program.

2. One item for each major element of every vocabulary word taught was included in the test.

In addition to the 54-item verb test, a shorter progress test for each Set was constructed. The items in these tests were limited to the content of the respective Sets and served only as interim progress checks. The results were not used for the purpose of validation.

(2.32) Noun Vocabulary Tests. A 28-item test, following the principles applied in the construction of verb tests, was devised to measure achievement for the subject noun segment of the Program. Like the verb tests, it contains several items for each of the eleven vocabulary words, and the pi tures used in test items do not appear in the Program. Alternatives include words competitive in both concept and configuration.

(2.33) Sentence Tests. There were three tests for sentences: the first tested understanding of the relationship of subject to verb and contained 20 items; the second tested understanding of the verb-object relationship and contained 20 items; the third covered the subject-verb-object relationship and contained 30 items.

Two types of multiple-choice items were used to test understanding of the verb-sentence relationship--one type required a word response and the other type a picture response.

The word-response items presented the student with a stimulus picture and an elliptical sentence. The stimulus picture contained two or more subjects, each performing a different action. The student's task was one of the following:

1. To read the subject of the incomplete sentence, locate that subject in the picture, and select the appropriate printed verb for the sentence blank

2. To read the object of the sentence, locate that object in the picture, and select the appropriate printed verb for the sentence blank

3. To read both the subject and the object of the sentence, locate the subject with the object, and select the appropriate printed verb for the sentence blank

The picture-response items presented the student with a simple sentence. His task was to read (1) subject and verb or (2) subject, verb and object, in order to select the appropriate picture.

The validation tests described above were administered as pretests and posttests in order to measure gain from the Program. As will be explained in (2.88) Validation Testing, only 40 of the 54 items in the Unit verb vocabulary test were scored. In addition, only the first sentence test (subject-verb relationship) was used with validation subjects. The schedule for administering validation tests and the teaching material of the Program appears in Appendix A. Sample items from all three types of tests are presented in Appendix C.

(2.40) Design and Preparation of Materials

The learning task for the present Program was defined as one of generalization with multiple discrimination. The tentative teaching model involved a systematic progression through four levels:

(2.41) The basal level (the level at which the student can already perform)

(2.42) Concept development

(2.43) Word association

(2.44) Level of mastery

(2.41) Basal Level. In order to design a teaching sequence leading to mastery, it is necessary first to determine the target student's basal level of performance--the level at which he can already perform. From observation of students' behavior during an exploratory phase of the project, it was predicted that this level would be low. Since it was the goal of the project to reach children as early as possible, every effort was made to adjust the beginning level of the Program to the most elementary level possible. Nonetheless, in order to establish a starting point, preparation of the first trial materials was based on the assumption of minimal word recognition skill and the ability to relate simple illustrations of familiar concepts to reality.

From the very outset of the project, the ability to demonstrate the skill of word recognition at a minimal level was considered a prerequisite. This skill was assessed not for the purpose of utilizing a particular vocabulary, but rather to ascertain the presence or absence of the skill. Children who failed the word recognition test, discussed in detail in (2.61) Word Recognition, were not considered candidates for the Program. No attempt was made to devise a procedure which would overcome this inadequacy since it did not seem possible to devise an effective teaching procedure which could be administered during the five day period allotted for training and orientation. Thus materials were prepared on the basis that the child had already developed sufficient word recognition skill for the learning tasks of the Program.

During the early trials of the Program it became evident that many of the trial subjects were failing due to an inability to relate pictures to experience. It was decided that the teaching of this skill would fall within the scope of the project. Unlike word recognition, it seemed possible to devise an effective teaching procedure to be administered during the five day training and orientation period. Activities designed to meet this need are described in (2.62) Association of Pictures with Reality.

Since the basal level of performance was expected to be low, a highly structured method of presentation was required. The tentative frame design provided a large area for the stimulus (picture and/or word) at the top of the frame with the response and two alternatives (pictures and/or words) in a horizontal arrangement across the bottom. It was decided that beginning frames should require only gross discrimination and that progressively finer discrimination would be required on subsequent frames.

(2.42) Concept Development. The plan of the Program followed a policy of developing a concept through pictures rather extensively before introducing the printed word. This policy tends to prevent the

association of the printed symbol with a narrow or completely erroneous meaning.

Concept formation was achieved by a series of picture matching frames, beginning with the element predicted to be the most familiar and progressing to less familiar ones. Beginning with the most familiar one, elements were ordered in such a manner as to facilitate expansion of the concept. Each successive example shared a feature with the previous one so that the learner could perceive the commonality as the range of meaning for each concept expanded. As the Program progressed the concept was further defined by the judicious use of alternatives which increased in similarity to the correct choice.

(2.43) Word Association. When the concept for a word was thought to be sufficiently established, the printed symbol was associated with examples of the various elements of the concept. A word-matching technique was employed to induce the student to attend and respond to the printed word. Early frames required only gross discrimination, but closer attention to word form was required as alternatives became more similar in configuration to the correct choice.

(2.44) Level of Mastery. When the word-matching sequence had reached a level of fine discrimination, the support supplied by matching was removed. In order to facilitate the transition from word matching to word recognition, early recognition frames were constructed with alternatives dissimilar to the response. In the final revision, cues were also used for this purpose. Frames approaching the terminal level alternated picture responses with word responses, each requiring successively finer discrimination until the desired level of mastery was attained. The final frames reflected the expected terminal behavior with regard to difficulty and extent of generalization. An excerpt from the final Program appears in Appendix B.

The model provided the framework within which trial materials were cast for subsequent presentation to trial subjects. The first lesson plans were written for only two words in order to obtain the feedback needed to discover the inadequacies in the tentative model and allow for appropriate changes before investing extensive time in the total Program.

As the first lesson plans evolved, attention was turned to the method of presenting the Program. Basic requirements for the method were established. A machine, adequate for trial and revision of materials, was constructed, but there was a continuing effort during this time to improve the method of presenting materials. A detailed account is provided in the section (2.70) Development of the Teaching Machine.

(2.50) Trial and Revision

In order to bring a program to an acceptable level of effectiveness and efficiency, repeated trials and revisions usually must be conducted. This phase of the project began as soon as materials for the first two verbs had been prepared, and continued concurrently with subsequent materials preparation for a period of 18 months.

From time to time small samples of deaf children, considered by their supervisors to be representative of their grade levels with regard to achievement, were selected. During the revision period for the first Set of materials, several groups were used successively for short periods of time. Revisions were made after each trial. During later stages two permanent sample groups were used. The second group received materials after revisions from trials with the first group.

Trial materials were administered individually by means of a trial model teaching machine. An observer recorded Program responses and other aspects of behavior, e.g., confidence-uncertainty, interest-boredom, random response-deliberate response. Analysis of program errors, together with other reactions, provided the basis for revision.

(2.51) Revisions in the Model. The revision period for the first Set of the Program was a critical one, for it was during this time that student performance revealed certain basic weaknesses in the Program and pointed the way to an improved model. On the basis of students' responses during the trials of Set One, the following revisions were made in the model:

1. Control of irrelevant variables. Many of the children were responding on the basis of perceptible characteristics--such as size, shape, line direction, degrees of shading, amount of detail, etc. Considerable effort went into the equalization of these influences within any given frame.

2. Elimination of confusion factors. Confusion resulted between words being taught in the same Set; the solution was the avoidance of other words from the same Set as alternatives, until the word being taught was firmly associated with the concept. Words were then brought together in carefully controlled sequences.

3. Designation of separate tracks. The slower students required more exposure to individual verbs before contending with them in competition. In order to prevent needless

repetition for the more capable students, separate tracks were established. Immediately before words in a Set appear in competition, the Standard Track (designed for the slower student) was interrupted and the foregoing material was repeated. When the slower student reached this point the second time, he continued to the terminal frames of the sequence. The more capable student followed the Accelerated Track which did not repeat.

4. Addition of writing frames. In order to utilize an additional sensory avenue and to require closer attention to word form, tracing and copying frames were inserted after the printed word had been introduced.

5. Insertion of intermediate frames. Where inter-frame increments proved too large, intermediate frames were inserted.

6. Introduction of mediating symbols. Many of the students failed to integrate subject and verb in the sentence structure portion of the Program. Small pictograph symbols were placed above the words in the sentences to facilitate integration. These symbols were later incorporated into the vocabulary sections to promote transition from word matching to word recognition. They also proved to be effective in bringing words in a Set together.

7. Addition of red underlining. After pictograph symbols were added to facilitate integration of subject and verb in the sentence structure portion, some of the students failed to integrate these two when the symbols were dropped. At this point red underscoring was used to direct attention to both words. Red was also used at other points of transition to prevent the disregarding of stimulus components.

8. Addition of arrow comprehension frames. In the word response frames of the sentence structure portions of the Program, arrows were essential to induce the student to locate the subject in the picture after reading it in the sentence. It was discovered that most of the students did not understand the purpose of the arrows. At this point a sequence of frames for teaching the comprehension of demonstrative arrows was inserted.

(2.52) Later Revisions. Since many of the basic weaknesses in the model were corrected as a result of trials with Set One, subsequent materials did not require such extensive revision. Problems were generally those peculiar to the specific content of the sequence. An excerpt from the final Program appears in Appendix B.

(2.60) Determination of Initial Behavior

From observation of students' behavior during the exploratory phase of the project, it had been predicted that the basal level of the target students' performance would be low. Subsequent experience during the trial and revision period proved this prediction to be justified.

After all adjustments had been made in the beginning level of the Program, two initial behaviors (abilities prerequisite to successful performance) were specified:

(2.61) Minimum word recognition skill

(2.62) Association of pictures with reality

(2.61) Word Recognition. As noted in a previous section minimum word recognition skill was considered an ability essential for the student to possess at the time he began the Program; therefore, those students who did not demonstrate minimum word recognition were not a part of the target population.

Minimum word recognition for an individual student was defined as the ability to recognize four out of six words. A test was constructed for each of the three schools participating in the validation of the Program. From a list of the first ten words taught in each school, six were selected as the content for the test and two additional ones were used as sample items. All ten words appeared as alternatives.

Each item presented the student with a simple drawing illustrating the concept element judged to be most familiar. His task was to select the correct word from among four choices. Although the word recognition tests were not designed to measure fine discrimination with respect to word configuration or concept, it was necessary to prevent the student from responding solely on the basis of familiarity with the correct word in the presence of unfamiliar ones. At least two words from the total list of ten were used as alternatives in each item so that the students could not merely choose the one familiar word, but every effort was made to minimize competition between the correct choice and the alternatives with regard to word form and concept represented.

In administering the test, instructions were accomplished by the use of gestures. Precautions were taken to insure understanding of the procedure. The two sample items were checked, and any assistance necessary for the correct completion of these items were given before the children were allowed to proceed with the six items of the test.

(2.62) Association of Pictures with Reality. Since still drawings were used throughout the Program to portray the concepts, it was essential that the target students be able to associate pictures with reality. In the very early trials of the Program, it became obvious that many of the students' failureswere resulting from an inability to make this association. In most cases this deficiency did not appear to be a function of intelligence.

It was apparent that many potential target students would be excluded from the Program unless some solution to the problem were found; therefore, it was decided to test the effects of a brief training session upon the performance of unsuccessful trial students. A set of materials, designed to teach the relationship between pictures and reality was administered to these children. Subsequent improvement in their Program performance justified the additional instructional time and the materials were further developed to accommodate the varying levels of ability.

The resulting Initial Behavior Testing-Training Sequence (IBT-TS), in its final form, served a dual purpose: (1) to evaluate the students with regard to initial behavior required to cope with the Program, and (2) to train those who had not achieved an appropriate level of skill. The sequence was administered individually with feedback provided by the instructor. The child's first response to an item (right or wrong) was recorded as his score. If he failed the item, he was then helped to understand it before proceeding to the next one.

In order to adapt the IBT-TS to the different levels of ability, three parallel sets of material were developed--one set for each of three successive days. Children who performed successfully on Day One or on Day Two were exempted from further training except for the last verb section which involved picture matching. Table I is a summary description of the stimulus-response tasks required of the student on one day.

Table I. Description of the Stimulus-Response Tasks for One Day of IBT-TS.

NOUN		VERB	
Stimulus Presented	Subject Response	Stimulus Presented	Subject Response
Picture of object	Select real object	Action by experimenter	Select picture of action
Real object	Select picture	Picture of action	Child performs the action
		Picture of action	Select picture of similar action

The sequence for Day One and for Day Two consisted of two major divisions:

(2.621) Nouns--teaching the relationship between pictured objects and real objects

(2.622) Verbs--teaching the relationship between pictured actions and real actions.

Day Three omitted the noun division. IBT-TS for Day One is presented in Appendix D.

The format of the sequence was designed to accustom the students to the Program format. Pictures were presented on 8 1/2" by 11" pages bound in looseleaf fashion. Accompanying objects were placed on a rectangular mat to the student's right of the notebook.

(2.621) Nouns. Since noun concepts are generally found to be easier for deaf children to learn than are verbs, the noun division was administered at the beginning of the sequence on Day One and on Day Two. A third day of training in this area was not considered necessary.

In each of the two noun sections the student was required to associate real objects with pictures of objects. The degree of similarity in appearance between the stimulus and the response ranged from almost identical to distinctly different. Since the sole aim of IBT-TS was the understanding of pictures in relation to reality, no miniature or artificial objects were used.

(2.622) Verbs. The first two verb sections for each day required the student not only to associate pictured events with real actions but also to associate an illustration of one element (or shade of meaning) with a live action involving a different element of the same verb. Varying degrees of generalization were required. In the two sections involving live actions, the student was required to make two responses--representing two different elements--to the same stimulus. As in the noun division, association of pictures with reality was the sole aim of the verb division of IBT-TS; therefore, no pretending was used in actions either performed by the instructor or accepted from the student. In the third section both the stimulus and the response were pictured verb concepts--the format representing that of the concept formation frames of the Program.

(2.70) Development of the Teaching Machine

(2.71) Initial Considerations. From the outset the goal of the project was to develop programmed instruction which utilized an inexpensive presentation. While there are obvious advantages in costly media such as film strips, motion picture films and video tape, it was felt that the use of still pictures in programmed instruction should not be neglected. In addition to cost, practical aspects such as operating space, storage space, electrical wiring requirements, maintenance and simplicity of operation for both student and teacher were considered.

Experience with target students during an earlier phase of the project made the following requirements apparent:

1. A highly structured presentation which could be achieved only with a machine

2. Frames large enough to accommodate clear pictures and still allow ample spacing between the stimulus and the choices

3. A simple, direct method of responding and receiving reinforcement

The target student could not be expected to make a two-step response involving an intermediate symbol (e.g., to select his answer, note the number or letter designation of his choice and find this designation in another place).

He could not be expected to compare his choice with the correct answer and decide whether he was right or wrong. (In many programs the student compares his answer with the correct answer to obtain reinforcement.)

4. A simple method of proceeding from one frame to the next.

The course of events which led to an acceptable teaching machine began with a search for an appropriate machine already in existence. None was found which met all the criteria established.

(2.72) Trial Model Teaching Machine. The first trial model devised consisted of a box which housed a stack of 8 1/2" by 11" cards in a nearly upright position with the first card exposed. A narrow mask, attached to the box with springs, covered the lower two inches of the exposed card and held the stack firmly against a supporting surface. The student looked at the stimulus at the top of the exposed card, selected his answer from a row of choices just above the mask, and inserted a stylus into a round opening in the mask directly below his choice. If his answer was correct, a bulb at the base of the box was lighted. If his answer was wrong, the bulb did not light. Power was supplied by a battery housed in the box and wired to the bulb and the stylus.

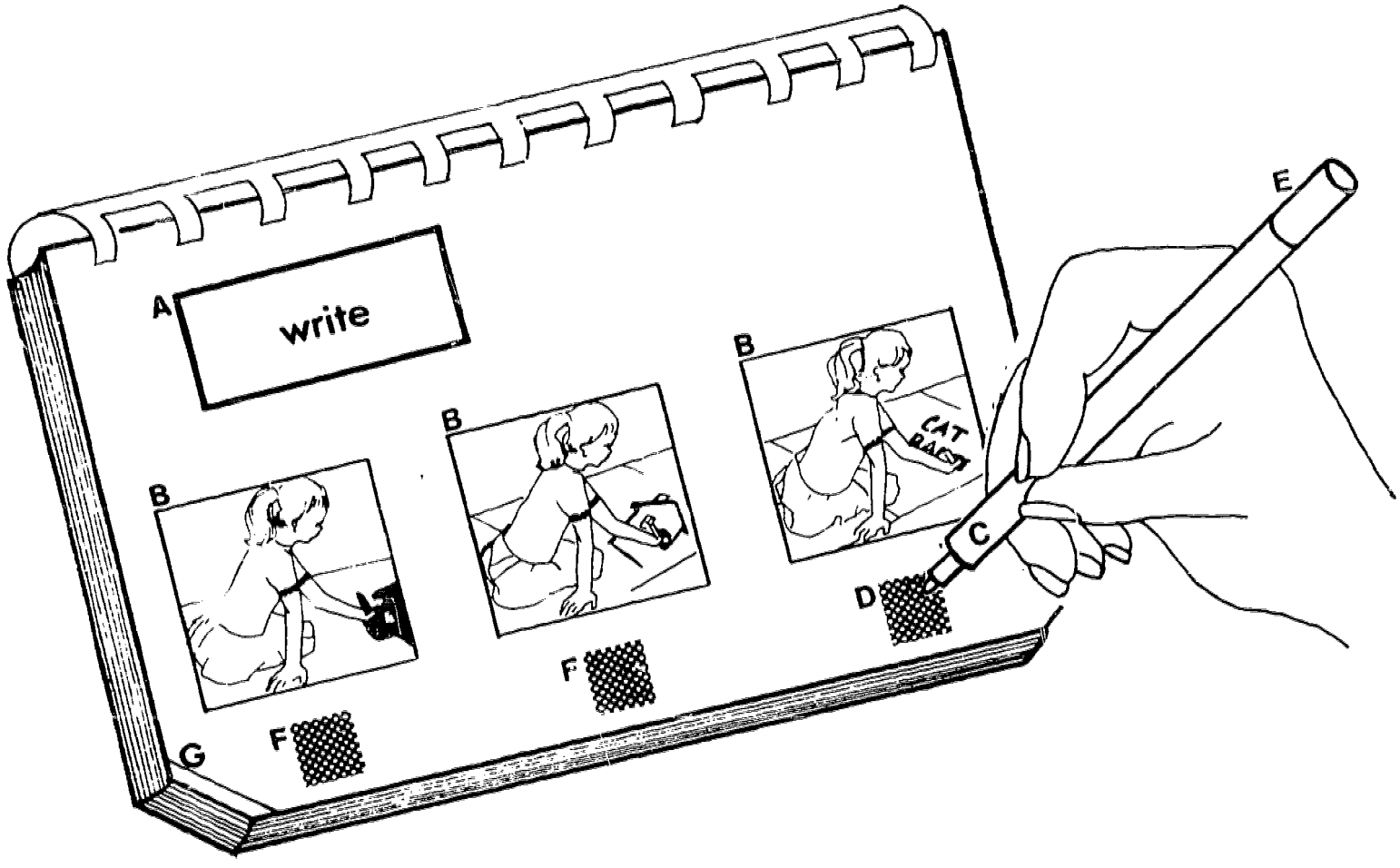
When the student had completed a frame (one frame to a card) he removed the card and placed it in a compartment for used cards at the back of the box. When he removed one card, the next one was exposed.

The machine described above was used effectively for several months in the individual administration of trial programmed materials. The device was relatively inexpensive, reusable materials were possible and there were no special electrical wiring requirements. In terms of presentation requirements, the device allowed ample frame space and provided a direct method of response.

In terms of the original project goals, the disadvantages rendered the device unacceptable for ultimate classroom use. In many classrooms the individual student's desk would not be suitable and the amount of storage space required would not be available. Although

the within-frame procedure was simple, the procedure for advancing from one frame to the next was difficult and allowed materials to become out of order. Efforts to improve the method of presentation led to the development of a device which retained the desirable features of the trial model but eliminated its major disadvantages.

(2.73) Final Model of the Teaching Machine. The final model illustrated on the following page consists of 8 1/2" by 11" books bound with plastic cones and a completely separate reinforcing device which approximates the size and shape of a primary pencil.



PROGRAM PRESENTATION AND REINFORCING DEVICE

Procedure:

1. The child looks at the exposed frame.

2. He looks at the stimulus (A).

3. He selects his answer from the choices (B) available.

4. He touches the tip of the reinforcing device (C) to the ink patch under his choice. If he touches the patch (D)* under the correct choice, the light (E) comes on. If he touches a patch (F)** under an incorrect choice the light does not come on. He then makes another choice.

5. He turns the page and looks at the next frame. The lower corners (G) of the pages are cut--odd numbered pages are cut deeper than even ones--to facilitate page turning and prevent turning two pages at once.

*Conductive ink is used under the correct choice.
**Nonconductive ink is used under incorrect choices.

At various points in the Program, the student encounters frames which require him to trace or copy. These pages are laminated and contain no ink patches. The student writes on the laminated page with a pencil containing a special lead which can later be removed.

The reinforcer is a self-contained unit housing batteries, light bulb and other electronic components. This arrangement eliminates the need for a box, thereby solving the problems of storage and operating space. With the box eliminated, frames can be bound with plastic cones so that advancing from one frame to the next involves simply turning the page of a book. The book form also eliminates the opportunity for materials to become out of order. In addition, the format restrictions of the first machine are eliminated permitting a large variety of frame designs.

The validation phase of the project was used for testing the method of presentation in a practical classroom situation. As teachers and project staff observed problems with the handling of materials, modifications were made. The method of presentation in use at the close of the validation period satisfied the following previously established requirements:

1. Simplicity of Operation. Manipulation of materials is easy for young children and takes up a minimum of the total instructional time. There is virtually no possibility of jamming. The method of response is direct and reinforcement is immediate. The procedure for changing batteries and bulbs in the reinforcing device is as simple as replacing these parts in a flashlight. In addition, maintenance includes wiping off the writing on a few plastic pages per book after each student's use.

2. Cost Factors. The cost of the reinforcing device, less than $8.00, is low compared to most teaching machines. Maintenance costs (replacement of batteries and bulbs) are also low; these parts should not need replacing more than twice in a school year. Although the printing is more expensive than conventional printing, the materials are completely reusable.

3. Building Requirements. Any individual desk provides adequate space for using the Program. Classroom storage for books requires space for two books per child--the one in use and the next one in the sequence. Reinforcing devices can easily be kept in a small box. The power supply is housed in the reinforcing device itself; therefore, no source of electricity is required from the classroom.

(2.80) Collection of Data for Validation

(2.81) Validation Procedure. The final step in the development of programmed instruction is validation--it must be demonstrated that target students learn from the program in the practical situation for which it is ultimately intended. In addition to effectiveness, the efficiency of the program must be stated. The following steps, generally considered to be necessary, were employed in the validation of the project Program:

1. A sample representative of the target population was selected.

2. The subjects were pretested to determine the level of prior knowledge of the Program content.

3. The subjects used the Program under target conditions and the instructional time was recorded.

4. The validation posttests were administered in order to determine the level of learning at the conclusion of the Program. Performance on these tests constitutes the behavior which serves as evidence of the learning achieved through use of the Program.

In addition to the above procedure, it was originally intended to compare the learning by the validation subjects with that of a control group by means of a standardized achievement test. The development of this test is outlined in Appendix E. Because of uncontrollable delays which occurred in the printing of programmed materials, this aspect of the evaluation had to be abandoned. These problems are discussed in Appendix F.

(2.82) Schedule of Subject Events. The collection of validation data involved the following steps, listed below in chronological order:

1. Word Recognition Test

*2. Subject Noun Test, pretest

*3. Unit Verb Vocabulary Test, pretest

4. Initial Behavior Testing-Training Sequence

5. Selected psychometric test items

6. Classroom use of the Program including recording of time
   - Introduction to teaching materials
   - Set One vocabulary
   - Subject noun vocabulary

*7. Subject Noun Test, posttest

*8. Subject-Verb Sentence Test, pretest

9. Classroom use of the Program resum l
   - Set One sentence sections
   - Set Two
   - Set Three

*10. Unit Verb Vocabulary Test, posttest

*11. Subject-Verb Sentence Test, posttest

*These items comprise the Program validation testing.

Tests were administered individually by trained personnel with directions accomplished by demonstration and gesture. Children were urged to respond to every item. The first three tests in the schedule were administered in the order of predicted difficulty.

(2.83) Selection of Subjects. The procedure for selecting subjects was designed to identify children who had acquired word recognition skill at a minimal level but had not yet acquired knowledge of the Program content. Within the sample selected, it was necessary to identify those children who needed instruction in subject noun vocabulary. The sample for validation was drawn from the preparatory levels of two state residential schools and one private day school in the southeastern area. The reader is reminded that the age of admission is different in each of these schools.

(2.831) Prior Knowledge of Program Content. Scores from the Unit Verb Vocabulary pretest were used to identify academic levels, within schools, in which there was insufficient margin to demonstrate a satisfactory gain. Levels in which half or more of the students scored 70% or better were excluded from the validation sample. Level III in two schools and Level II in one school were excluded on this basis. Because of problems which arose with the printing of Program materials (see Appendix F), Levels II and III in the remaining school had to be excluded also. None of these children participated in the classroom use of the Program. The levels remaining, Level I from all three schools and Level II from one state school, contained 115 children.

(2.832) Word Recognition Skill. The Word Recognition Test was used to identify children within these levels who did not demonstrate word recognition ability at a minimal level. Those who failed more than two of the six items in the test, 22 of the 115 children, were excluded from the sample. It had been predicted that such children could not succeed in the Program; therefore, they were not considered a part of the target population. However, they were included in all validation activities in order to test this assumption.

(2.833) Incomplete Data. Sixteen additional subjects were lost because of incomplete data due to absence during pretesting, other preliminary activities, or posttesting.

(2.834) Summary of the Sample. The validation sample was composed of 78 subjects who showed low pretest performance, who demonstrated word recognition ability at a minimal level, and who participated in all validation activities. The distribution of subjects appears in Table II.

Table II. Characteristics of the Validation Sample.

	N	Sex		Race		Age	Psychometric Levels			ISO Hearing Level
		M	F	W	N	Y-M	FB*	PI**	PA***	Avg. for 250-500 Hz
Level I										
School										
I	31	18	13	28	4	6- 5	5-11	5-8	5-11	82
II	13	7	6	9	4	7- 9	7- 2	5-6	6- 2	N. A.
III	5	1	4	5	0	5-11	4- 8	6-5	7- 5	77
Level II										
School										
I	29	16	13	26	3	7- 9	6-11	6-2	6- 7	76

*Form Board **Picture Identification ***Picture Association

(2.835) Supplementary Program. Instruction in noun vocabulary was provided for validation subjects who had not previously mastered the nouns prerequisite to the sentence portions of the Program. Scores from the Subject Noun pretest were used to exempt children from the supplementary Subject Noun Program or from one of the two sections. Students who missed two or less of the 28 items were excused from the entire supplementary Program. Those who missed one or less within either of the two subtests were excused from the corresponding section of the Program.

(2.84) Subject Information. In order to obtain uniform measures of learning ability across schools, three psychometric items were administered: (1) the Seguin Form Board from the Grace Arthur Point Scale of Performance, Revised Form II, (2) Picture Identification and (3) Picture Association from the Hiskey-Nebraska Test of Learning Aptitude. Tests were chosen on the basis of their apparent relationship to the tasks required by the Program. The Seguin Form Board is a test of visual-motor function which is not bound to social or verbal skills. The Picture Identification portion of the Hiskey involves the visual matching of identical items whereas the Picture Association requires more abstract associations. These were administered during the three day period in which the Initial Behavior Testing-Training Sequence was administered.

In addition to the psychometric data, audiometric data were obtained for the children in two of the schools. The average hearing level for 250 and 500 H_z can be found in Table II.

(2.85) Initial Behavior Testing. Initial behavior in two areas was evaluated. As previously discussed, inadequate performance on the Word Recognition Test excluded children from the validation sample. The Initial Behavior Testing-Training Sequence was administered in order to assess the ability to associate pictures with reality; to provide instruction for children who demonstrated a deficiency in this area; and to serve as an orientation to the Program format. The three parallel sessions were administered individually on three successive days, each session requiring approximately 15 minutes per child.

(2.86) Track Assignment. During the trial and revision phase, it became apparent that different Program tracks would be needed in order to provide sufficient exposure for some students and yet avoid needless repetition for others. The primary considerations in initial assignment to Standard or Accelerated Track were performance on IBT-TS and in the first three sections of the Program. In borderline cases consideration was also given to scores on psychometric test items. All children who failed the Word Recognition Test were assigned to the Standard Track.

