THE EFFECT OF DISCRIMINATION TRAINING ON
CONCEPT FORMATION SKILLS AND ACADEMIC ACHIEVEMENT

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by
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ABSTRACT

THE EFFECT OF DISCRIMINATION TRAINING ON
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by

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A visual discrimination concept formation training program for low achievers was given to a group of 53 fourth and fifth grade children over a period of three months. Transfer effects of the training procedures were assessed by the Cognitive Abilities Test (CAT) and by the Comprehensive Test of Basic Skills (CTBS).

A 3 x 2 factorial analysis of the CAT difference scores indicated no main effect of the training with the experimental group as a whole, as compared to the Control Group 1, which played educational games for equivalent time segments, or as compared to Control Group 2, which did not participate in any training activities. However, the analysis did reveal a group by grade interaction, and Duncan's Multiple Range Tests indicated that the fifth grade experimental group made significantly greater gains on the CAT than did any of the other groups except the two fourth grade control groups.

An analysis of variance of the CTBS difference scores showed only a main effect of grade, with fourth graders making significantly greater gains than fifth graders.

Possible reasons for this pattern of results were offered, along with suggestions for future research on this topic.
The Effect of Discrimination Training on Concept Formation Skills and Academic Achievement

In classroom situations it has been observed that slow learners often cannot discriminate between two similar complex stimuli. Objects that are similar in several respects but different in one or more important dimensions cannot be separated into different categories unless a discrimination of their differences can be made. Learners who cannot differentiate the invariant features of a category of objects find concept learning difficult. Gagné has described concept learning as establishment of a mediating response to stimuli which differ from each other physically" (Gagné, 1962, p. 312). Concept formation requires a discrimination and then a selection of the stimuli which contain the relevant dimensions and a rejection of the stimuli which do not.

For example, to form the class or concept of "square," one must experience an assortment of squares, attend to the relevant properties of equal angles and equal sides, ignore the properties of color and length of sides, and be able to see that those items are different from similar four-sided figures with equal angles or sides. The child who is unable to identify the relevant differences between a square and another kind of rectangle will not be able to learn the concept of a square.

Gagné contends that concept learning is a prerequisite to principle learning and problem solving, which he believes to be the highest order of learning. Conceptualization seems essential to all areas of academic achievement, and the few children who have not
developed this skill are severely handicapped.

The question might be asked whether training such children to recognize the critical features that identify a class of stimuli would facilitate classification skills, as well as transfer to learning many kinds of academic concepts in the classroom. For example, if children could be taught to recognize that the common attribute of "three-ness" is often marked by a common prefix in a group of vocabulary words such as tricycle, triangle, and triple, they should be able to apply that knowledge to unfamiliar words such as trifocal or triglyceride. If they could recognize the invariants and/or progressive changes in a group of arithmetic problems such as $23 \times 1 = 23$, $23 \times 10 = 230$, $23 \times 100 = 2300$, an important concept about place value could be learned. Recognizing the similarity between words such as dog, table, and lake, as distinguished from the words hopping, sweet, and oh, might permit them to readily recognize the concept of "things" which are called nouns.

The above examples relate to the process of transfer of training, defined by Ellis as "the influence of prior learning on performance in a new situation" (Ellis, 1972, p. 81). Transfer of training may be positive or negative and specific or general. Transfer is called positive if prior learning facilitates new learning, e.g. if knowing "pole, file, and late" facilitates the spelling and reading of "hole, pile, and date." This usually occurs when an old response to a new stimulus is required. Negative transfer occurs if prior learning interferes with new, and usually occurs when a new response to an old stimulus is required. For example, if after
identifying the common prefix tri- in triple, tricycle, and triangle, the child interprets the unfamiliar word "trifling" as "three flings," negative transfer has occurred.

Specific transfer requires common elements in both the old and the new learning tasks. The more elements in common which are shared by two tasks, the greater the amount of positive or negative transfer. Specific transfer has long been identified as a factor in human learning.

General positive transfer, or "learning to learn," refers to a facilitation of learning which can occur even when common elements in old and new learning tasks are not evident. For many years it was assumed that intellectual pursuits such as memorizing poetry, learning Latin, or studying logic would develop mental faculties, much as physical exercise develops muscles. This idea began to face disrepute after Thorndike published his Identical-Elements Theory in 1903. This theory stated that transfer depends on the presence of identical elements, either of substance or procedure, in the original learning and in the new learning which it facilitates (Hilgard & Bower, 1966).