Subsequent reassignments were based primarily on scores from the progress tests following individual Sets. These tests served only as interim progress checks--the scores were not a part of the validation data. If a student in the Accelerated Track missed two or more items on the progress test for one Set, he was assigned to the Standard Track for the next Set. If a student in the Standard Track achieved a perfect score, assignment to the Accelerated Track for the next Set was considered. Such decisions were less objective because judgments were necessary regarding the child's ability to maintain mastery performance without the repetition provided by the Standard Track. In such cases judgments by the child's teacher and the project supervisor were the determining factor.

(2.87) Classroom Use of the Program. Since the Program was designed to be used within the framework of the regular routine in classes for deaf children, the validation subjects used the Program in their classrooms under the supervision of their teachers. The teachers were asked to observe the children's reactions and comment upon these observations.

(2.871) Individual Orientation. Ten demonstration frames, representing most of the frame types appearing in the Program, were used to teach the procedure. Directions were accomplished by a specified sequence of individual demonstration and guidance, with the gradual withdrawal of assistance. It was anticipated that, upon completion of these frames, the procedure would be learned by most of the children. However, children were individually supervised; errors were recorded; and any assistance necessary was provided through Section C, Part 1 of Set One. It is at this point that the two tracks diverge; therefore, decisions regarding track assignments were necessary at this time.

(2.872) Classroom Participation. Upon completion of individual orientation and track assignment, a member of the project staff supervised the beginning use of the Program in each classroom and instructed the teacher in the procedure to be followed. In addition, a supervisor was available in each school to assist teachers with procedure, scheduling and materials for the duration of the validation period.

In the classroom the children worked independently in their usual setting for individual activities. In most classes individual desks were used, but in a few rooms it was necessary to use large tables. Each day the teacher distributed Program books and reinforcing devices; checked to see that children were ready to work; and gave a starting signal. Each child worked at his own rate until the signal to stop was given--usually five to ten minutes. He then marked his place and the

teacher collected materials. A record was kept of the approximate total work time for each child.

When a child had completed one book of the Program, he received the next one in the sequence--progressing through his designated schedule for the main Program and the supplementary Subject Noun Program, if needed. At designated intervals in the Program, progress tests, covering the immediately preceding content, were administered individually by the project supervisor. As previously noted, decisions regarding the child's track assignment for the next Set were made on the basis of these tests. The teacher was provided with a schedule designating the sequence of books and the various testing points for each child.

(2.873) Problems Associated with Classroom Use. On a number of occasions, two to four week lapses of time intervened between the completion of one book and the starting of the next one in the series. These lapses were due to uncontrollable delays in the printing of Program materials. The basic problems were (1) matching the appearance of conductive and non-conductive ink patches and (2) the contamination of the non-conductive patches by the conductive material. The series of frustrating problems encountered and the ultimate solution are discussed in detail in Appendix F. Perhaps the most unfortunate result of these delays was the loss of classroom time necessary for validation of the final portions of the Program--Set Four and Book VI of Set Three.

(2.874) Modifications in the Presentation. During the trial and revision phase of the Program, repeated efforts were made to anticipate problems which might arise in the target situation. We realized that, in spite of these efforts, unpredicted problems might arise when the Program was subjected to regular classroom use. Therefore, it was decided to sacrifice uniformity in Program procedure, from Set to Set, in order to allow for improvements in the method of presentation. As teachers and project staff observed problems, possible solutions were developed and tested in the classroom until a desirable solution was found.

In the early portions of the Program, frames which required the student to write also appeared in a separate throw-away writing book. On designated frames in the main book, the student was cued to write on an identical page in his writing book. Many students had difficulty in shifting back and forth between the main book and the writing book at the appropriate places. Some continued in the writing book beyond the appropriate point, thus encountering writing frames out of sequence. The difficulties involved in distributing the matched

sets of materials--plus marking and finding the place in both books--consumed a disproportionate amount of classroom time. In addition, management of materials and schedules was difficult for the teachers.

The project staff felt that confusion on the part of the students probably interfered with learning. In addition, children appeared to dislike the writing frames. In any case, the waste of classroom and teacher time resulting from the use of the dual-book arrangement, could not be tolerated. The ultimate solution involved the use of erasable plasticized writing pages within the main book, thus eliminating the need for separate writing books. Teachers were unanimous in their choice of the single book arrangement as opposed to the earlier edition, and children no longer appeared to dislike the writing pages

(2.88) Validation Testing. In order to evaluate learning resulting from the use of the Program, pretest and posttest measures were obtained for each area of instruction. The three areas in which validation testing was carried out were verb vocabulary, sentence structure and noun vocabulary. Of necessity the sentence structure pretest was administered after the students had completed Set One of the main Program and had met the requirement in subject nouns--either by mastery on the pretest or by completing the supplementary Subject Noun Program. All tests were administered on an individual basis by trained personnel. Specification of the positions of the validation tests can be found in Appendix A.

The 54-item Unit Verb Vocabulary Test, which served as the primary validation instrument, covered all four Sets of the Unit. At the time the pretest was administered, it was expected that all four Sets would be validated. However, because of delays encountered with the printing of Program materials, Set Four could not be used in the classrooms. Since all 54 items had been administered in pretesting, the same procedure was followed in posttesting. Both pretests and posttests were then rescored as 40-item tests, omitting the fourteen items which related to Set Four.

RESULTS

Data were collected primarily for the purpose of validating the Program Unit. Pretest and posttest measures were obtained in each of the three areas of instruction--verb vocabulary, noun vocabulary, and sentence structure--on each of the four sample groups. Additional data were collected to permit examination of the relationship between characteristics of the sample and their performance on the Program.

(3.10) Program Effectiveness

(3.11) Summary of Pretest-Posttest Differences. The sign test (11) was used to make the twelve possible comparisons between pretest and posttest scores (three instruction areas times four sample groups). The hypothesis predicted that posttest scores would be higher than pretest scores; therefore, the region of rejection was one-tailed. The number of positive signs (posttest higher than pretest) and their associated probabilities for each area are shown in Table III.

It can be seen that, in each of the three schools and at both levels, the differences were significant beyond the .05 level in all three areas of instruction. Where the number of subjects is greater than 25, the probability levels are quite small, due in part, to a difference in the sign test formula for large samples. Of the total of 212 possible pretest-posttest comparisons, 197 posttest scores were higher than the corresponding pretest scores, nine were ties, and six posttest scores were lower than the corresponding pretest scores. Since significant learning took place both in state residential schools and in a private day school; in schools located in different states; and with children who exhibited a wide range in chronological and mental ages, it would appear that these programmed materials have widespread applicability.

(3.12) Validation Criteria. The effectiveness of programmed instruction may be evaluated in several ways. One may establish an a priori final performance criterion, e.g., 90% mastery, and ask what portion of the students met this criterion on the posttest, or one may examine the extent of the gain from pretest to posttest resulting from the program.

It should be noted that achievement of mastery and gain standards may be influenced by preknowledge of the program content as determined by pretest performance. If the level of preknowledge is low, it may be

Table III. Sign Test Summary of Pretest-Posttest Changes for the Three Areas of Instruction for all Sample Groups. N = number of pairs excluding ties; x = number of positive signs.

Level	School	N	x	P (one-tailed)
Verb Vocabulary Test				
I	I	31	30	<.00003
I	II	13	12	.002
I	III	5	5	.031
II	I	29	29	<.00003
Subject Noun Test				
I	I	29	29	<.00003
I	II	13	13	<.001
I	III	5	5	.031
II	I	9*	9	.002
Sentence Test				
I	I	28	26	<.00003
I	II	11	9	.033
I	III	5	5	.031
II	I	25	25	<.001

*Of the 29 children in Level II, 20 were exempt from the supplementary Subject Noun Program.

difficult to meet high final performance standards in a limited amount of time. However, a low pretest score is an advantage in meeting gain standards in that it provides a wide margin in which gain can occur. Conversely, a high pretest score may be an advantage in attaining high final performance criteria, but it restricts the margin in which gain can occur. Thus it would appear to be difficult to achieve both mastery and high gain. Nonetheless, attainment of both standards was attempted for the two instruction areas of the main Program, verb vocabulary and sentence structure. Attainment of only one standard, high final performance, was attempted for the supplementary Program in subject nouns. The reasons for this decision will be explained in (3.122) Noun Vocabulary.

Two factors are involved in the selection of a final performance criterion for program effectiveness: the proportion of the population expected to meet the mastery level and the designation of what constitutes mastery. In an area such as acquisition of language by deaf children, it would appear necessary to set a goal which can be achieved by the majority of the children; to require that all children achieve the goal would be unrealistic. When the content of the material being presented will form the bases for further learning, mastery should be defined rather rigorously. The final performance criterion selected was 80/90--80% of the validation subjects achieving a mastery score of 90% on the Program posttests.

Two measures of gain were selected. One is a measure of program evaluation proposed by McGuigan (10) in which the actual gain (difference between posttest and pretest means) is compared with the possible gain (difference between the maximum score and the pretest mean). The resultant values range from 0 to 1. When the value of $(M_2 - M_1) / (P - M_1)$ is .5 or greater, the program is considered satisfactory. The second gain measure, proposed by Blake (1), is a modification of the McGuigan gain ratio. In order to allow for the students' preknowledge, the term $(M_2 - M_1) / P$ is added to McGuigan's ratio with resultant values ranging from 0 to 2. Blake established a value of 1.2 or greater as satisfactory.

(3.121) Verb Vocabulary. Application of the three validation criteria to the major segment of the Program, verb vocabulary, is found in Table IV.

Table IV. Application of the Validation Criteria to the Verb Vocabulary Program for all Sample Groups. Perfect score = 40; chance = 10.

	N	Median Post	Mastery	Means Pre	Means Post	Gain McG.	Gain Blake
Level I							
School							
I	31	38.2	68%	10.9	34.4	.81	1.40
II	13	35.0	46%	10.4	32.5	.75	1.30
III	5	37.8	100%	9.4	37.6	.92	1.63
Level II							
School							
I	29	39.4	97%	13.6	38.7	.95	1.58

As can be seen, there was a broad range in mastery achievement. Two of the four sample groups exceeded the 80/90 criterion by a wide margin; however, in one of the other sample groups only 46% of the students achieved mastery. Of the two groups which met the mastery criterion, one (School III) was a somewhat biased sample.* The other group (School I, Level II) consisted of children who, as a group, were older and had more school experience than the other children. Examination of the pretest means makes it apparent that the differences in mastery cannot be attributed to large differences in initial performance. The Fisher exact probability test (11) was applied to the proportion of School I, Level I children achieving mastery (68%) and the proportion of Level II children achieving mastery (97%). The resultant p value of .004 indicates that a significantly greater proportion of Level II children achieved mastery in verb vocabulary.

*Because of problems with the printing of Program materials, validation was begun later in the school year than originally planned. School III was the last school to begin the Program and sufficient time was not available for all subjects to finish. Only the five children who worked rapidly were able to finish. Judging from progress tests accompanying each Set, three of the slower children would have achieved mastery and two would not.

The McGuigan gain ratios, which range from .75 to .95, exceed the .5 criterion value for every sample group. Similarly, each of the modified gain ratios for the four groups exceed the criterion of 1.2 established by Blake. These gains in verb knowledge demonstrate the efficacy of programmed instruction as a tool in the acquisition of language by deaf children.

In summary, both gain standards were met by all four sample groups, but the mastery standard was met by only two of the groups. It is important to note that the mean pretest scores, except for the 13.6 mean of the Level II children, were at the chance level of 10. Thus, the pretest and posttest verb scores illustrate the paradox that, while a low level of preknowledge may be advantageous in achieving gain standards, it may be a disadvantage in achieving mastery standards.

(3.122) Noun Vocabulary. It was anticipated that many of the subjects selected for validation of the main Program would demonstrate sufficient preknowledge of the noun vocabulary to render them inappropriate for validation of the supplementary Subject Noun Program. However, mastery of the noun vocabulary was considered necessary for success in the sentence structure portion of the main Program; therefore, only validation subjects who met the 90% mastery criterion on the 28-item Subject Noun pretest were exempted from this Program. Since the sole purpose of this Program was to insure initial behavior needed for the sentence structure portion of the main Program, the primary concern was the achievement of mastery by as many subjects as possible rather than the extent of the gain. In Table V the validation data are displayed separately for the total group (Program participants and students exempted) and for the group which received the Program. The exemptions, resulting from mastery scores on the pretest, consisted of one child at Level I and 20 children at Level II.

The 80/90 criterion was met by three of the four sample groups from the total sample. For children who took the Program, the mastery criterion was met by the Level I groups in two schools and missed by 2% by the Level II group. The notable exception to this goal is found in the School II data where the percentage of children achieving 90% is unacceptably low. It should be noted that the pretest scores for this group were lower than any of the others.

While only one student in Level I was exempted from the Subject Noun Program group, approximately two-thirds of the students in Level II were exempted. It appears reasonable to assume that those who achieved mastery on the pretest were the better students and that their exclusion biased the Level II Program sample. Therefore it was anticipated that comparison of Level I and Level II Program groups

Table V. Application of the Validation Criteria to the Subject Noun Program for all Sample Groups. Perfect score = 28; chance = 7.

	Total Group			Program Group						
	N	Median Post	Mastery	N	Median Post	Mastery	Means Pre	Means Post	McG.	Blake
Level I										
School										
I	31	27.0	84%	30	26.9	83%	14.7	26.1	.86	1.27
II	13	23.2	39%	13	23.2	39%	11.8	21.9	.67	1.05
III	5	27.2	100%	5	27.2	100%	18.8	27.0	.89	1.18
Level II										
School										
I	29	27.3	93%	9	26.9	78%	17.3	25.8	.79	1.10

from School I might show mastery and gain values higher at Level I. However, the data for the total groups show Level II considerably higher in percentage of students achieving mastery.

Although gain was not of direct concern, it is of interest to note that the value yielded by the application of McGuigan's ratio exceeded the .5 criterion in every case. However, the effect of higher pretest scores upon Blake's modified gain ratio is evident--the resulting value achieved the 1.2 criterion only at Level I in School I. It should be noted that the highest value possible at School III was 1.33--assuming all the children had achieved perfect scores.

The primary goal--achieving the 80/90 criterion with the total sample--was reached with three of the four groups. The children in School II scored lowest on all three performance criteria. This finding is not surprising since they held a similar rank on the verb vocabulary tests. In both instruction areas, the percentage of children in this group attaining mastery was about half that desired. Obviously, the failure of the majority of the children in School II to achieve mastery in verb and noun vocabulary would be expected to influence performance adversely on the subsequent sentence structure portion.

(3.123) Sentences. The evaluation of the sentence structure portion of the main Program is displayed in Table VI.

The 80/90 criterion was achieved with three of the four groups, the exception being Level I in School II. As noted in the previous section, this group did not achieve mastery in either of the component vocabulary areas--nouns or verbs. Therefore, it is not surprising that achievement on sentence structure was unsatisfactory. However, the percentage achieving mastery (58%) was higher than for verbs (46%) or nouns (39%). No other group evidenced this relationship.

All gain ratios, computed according to McGuigan, exceeded the .5 criterion. However, the effect of the higher pretest scores on Blake's ratio is evident. Although three groups met the mastery criterion and all four met McGuigan's criterion, only School III met Blake's criterion of 1.2. This group scored lowest on the pretest and all achieved perfect scores on the posttest. Even with a mean posttest score of 19.6 out of 20 items, Level II missed the 1.2 criterion by a small margin.

Although high pretest scores were expected on the Subject Noun test, such was not the case with sentence structure since pretest scores during the trial and revision phase of the project had been close to chance. There are several possible explanations for these

Table VI. Application of the Validation Criteria to the Sentence Structure Program for all Sample Groups. Perfect score = 20; chance = 6.7.

	N	Median Post	Mastery	Means		Gain	
				Pre	Post	McG.	Blake
Level I							
School							
I	31	19.6	81%	11.8	17.9	.74	1.05
II	12*	18.0	58%	9.1	15.9	.63	.97
III	5	20.0	100%	8.6	20.0	1.00	1.57
Level II							
School							
I	29	19.8	93%	14.3	19.6	.92	1.18

*One child in School II was unavailable for the Sentence Posttest.

higher scores which occurred during the validation phase:

1. It is possible that the sample used in trial and revision was not representative of the larger validation sample.

2. Whereas chance performance in the two vocabulary areas was 25%, chance on the sentence structure test was 33 1/3%. Furthermore, the child who recognized only one of the two principal stimulus components increased his probability of attaining a correct answer without comprehension of the subject-verb relationship from 33 1/3% to 50%.

3. Unlike the two vocabulary tests, it was possible for the student to learn the required task, understanding the subject-verb relationship, from the test itself.

(3.124) Summary of Validation Criteria. Seventy-seven percent of the total sample of 78 children achieved mastery in Verb Vocabulary. Of the 57 children who took the Subject Noun Program 74% achieved mastery. Thus, including the 21 children who met the mastery criterion on the pretest, 81% of the total sample achieved mastery of nouns before proceeding to the sentence structure portion of the Program. Eighty-three per cent of the total sample achieved

master on sentence structure. Of the twelve instances in which the mastery criterion was applied (three instruction areas times four sample groups) the criterion was met in eight instances. Application of the gain ratio criteria to the two instruction areas of the main Program, verb vocabulary and sentence structure, disclosed that all four sample groups met McGuigan's criterion in both areas of instruction. When Blake's more rigorous criterion was applied, all four groups attained the standard in verb vocabulary, but only one group in sentence structure. In brief, the gain ratio criteria were applied 16 times. The validation sample groups met these criteria in 13 of the 16 applications.

(3.13) Relevance of the Program. It is of interest to examine the relationship, if any, of the materials presented in the Program to those utilized in conventional methods. While the final design of the project was not intended to provide for direct examination of this relationship, data are available which appear to be pertinent to the question. The Unit Verb Vocabulary test scores from School I were utilized in this endeavor since (1) pretest measures were available from three levels for comparative purposes; and (2) the sample sizes of 31, 29, and 26 from School I were large enough to allow logical inference. The median verb vocabulary scores for the three levels are presented in Table VII.

Table VII. Median Pretest and Posttest Unit Verb Vocabulary Scores from School I. Perfect score = 40; chance = 10.

	Level I	Level II	Level III
Pretest Median	10.2	12.0	29.0
Posttest Median	38.2	39.4	N.A.*
N	31	29	26

*The Verb Program was not administered to the Level III children because of their relatively high pretest scores.

Examination of the pretest medians from the Level I and Level II sample groups makes it evident that these children were not familiar with the verb vocabulary of the Program. In contrast, the Level III pretest median (72%) indicates a moderately high level of preknowledge. The fact that the children at Level III had learned a considerable portion of the verb vocabulary appears to demonstrate the relevance of the Program content to academic achievement.

The merit of the Program can also be evaluated by comparison of the posttest median of 39.4 for Level II with the pretest median of 29.0 for Level III.* Since the Level II students scored 30% higher in May than the Level III students in December, it seems unlikely that the high achievement of the Level II students would have occurred without the Program. A parallel can be found in the May posttest median of 38.2 for Level I and the December pretest median of 12.0 for Level II. It is even less likely that the gain exhibited by the Level I children would have occurred without the Program. Since the Program vocabulary was learned at levels where such verbs apparently are not usually acquired, we feel that this is important evidence that verb vocabulary can be learned earlier and at a more rapid rate through the medium of programmed instruction.

(3.14) Sets of the Main Program. The divisions of the main Program which were administered for the purpose of validation consisted of three Sets--each designed to teach four verbs at a high level of generalization and sentence structure. Validation of verb vocabulary was based on a comprehensive test which covered the vocabulary from all three Sets. In order to study the achievement on verb vocabulary for individual Sets, the items pertaining to each Set were treated as subtests of the overall Unit Test. A series of sign tests (11) were performed on the pretest and posttest scores within each sub-test. The resultant data, which appear in Table VIII, show that all four groups of children demonstrated significant learning on all three Sets.

In order to study the relative achievement among the three Sets--having different possible scores--mean scores were converted to percentages. None of the differences among the pretest scores for the three Sets were significant within any of the four subject groups, nor were the posttest differences significant within groups. The pooled data show pretest percentages correct of 34%, 29%, and 25% for Sets One, Two, and Three respectively, and posttest percentages of 88%, 90%, and 91%. It is interesting to note that the downward trend--from Set One through Set Three--within the pretest percentages is reversed for the posttests. Thus the pretest-posttest differences within each Set (54%, 61%, and 66%) show the greatest gain in Set Three, i.e., an apparent trend toward increased learning as the children progressed through the program.

*Program pretesting took place in December and posttesting in May.

Table VIII. Sign Test Summary of Pretest-Posttest Changes for the Sets of the Verb Vocabulary Program for all Sample Groups. N = number of pairs excluding ties; x = number of positive signs.

Level	School	N	x	P (one-tailed)
Set One				
I	I	30	30	<.00003
I	II	13	13	<.002
I	III	5	5	.031
II	I	27	27	<.0003
Set Two				
I	I	29	27	<.00003
I	II	12	11	.003
I	III	5	5	.031
II	I	29	28	<.00003
Set Three				
I	I	29	27	<.00003
I	II	13	12	.002
I	III	5	5	.031
II	I	29	27	<.00003

(3.15) Children Excluded from the Sample. It will be recalled that children who do not demonstrate word recognition ability at a minimal level, regardless of the reasons, are not considered a part of the target population for the Program; therefore, those children in the participating schools who failed the Word Recognition Test were not included in the validation sample. It had been predicted that such children would not succeed in the Program; however, they were included in all validation activities in order to test this assumption.

The 22 children from the three schools who did not meet the word recognition requirement for admission to the validation sample performed as follows:

Eight children did not appear to comprehend the procedure and scored at a chance level on the first Progress test (covering only Set One vocabulary). Participation in the Program was discontinued for these children at the end of Set One.

Seven children did not progress beyond Set One in the Program although they continued to participate until the end of the school year. Two of these children scored 62% correct on the first Progress test and the other five scored less than 50%.

Four children achieved satisfactory scores on the first Progress test (88% - 94%) but worked so slowly that they did not progress beyond Set One. They became increasingly disinterested and were working more slowly at the close of the validation period than at the beginning.

Three children were able to complete the Program and the validation posttests. The highest verb vocabulary posttest score achieved by any of these children was 55% correct.

In summary, although children who did not demonstrate prerequisite word recognition ability varied in their performance, none of them performed satisfactorily. Therefore, the assumption that children who fail the Word Recognition Test should not be considered candidates for the Program was verified.

(3.20) Program Efficiency

(3.21) Time Requirements for the Program. In addition to the effectiveness of a program, one must consider its efficiency--the amount of time required to complete the program. In order to provide for evaluation of this aspect of the project Program, classroom teachers recorded the time spent by the students working in the Program books. The resultant data for the main Program, verb vocabulary and sentence structure appear in Table IX.

Table IX. Program Time in Minutes for the Verb Vocabulary-Sentence Structure Program for all Sample Groups.

	N	Range	Mean
All Subjects	78	129-495	281
Level I			
School			
I	31	183-495	342
II	13	224-329	276
III	5	191-308	267
Level II			
School			
I	29	129-335	224

It can be seen that the average time required to complete the main Program was less than five hours--the equivalent of approximately one school day's instructional time for most of the children involved. The slowest child spent less than two days. As might be expected, the Level I children spent longer on the average and had a wider range than the Level II children.

Data were also gathered on the amount of time required by the 58 children who needed the supplementary Subject Noun Program. Forty-seven needed the entire sequence; their average time was 63 minutes. The eleven children who needed only a portion of the supplementary Program averaged 28 minutes. Thus, for all subjects, the amount of work time spent in the main Program (verb vocabulary and sentence structure) plus the supplementary Program (nouns) was the equivalent of two school days or less since the time required by the slowest child was ten hours.

Additional time was required for daily distribution and collection of Program materials, IBT-TS, validation testing and periodic progress testing. Although time spent on these activities was not recorded, it was estimated on the basis of observation to have averaged about three and one-half hours per child. Therefore, the total time required for the administration of the Program and its

related activities was the equivalent of approximately two school days for the majority of the children--for the slowest child less than three days.

Information gained from observation, classroom teachers, and time data indicate that the total time requirements for the future administration of the Program could be substantially reduced, especially for Set One and Subject Nouns. Because of the children's confusion with the procedure involved in the writing task in Set One and Subject Nouns, the Program presentation was modified so as to simplify the procedure in Set Two and Set Three. Many of the teachers reported that their children handled the modified materials much more efficiently. Time data for the three Sets of the main Program support this observation. While there was a decrease of only 17% in the number of Program frames from Set One to Set Two, the decrease in Program time for Level I at School I was 48%. The differences between Set Two and Set Three were very small--a 12% reduction in the number of frames and 18% in time. Similar trends were observed in the other subject groups. It is logical to assume that the increased efficiency beginning with Set Two is due in part to practice effect. However, it is also reasonable to assume that the simplification of procedure exerted a favorable influence upon efficiency--especially since the teachers reported a marked improvement beginning with the use of the modified materials.

With the original presentation, used in Set One, there was also confusion involved with the daily distribution and collection of materials. Teachers reported a substantial reduction in the time required for this aspect of Program use with the introduction of the modified presentation in Set Two. In our judgment the total time required for the administration of Set One and Subject Nouns could be reduced by about 50 minutes with the use of the modified presentation.

Other smaller reductions in the total time required for the Program and its related activities could be achieved in two areas. In regular classroom use the Progress pretests, immediately preceding each Set, could be omitted. It is not recommended that the Progress posttests be omitted as these provide the teacher and the child with information regarding progress at various points in the Program. In the future, the noun division of the IBT-TS, which proved to be ineffective, could also be omitted. These two revisions in the total Program schedule should reduce the time requirements by approximately 30 minutes.

In summary, it is estimated that the Program, as it was field tested, required an average total administration time of approximately seven hours for the fastest group (School I, Level II) and about eleven

hours for the slowest group (School I, Level I). The slowest individual required approximately 14 hours. In view of the achievement discussed in the previous sections, which took the participants in Levels I and II beyond the average achievement of the Level III children in the same school, the Program would appear to be an efficient utilization of classroom time. In our judgment, the recommended modifications in the Program presentation and in various testing activities could reduce the average time requirement by approximately one and one-half hours for a group of children similar to the slowest group.

(3.22) Program Time and Achievement. In order to study the relationship between Program time and achievement, the combined scores for the two areas of the main Program, verb vocabulary and sentence structure, were divided by quartiles and the respective time data were compared. While it was felt desirable to use data from the total sample, these data were not amenable to grouping by achievement quartiles. For example, there were no children below mastery in School III; therefore high and low achievement groups would have been drawn predominately from different schools. Similar problems were encountered with grouping by the time data. Therefore, we elected to consider only the data from School I and to examine the data for the two levels separately. The time required on the main Program for the upper and lower 25% achievers, according to their combined scores for verb vocabulary and sentence structure posttests, appear in Table X.

Table X. Program Achievement and Time for the Upper 25% and the Lower 25% Achievers in Levels I and II at School I. Perfect score (verb vocabulary - sentence structure) = 60; chance = 17.

	N	Posttest Mean	Time in Minutes Mean	Time in Minutes Range
Level I				
Upper 25%	8	59.9	324	183-495
Lower 25%	8	35.0	349	218-492
Level II				
Upper 25%	7	60.0	226	146-303
Lower 25%	7	54.7	259	142-335

At Level I the children in the upper achievement quarter took only 25 minutes less time to complete the Program than the children in the lower quarter. However, the achievement differences are substantial. All the children in the upper quarter achieved mastery; none of those in the lower quarter achieved mastery. At Level II children in the upper quarter took 33 minutes less than those in the lower quarter. In contrast to Level I, only one child in the lower quarter failed to achieve mastery.

While within each level the children in the upper quarter tended to spend less time than those in the lower quarter, there is a much greater difference between levels--both mean times at Level I are longer than either of the means at Level II by approximately a 3:2 ratio. As was noted above, children in the lower quarter at Level I are in an achievement class which is markedly different from the other three groups. Such factors as age and academic level may have had significant influence on their performance. These and other factors will be examined in (3.40) Characteristics of the Subjects.

It is important to note that at Level I, both the fastest child and the slowest one were members of the high achievement group. Thus, while it is evident that as a group the highest achievers took less time to complete the Program than the lowest achievers, the data also demonstrate that high achievement is not based on a rapid work rate. In view of these findings, it is recommended that children not be pressured to work rapidly through the Program, but rather that they be encouraged to work carefully and accurately.

(3.23) Standard and Accelerated Tracks. In order to permit greater efficiency and to avoid boredom for the more capable students and, at the same time, provide the repetition necessary for others, two tracks were designed for the main Program (2.86, Track Assignment). Children in the Standard Track repeated certain segments of the verb vocabulary sequence while children in the Accelerated Track continued through the Program without repeating any material. Level II at School I was the only group which contained a sufficient number of cases in each track to permit comparison of the time requirements for the two different tracks. The time data and the average achievement on the main Program for the Level II children in the Accelerated Track, those in the Standard Track, and those who were shifted from Standard to Accelerated Track after Set One appear in Table XI.

Table XI. Program Achievement and Time for Level II Children in Standard Track, Mixed Standard and Accelerated Tracks, and Accelerated Track. Perfect score (verb vocabulary - sentence structure) = 60; chance = 17.

Track	N	Posttest Mean	Time in Minutes	
			Mean	Range
Accelerated	16	59.1	186	129-245
Mixed	5	59.0	252	235-266
Standard	8	56.1	289	248-335

It is readily apparent that utilization of the Accelerated Track by the more capable children at Level II did not adversely affect their performance and apparently resulted in considerable saving in time. The one non-mastery achiever at Level II was assigned to the Standard Track throughout the Program. At Level I 16 of the 49 children from all three schools were assigned to the Accelerated Track for some portion of the Program. Twelve of these achieved mastery of 54 or more. The scores of the four children who failed to achieve mastery ranged from 48 - 52.

(3.30) Initial Behavior Testing-Training Sequence

Two initial behaviors (abilities prerequisite for success in the Program) were specified: (1) word recognition skill at a minimal level and (2) the ability to associate pictures with reality. No attempt was made to overcome deficiencies in word recognition skill; children who did not demonstrate a minimal level of proficiency were excluded from the validation sample, although they participated in all Program activities (3.15, Children Excluded from the Validation Sample). However, children who demonstrated a deficiency in the ability to associate pictures with reality were not excluded. The Initial Behavior Testing-Training Sequence was designed not only to assess ability in this area but also to provide instruction for children who demonstrated a deficiency.

The IBT-TS consisted of two divisions. The first required the association of pictured objects (nouns) to real objects and the second the association of pictured actions (verbs) with live actions. Test scores were obtained by recording the child's first response to each item. Instruction was accomplished by providing feedback for each response and by assistance with items failed.

Performance levels on the noun division were high. Fifty-seven children scored at the proficiency level (one or no errors) during the first session (Day I). Of the 21 children who made two or more errors during the first session, only one made as many as two errors during the second session (Day II). No noun instruction was planned for Day III.

In order to adapt the verb division of the IBT-TS to varying levels of ability, three parallel sets of materials, each containing A, B, and C, Sections, were developed and administered on three successive days prior to beginning the Program. Children who performed satisfactorily on Day I or on Day II were exempted from Section A and Section B of the verb sequence on the following day. All students received Section C each day.

(3.31) Learning from the Verb Division of IBT-TS. Of the total sample, a group of 23 children achieved proficiency (two errors or less) on Day I and were exempt from Sections A and B on the following days. A second group of 21 children achieved proficiency on Day II and were exempt from Sections A and B on Day III. A third group of 34 children required the entire sequence. No School III children are included in the third group, since all of them achieved proficiency either on Day I or on Day II. The data for these three groups appear in Table XII.

Within Group II the performance of Level I and Level II was very similar. Both levels evidenced a decrease in errors of more than 50% from Day I to Day II. The Day II errors for this group were similar to the Day I errors for Group I. Within Group III, Level II evidenced a consistent decrease in errors from Day I to Day II to Day III. Although Level I showed an overall decrease in errors from Day I to Day III, there was a slight increase from Day I to Day II. The performance of the two levels was very similar on Day III. Only 16 of the 34 children in Group III achieved proficiency on Day III.

Of the total of 55 children who demonstrated a deficiency on Day I, 37 achieved proficiency by the conclusion of the testing-training sequence. Including those whose performance was acceptable on Day I, 60 of the 78 children demonstrated ability to associate pictures with experience before beginning the Program, and 18 children (all from Group III) still had not attained proficiency when they began the Program.

Table XII. IBT-TS Errors on the Verb Division, Sections A and B, for all Subjects. Total N for Level I = 49; Level II = 29.

	N	Errors			Proficiency
		Day I	Day II	Day III	
Group I					
Level I	9	7%			100%
Level II	14	7%			100%
Group II					
Level I	15	25%	9%		100%
Level II	6	24%	9%		100%
Group III					
Level I	25	26%	29%	17%	44%
Level II	9	33%	23%	16%	56%

(3.32) Influence of IBT-TS on Program Achievement. Of the 60 children who, at some point, achieved proficiency on IBT-TS, 80% achieved mastery in the main Program. Of the 18 children who did not achieve proficiency on IBT-TS, 64% achieved mastery in the Program. This observation can be contrasted with the finding that none of the children who failed the Word Recognition Test achieved mastery on the Program. Apparently, of the two behaviors predicted to be prerequisite for Program success, only word recognition skill was in fact essential. Proficiency on IBT-TS, although beneficial, did not prove to be necessary.

(3.40) Characteristics of the Subjects

In an attempt to determine the target population appropriate for the Program, various characteristics of the validation sample were studied in relation to Program performance. The following variables were examined: chronological age, academic level, psychometric level, race, sex, and hearing level. Chronological ages were recorded as of January 1, approximately the time when most of the children began the Program. Grade placement, which had been assigned by the individual

schools, determined academic level. It is likely that criteria for level placement varied from school to school. In order to obtain uniform measures of learning ability across schools, three psychometric test items were administered: (1) the Seguin Form Board from the Grace Arthur Point Scale of Performance, Revised Form II, (2) Picture Identification and (3) Picture Association from the Hiskey-Nebraska Test of Learning Aptitude (2.84, Subject Information). Subjects were selected without regard to race or sex. Hearing level was estimated by averaging ISO response levels at 250 and 500 H_z. A portion of the data on the above characteristics for each of the four sample groups appears in Table XIII.

The Program sample included children at two academic levels with a wide range in chronological age--from age five at Level I to age ten at Level II. The range in level for each of the three psychometric items was even wider. Of the twelve possible comparisons between chronological age and psychometric level (three psychometric items for each of the four groups) the mean psychometric level was lower than the corresponding chronological age in ten instances. In all instances the lower limit of the psychometric range was below that of the corresponding chronological age, and in all but one instance the psychometric range was wider.

In order to study the effects of the various subject characteristics on achievement, the data were divided by quartiles. As in the previous section, (3.22) Program Time and Achievement, the data relating achievement to other variables were not amenable to quarter grouping when the total sample was considered. Therefore, School I with its large sample again was selected for examination. This procedure had the additional benefit of allowing comparisons with previously established quarter groups.

(3.41) Chronological Age and Academic Level. The effects of age and academic level on achievement were examined by means of quarters selected according to age within each of the two academic levels at School I. The ages and corresponding achievement data appear in Table XIV.

Table XIII. Chronological Ages and Psychometric Levels (Form Board, Picture Identification, Picture Association) in Years and Months for all Sample Groups.

	N	Age		Form Board		Identification		Association	
		Mean	Range	Mean	Range	Mean	Range	Mean	Range
Level I									
School									
I	31	6- 5	5-0-- 9-0	5-11	4-6--11-6	5-8	4-6--10-6	5-11	3-6-- 8-6
II	13	7- 9	6-1-- 9-4	7- 2	4-6--11-6	5-6	4-6-- 7-0	6- 2	4-0--10-0
III	5	5-11	5-4-- 6-2	4- 8	4-6-- 5-6	6-5	4-6--10-6	7- 5	4-6-- 8-6
Level II									
School									
I	29	7- 9	6-1--10-0	6-11	4-6--11-6	6-2	4-6--10-6	6- 7	4-6--10-0

Table XIV. Program Achievement for Age Groups Defined by Quartiles, Level I and Level II, School I. Perfect score (verb vocabulary - sentence structure) = 60; chance = 17.

	Age		Achievement		
N	Mean	Range	Mean	Range	Mastery
Level I					
8	5-2	5- 0-- 5- 7	47.2	17-60	50%
7	6-0	5- 9-- 6- 2	53.0	29-60	71%
8	6-6	6- 3-- 6- 9	55.0	24-60	88%
8	7-8	6-11-- 9- 0	53.0	41-60	62%
Level II					
8	6-5	6- 1-- 6- 8	56.9	43-60	88%
7	7-2	6-10-- 7- 8	58.4	55-60	100%
7	8-3	7- 8-- 8-10	58.0	56-59	100%
7	9-4	8-11--10- 0	59.4	57-60	100%

Within Level I, as age increases there is a corresponding increase in achievement through the first three quarters. However, with the fourth group, which shows the largest increase in age, this trend is reversed. The average achievement for the oldest group is the same as that of the second group, but the percentage attaining mastery is lower. It should be noted that all four age groups show wide range in achievement--all containing both non-mastery students and those with perfect scores. The range for the youngest group extends from chance to perfect performance. There is however, an overall trend toward a narrower range in achievement as age increases.

Within Level II the data show a slight overall increase in achievement from the youngest to the oldest group, with the two middle groups about the same. Since there was only one non-mastery student at Level II, the average achievement for each quarter is above mastery (54) and the corresponding mastery percentages all exceed the 80/90 criterion. The effect of age on achievement appears to be less evident at Level II than at Level I. The fact that age per se is of relatively small influence is demonstrated by the fact that the youngest child (5-0) and the oldest child (10-0) both achieved mastery on the main Program.

The effect of academic level on achievement can be seen by examination of comparable age groups from the two different levels. The third quarter of Level I, when compared to the first quarter of Level II, showed slightly lower achievement, although the mastery percentage was the same. When the fourth quarter of Level I is compared with the second or third quarter of Level II, it is also apparent that these Level I subjects scored lower in achievement and the percentage of mastery was smaller. Thus children at Level II, when compared with their age peers at Level I, performed somewhat better. However, the greatest difference in achievement between the two Levels, age constant, is not as large as the effect on achievement associated with age differences within Level I.

It appears that evidence of an interaction between age and academic level can be found in the fourth quarters--the oldest children at Level I and at Level II. It is reasonable to assume that some of the oldest children in these two groups are present in their respective grade levels because of poor classroom achievement. If this premise is correct, it is not surprising that the oldest children at Level I achieved a lower average score than younger children in the third quarter at the same level. However, every child in the oldest group at Level II, all of whom are above the appropriate age range for their level, scored above mastery. One can only speculate as to the possible reasons, e.g., length of classroom experience, for the high achievement of these children.

(3.42) Psychometric Level. Three psychometric test items for the Level I, School I children were examined in detail to explore possible relationships between learning ability and achievement. The Level II data were not similarly examined because all but one child achieved mastery. The data, which were grouped by achievement quarters, appear in Table XV.

Increases in achievement scores appear to be unrelated to Form Board scores. While Picture Identification scores evidenced an irregular, but apparently positive, relationship with achievement, only the Picture Association means show a consistent trend. Eighty per cent of the children with Picture Association scores of 6-6 or better achieved mastery. However, it is important to note that the highest achievement quarter contained the lowest Picture Association score and the lowest achievement quarter, with no mastery achievers, contained a Picture Association score of 7-0.

Table XV. Psychometric Levels (Form Board, Picture Identification, Picture Association) of Achievement Groups Defined by Quartiles, Level I, School I. Perfect score (verb vocabulary - sentence structure) = 60; chance = 17.

N	Achievement Mean	Achievement Mastery	FB Mean	PI Mean	PA Mean	PA Range
8	35.0	0%	6- 3	5- 3	5- 2	4-0--7-0
7	54.9	71%	5- 4	5-11	5-11	4-6--7-6
8	58.8	100%	6- 2	5- 4	6- 2	4-6--7-6
8	59.9	100%	5-11	6- 2	6- 5	3-6--8-6

Since the achievement scores evidenced a greater relationship to Picture Association than to either of the other psychometric measures, we elected to regroup the data in quarters based on Picture Association scores. These data are presented in Table XVI.

Table XVI. Program Achievement of Groups Defined by Picture Association Quartiles, Level I, School I. Perfect score (verb vocabulary - sentence structure) = 60; chance = 17.

N	PA Mean	PA Range	Achievement Mean	Achievement Range	Achievement Mastery
8	4-4	3-6--4-6	44.1	17-60	50%
7	5-5	4-6--5-6	52.0	29-60	62%
8	6-6	6-0--7-0	55.7	45-60	71%
8	7-7	7-0--8-6	56.8	41-60	88%

As expected the data show an increase in achievement as Picture Association scores increase. Again it is evident that this relationship is weak; the lowest Picture Association quarter included both the lowest achiever and a perfect scorer. In the highest quarter, where 88% of the children achieved mastery, there was one failure. In comparison, only 50% of the children in the upper quarter by Form Board scores achieved mastery.

(3.43) Race, Sex and Hearing Loss. In order to examine the effects of race, sex, and hearing loss on Program performance, a series of matched groups were formed. Eleven Negro children were matched on the bases of age, level and school with eleven White children. The achievement for the Negro students was 51.1 in 300 minutes and for White students 52.4 in 264 minutes.

The effects of sex and hearing loss on achievement were examined in a similar manner at Level I and at Level II in School I only. In regard to sex, the achievement for ten boys at Level I was 51.2 in 382 minutes and for ten girls was 49.9 in 382 minutes. At Level II the achievement for 13 boys was 57.4 in 222 minutes and for 13 girls was 59.3 in 227 minutes. With respect to hearing loss, the achievement for the eight Level I children with the least loss (67db average) was 50.6 in 350 minutes; for the eight with the most loss (95db average) was 48.0 in 354 minutes. At Level II the eight children with the least loss (56db average) achieved an average score of 57.8 in 223 minutes as opposed to 57.0 in 226 minutes for the eight children with the most loss (91db average). It is apparent that the differences in achievement and time attributable to race, sex, and hearing loss were small. With the exception of the difference of 2.6 between hearing loss groups at Level I, all differences in achievement were less than two points.

(3.44) Summary of Subject Characteristics. In this and previous sections the influence of a number of variables upon achievement on the Program has been examined. The only efficient instrument for predicting performance proved to be the Word Recognition Test. It will be recalled that, of the 22 children excluded from the validation sample on the basis of this test, none achieved mastery in the main Program. Of the 78 children who passed the Word Recognition Test, 76% achieved mastery in the main Program.

Such variables as race, sex, amount of hearing loss, Seguin Form Board score, and IBT-TS errors evidenced very little relationship to achievement. Other variables such as school, level, age and the Hiskey Picture Association level have shown effects on achievement as large as five to ten points. However, there was always a wide range of scores within high and low achievement groups and frequently complete overlapping of score ranges. Perhaps the fact that these characteristics did not constitute significant limitations within the sample is illustrated

by S. W. in Level I at School I, the youngest child in the entire sample (5-0), with an 83db hearing loss and the lowest Picture Association score recorded (3-6), who achieved a perfect posttest score of 60 for the main Program.

CONCLUSIONS AND RECOMMENDATIONS

(4.10) Summary and Conclusions

A unit of programmed instruction utilizing a simple, inexpensive feedback device was developed for young deaf children. The main Program consisted of two areas of instruction--verb vocabulary at a high level of generalization and sentence structure. A third area, noun vocabulary, was provided in a supplementary Program for students who needed instruction in the noun vocabulary prerequisite to the sentence portions of the main Program. Terminal behavior was specified by means of three validation tests--one for each area of instruction.

After extensive trial and revision of the Program materials, the final form was field tested with 78 children in the preparatory levels of two state residential schools and one private day school in the southeastern area. Level I at each of the three schools and Level II in one of the state schools comprised the four sample groups. Within these groups a satisfactory score on a simple test of minimum word recognition ability was the only criterion for admission to the sample. The subjects ranged from five years of age at Level I to ten years at Level II, and from three and one-half to ten and one-half years on psychometric scores.

The effectiveness of the Program was evaluated by validation pretest and posttest measures for each of the three areas of instruction. Three validation criteria--one final performance criterion and two measures of gain--were applied to the test results for each of the four sample groups. The final performance (mastery) criterion selected was 80/90--80% of the validation subjects achieving a mastery score of 90% on the Program posttests. The first gain ratio, proposed by McGuigan (10) compares the actual gain with the possible gain. The resultant values range from 0 to 1 with .5 or greater considered satisfactory. The second measure of gain, a modification of McGuigan's ratio proposed by Blake (1), is a more rigorous standard which penalizes the programmer for the students' preknowledge of the program content. The values range from 0 to 2 with 1.2 considered satisfactory. All three criteria were applied to the two instruction areas of the main Program for each of the four sample groups; however, the mastery criterion was the only goal for the supplementary Program.

The mastery criterion was met by two of the four sample groups in verb vocabulary, by three groups in noun vocabulary, and by three in sentence structure. Mastery within sample groups ranged from 46% to 100%. One sample group failed to meet the 80/90 criterion in any of the three areas of instruction.

The McGuigan gain ratio criterion was exceeded by all four sample groups on both the verb vocabulary and the sentence structure portions of the main Program. The same sample group which failed to achieve mastery on the verb, noun and sentence areas consistently evidenced less gain than the other three groups.

Application of Blake's ratio showed that all four sample groups exceeded the criterion in the area of verb vocabulary. However, only one sample group met the criterion in the area of sentence structure. Again, the sample group which failed to meet the mastery criterion and which evidenced the lowest McGuigan gain ratios, evidenced the smallest gain by Blake's ratio.

The criteria were applied to the data from the Level I sample groups 21 times. In 15 of 21 instances, the criteria were met. The same criteria were applied to the Level II data seven times; six times the criteria were met. In the one exception, the criterion was missed by a very narrow margin. In summary, the validation criteria were applied in 28 instances to the data from the four sample groups. The Program met the standards in 21 instances. Of the total sample of 78 children, 77% achieved mastery in verb vocabulary, 81% in nouns, and 83% in sentences. Application of the sign test to the pretest and posttest scores showed significant learning by each of the four sample groups in all areas of instruction.

For the main Program, the estimated average time spent by the 49 children at Level I was approximately 317 minutes; the 29 Level II children spent approximately 224 minutes. For the 47 children who took the entire supplementary noun Program, the estimated average time was 63 minutes. The eleven children who needed only a portion of this Program averaged approximately 28 minutes. Additional time required for related activities, such as distribution of materials in the classroom and testing, was estimated at 210 minutes per child. It is estimated that the time required for the administration of the Program and its related activities averaged approximately seven hours for the fastest group and eleven hours for the slowest group. The slowest individual spent approximately 14 hours.

The relationship between achievement on the Program and a number of variables was examined. Race, sex, amount of hearing loss, Seguin Form Board score, and Picture Identification score evidenced very little

effect on achievement. School, age and Picture Association score appeared to have a larger effect on achievement. None of the variables examined evidenced sufficient relationship with achievement to be useful for predictive purposes. The only efficient instrument for predicting Program performance proved to be the Word Recognition Test. Of the 22 children who failed this test, none achieved mastery.

Since in 21 of 28 instances the criteria for effectiveness were met by the subject groups in the equivalent of approximately two school days, it appears reasonable to conclude that the Program teaching sequence, together with the modified method of presentation, constitutes an effective and efficient teaching technique. Inasmuch as the sample contained children from three schools, and high achievers were as young as 5.0 years with psychometric age equivalents as low as 3.5, it also appears reasonable to conclude that the Program has widespread applicability for young deaf children. One may also conclude that the goal of developing programmed instruction utilizing a simple, inexpensive medium ready for use in existing classrooms was attained.

Two findings warrant restatement because of the impliciations for future application of this or similarly designed programmed instruction. First, the fact that the Level III children demonstrated 72% preknowledge of the Program content in verb vocabulary can be construed as evidence that the Program is relevant to academic achievement. Secondly, the high achievement (96%) by the Level I children from the same school demonstrates that verb vocabulary can be learned earlier and at a more rapid rate through the medium of programmed instruction. The implications of these findings constitute, in our judgment, a justification for further research and development of similar programmed instruction units.

(4.20) Recommendations

During classroom use of the Program two serious problems arose which could be corrected in the future. First, because of delays in obtaining printed materials, student use of the Program was interrupted at various points for considerable periods of time. Second, the procedure utilized for the writing frames in Set One and in the supplementary Program resulted in confusion for many of the children. A solution to this problem was found and materials for Sets Two and Three were modified to accommodate the new procedure. The effect of these two conditions upon Program achievement cannot be estimated, but it is reasonable to assume some adverse effect.

Since the Program met the criteria for effectiveness in 21 of 28 instances, the possibility that it would have met all criteria with the

above conditions corrected should not be ignored. Therefore, we recommend that the Program be field tested again with a similar group of children under the following conditions:

1. That the writing frames in Set One and the supplementary Subject Noun Program be changed to the format used successfully in Sets Two and Three;

2. That all materials be obtained before children begin the Program;

3. That Set Four, which could not be used during the first field testing, be included.

If, in the second field testing, the Program does not meet the 80/90 mastery criterion and Blake's gain criterion, we recommend further trial and revision. When the Program Unit has met both mastery and gain criteria, we offer the following recommendations:

1. That the Program Unit be disseminated to school personnel who wish to use it;

2. That the Program Unit be used as a base for programming more difficult language concepts--those which require an understanding of simple intra-sentence relationships (taught in the Program Unit) for their development, e.g., verb tense, negation, and such words as have, is and can.

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Appendix A-1: Outline of the Program Unit

UNIT VERB VOCABULARY PRETEST (16 Verbs)

- Set One (4 Verbs)
  - Pretest
    - Program: jump, eat, paint, wash
  - Posttest

- Subject Nouns (11 Nouns)
  - Pretest*
    - Program: people, animals
  - Posttest

- Sentence Structure
  - Pretest
    - Program: subject-verb relationship
  - Posttest

- Set Two (4 Verbs)
  - Pretest
    - Program: run, sit, stand, walk
  - Posttest
    - Review: Sets One and Two
      - Vocabulary
      - Sentence Structure

- Set Three (4 Verbs)
  - Pretest
    - Program: drink, sleep, write, cook
  - Posttest
    - Review: Sets One, Two and Three
      - Vocabulary
      - Sentence Structure

- Object Nouns
  - Pretest**
    - Object noun instruction
  - Posttest

- Sentence Structure: Verb-object relationship

*Children who achieve mastery on this test omit the Subject Noun Program.
**Children who achieve mastery on this test omit object noun instruction.

Set Four (4 Verbs)

- Pretest
  - Program: draw, cut, push, carry
- Posttest
  - Review: Sets One, Two, Three and Four
    - Vocabulary
    - Sentence Structure
      - Subject-verb
      - Verb-object
    - Sentence Structure: Subject-verb-object relationship

UNIT VERB VOCABULARY POSTTEST

UNIT FINAL SENTENCE TEST

Appendix A-2: Content of the Unit with Testing Schedule

Pretest UNIT Verb Vocabulary

SET ONE

STANDARD TRACK		ACCELERATED TRACK
Pretest, Set One Progress		Pretest, Set One Progress
BOOK I Section A Jump B Eat C Jump-Eat, Part 1		BOOK I OMITTED
BOOK II Section A Jump B Eat C Jump-Eat, Part 1	Repetition of BOOK I	BOOK II Section A Jump B Eat C Jump-Eat, Part 1
C Jump-Eat, Part 2		C Jump-Eat, Part 2
BOOK III Section D Paint E Wash F Paint-Wash, Part 1		BOOK III OMITTED
BOOK IV Section D Paint E Wash F Paint-Wash, Part 1	Repetition of BOOK III	BOOK IV Section D Paint E Wash F Paint-Wash, Part 1
F Paint-Wash, Part 2 G Jump-Eat-Paint-Wash		F Paint-Wash, Part 2 G Jump-Eat-Paint-Wash
Posttest, Set One Progress		Posttest, Set One Progress

SET ONE (Cont'd)

STANDARD TRACK	ACCELERATED TRACK
Pretest, Subject-Noun Vocabulary*	Pretest, Subject-Noun Vocabulary*
Pretest, Subject-Verb Relationship	Pretest, Subject-Verb Relationship
BOOK V Section H Verb in Sentence; I Subject in Sentence	**BOOK V** Section H Verb in Sentence; I Subject in Sentence
BOOK VI Section J Subject and Verb in Sentence; K Subject and Verb in Sentence	**BOOK VI** Section J Subject and Verb in Sentence; K Subject and Verb in Sentence
Posttest, Subject-Verb Relationship	Posttest, Subject-Verb Relationship

*Children who achieved mastery continued in Set One. Those who did not received the Subject Noun Program (outlined on the following page). This test was administered to the validation subjects prior to Set One.

SUBJECT NOUN PROGRAM

Pretest, Subject Noun Vocabulary*

Group I*	Group II*	Group III*
BOOK I	BOOK I	BOOK I
Section	Section	
A Boy	A Boy	
B Girl	B Girl	OMITTED
C Boy-Girl	C Boy-Girl	
BOOK II	BOOK II	BOOK II
Section	Section	
D Man	D Man	
E Woman	E Woman	OMITTED
F Man-Woman	F Man-Woman	
G Baby	G Baby	
H Boy-Girl-Man-Woman-Baby	H Boy-Girl-Man-Woman-Baby	
BOOK III	BOOK III	BOOK III
Section		Section
A Dog		A Dog
B Cat		B Cat
C Fish	OMITTED	C Fish
D Horse		D Horse
E Rabbit		E Rabbit
F Bird		F Bird

Posttest, Subject Noun Vocabulary

*Children who required the Subject Noun Program were divided into three groups, irrespective of their assigned verb track:

I Those who needed all three books.
II Those who needed Books I and II only.
III Those who needed Book III only.

SET TWO

STANDARD TRACK		ACCELERATED TRACK
Pretest, Set Two Progress		Pretest, Set Two Progress
BOOK I Section A Run B Sit C Run-Sit, Part 1		BOOK I OMITTED
BOOK II Section A Run B Sit C Run-Sit, Part 1	Repetition of BOOK I	BOOK II Section A Run B Sit C Run-Sit, Part 1
C Run-Sit, Part 2		C Run-Sit, Part 2
BOOK III Section D Stand E Walk F Stand-Walk, Part 1		BOOK III OMITTED
BOOK IV Section D Stand E Walk F Stand-Walk, Part 1	Repetition of BOOK III	BOOK IV Section D Stand E Walk F Stand-Walk, Part 1
F Stand-Walk, Part 2 G Run-Sit-Stand-Walk		F Stand-Walk, Part 2 G Run-Sit-Stand-Walk
Posttest, Set Two Progress		Posttest, Set Two Progress

SET TWO (Cont'd)

BOOK V--Review Section	BOOK V--Review Section
H Cumulative Verb Vocabulary	H Cumulative Verb Vocabulary
I Sentence Structure	I Sentence Structure
J Sentence Structure	J Sentence Structure

SET THREE

STANDARD TRACK		ACCELERATED TRACK
Pretest, Set Three Progress		Pretest, Set Three Progress
BOOK I Section A Drink B Sleep C Drink-Sleep, Part 1		BOOK I OMITTED
BOOK II Section A Drink B Sleep C Drink-Sleep, Part 1	Repetition of BOOK I	BOOK II Section A Drink B Sleep C Drink-Sleep, Part 1
C Drink-Sleep, Part 2		C Drink-Sleep, Part 2
BOOK III Section D Write E Cook F Write-Cook, Part 1		BOOK III OMITTED
BOOK IV Section D Write E Cook F Write-Cook, Part 1	Repetition of BOOK III	BOOK IV Section D Write E Cook F Write-Cook, Part 1
F Write-Cook, Part 2 G Drink-Sleep-Write-Cook		F Write-Cook, Part 2 G Drink-Sleep-Write-Cook
Posttest, Set Three Progress		Posttest, Set Three Progress

SET THREE (Cont'd)

STANDARD TRACK	ACCELERATED TRACK
BOOK V--Review	BOOK V--Review
Section	Section
H Cumulative Verb Vocabulary	H Cumulative Verb Vocabulary
I Sentence Structure	I Sentence Structure
J Sentence Structure	J Sentence Structure

Because of problems in obtaining printed materials (see Appendix F), the remainder of the program could not be validated within the time limits of the project. Validation posttesting was conducted after Book V of Set Three.

Pretest, Object Nouns Vocabulary*	Pretest, Object Nouns Vocabulary
BOOK VI	BOOK VI
Section	Section
K Verb-Object Relationship	K Verb-Object Relationship
L Verb-Object Relationship	L Verb-Object Relationship
M Verb-Object Relationship	M Verb-Object Relationship

*Children who achieved mastery on this test continued in Set Three. Those who failed received object noun instruction.