Renewal of interest in a less global form of general transfer of training has been awakened since the concept of general transfer of training was studied in great detail by Harlow (1949). He found that during a long series of six-trial discrimination problems, monkeys showed progressive improvement from problem to problem, finally improving to near perfection on or after the second trial. Harlow claimed this finding reconciled the long-standing controversy
between theories of association learning and insight learning as to whether learning is an incremental gradual process or a sudden reorganization process. "This learning to learn transforms the organism from a creature that adapts to a changing environment by trial and error to one that adapts by seeming hypothesis and insight" (Harlow, 1949, p. 51).

Harlow attributes this phenomenon to a reduction in error factors.

"... A discrimination learning set is not a unitary change but is the resultant of a multiplicity of changes which have taken place at different rates and with different degrees of efficiency.... Learning curves can be drawn for each of the changes contributing to a learning set, such as elimination of stimulus perseveration errors, differential cue errors, and response shift errors" (Harlow, 1950, p. 38).

Subsequent studies by many investigators employing many types of learning problems (discrimination, reversals, transposition), and with infrahuman as well as human subjects have firmly established the existence of the learning to learn phenomenon. Reviewing a comprehensive body of these data, Harlow (1959) differentiated specific transfer (intraproblem or single-problem learning) from the learning to learn phenomenon (interproblem or multiple-problem learning, or learning set (LS)): "In spite of similarities between intraproblem and interproblem learning, the LS learning is dependent upon some capacity factor or factors transcending those needed for intraproblem learning of equivalent problems" (Harlow, 1959, p.504).

The development of the learning to learn capacity appears to coincide with ontogenetic and phylogenetic development. While the
development of individual problem learning occurs at an early age in any given species, development of learning set for the same kind of problem does not occur until much later. For example, rhesus monkeys can solve individual discrimination problems by sixty days of age, but are incapable of forming discrimination learning set before 150 days, and full capacity does not develop until two or three years of age. Likewise,

"single-problem learning is relatively uncorrelated with phyletic position among animals, whereas LS learning is highly related to the phyletic position. These data, therefore, support the position that some capacity of factor or factors operate to differentiate single-problem and multiple-problem acquisition" (Harlow, 1959, p. 508).

Duncan has also dealt extensively with the learning to learn phenomenon. He noted that,

"some type of habit that facilitates positive transfer can be developed when there is only a general similarity among tasks" (Duncan, 1958, p. 63).

"In asking what S learns it should be noted that we are not dealing with transfer which is based on stimulus or response generalization in the usual sense.... Rather we are concerned with the kind of nonspecific habit or skill that is similar to what has been called learning to learn or learning set, and that facilitates transfer among tasks which have overall similarity but which lack easily identifiable dimensions of stimulus or response similarity" (Duncan, 1958, p. 71).

Duncan theorized that the individual develops the habit of paying close attention to every stimulus in every set of problems, and that in this way he learns as a general transferable principle the value of looking carefully at each stimulus presented, "not only at its obvious characteristics, but also to any minor details" (Duncan, 1958, p. 71).
Many writers have attempted to specify the basis of the skill which develops from general experience with stimuli. For example, Crafts (1927) attributed it to the development of a habit of looking, searching, or exploring as antecedent to the final response; Kurtz (1955) to the development of "observing responses," Reid (1953) to a response of discriminating, and Eckland and Wickens (1954) to a "perceptual set" in which the subject becomes more sensitive to the relevant than to the irrelevant among the stimuli.

Thus it appears possible that if a habit of carefully examining stimuli to be classified could be developed in subjects, that habit might be expected to operate whenever mastery of academic content requires the learning of a new concept. If so, achievement should be facilitated thereby.

Other transfer of training studies have sought to determine some of the important training variables.

Training on a variety of tasks is more effective for general transfer than training on a single task, according to Duncan (1958). In his experiment with college students, varied training was accomplished by training on two, five, or ten different tasks. A one-task condition served as a control for varied training. There were 13 stimuli within each task. Each stimulus within a task was produced by drawing surplus lines over a basic figure, such as a circle, a letter, etc. A different basic underlying figure was used for each task so there was no obvious similarity of figures between tasks. All subjects were tested on two transfer tasks: specific transfer was tested using stimuli similar to the training task, i.e. each test
stimulus was produced by drawing surplus lines over a basic H figure. General transfer was tested using nonsense syllables. Results indicated that the greater the variation in training, the greater the general transfer.