SET FOUR

STANDARD TRACK		ACCELERATED TRACK
Pretest, Set Four Progress		Pretest, Set Four Progress
BOOK I Section A Draw B Cut C Draw-Cut, Part 1		**BOOK I** OMITTED
BOOK II Section A Draw B Cut C Draw-Cut, Part 1 C Draw-Cut, Part 2	Repetition of BOOK I	**BOOK II** Section A Draw B Cut C Draw-Cut, Part 1 C Draw-Cut, Part 2
BOOK III Section D Push E Carry F Push-Carry, Part 1		**BOOK III** OMITTED
BOOK IV Section D Push E Carry F Push-Carry, Part 1 F Push-Carry, Part 2 G Draw-Cut-Push-Carry	Repetition of BOOK III	**BOOK IV** Section D Push E Carry F Push-Carry, Part 1 F Push-Carry, Part 2 G Draw-Cut-Push-Carry
Posttest, Set Four Progress		Posttest, Set Four Progress

SET FOUR (Cont'd)

STANDARD TRACK	ACCELERATED TRACK
BOOK V--Review	BOOK V--Review
Section	Section
H Cumulative Verb Vocabulary	H Cumulative Verb Vocabulary
I Sentence Structure	I Sentence Structure
J Sentence Structure	J Sentence Structure

BOOK VI	BOOK VI
Section	Section
K Subject, Verb and Object in Sentence	K Subject, Verb and Object in Sentence
L Subject, Verb and Object in Sentence	L Subject, Verb and Object in Sentence
M Subject, Verb and Object in Sentence	M Subject, Verb and Object in Sentence

Posttest UNIT Verb Vocabulary (All Subjects)

Final UNIT Sentence Test (All Subjects)

Appendix B: Excerpts from the Program

Appendix B contains excerpts from Set Three of the Program, Using Verbs, A Programmed Course for Deaf Children. It follows one verb through the teaching sequence. Like the other Sets, Set Three teaches four verbs divided into two teaching pairs as follows:

First pair
- *A. First verb alone
- B. Second verb alone
- *C. First pair combined

Second pair
- D. Third verb alone
- E. Fourth verb alone
- F. Second pair combined

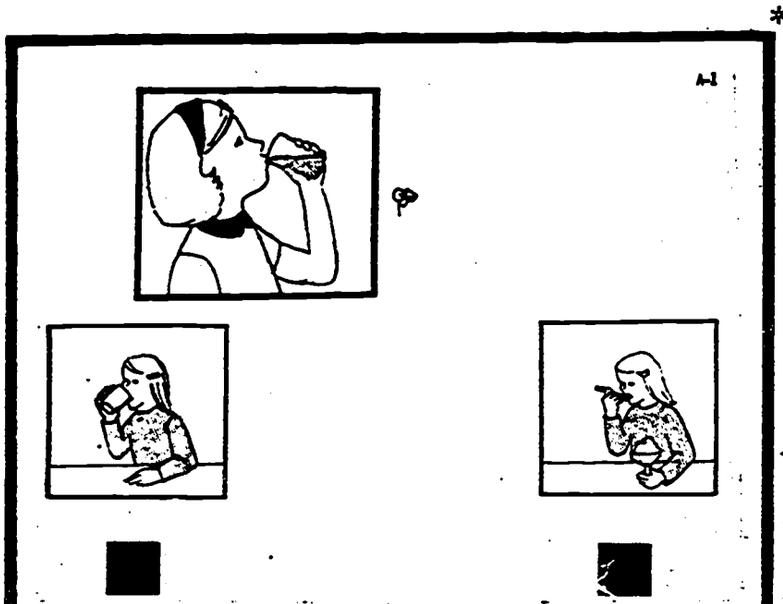
Four words of the set combined
- *G.

Review
- *H. Cumulative vocabulary review
- *I. Sentence Review
- *J. Sentence Review

*Sections included in the excerpt

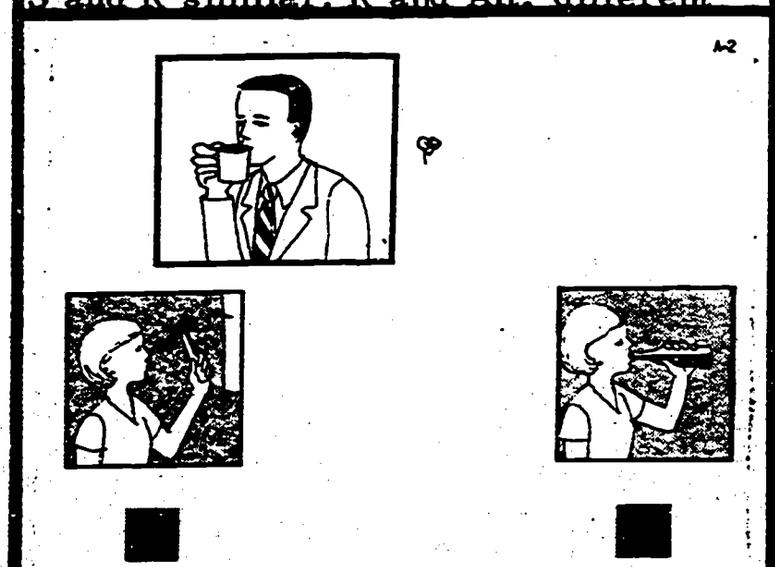
S = Stimulus
R = Response (correct choice)
Alt. = Alternative (incorrect choice)

All frames are photoreduced. The actual frame size is 8-1/2 x 11".

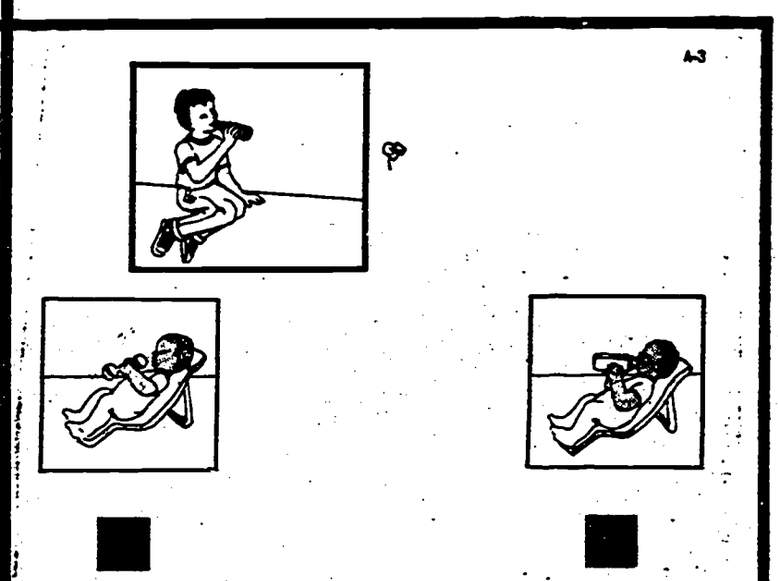


CONCEPT DEVELOPMENT (A-1--A-9)
S and R similar; R and Alt. different

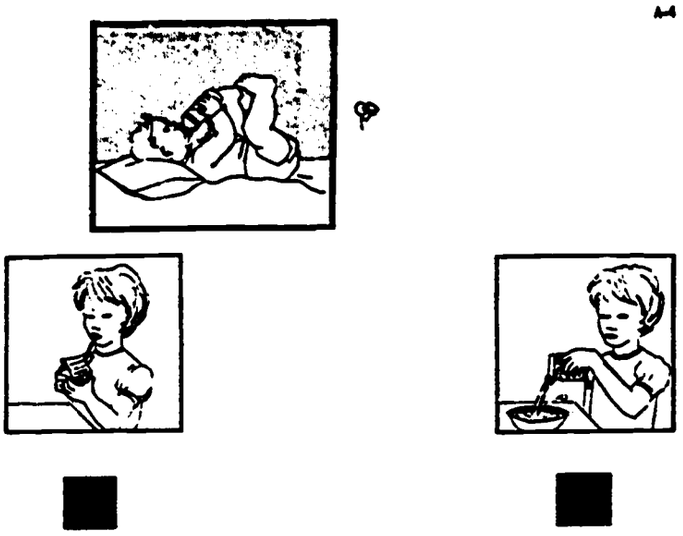
Section A (23 frames) includes concept development and association of the printed word form for the first verb in the Set.



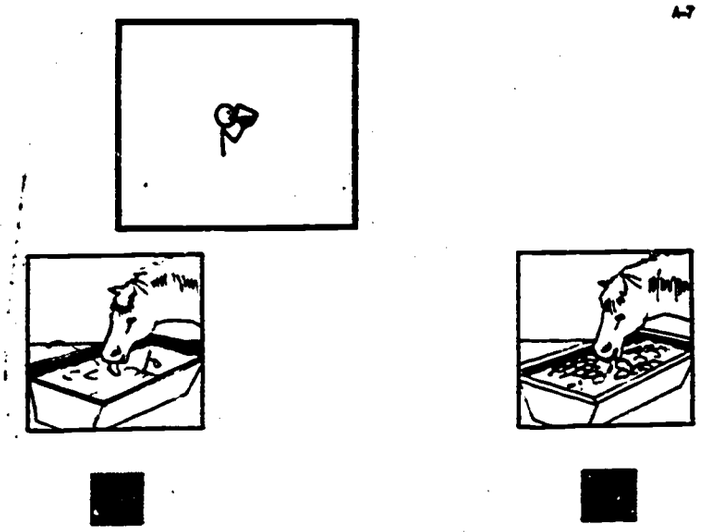
Expansion of concept



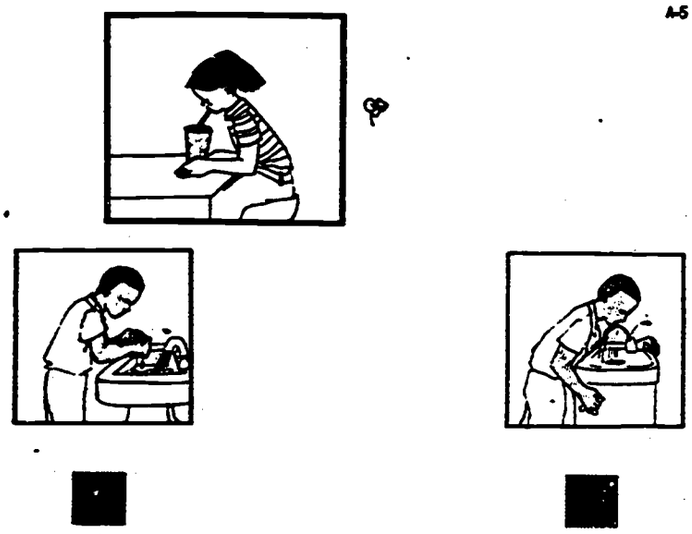
Expansion of concept



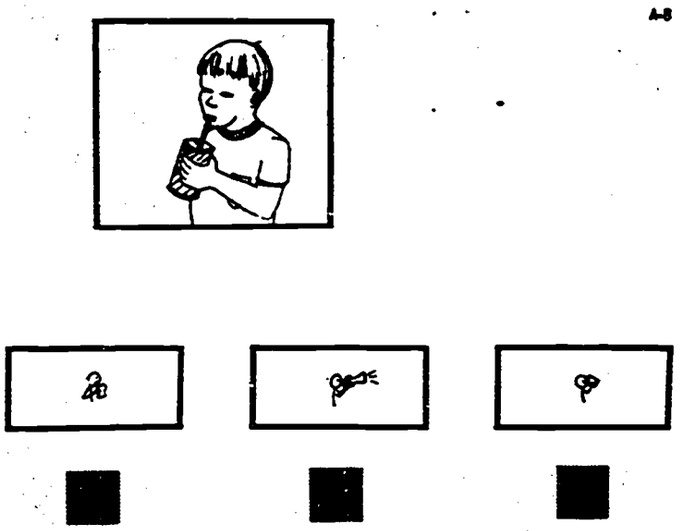
S and R more dissimilar; R and Alt. more similar



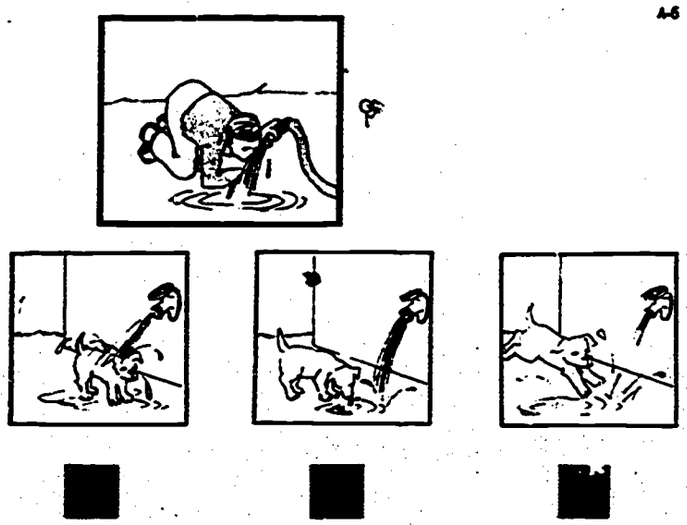
Association of mediating symbol with concept



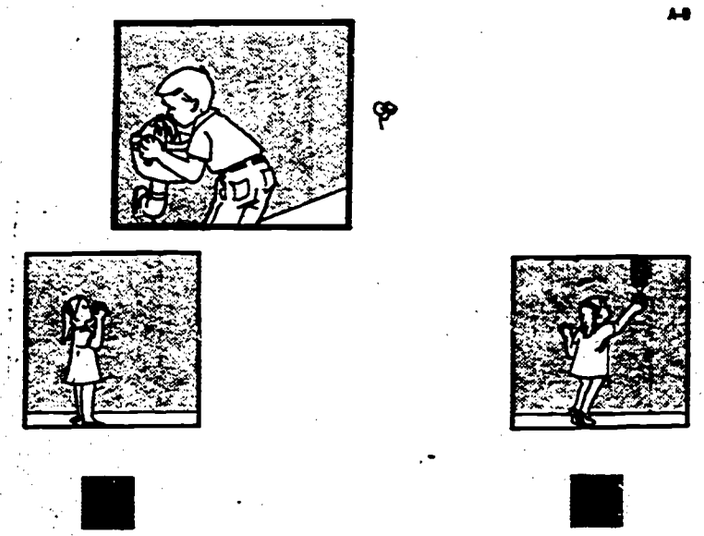
S and R very dissimilar; Alt. competitive



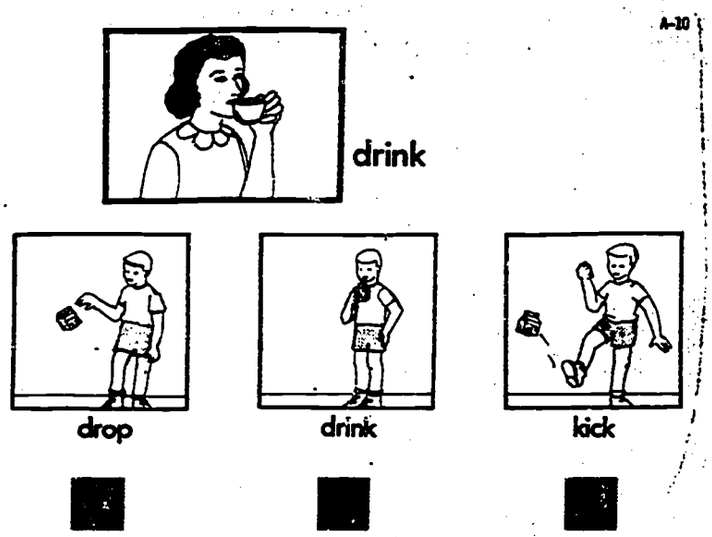
Association of symbol; direct response to symbol



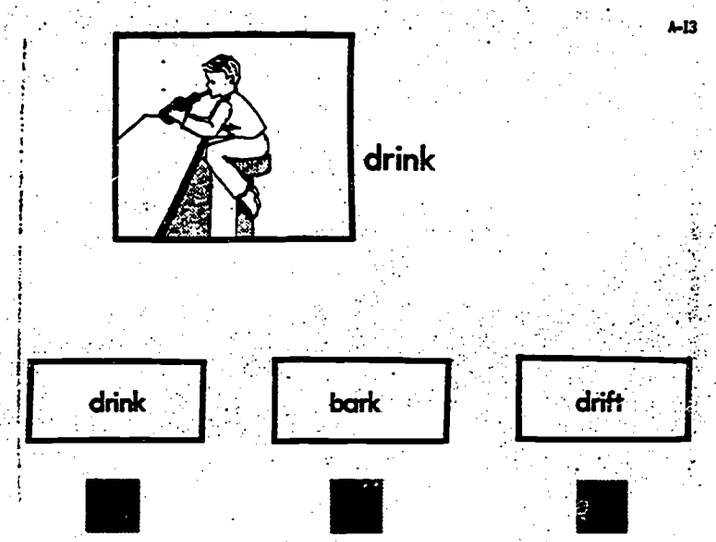
S and R very dissimilar; Alts. highly competitive



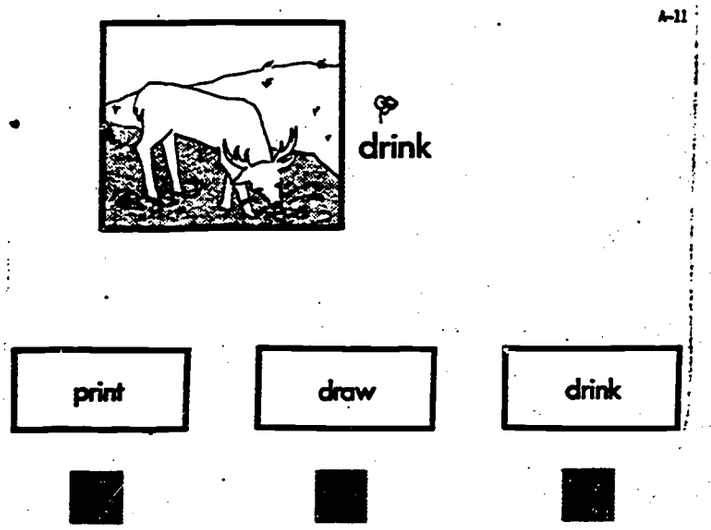
Terminal frame for concept



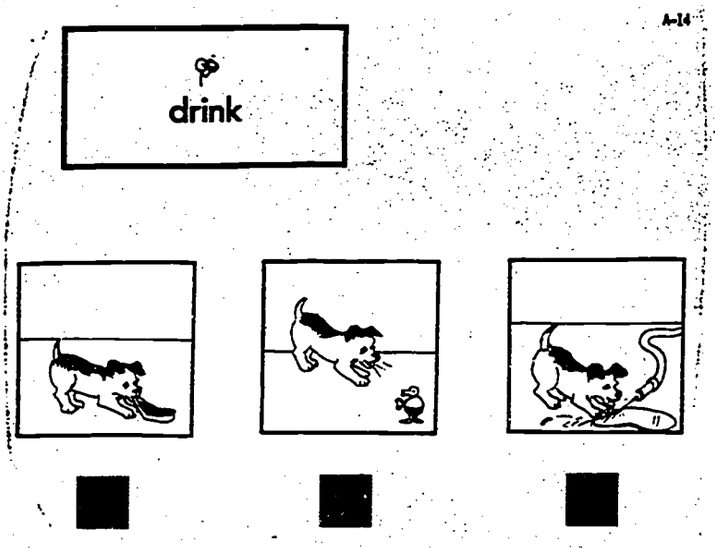
WORD RECOGNITION (A-10--A-13)
Word matching with pictures



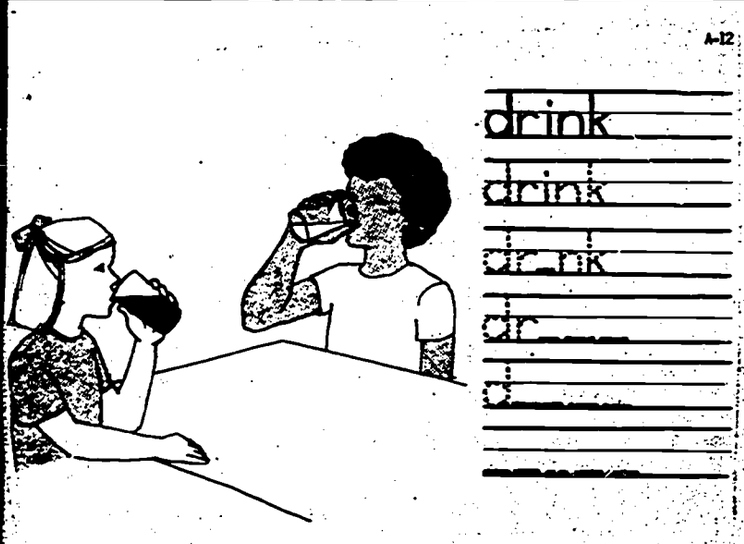
Word matching; words competitive in form



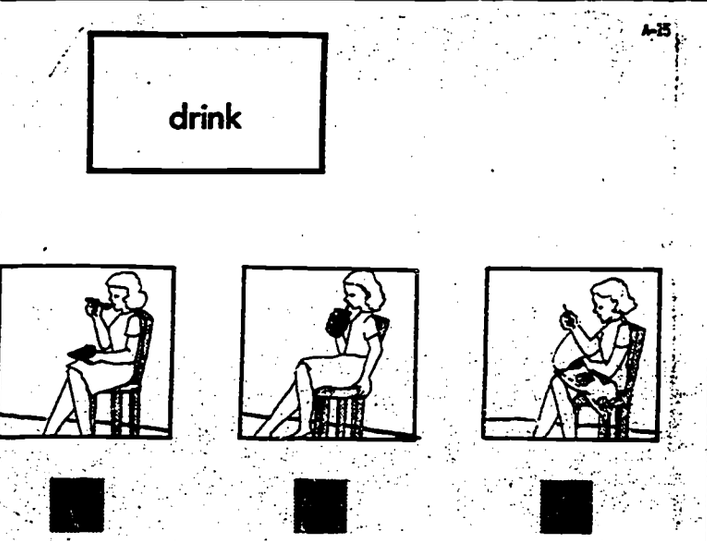
Word matching; (must attend word); Alt. competitive



TERMINAL SEQUENCE (A-14--A-23)
Transition to picture terminal



Tracing and copying frame (erasable plasticized page)



First picture terminal

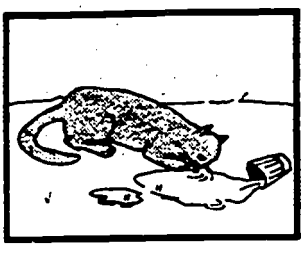
A-16

drink

think | drink | dunk

Word matching; Alts. highly competitive

A-17



drill | stir | drink

Transition to word terminal with mediating symbols

A-18

drink

Picture terminal

A-19

pinch | drink | break

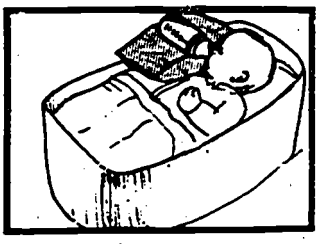
Word terminal

A-20

drink

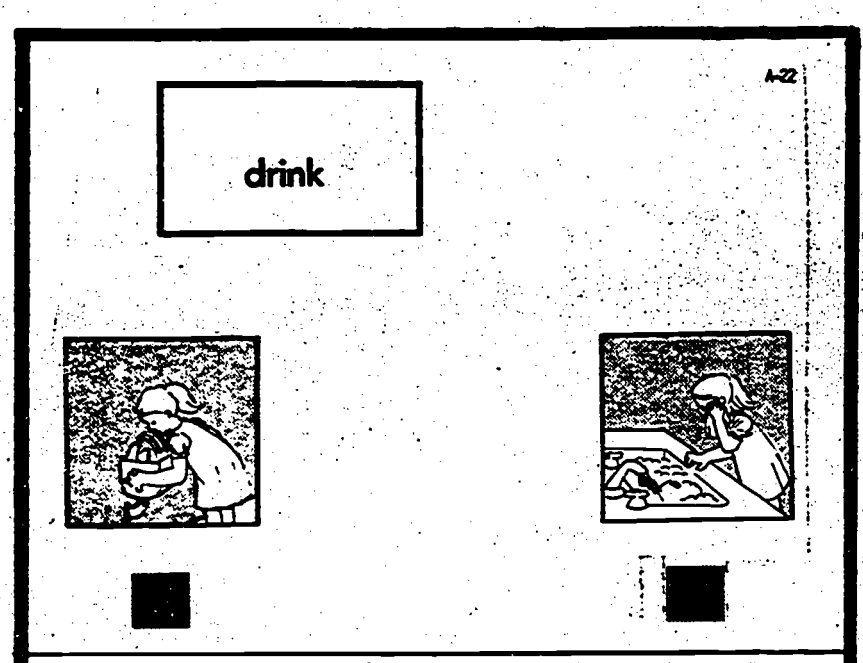
Picture terminal

A-21

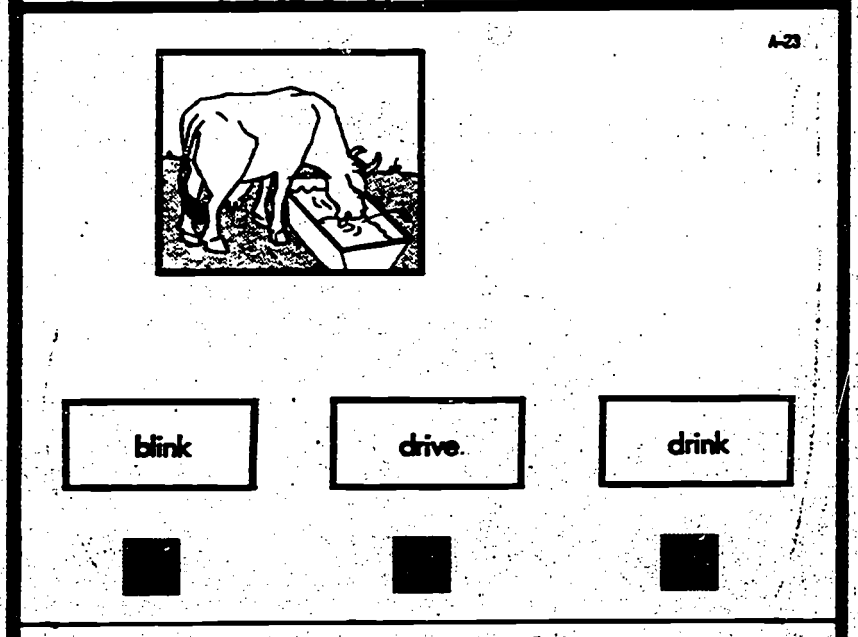


drink | draft | bring

Word terminal



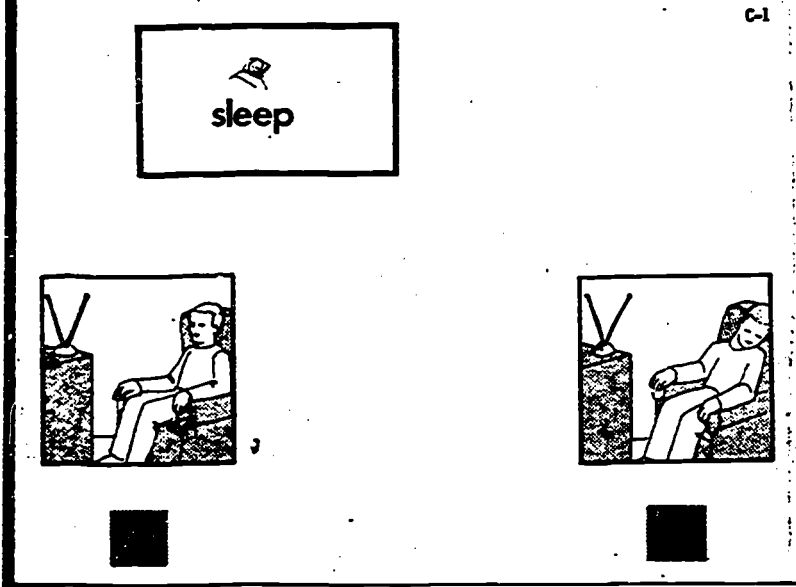
Picture terminal



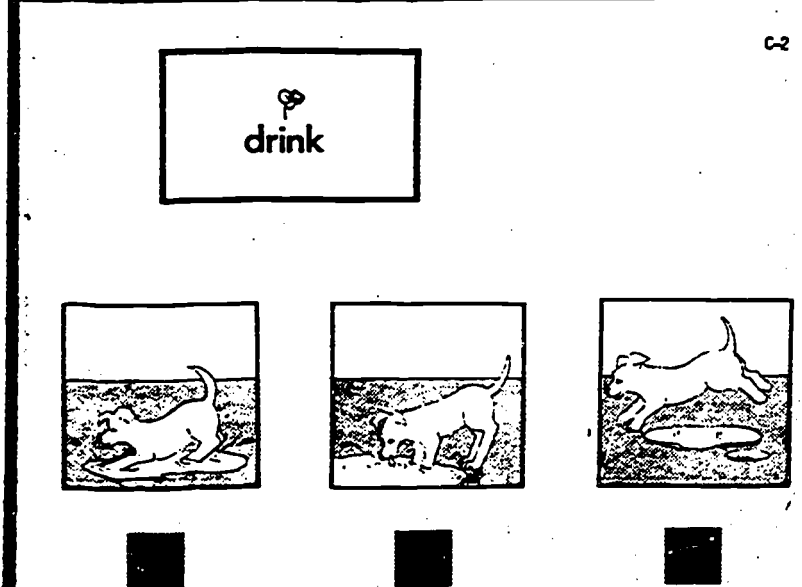
Word terminal; Alts. highly competitive

In the actual program a similar sequence for the verb sleep (Section B) follows Section A.