A simultaneous presentation of instances of the concept results in more rapid concept learning than does successive presentation of instances, according to Cahill and Hovland's 1960 experiment using college students as subjects. Presumably this is so because the simultaneous presentation is less dependent on memory.

A combination of positive and negative instances of a concept produced more efficient learning than all positive or all negative in a study by Huttenlocher (1962). Wallach and Caron explained their similar findings in this statement,

"The characteristics we take as critical for defining a class depend not only on the positive exemplars of that class to which we have been exposed, but also on the particular sorts of negative exemplars that have been considered as a contrast" (Wallach & Caron, 1959, p. 461).

Explicit instructions about task goals are especially helpful with children of average ability. Osler and Weiss (1962) found that with the instruction to "Look at the picture to see something that will help you choose," children of average IQ improved, while children of high IQ remained the same. They interpreted this as an indication that lower IQ children may be less likely to engage in hypothesis testing unless instructed to do so.

Byers' (1967) study underscored the importance of hypothesis testing in concept formation. He found that college students were more successful in a concept attainment task if they were forced to
state a hypothesis after each trial than if they were permitted to
wait until they were ready. He theorized that learning to learn may
be in part due to the acquisition of mediational chains that usually
develop over a course of practice, and this can be facilitated by
requiring the subject to continually hypothesize.

Reward systems must be used carefully or they can have
unexpected and undesirable results. For instance, White (1963)
points out that the effectiveness of reward depends upon certain
characteristics of children used. Lower class children learn better
with a tangible reward, such as candy, while middle class children
learn well with a symbolic reward, such as a light flash.

Once a reward system has begun, failure to reward is dis-
ruptive (McGeoch, 1952), and can serve as a punishment (Spiker,
1960).

Furthermore, the reward itself can be disruptive. Miller
and Estes (1961) found that children given money rewards were less
efficient than others given only knowledge of results, probably
because they became preoccupied with "counting, gloating, and
worrying" over their hoard. The present experimenter has had
similar experiences in previous dealings with children.

The White and the Miller and Estes studies illustrate that
reward has at least two important functions: feedback for correct
responses, and motivation to respond correctly. Pribram (1964)
called these functions "informative and valuative." If children are
already motivated to respond correctly, only feedback is needed.
Fellows (1968) pointed to the importance of giving feedback during
the necessary "orienting-preparatory activity" instead of simply reinforcing the final response. Skinner (1955) recommends immediate and continuous feedback in which the child is given positive feedback for a correct response and is required to guess again for an incorrect response.

On the basis of the above evidence it would seem judicious not to give tangible rewards to participants at the beginning of the experiment, but to structure the training sessions so that maximum feedback would occur. In the event that reward becomes expedient to maintain motivation, it should not be based on the final response to each problem, and it should be minimal in amount and on an intermittent schedule.

The present study attempts to develop a visual discrimination concept formation training program for low achievers which, if successful, would improve their academic achievement in the classroom. It is hypothesized that if conceptualization difficulties are diminished, improved academic achievement could occur through the learning to learn transfer process. In this type of training the children would not be taught the specific content on which they would be tested later, but would be taught a method of looking for invariant properties of a class of stimuli, or of looking for regular progressions.

Because memory processes are involved when inherently meaningless labels such as noun, place value, or prefix are appropriately applied to many of the concepts routinely assessed by achievement tests, it is difficult to separate concept formation abilities from those of memory and other important variables. Guilford's (1959)
model for a Structure of the Intellect contains 120 areas formed by combining five operational factors, two of which are memory and cognition, with four content and six product factors. Guilford proposed that deficiencies in each area may be improved with practice, and Meeker (1969) has reviewed currently published tests, identifying those which would measure the various areas, and suggests general training activities to treat each diagnosed area of deficiency.

In the present experiment, precautions were taken to control for such important variables as memory by simultaneous rather than successive presentation of stimuli, by supplying a "facts sheet" during the pre and post achievement tests, etc., and motivation by giving equivalent time, attention, and reinforcement to a control group.

In summary, a survey of the literature has substantiated the existence of general transfer or learning to learn, although the phenomenon has not yet been experimentally demonstrated to improve academic achievement. The literature also can serve as a guide for devising a discrimination training program by providing relevant information about training stimuli, instructions, and reward systems.
METHOD

General procedure.

The sequence for the experiment was as follows:

a) All fourth and fifth grade students were pretested in mid-October on portions of the Comprehensive Test of Basic Skills (CTBS).

b) Low scoring subjects in each class were rank ordered by averaged CTBS scores. Members of each successive triad were randomly assigned to the experimental or one of the two control groups.

c) Subjects selected for the study were pretested in late October on portions of the Cognitive Abilities Test (CAT) to establish pre-training scores.

d) The experimental group and one control group participated in 18 training sessions over a period of ten weeks.

e) All three groups were given the CTBS and CAT as a post-test at the end of the fall semester and difference scores between pre and post-testing were obtained.

Subjects.

The subjects were fourth and fifth grade students at Elmhurst School, Ventura, California, a public school located in a largely white, middle-class socioeconomic neighborhood. The school was selected because the experimenter had been a fifth grade teacher there the previous year and was able to get the cooperation and support of the principal, the five teachers of the participating students, and the consent of parents of the participants.
The program was restricted to the fourth and fifth grades because the experimenter had administered the test instruments to the current sixth grade the preceding year as part of a pilot study for the present experiment. The third grade and below were excluded because there is some research evidence which indicates that young low-achievers might require work at the motor level before progressing to the level of tasks planned for this study (Footlik, 1970).

A letter describing the general nature of the experiment (see Appendix A) was sent home with the children on Friday, October 4, 1974 to obtain tacit parental consent. Parents of two fourth grade children requested the exemption of their children from the program.

Of the 140 potential subjects, sixty-four were evenly distributed in the two fifth grade classes, thirteen of the fourth graders were enrolled in a combination third-fourth grade class, and the other sixty-three possible participants were enrolled in regular fourth grade classes. Originally it had been planned to include seven children who were working at the fourth and fifth grade level in an Educationally Handicapped classroom. However, it was discovered that all of them were receiving training on a filmstrip program similar to the planned experiment. In addition, their teacher was hospitalized at that time with a terminal illness. For these reasons, these children were not used in the present study.

CTBS pre-testing.

The California Test of Basic Skills (1969) was originally chosen as a screening device and transfer test because it was the
achievement test routinely used by the school district. It was usually administered in October to all fourth and fifth graders, which would make it a convenient data source. (Also, it was hoped that evidence of increased scores on a recognized achievement test following the training program might influence the adoption of such training for regular classroom use where indicated.) Unfortunately, in 1974 the district decided to eliminate the CTBS from the regular testing program, so the tests were administered by the experimenter.

The four subtests of the CTBS selected for use were Language Mechanics (Test 3), Arithmetic Concepts (Test 7), Arithmetic Applications (Test 8), and Study Skills (Test 10). See Appendix B for sample items from these subtests. The experimenter judged these subtests to have a higher proportion of items requiring conceptualization than memorization of facts. To further minimize the importance of memory, information sheets (see Appendix C) containing facts relating to test questions on Tests 3, 7, and 8 were distributed to each child and read aloud by the experimenter before testing. For example, an item in the Arithmetic Concepts test is, "Of the following, which has the greatest divisor? 8) 16, 6) 28 ..." The information sheet supplied the following help: "In the problem 2) 6, 2 is the divisor, 3 is the quotient, 6 is the dividend." An extra four minutes were given in the administration on each of these tests to permit the subjects to consult the information sheets. Most subjects finished these subtests before the expiration of the testing period.
Before the experimenter read the conventional instructions from the examiner's manual, all of the subjects were told that the tests were part of an experiment to see how to help children learn better, and that some of them would be chosen for more testing and activities, depending on the kind of answers that were given. They were told they should not be nervous because the tests would not affect their grades, but that they should do their best.

The two fifth grades were tested together in the cafeteria. The two fourth grades were each tested in their classrooms because the cafeteria was not available during their scheduled test time. The seven Educationally Handicapped students were included with one regular class, and the twelve fourth graders from the combination class were included with the other regular fourth grade testing program.

For all groups the Language Mechanics and Study Skills subtests were administered during the afternoon of the first testing session, and the Arithmetic Concepts and Arithmetic Applications subtests were given on another afternoon. The fourth grades were pretested on Tuesday and Thursday, October 8th and 10th, with a "student free" day (teachers plan objectives; students stay home) intervening. The fifth grades were tested on Monday, October 14th and Tuesday, October 15th. Absentees were tested on Monday, October 21st. In addition to the two students eliminated by parents' request, two were omitted because they were absent during the pre-testing sessions. The total number pre-tested on the CTBS was 136: 63 fifth graders and 73 fourth graders,
Selection of subjects and assignment to groups.