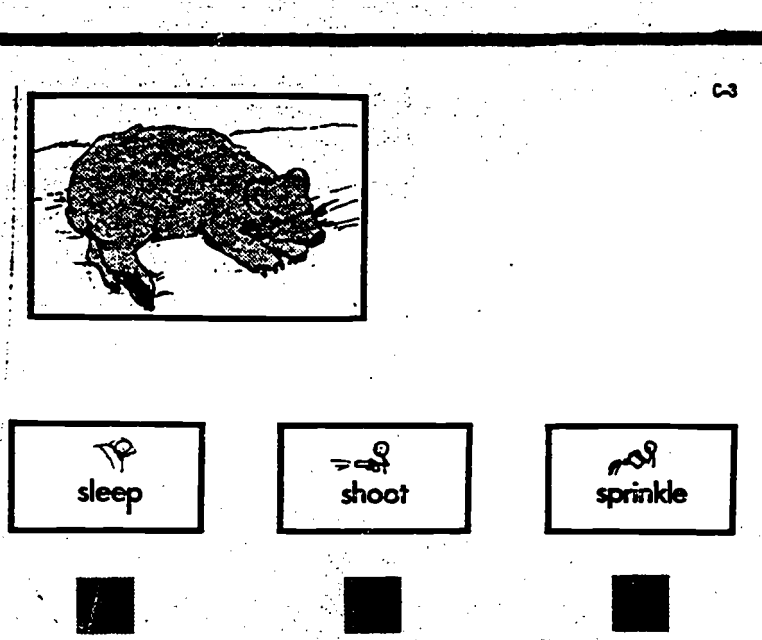
Section C brings the two words from the first teaching pair (drink and sleep) together in a carefully controlled sequence. The words are alternated without the possibility of a response to the other word from the teaching pair. The two words appear in competition first in cued frames and then in terminals.



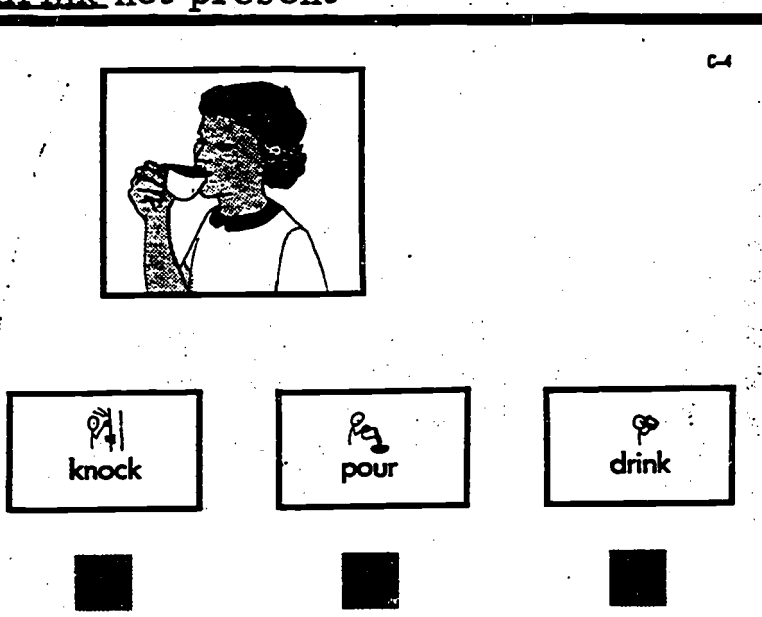
Cued picture response for second word in teaching pair; drink not present



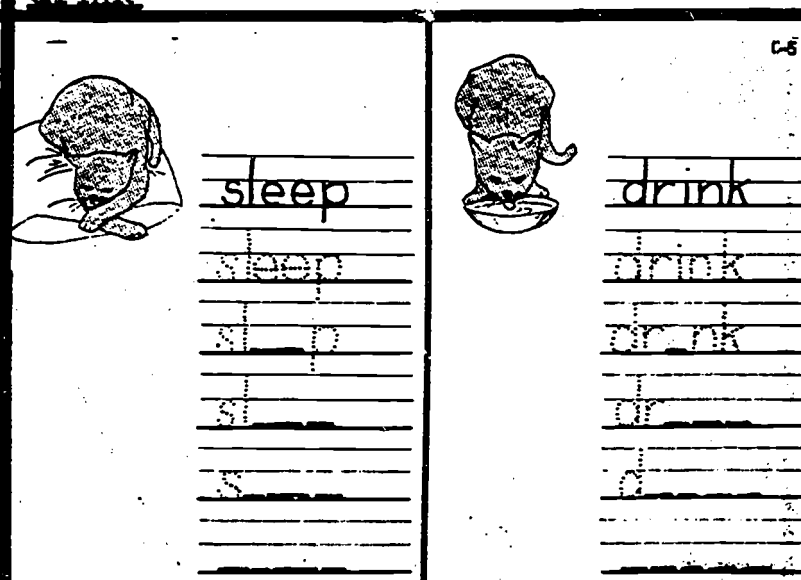
Previous frame type repeated for drink



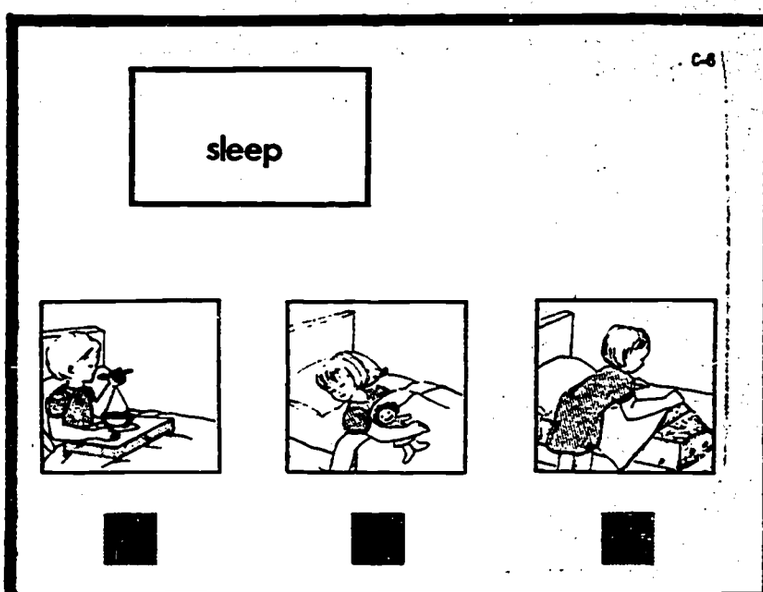
Cued word response for second word; drink not present



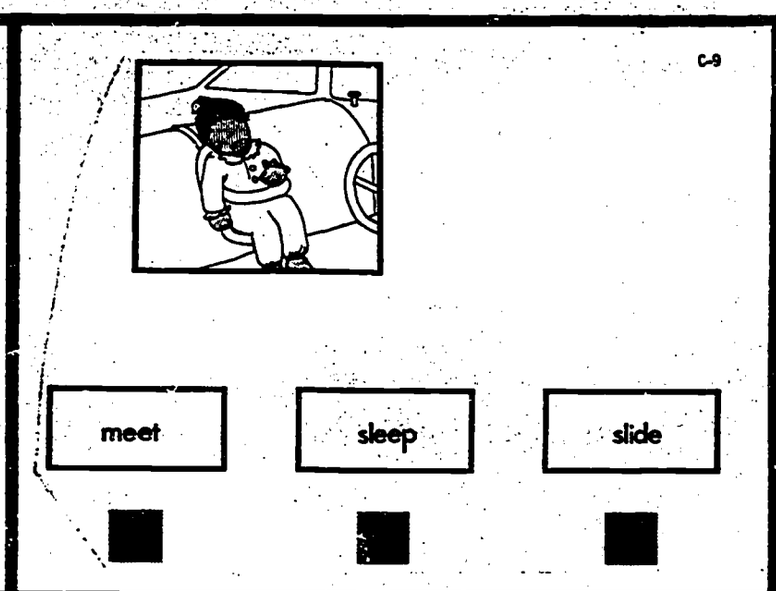
Previous frame type repeated for drink



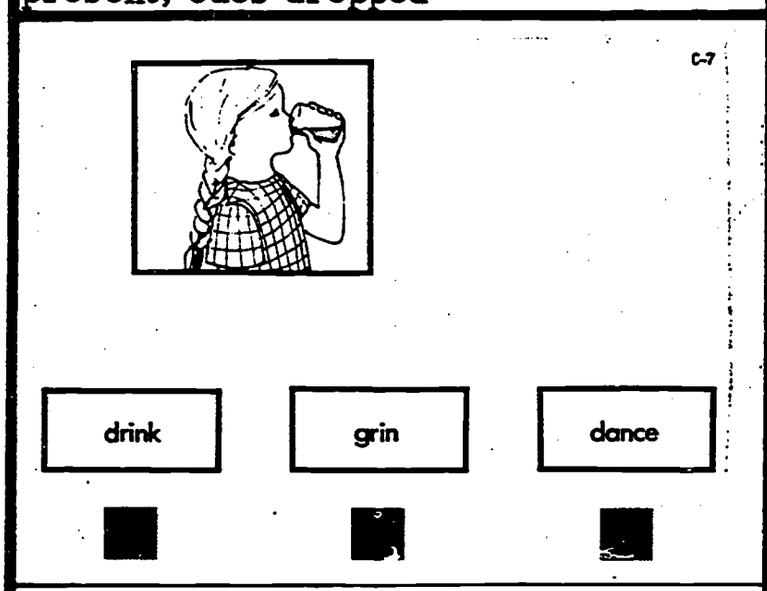
Tracing and copying frame for both words of pair



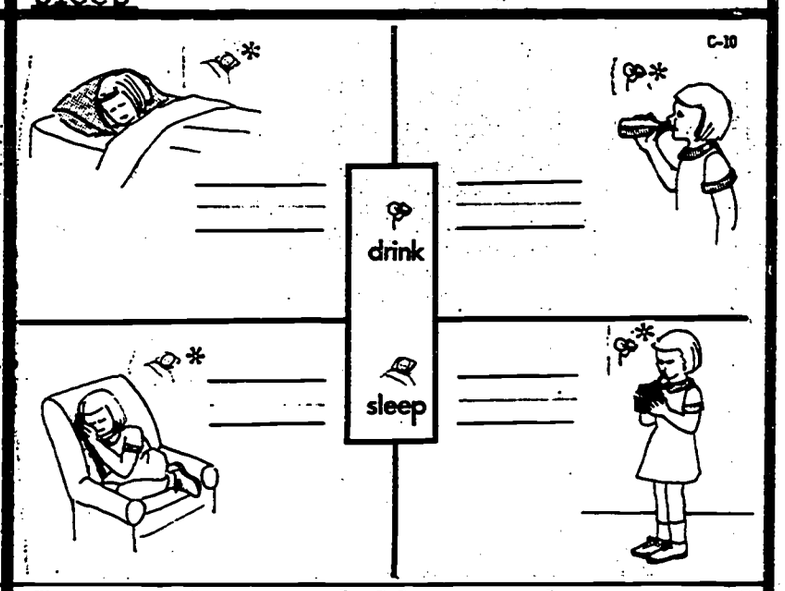
Picture response for sleep; drink not present; cues dropped



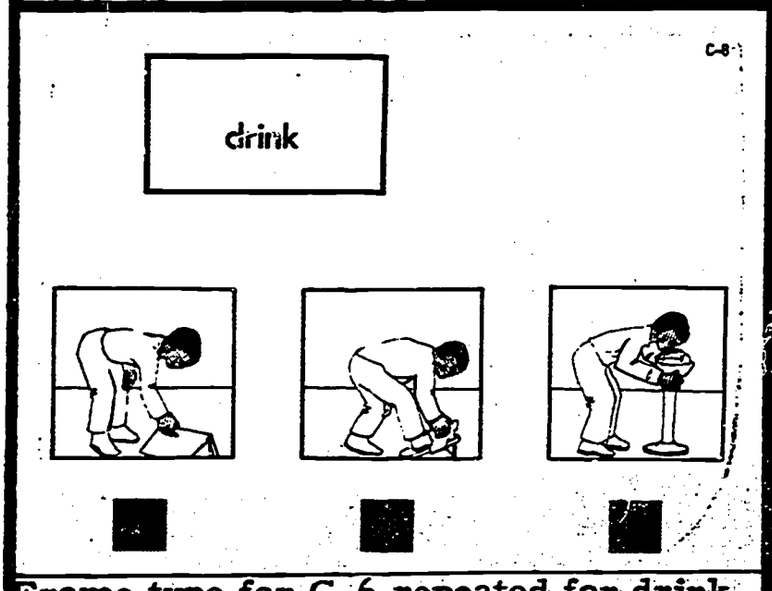
Frame type for C-7 repeated for sleep



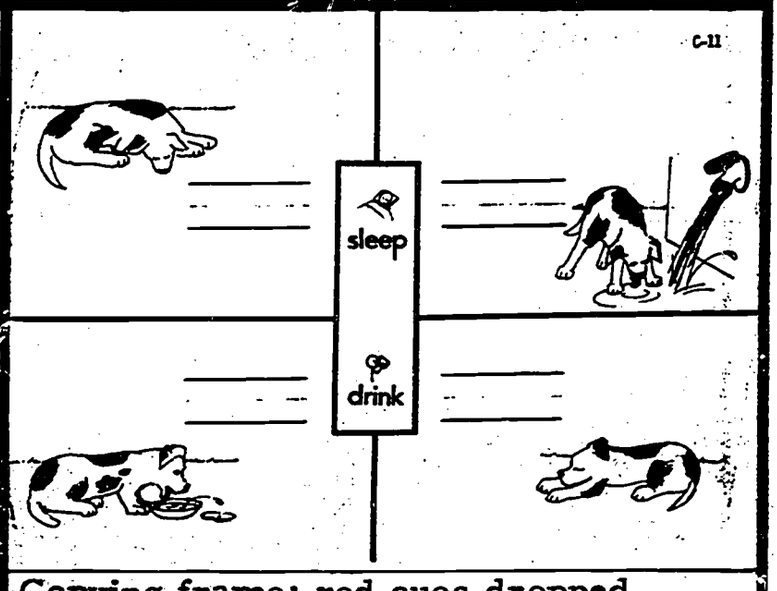
Word response for drink; sleep not present; cues dropped



Copying frame; child must choose word
*Red cues



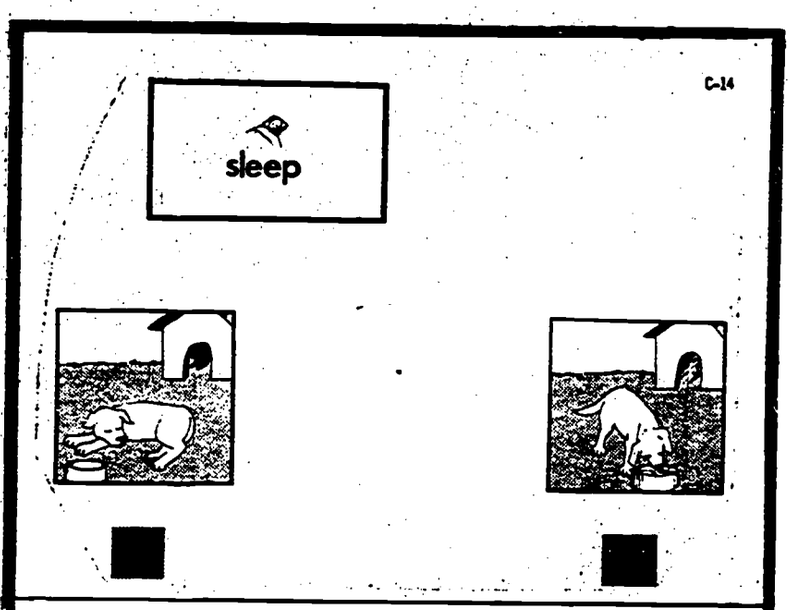
Frame type for C-6 repeated for drink



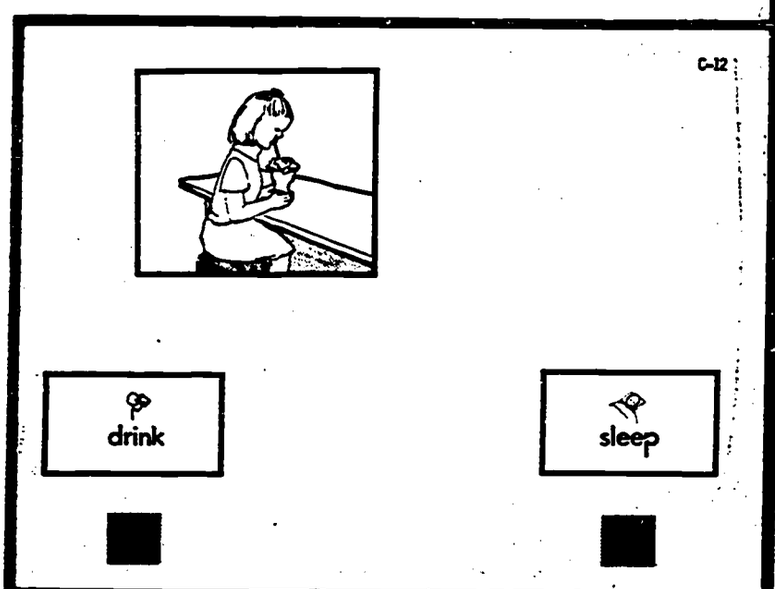
Copying frame; red cues dropped

TERMINAL SEQUENCE:
Part 2 of Section C

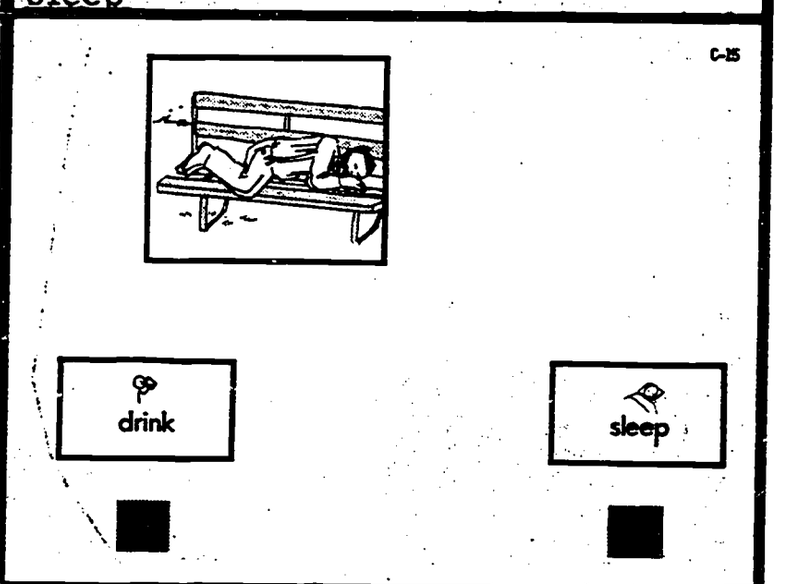
From this point the two words from the teaching pair appear in competition. Accelerated students advance to Part 2. Standard track students repeat Sections A, B, and C-Part 1; then advance to Part 2.



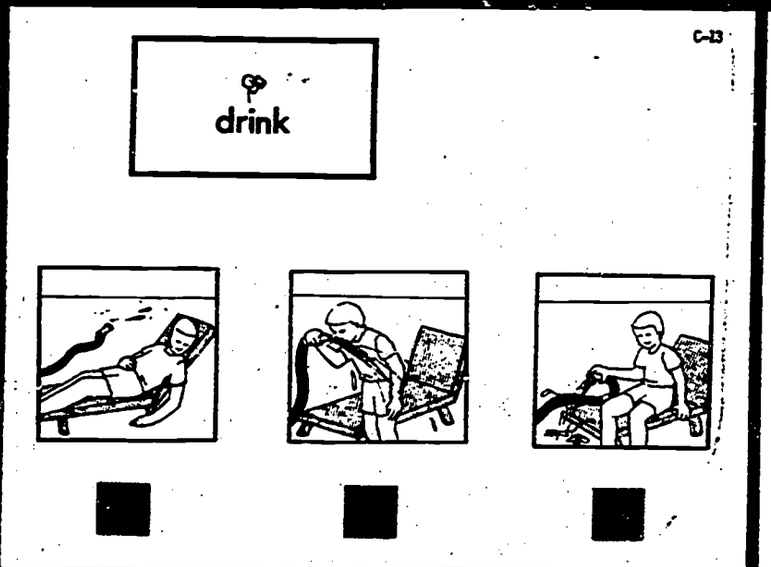
Previous frame type repeated for sleep



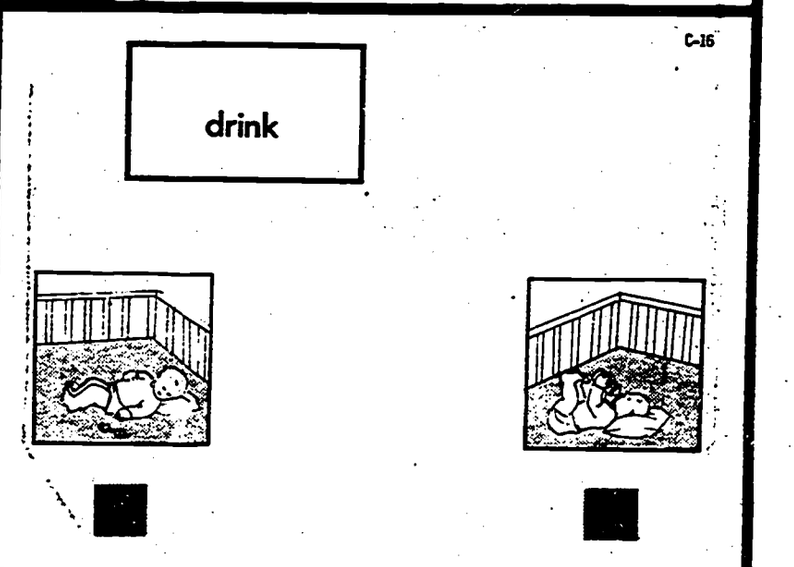
Cued word response for drink



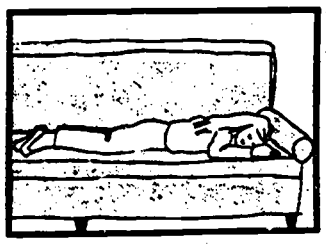
Frame type for C-12 repeated for sleep



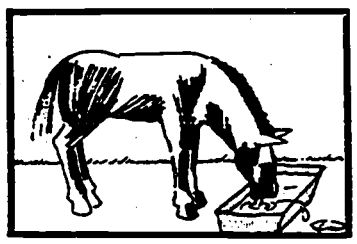
Cued picture response for drink



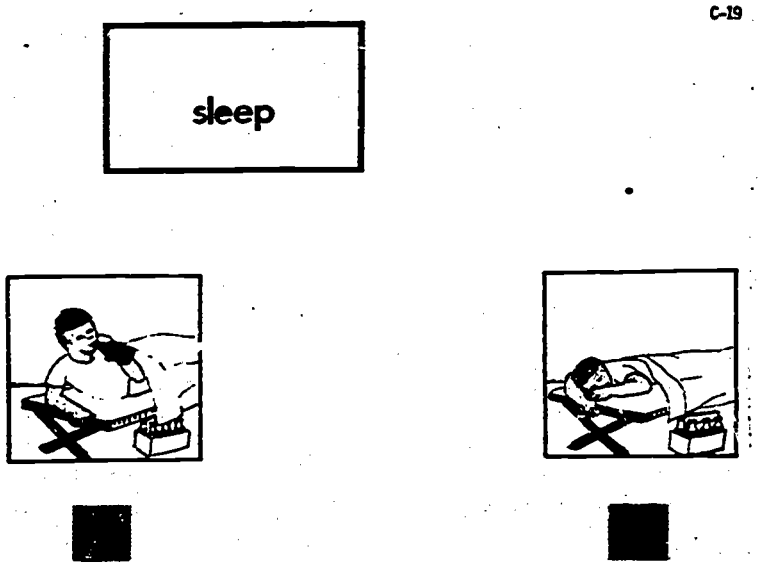
Picture terminal for drink



Word terminal for sleep



Word terminal for drink



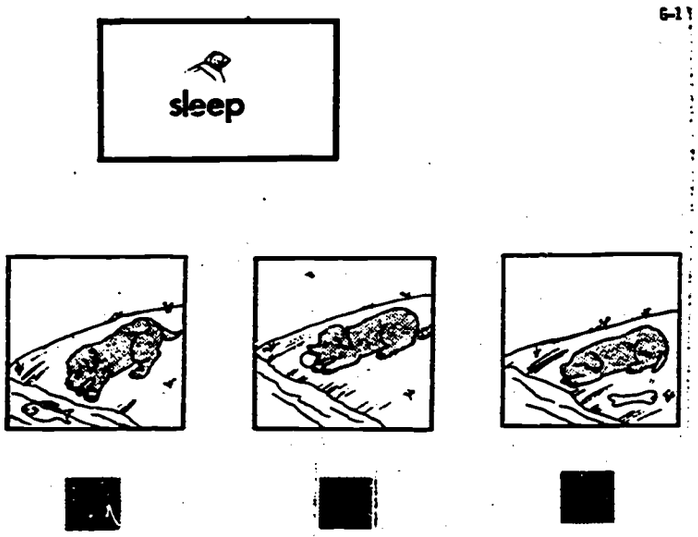
Picture terminal for sleep

In the actual program a similar sequence for the second teaching pair (write and cook) follows Section C.

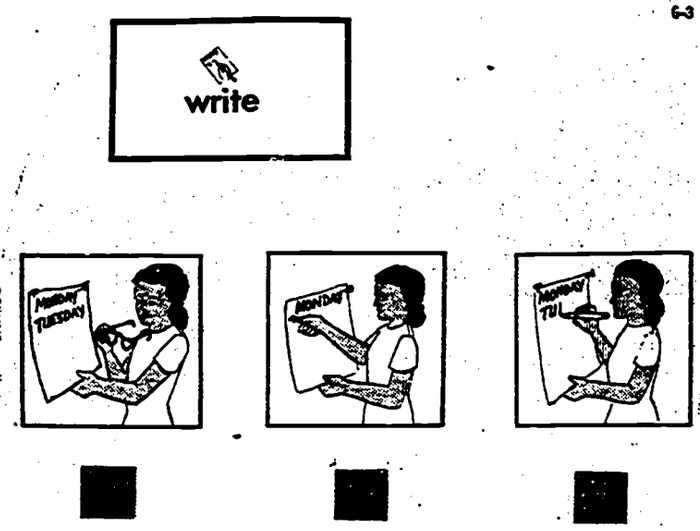
D - write separately
E - cook separately
F - write and cook combined

Section G brings the four words from the entire Set (drink, sleep, write and cook) together in a carefully controlled sequence. The words are alternated first without the possibility of a response to the other words from the Set. The four words appear in competition first in cued frames and then in terminals.

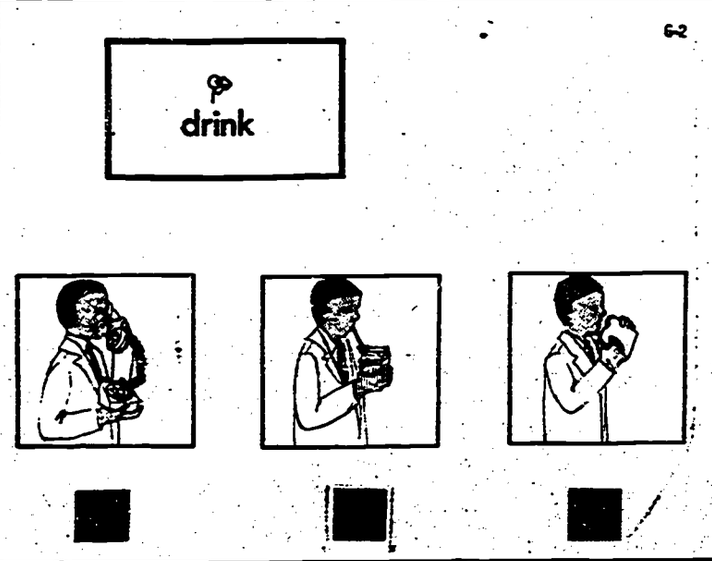
Frames G-34 - G-45 teach recognition of the root word in a sentence with present progressive tense.



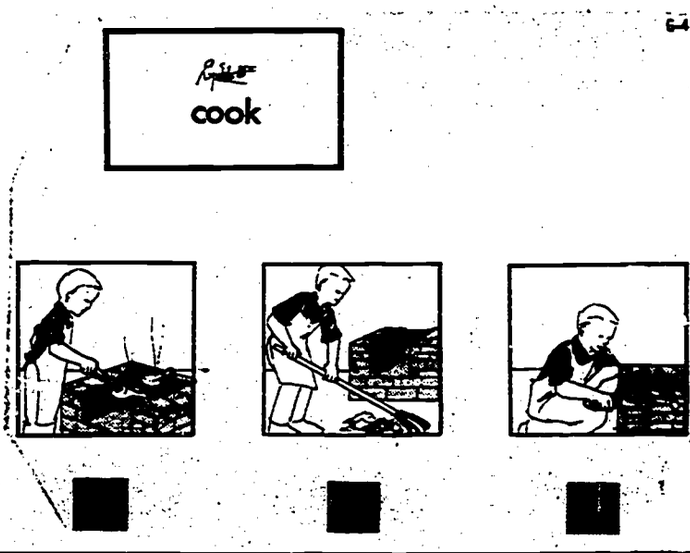
Cued picture response for sleep; other words from Set not present



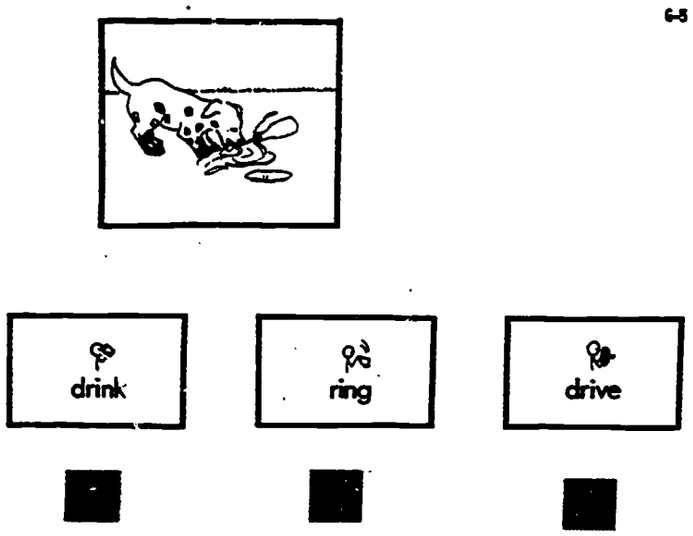
Previous frame type repeated for write



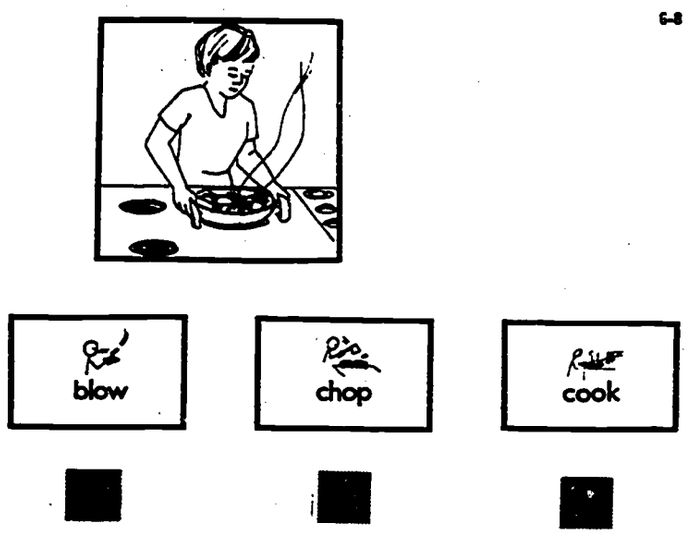
Previous frame type repeated for drink



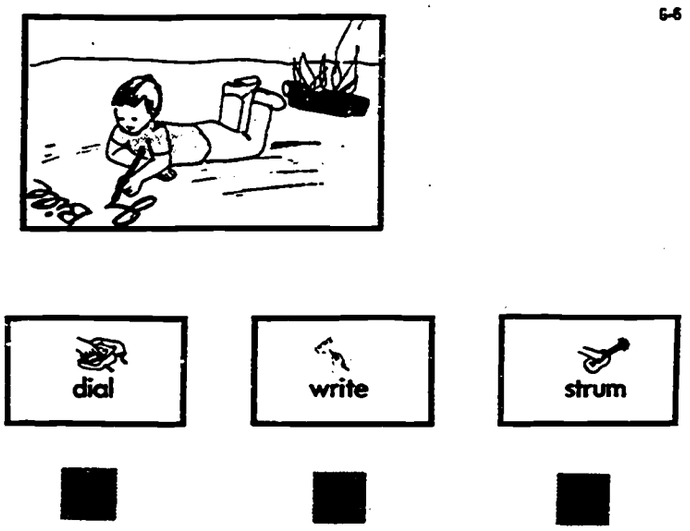
Previous frame type repeated for cook



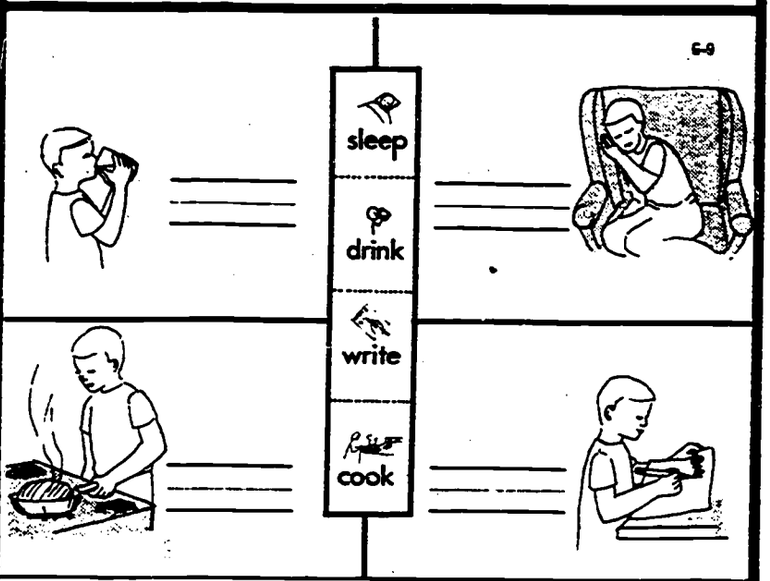
Cued word response for drink; other words from Set not present



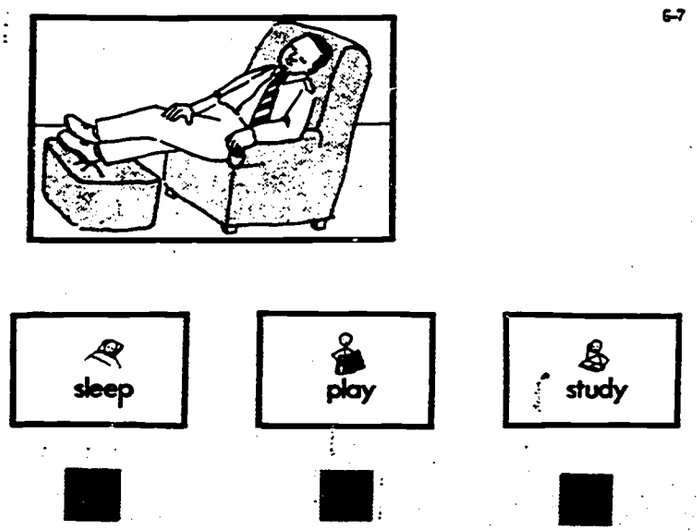
Previous frame type repeated for cook



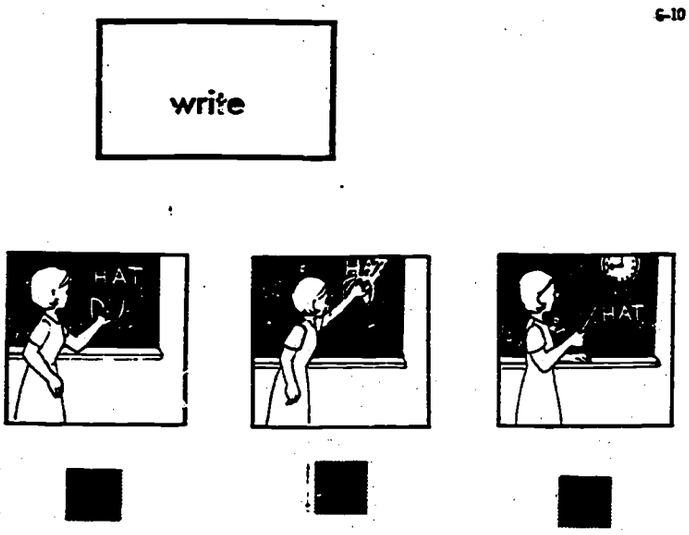
Previous frame type repeated for write



Copying frame; child must choose word



Previous frame type repeated for sleep



Picture response for write; other words from Set not present; cues dropped

G-11

sleep

Previous frame type repeated for sleep

G-12

cook

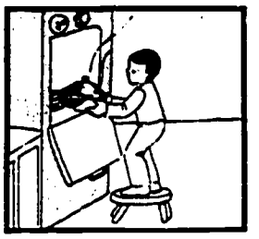
Previous frame type repeated for cook

G-13

drink

Previous frame type repeated for drink

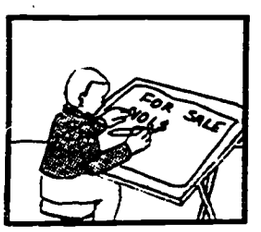
G-14



mock | cook | chant

Word response for cook; other words from the Set not present

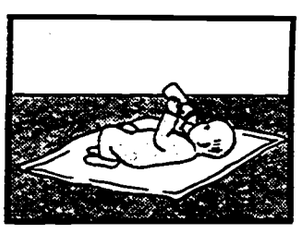
G-15



write | weld | smite

Previous frame type repeated for write

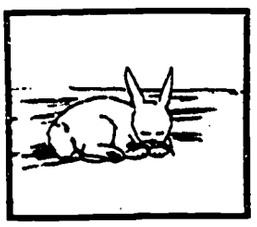
G-16



dive | drink | droop

Previous frame type repeated for drink

6-17

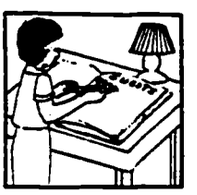
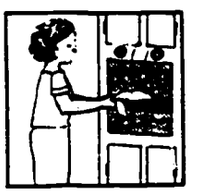


stop | shine | sleep

Previous frame type repeated for sleep

6-19

write

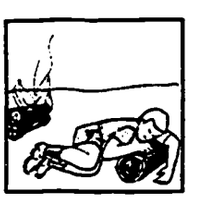
Previous frame type repeated for write

TERMINAL SEQUENCE:

From this point the four words in the Set appear in competition - first in cued frames and then in terminal frames.

6-20

cook



Previous frame type repeated for cook

6-18

drink

Cued picture response for drink;other words from the Set present

6-21

sleep

Previous frame type repeated for sleep

6-22

write | sleep | drink

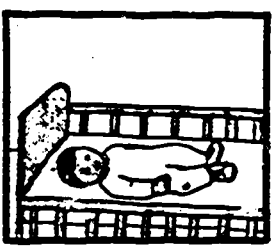
Cued word response for write; other words from the Set present

6-23

sleep | cook | write

Previous frame type repeated for cook

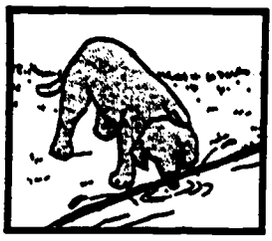
6-24



cook | drink | sleep

Previous frame type repeated for sleep

6-25



write | drink | cook

Previous frame type repeated for drink

6-26

sleep

Picture terminal for sleep

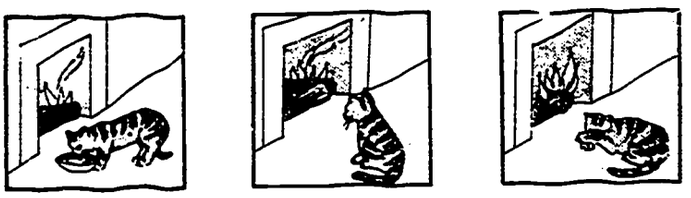
6-27

write

Previous frame type repeated for write

6-28

drink



Previous frame type repeated for drink

6-29

cook

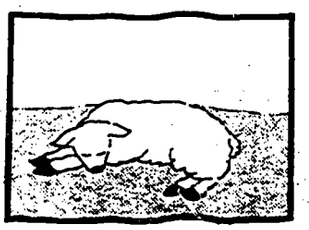
Previous frame type repeated for cook

6-30

sleep | write | drink

Word terminal for drink

6-31



sleep | cook | write

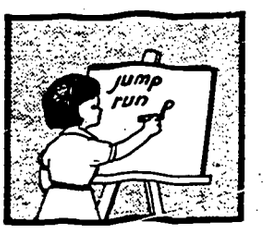
Previous frame type repeated for sleep

6-32

drink | sleep | cook

Previous frame type repeated for cook

6-33



cook | write | drink

Previous frame type repeated for write

G-34

The girl is drinking.

sleep | cook | drink

WORD IN SENTENCE: (G-34--G-45)
Attention to verb in sentence

G-35

The girl is sleeping.

write | sleep | cook

Previous frame type repeated for sleep

G-36

The girl is cooking.

cook | drink | write

Previous frame type repeated for cook

G-37

The girl is writing.

drink | write | sleep

Previous frame type repeated for write

G-38

The girl is _____.

sleeping | cooking | drinking

Cued verb with ing (root underscored) selected for blank -- sleep

G-39

The girl is _____.

cooking | drinking | writing

Previous frame type repeated for drink

G-40

The girl is _____.

sleeping | writing | cooking

Previous frame type repeated for cook

G-41

The girl is _____.

writing | sleeping | drinking

Previous frame type repeated for write

G-42

The girl is _____.

sleeping | drinking | cooking

Terminal for drink; cues and underscoring removed

G-43

The girl is _____.

cooking | writing | sleeping

Previous frame type repeated for cook

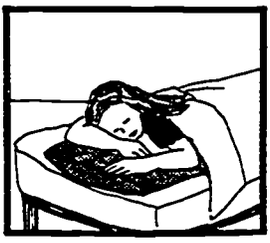
G-44

The girl is _____.

drinking | sleeping | writing

Previous frame type repeated for write

G-45

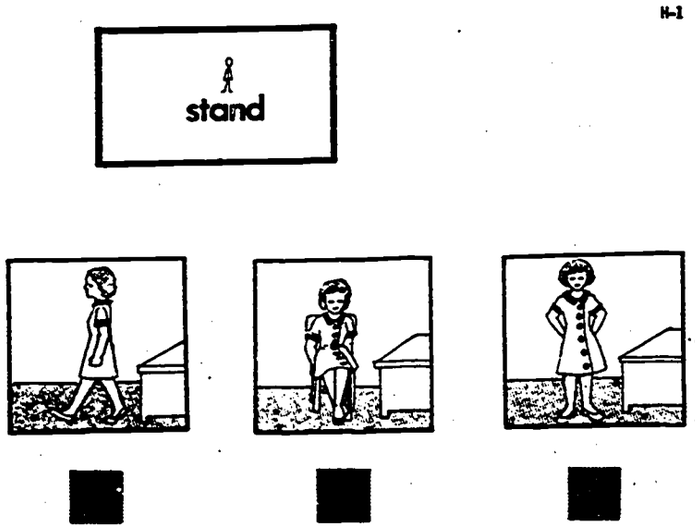


The girl is _____.

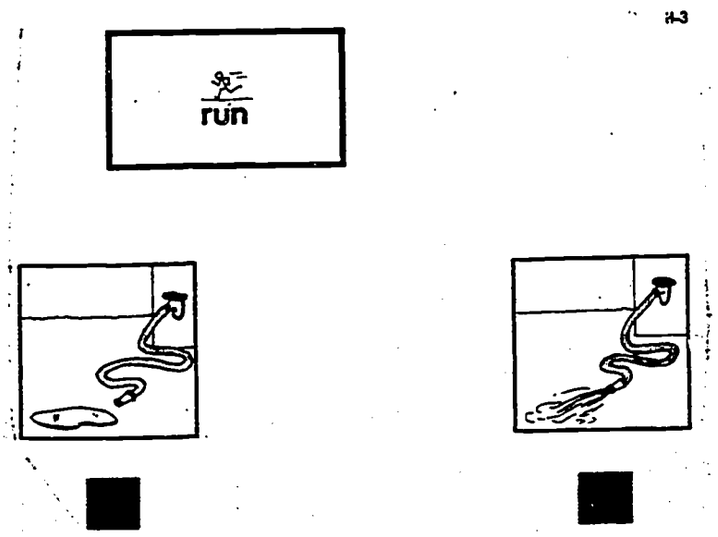
cooking | sleeping | drinking

Previous frame type repeated for sleep

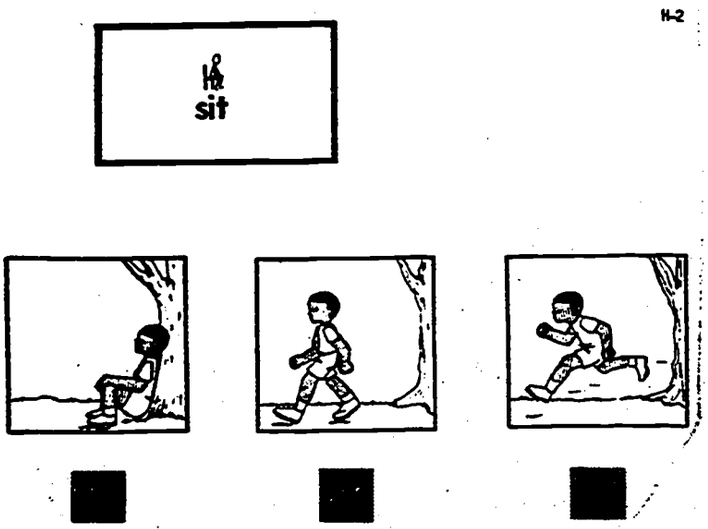
Section H is a review of the cumulative vocabulary as follows:
Set Two (H-1 - H-5)
Set One and Set Two together (H-6 - H-14)
Set One, Set Two and Set Three together (H-15 - H-27)
Since Set One is reviewed in the latter sections of Set Two, it is reviewed less thoroughly than Set Two in the present Set.



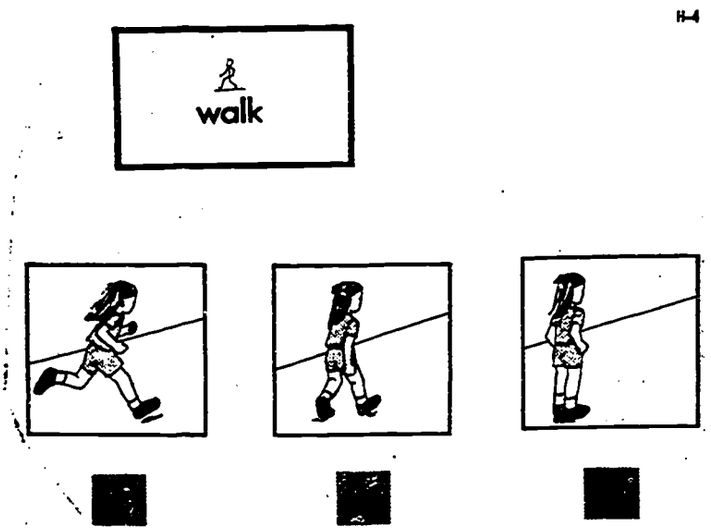
REVIEW - SET TWO:
Cued picture response for stand



Previous frame type repeated for run (running water)

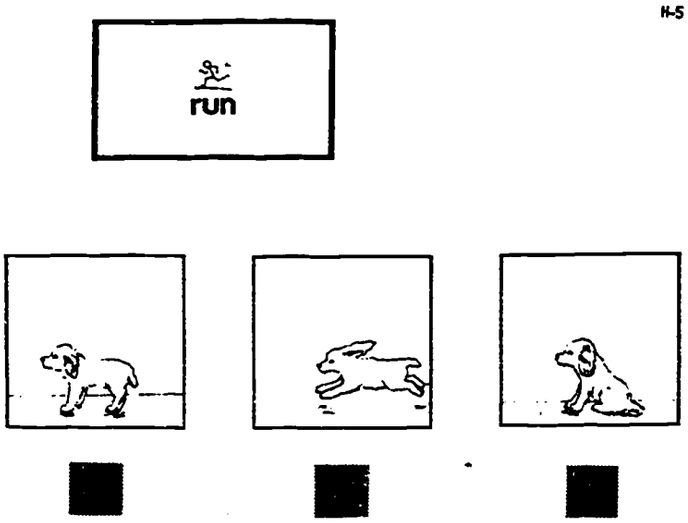


Previous frame type repeated for sit



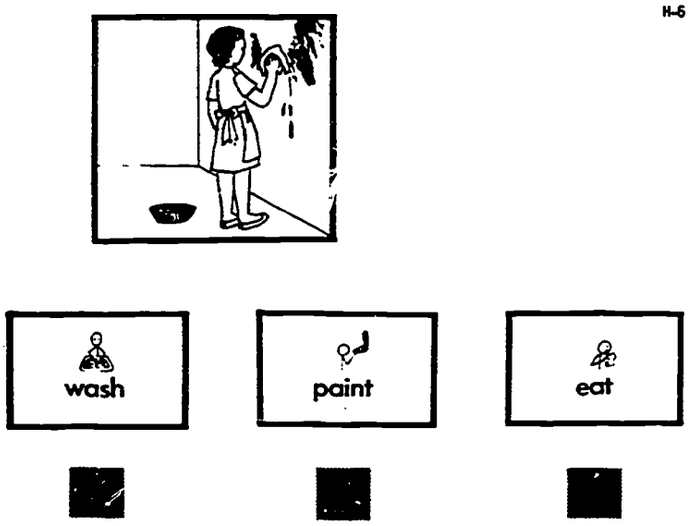
Previous frame type repeated for walk

H-5



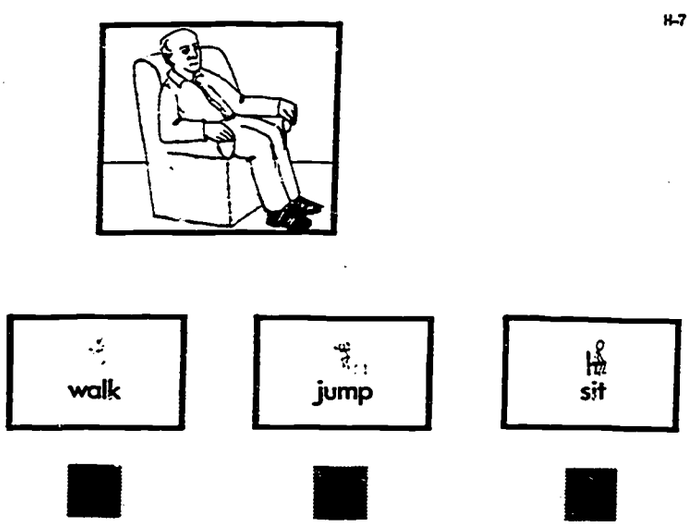
Previous frame type repeated for run

H-6



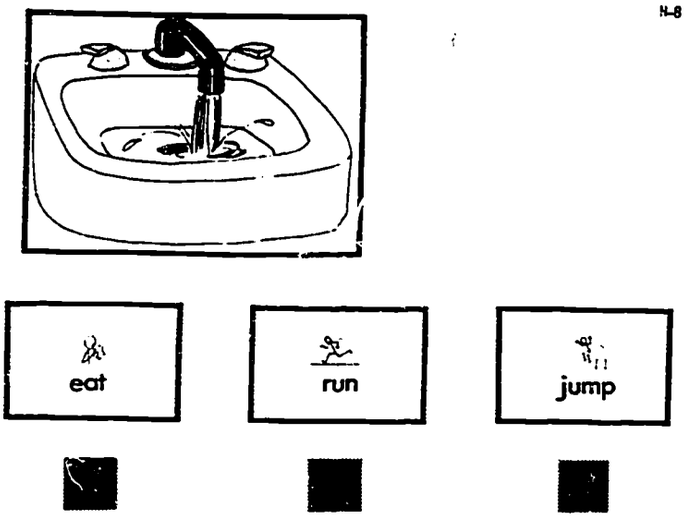
REVIEW - SETS ONE AND TWO:
Cued word response for wash (Set One)

H-7



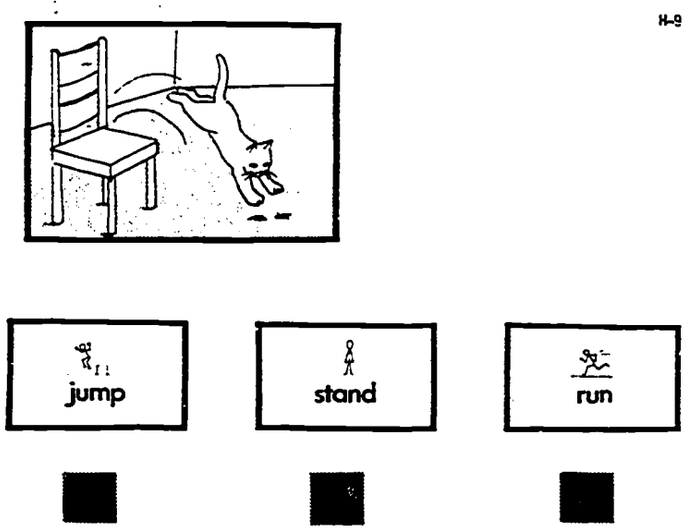
Previous frame type repeated for sit (Set Two)

H-8



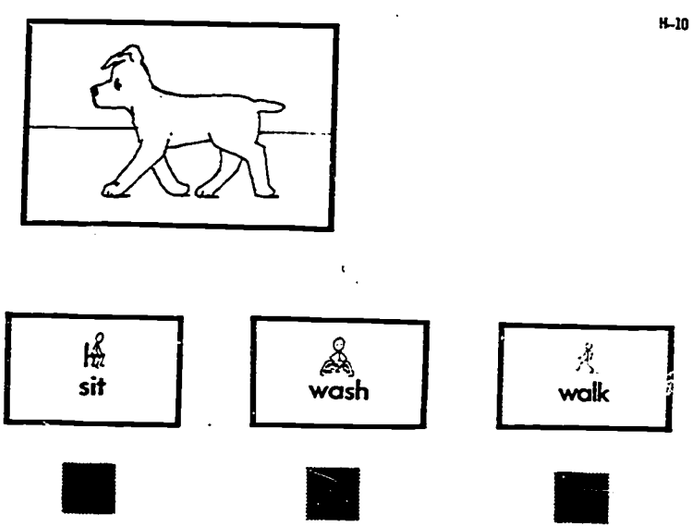
Previous frame type repeated for run (Set Two)

H-9



Previous frame type repeated for jump (Set One)

H-10



Previous frame type repeated for walk (Set Two)

H-11

paint | eat | wash

Previous frame type repeated for eat (Set One)

H-12

run | walk | stand

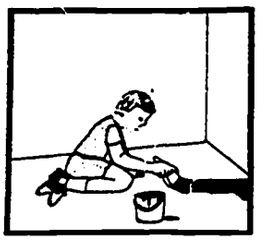
Previous frame type repeated for run (Set Two)

H-13

stand | jump | walk

Previous frame type repeated for stand (Set Two)

H-14



eat | wash | paint

Previous frame type repeated for paint (Set One)

H-15

jump | write | stand

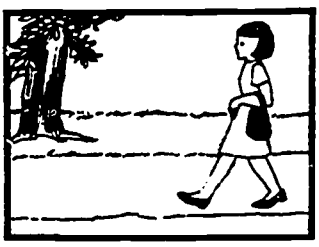
REVIEW - SETS ONE, TWO & THREE: Word terminal for write (Set Three)

H-16

stand | cook | jump

Previous frame type for jump (Set One)

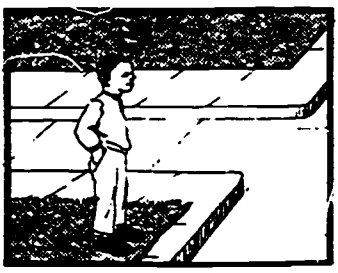
H-17



walk | paint | cook

Previous frame type for walk (Set Two)

H-18



wash | stand | drink

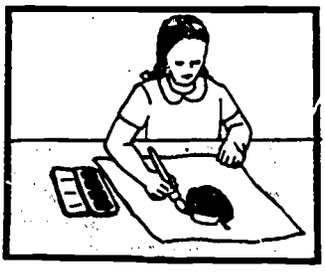
Previous frame type for stand (Set Two)

H-19

paint | sit | sleep

Previous frame type for sleep (Set Three)

H-20



drink | paint | run

Previous frame type for paint (Set One)

H-21

run | drink | jump

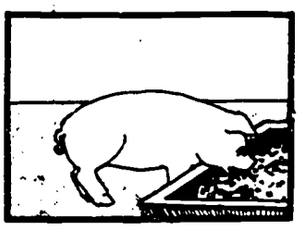
Previous frame type for run (Set Two)

H-22

eat | drink | walk

Previous frame type for drink (Set Three)

H-23



write | sit | eat

Previous frame type for eat (Set One)

H-26

walk | wash | sleep

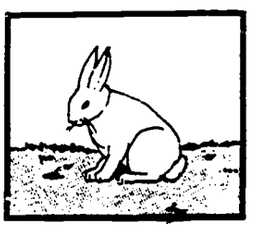
Previous frame type for wash (Set One)

H-24

cook | run | wash

Previous frame type for cook (Set Three)

H-27



sit | jump | write

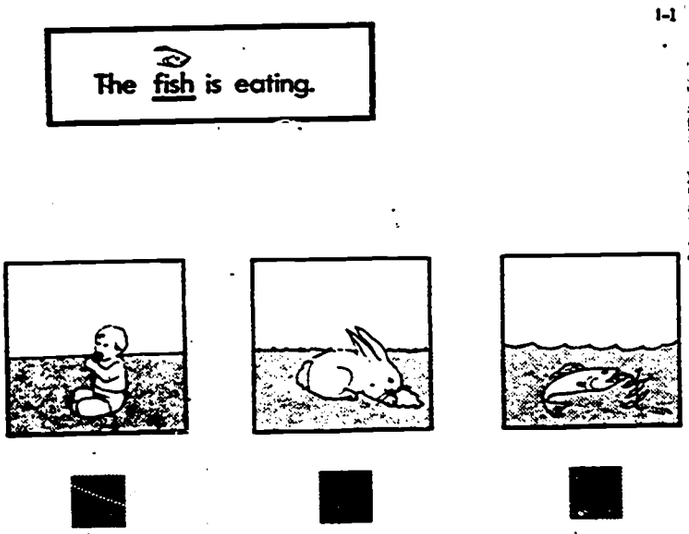
Previous frame type for sit (Set Two)

H-25

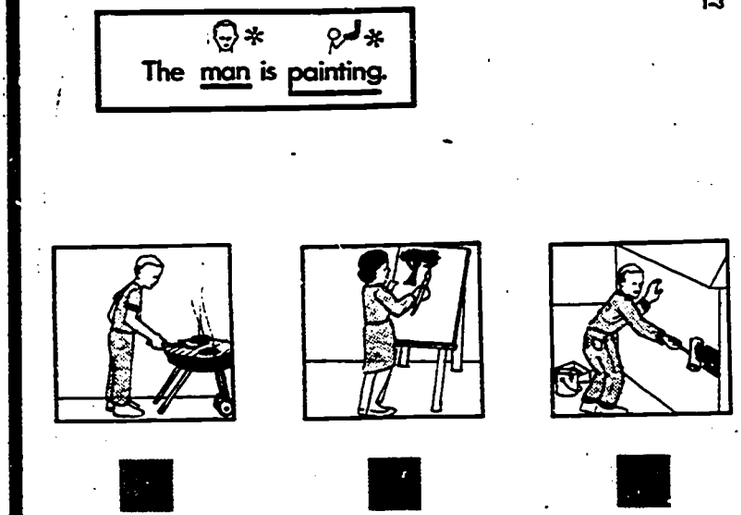
sleep | eat | run

Previous frame type for run (Set Two)

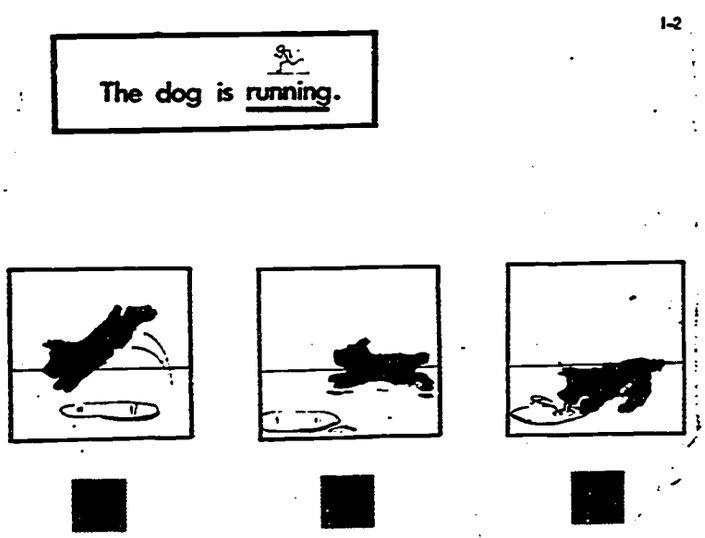
Section I reviews the picture response portion of sentence structure--the relationship of the verb to the subject. Various devices are used to induce the student to attend both the subject and the verb and to integrate them. Vocabulary from all three Sets is included.



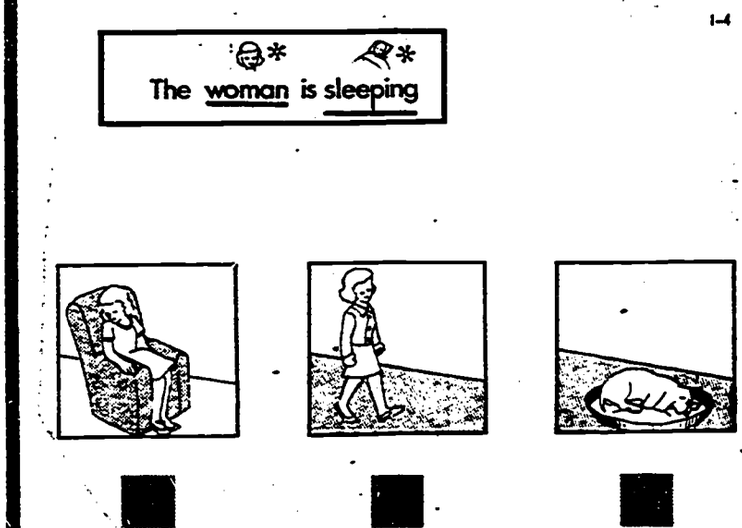
Must attend subject only; Alts. constant except for subject



Must integrate subject and verb
*Symbols are red for attention



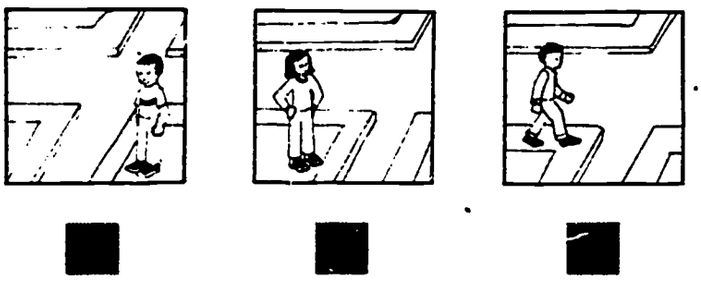
Must attend verb only; Alts. constant except for verb



Previous frame type repeated
*Symbols are red for attention

1-5

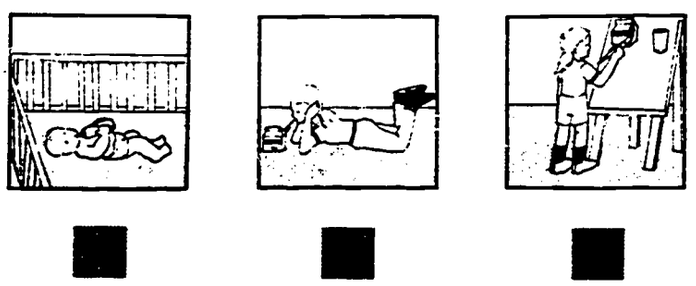
The boy is standing.



Previous frame type with red print dropped

1-6

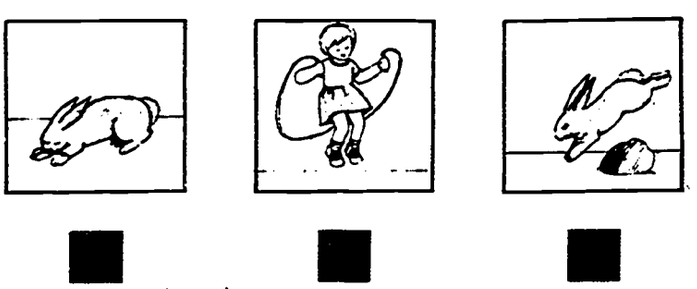
The girl is drinking milk.



Previous frame type

1-7

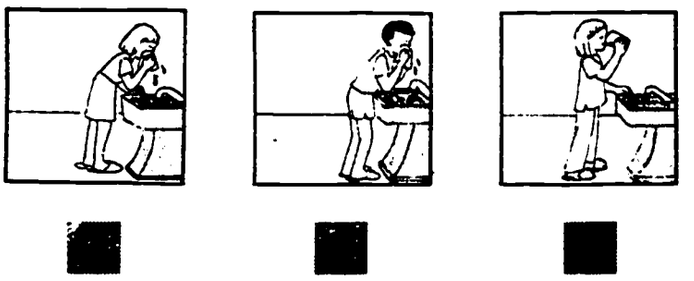
The rabbit is jumping. *



Must integrate subject and verb
*Red underscore for attention

1-8

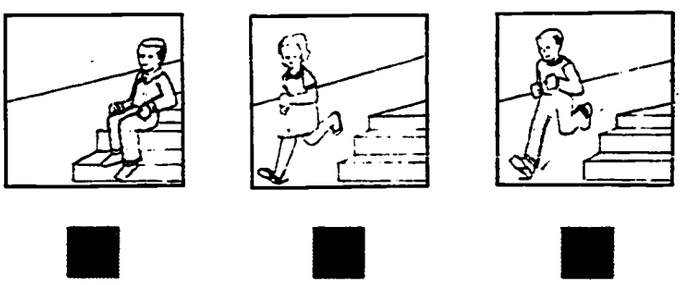
The girl is washing.



Frame type I-6 repeated

1-9

The man is running. *



Frame type I-7 repeated
*Red underscore for attention

1-10

The woman is cooking. *

Previous frame type
*Red underscore for attention

1-11

The boy is sitting.

Terminal frame; must integrate subject and verb without cues

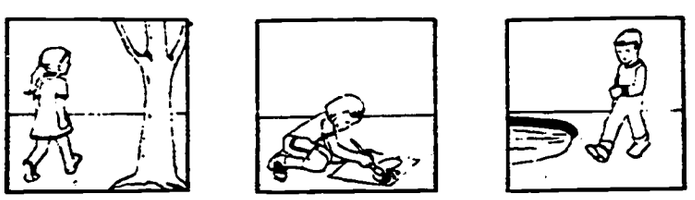
1-12

The woman is drinking.

Terminal frame

1-13

The girl is walking.



Terminal frame

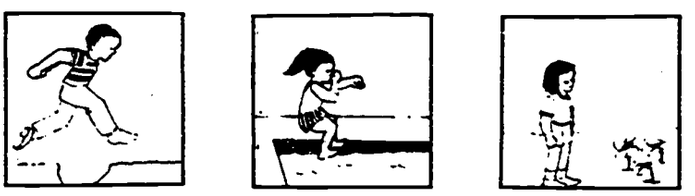
1-14

The boy is writing.

Terminal frame

1-15

The girl is jumping.



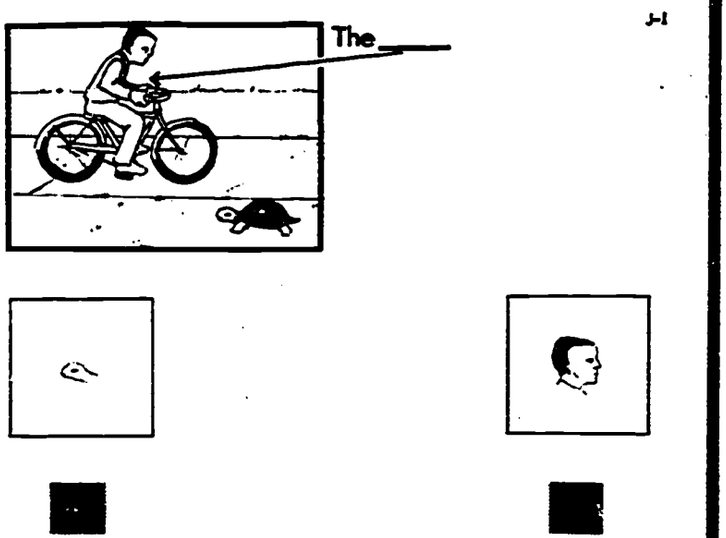
Terminal frame

1-16

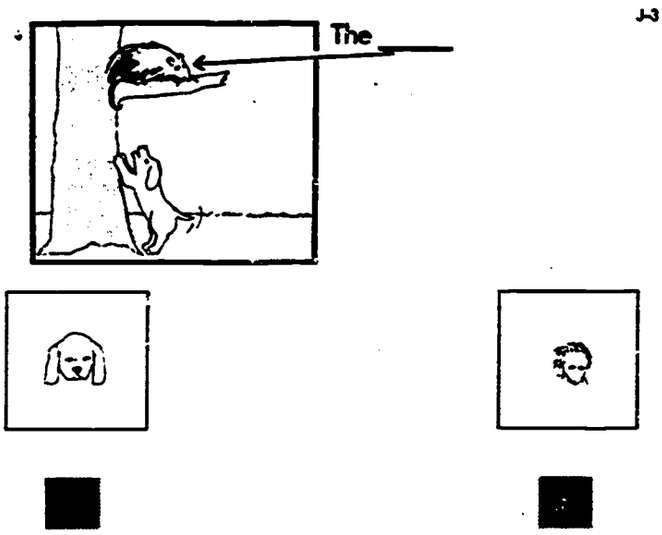
The man is washing an apple.

Terminal frame

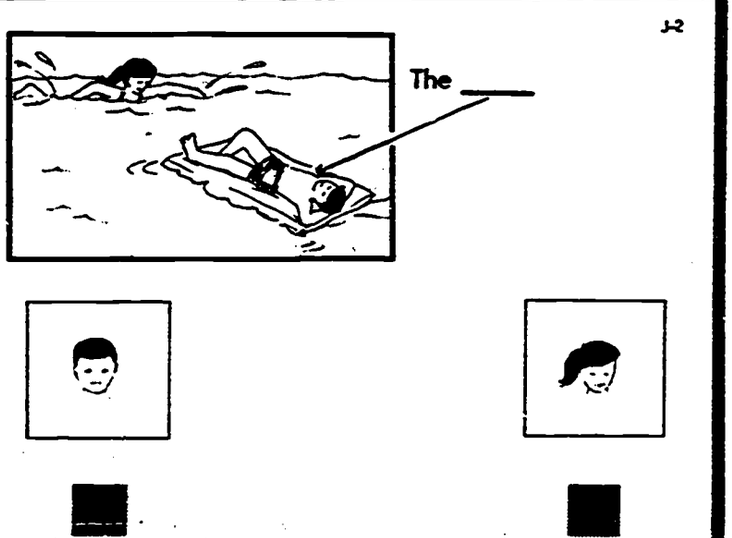
Section J reviews the word response portion of sentence structure--the relationship of the verb to the subject. Various devices are used to induce the student to attend to the subject in the sentence, locate it in the picture and select the appropriate verb. Vocabulary from all three Sets is included.



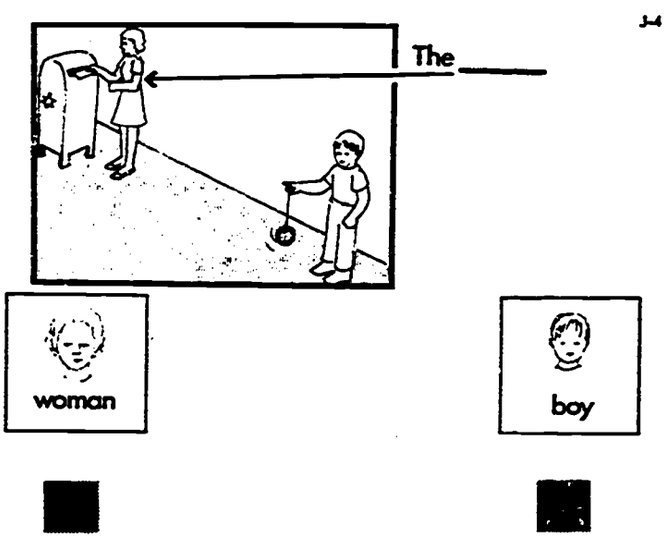
FUNCTION OF ARROWS (J-1 - J-4)
Must attend arrow to respond correctly



Previous frame type repeated; placement of subject in picture shifted

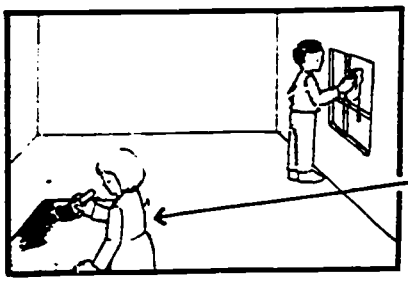


Previous frame type; placement of subject in picture shifted



Previous frame type with word added

J-5

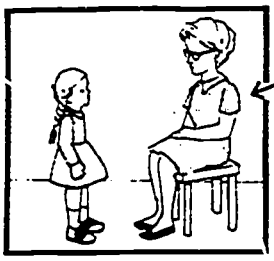


The girl is _____.

washing | painting | cooking

Must locate subject and select verb; symbols to facilitate reading task

J-6

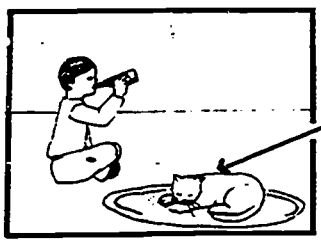


The woman is _____.

sitting | jumping | standing

Previous frame type repeated; placement of subject in picture shifted

J-7

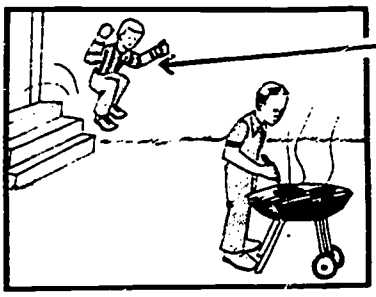


The cat is _____.

drinking | sleeping | walking

Previous frame type with response cues dropped

J-8

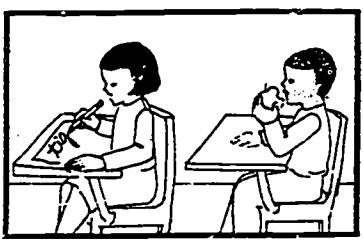


The boy is _____.

running | cooking | jumping

Previous frame type; placement of subject in picture shifted

J-9

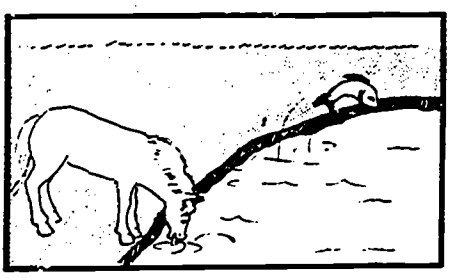


The boy is _____.
*

eating | writing | painting

Must attend subject and select verb
*Red underscore for attention

J-10

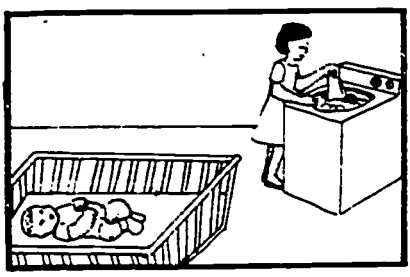


The horse is _____.

jumping | sleeping | drinking

Previous frame type; red underscore dropped

J-11

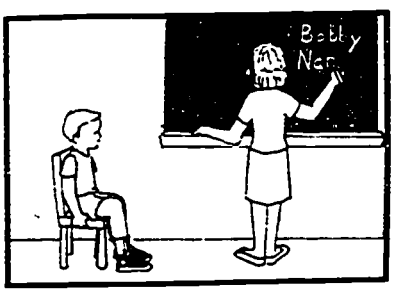


The woman is _____.
*

sleeping | washing | eating

Previous type, response cues dropped
*Red underscore for attention

J-12

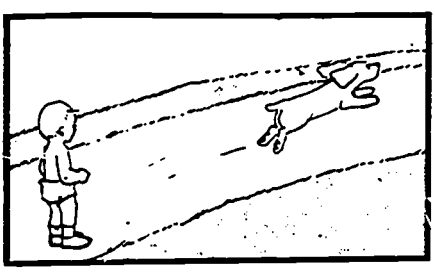


The woman is _____.

walking | writing | sitting

Previous frame type; red underscore dropped

J-13



The baby is _____.

standing | running | painting

Previous frame type repeated; placement of a subject in picture shifted

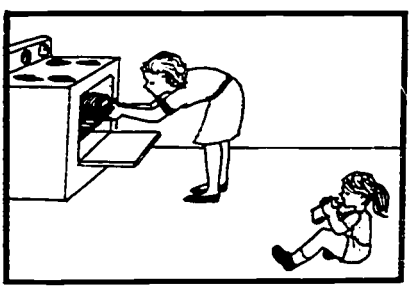
J-14

The girl is _____.

writing | drinking | walking

Must read subject and select verb
*Red underscore for attention

J-15

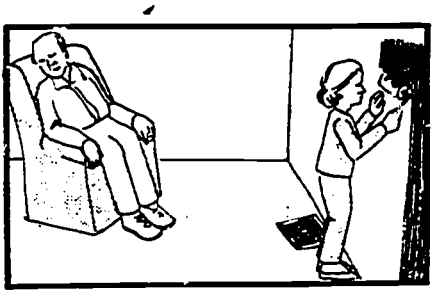


The woman is _____.

cooking | sitting | eating

Previous frame type; red underscore dropped

J-16

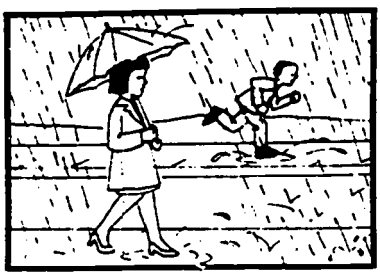


The man is _____

painting | sleeping | washing

Previous frame type; placement of subject in picture shifted

J-17



The man is _____.

walking | drinking | running

Terminal frame; all cues dropped

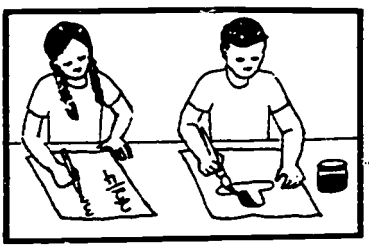
J-18

The bird is _____.

cooking | eating | sitting

Terminal frame

J-19



The boy is _____.

painting | jumping | writing

Terminal frame

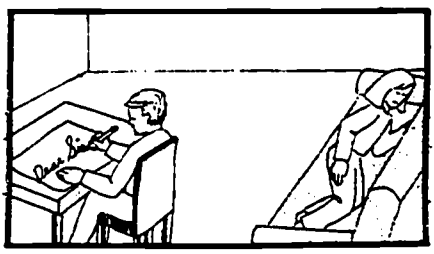
J-20

The girl is _____.

running | washing | cooking

Terminal frame

J-21

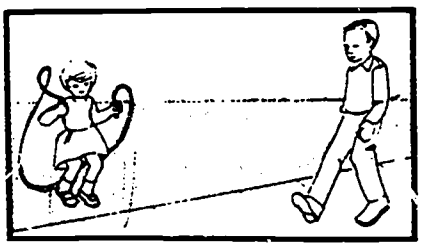


The boy is _____.

writing | standing | sleeping

Terminal frame

J-22



The man is _____.

jumping | walking | drinking

Terminal frame

Appendix C-1: Vocabulary Test Items for One Verb

9

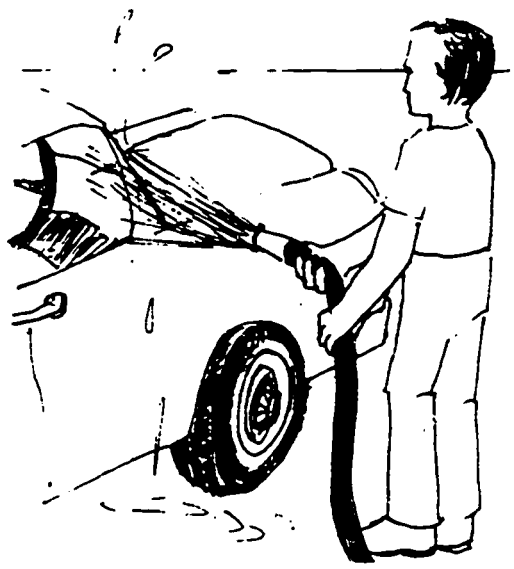
wash
cook
push
walk

(Photoreduced 10%)

17

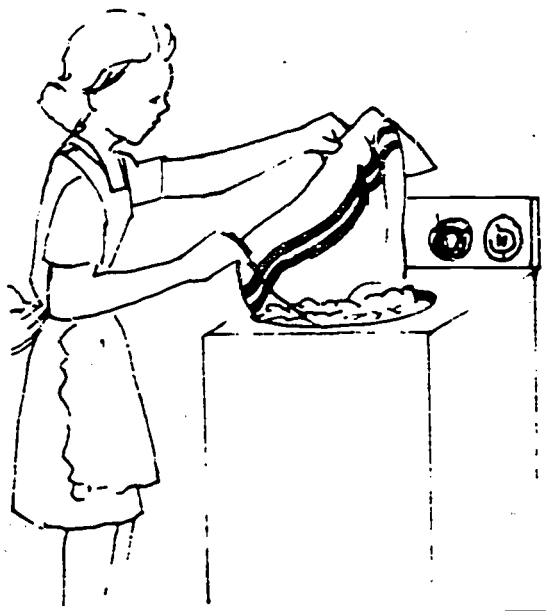
paint
wash
draw
stand

25



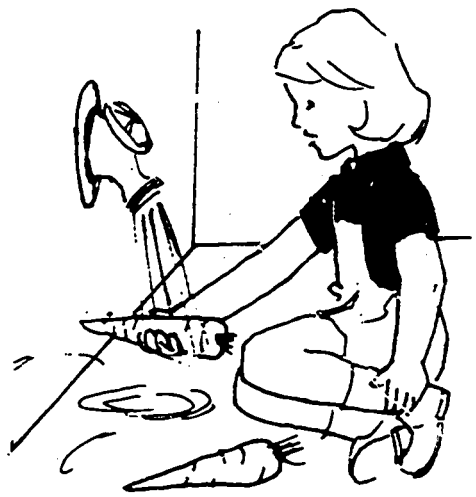
cut
drink
sit
wash

44



write
cook
wash
run

54



walk
wash
sleep
carry

Appendix C-2: Vocabulary Test Items for Two Nouns

(photoreduced 10%)

12

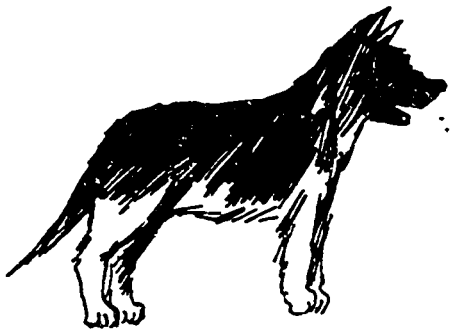
table

man

girl

woman

7



cat

horse

dog

ball

19

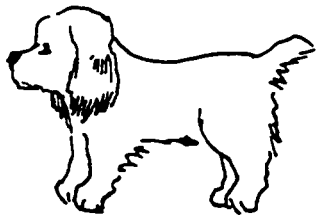
girl

woman

man

wagon

14



cat

dog

boy

doll

26

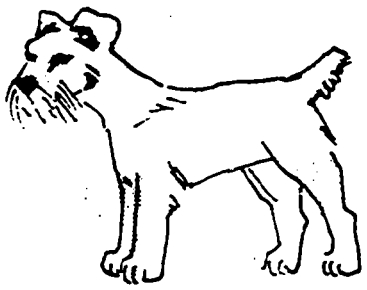
woman

room

mouse

girl

28



rat

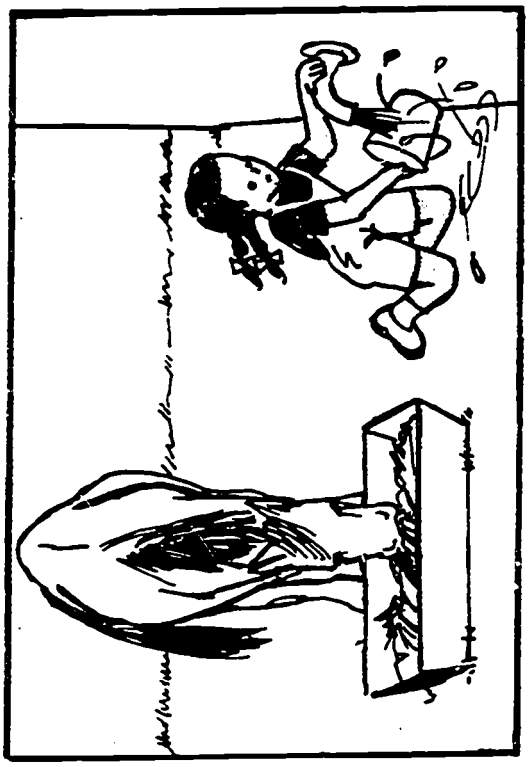
bird

bus

dog

Appendix C-3: Sentence Structure Test I

(Photored



The horse is _____.

jumping

washing

eating

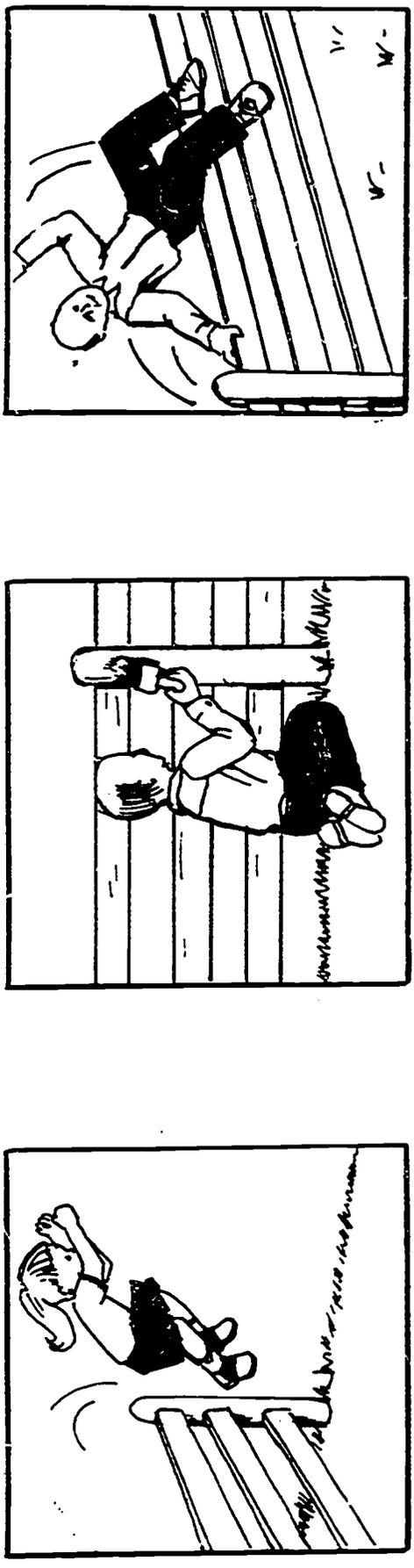
5

t Items

educed 10%)

17

The man is jumping.



Appendix D: Initial Behavior Testing-Training Sequence--Verbs, Day I

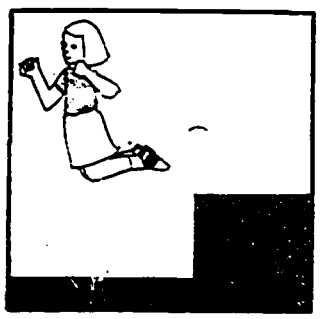
SECTION A--Procedure:

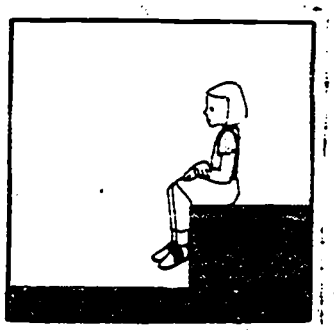
The instructor performs an action while the child watches.
A page containing verb pictures is exposed.
The child selects his response from these pictures.

(The following pictures are photoreduced. Actual pages are 8-1/2" x 11".)

Instructor jumps once across the floor.

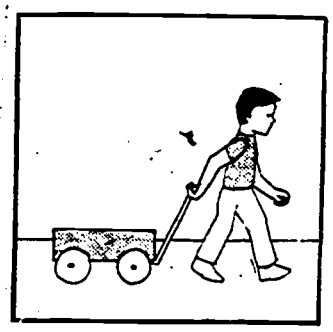
A-1.

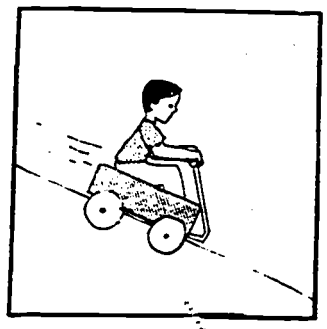




Instructor pulls a pull-toy.

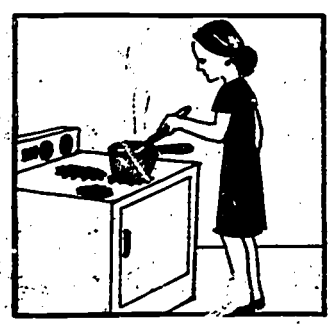
A-2.





Instructor sweeps with a broom similar to the one pictured and in a similar manner.

A-3.

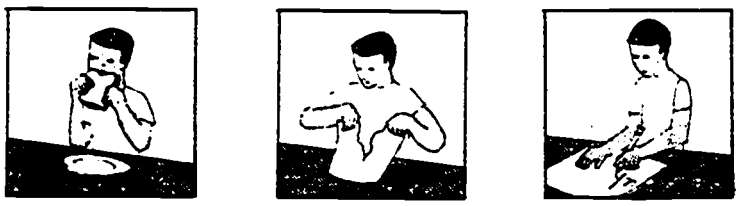


Instructor repeats the action.

A-4.

Instructor tears a small piece of cloth.

A-5.



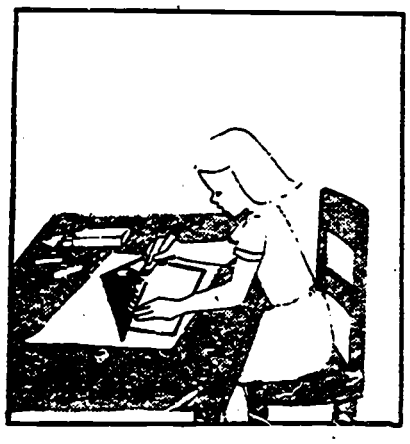
Instructor pours cereal from a box into a bowl.

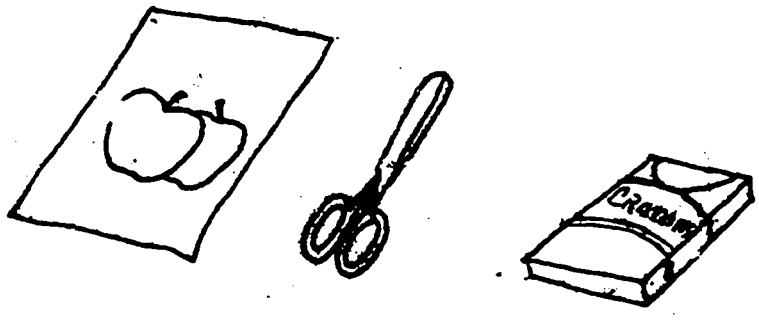
A-6.

SECTION B--Procedure:

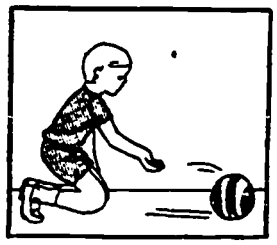
The child looks at a picture of an action (left).
He performs the action.
Necessary props are available on a mat (right).
Unnecessary props are included to prevent a response solely on the basis of the props.

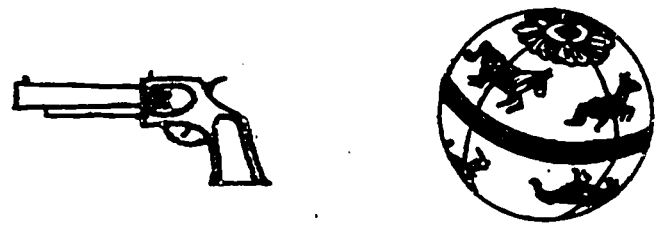
B-1.





B-2.

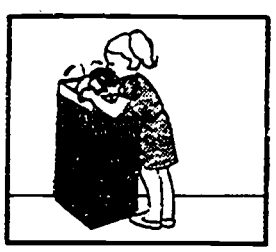




B-3.

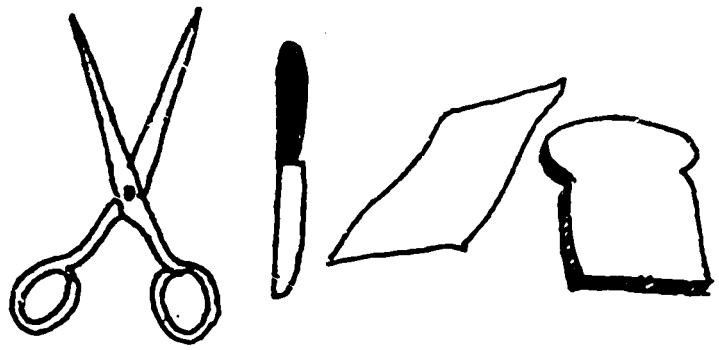
(Used props are removed, usually paper cup with water.)

B-4.



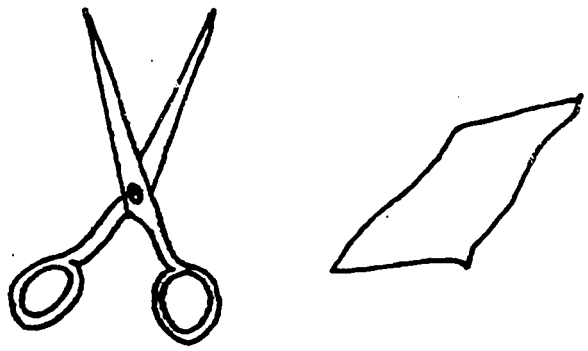
(Props remaining from B-3.)

B-5.



(Used props are removed, usually bread and knife.)

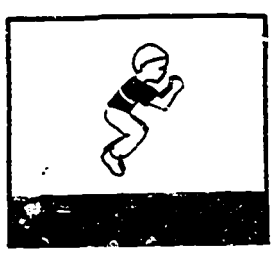
B-6.



(Props remaining from B-5.)

(Nc props are necessary for B-7 or B-8.)

B-7.

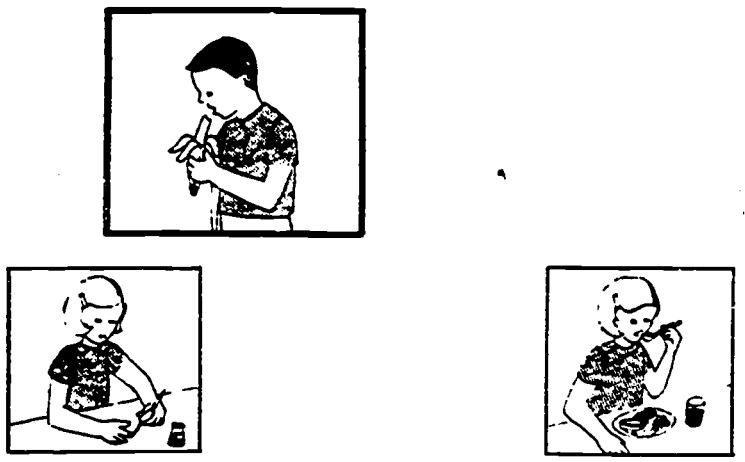


B-8.

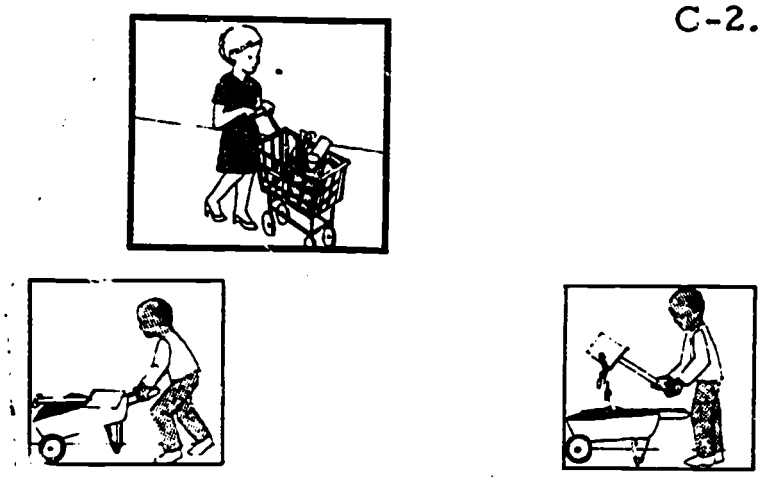
SECTION C--Procedure:

The instructor covers the response pictures (lower portion of page) with a shield.
The child looks at the stimulus picture (top of page).
The shield is removed and the child selects his response.

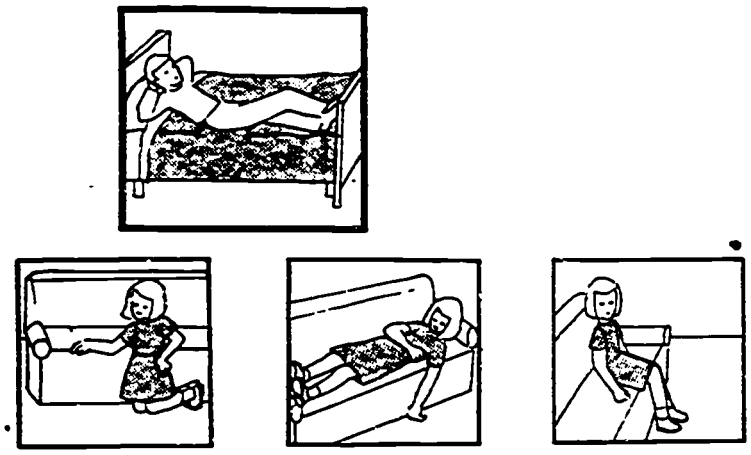
C-1.



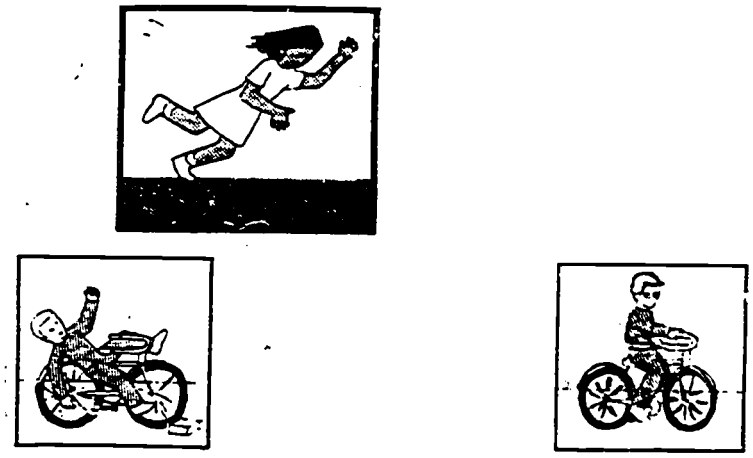
C-2.



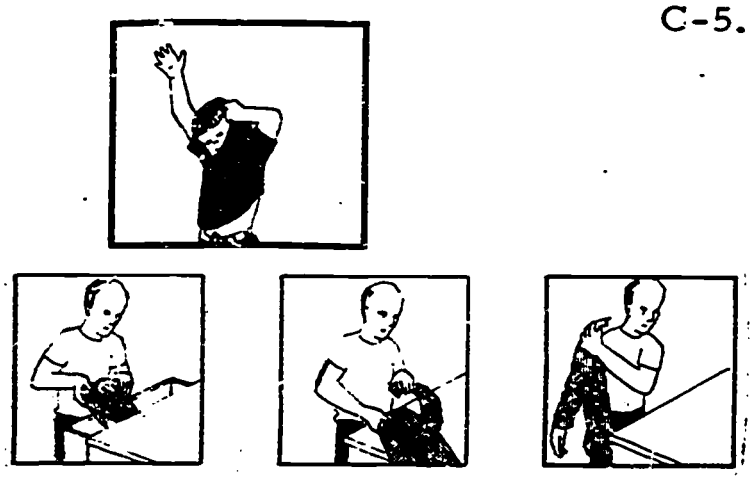
C-3.



C-4.



C-5.



Appendix E: Verb Use Test for the Deaf

In addition to the Program validation procedure, it was originally intended to compare the learning by the Program subjects with that of a control group. In order to obtain data for measuring the progress of the Program and the control subjects, the Verb Use Test for the Deaf was designed. Due to uncontrollable delays which occurred in the printing of conductive and non-conductive ink patches required for indicating Program responses, this aspect of the evaluation had to be abandoned. These problems are explained in Appendix F.

An outline of the developmental stages of the test is presented below, followed by standardization data obtained on 506 children from eight schools for the deaf.

TEST DEVELOPMENT

I. Selection of content
   A. Vocabulary
      1. Sources of vocabulary
         a. CID Language Outline (first three levels)
         b. Index--Instant Words (Words most used in reading and writing English) edited by Edward B. Fry, from word counts by Rinsland, Thorndike, Lorge, Horne, Fitzpatrick and Dolch
         c. School materials
            (1) Reading texts
            (2) Workbooks
      2. Vocabulary usage
         a. Multiple meanings of one verb
            (1) Selection of words
            (2) Selection of meanings for each word
         b. Multiple language for one situation
            (1) Selection of situations
            (2) Selection of language for each situation

   B. Tense
      1. Importance in communication
      2. Difficulty of construction
      3. Difficulty of time concept involved

II. Construction of items
   A. General requirements
      1. Situation within experience of children
      2. Simple accompanying vocabulary
      3. Visual clue relation subject in sentence to illustration

B. Vocabulary items
   1. Expressive
      a. Illustrations
         (1) Single pictures
         (2) Sequence of pictures
         (3) Sequence with conversation balloons
      b. Elliptical sentence with multiple choice response
   2. Receptive-parallel items for selected expressive items

C. Tense items
   1. Sequence with conversation balloons
   2. Time concept from illustration rather than "when" words

III. Revision procedure
   A. First field testing
      1. Subjects
         a. Deaf subjects
            (1) Tennessee School for the Deaf--42 children from Levels II, III and IV
            (2) Birmingham Day Program--ten children from Levels I, II and III
         b. Hearing subjects
            (1) Two first-grade classes
            (2) Two seventh-grade classes
            (3) Selected children between third and seventh grade levels
      2. Data obtained
         a. Item analysis
            (1) Item difficulty (proportion answering each item correctly)
            (2) Proportion choosing each incorrect alternative
            (3) Discriminating power (correlation of item with total score)
         b. Reliability

Table I. Summary of Reliability Coefficient According to Kuder-Richardson Formula 20 for Types of Test Items

Type of Test	r Coefficient
Expressive	
Part 1	0.967
Part 2	0.968
Receptive	0.832
Tense	0.517

3. Editing and reassembling of items
   a. Revision of faulty items
   b. Elimination of ineffective items
   c. Addition of new items
   d. Elimination of receptive sections to reduce receptive-expressive redundancy and shorten test length
   e. Arranging items from easy to difficult

B. Second field testing
   1. Subjects (deaf)
      a. Tennessee School for the Deaf--50 children from Levels II through VIII
      b. Tampa--nine children from Levels II through VIII
   2. Data obtained
      a. Item analysis
         (1) Item difficulty
         (2) Proportion choosing each incorrect alternative
         (3) Discriminating power
      b. Reliability

Table II. Summary of Reliability Coefficient According to Kuder-Richardson Formula 20 for Types of Test Items on Second Field Testing

Type of Test	r Coefficient
Vocabulary	
Items 1-100	0.967
Items 100-200	0.968
Tense	0.921

C. Division of Vocabulary items into alternate test forms--A and B
   1. Equalization of the following
      a. Multiple meaning for the same word
      b. Variation of language for same situation
      c. Necessity of comprehending entire sentence
      d. Special constructions
      e. Lexical categories
   2. Statistical considerations

Table III. Summary of the Statistical Bases for Division of Vocabulary Items into Alternate Forms for Section I (single pictures), Section II (sequences of pictures), and Section III (sequence plus conversation balloon).

Section	Form	Number of Items	Difficulty Range	Difficulty Mean	Mean r with Total Score
I	A	50	.97-.17	.55	.47
	B	50	.97-.12	.55	.46
II	A	27	.95-.25	.45	.50
	B	27	.88-.24	.46	.50
III	A	23	.75-.14	.39	.46
	B	23	.71-.12	.39	.48

D. Division of Tense items into alternate test forms--A and B.
   1. Equalization of the following
      a. Simple past
      b. Simple present
      c. Present progressive
      d. Future with will
      e. Future with present progressive of go plus infinitive
      f. Negative
   2. Statistical considerations

Table IV. Summary of Statistical Bases for Division of Tense Items into Alternate Test Forms

Form	Number of Items	Difficulty Range	Difficulty Mean	Mean r with Total Score
A	25	.51-.29	.41	.44
B	25	.57-.22	.41	.44

IV. Standardization
   A. Subjects--beginning in Levels III through VIII
      1. Alabama School for the Deaf
      2. Atlanta Speech School
      3. Dade County Public School Program for the Deaf (Miami)
      4. Florida School for the Deaf
      5. Georgia School for the Deaf
      6. Lexington School for the Deaf
      7. Nashville Public School Program for the Deaf
      8. North Carolina School for the Deaf (Morganton)

B. Administration of alternate test forms
   1. First testing
      a. Form A--sample one (approximately half the subjects)
      b. Form B--sample two (remaining subjects)
   2. Second testing (one week later)
      a. Form B--sample one
      b. Form A--sample two

Table V. Correlations between Vocabulary Scores, Tense Scores, and Total Scores of Forms A and B of the Verb Use Test for the Deaf. Samples drawn from children enrolled in eight schools for the deaf.

Age Level*	N	Vocabulary 100 Items	Tense 25 Items	Total 125 Items
8	38	.91	.75	.92
9	69	.92	.70	.93
10	88	.97	.88	.97
11	77	.96	.78	.96
12	98	.97	.85	.97
13	96	.96	.78	.95
14	40	.97	.89	.98

*The test was administered in October. Children reached the age shown between January 1 and December 31 of that year.

Table VI. Means* and Standard Deviations of Verb Vocabulary and Tense Scores on Forms A and B of the Verb Use Test for the Deaf. Samples drawn from eight schools for the deaf. Verb Vocabulary = 100 items with a chance score of 25, verb tense = 25 items with a chance score of 6.2.

Age Level	Vocabulary A		Tense A		Vocabulary B		Tense B	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
8	40.1	19.4	9.4	5.1	41.3	19.1	9.3	5.4
9	45.0	21.5	10.0	5.3	46.7	21.8	9.7	4.8
10	51.8	24.0	11.0	5.9	50.3	22.2	10.6	5.5
11	62.0	23.3	13.6	6.1	63.7	24.6	13.5	6.2
12	68.1	24.0	13.9	6.4	68.4	22.1	13.8	6.2
13	66.1	20.0	12.8	5.9	64.9	22.8	12.9	5.6
14	66.4	25.9	13.4	6.8	68.5	24.0	13.6	5.1

*t tests between Form A and Form B verb vocabulary means, age levels pooled, and between A and B verb tense means were less than 1.0.

Appendix F: Special Problems

Serious disruption of the project schedule resulted from the problems encountered with the printing of conductive and non-conductive ink patches required for the Program presentation. The reader is reminded that a student using the Program looks at a stimulus at the top of a page, selects his answer from three choices across the lower portion of the page and then touches the tip of the reinforcing device to the ink patch under his choice. The ink patch under the correct choice is printed with conductive ink and completes a circuit in the device causing it to light. The patches under the incorrect choices are non-conductive and therefore do not complete the circuit. In order to prevent student responses based on cues from the ink patches per se, all patches must be identical in appearance. An illustration of the Program presentation appears in (2.73) Final Model of the Teaching Machine.

When satisfactory samples of conductive ink patches had been printed and tested with the reinforcing device for consistency of response and durability, it appeared that the major problems associated with the method of presentation had been solved. However, it subsequently proved to be impossible to match the non-conductive patches, printed with conventional printers' ink, to the solid patch of conductive ink. Uniformity in appearance was then achieved by printing the non-conductive patches with the special base used for conductive ink, without the conductive component. Program samples printed by this method were carefully checked for appearance and conductive properties, and all problems appeared to be solved. Although the production schedule had been delayed to some extent, it still appeared possible to begin classroom use of Program materials according to the original field testing schedule.

When the first Program books were delivered, it was discovered that many of the wrong-answer patches (those under incorrect choices) contained sufficient conductive properties to activate the reinforcing device--thus incorrect responses would be reinforced. Efforts to determine the source of this contamination were confounded by the fact that those patches were changing in conductive properties with exposure to air. Materials which had been thoroughly checked upon delivery were later discovered to contain contaminated wrong-answer patches. The research departments of two ink companies were engaged by the printer in the search for a non-conductive ink which would match the conductive ink in appearance and could be used in a printing press. Since the conductive ink has an unusually flat finish, this task was a difficult one and approximately six weeks of fruitless research followed.

In the interim the project staff sought a solution which would permit the use of conventional ink for non-conductive patches. The method

eventually adopted involved the use of patterned ink patches which negated the visible differences in sheen between the two types of ink. The new design of the response patch did not immediately resolve all problems. The printing of a pattern fine enough to provide sufficient conductivity for the right-answer patches proved to be difficult because of the thick consistency of the special ink. In addition, some degree of contamination occurred in small areas of the wrong-answer patches; however, the degree of conductivity did not increase with exposure to air. Through the printer's persistent efforts to devise production methods which would eliminate contamination, it was gradually reduced in subsequent materials and virtually eliminated in the last books printed.

Although the problems associated with the special printing required for the Program were eventually resolved, the loss of time for classroom use of instructional materials seriously interfered with evaluation plans, which included both the validation of instructional materials and the comparison of Program subjects with a control group. Validation of instruction is considered a part of program development per se. A sample which is representative of the target population must use the materials under target conditions and their learning must be described by means of pretest and posttest measures. The validation tests cover the specific content of the instructional materials, and students are expected to achieve mastery on these tests after they have completed the program. In the present project, validation tests were administered only to students who used the Program.

In addition to validation, it was originally intended to compare achievement of Program subjects, in one state residential school and one private day school, with the achievement of control subjects. The control group consisted of students in the same levels at the same two schools during the previous school year. For this purpose an achievement test with alternate forms was developed and standardized.

The standardized achievement test was administered in September and May of the 1966-1967 school year to the children expected to be the control subjects. At the beginning of the experimental year (1967-1968) some delay in the production of materials had been encountered; however, it appeared that the original plans could still be executed on schedule. The standardized achievement test was administered to the state school children in Levels II, III and IV. It was expected that these children would constitute the major portion of the experimental group. Preliminary Program activities, including validation pretesting and the Initial Behavior Testing-Training Sequence, were also administered to these children in preparation for beginning the Program. The first Program books were delivered the evening before the designated time for their use and the schedule appeared to be going according to plan. It was then

discovered that wrong-answer patches were contaminated--these faulty materials could not be introduced to the students.

When acceptable materials were finally obtained, more than four months had elapsed; validation pretesting could no longer be considered valid and the effectiveness of IBT-TS was questionable. Project consultants advised against repeating these measures with the same children. It was apparent that the Program sample for which control data were available must be abandoned and that evaluations based on direct comparisons of control and experimental samples would not be possible.

It appeared that validation of the Program, considered the crucial aspect of the evaluation, would still be feasible; therefore a new sample was sought for this purpose. Since student use of the Program had been delayed from September until January, it was possible for students in their first year of school to participate. However, the number of Level I children in the two participating schools was not sufficient for the purpose of validation. The cooperation of another state school made it possible to obtain an adequate number of subjects and also to include children in Level II.

All problems with printing had not been resolved at the time the Program was introduced to the students. In spite of persistent efforts on the part of the printer to overcome production difficulties, delays continued to occur throughout the validation period. The last Set of the Program, consisting of six books, and one book of the previous Set could not be produced early enough in the school year to be used by the validation sample. The most unfortunate result of these delays was the loss of time necessary to validate these final portions of the Program--approximately 25% of the total Program Unit.

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Using Verbs: A Programmed Course for Deaf Children

ABSTRACT

The purpose of the project was to develop and field test a program of instruction for young deaf children which could be used in existing classrooms. The main Program contained two areas of instruction in written language--verb vocabulary at a high level of generalization and sentence structure. The Program materials were field tested with 78 children in the preparatory levels of three schools. The only criterion for admission to the sample was a simple test of minimum word recognition ability. Subjects ranged from five to ten years of age, and from three and one-half to ten and one-half years on psychometric scores.

Three validation criteria--one final performance criterion and two measures of gain--were applied in 28 instances to the pre-post-test data from the sample groups. The criteria were met in 21 instances. Of the 78 children, 77% achieved mastery in verb vocabulary, and 83% in sentences. Each of the sample groups evidenced statistically significant learning in all areas of instruction. The mean time required for the Program was 4.7 hours. It was concluded that the Program represents a very effective, as well as an efficient, method of teaching written language to young deaf children.