The scores obtained by each subject on the CTBS subtests were converted to Expanded Standard Scores, as recommended by the CTBS Examiner's Manual, and averaged for each student. These averaged scores were rank ordered by teacher (See Appendix D) to control for specific content that might be taught by one or more teachers and tested on the CTBS. The lowest scoring subjects in each grade were selected without attempting to have an equal number of subjects in each grade, since it was hypothesized that only low scoring subjects would benefit from training, and a requirement of equal n's would have resulted in the selection of fifth graders with above average scores according to the publisher's norms. Consequently 34 fourth graders and 26 fifth graders were selected, of which 30 fourth graders and 23 fifth graders remained at the completion of the training and testing program.

The sixty subjects selected were randomly assigned to one of three groups: an Experimental Group, which participated in training activities designed to sharpen visual discrimination skills and to provide practice in concept formation, a Control Group 1, which received equivalent attention in activities which were not designed to provide practice in visual discrimination or concept formation, and Control Group 2, which did not participate in any training activities, but was simply given the pre and post-test instruments.

Random assignment to the groups was made by tossing two coins simultaneously for the first two subjects in each successive
triad of the rank ordered subjects. If the toss resulted in two heads, the subject was assigned to the Experimental Group, if a head and a tail resulted, he was assigned to Control Group 1, and if two tails resulted, he was assigned to Control Group 2. After the first two tosses, the third of the triad was assigned to the remaining group.

Unfortunately blocking by teachers (i.e. assigning all of one teacher's rank ordered subjects by triads, followed by the next teacher's subjects, etc.) significantly reduced the similarity of the CTBS pre-test scores within triads by grade level.

To prevent the detrimental effects which might occur if it were noticed that only low achievers were being selected, one or two of the highest scorers from each room were also included in subsequent pre and post-testing, i.e. they were treated the same as Control Group 2, except that tests were not scored and are not included in the present study.

**CAT pre-testing.**

Testing on the Cognitive Abilities subtests (1971; see Appendix E for sample items from this test) was done in groups of six subjects (two from the Experimental Group, two from Control Group 1, and two from Control Group 2, insofar as possible) in the small portable bungalow in which the training sessions were later conducted. One quantitative and two non-verbal subtests from the CAT were administered: Q-2 Number Series, NV-1 Figure Classification, and NV-2 Figure Analogies. These subtests were selected because they measure the ability to focus on a common characteristic or progressive change. Testing on the CAT began
October 28th and continued until November 8th. The subjects took only one CAT subtest per day.

**Group orientation.**

Prior to the first training activity the Experimental Group and Control Group 1, in groups of four each, were told that they had been chosen by tossed coins to participate in a training program, that many who had been tested would not take part in the project, and that they should not discuss the activities with anyone. Orientation of both groups was phrased to establish an expectation that the activities would improve their school performance; the only difference between the orientation of the groups was the description of the forthcoming activities. The twenty subjects (eleven fourth graders and nine fifth graders) in the Experimental Group were told that they would be playing games and doing things to make them look at things in a different way, i.e. to notice similarities and differences between things, that this would help them in their school work, and that later they would be tested again to find out how much it helped them. The twenty subjects (eleven fourth graders and nine fifth graders) of Control Group 1 were told that they would be playing educational games, that the games would help them in their school work, and that later they would be tested again to find out how much the games had helped them learn. The twenty subjects (twelve fourth graders and eight fifth graders) of Control Group 2 were given no instructions or attention until post-test time.

**Training schedule.**

Assignment of subjects to groups for training was made daily by shuffling the subjects' individual activity record card.
Groupings were determined by chance, except that a schedule conflict with the learning disabilities teacher had to be avoided for four students, personality clashes were prevented between a boy and his three "persecutors," and combinations of most single fifth graders with two or more fourth graders was avoided for the most part after it was discovered that many seriously resented being grouped with the younger students.

Before the training program began, a coin was flipped for each week to establish in advance whether a group of Control Group 1 subjects or a group of Experimental subjects would begin first, after which the groups were alternated for the remainder of the day and the rest of the week. The proposed schedule can be seen in Appendix F. It was followed with respect to selecting the first group for each day, but proved to be too inflexible to cope with the exigencies of the school program. For example, at the beginning, the method of selecting and sending for each group was too time consuming and had to be perfected. During the fourth week, it was found to be much more convenient to alternate the group activities after every two sessions, e.g. an activity was provided for two successive groups of four control subjects, then new materials were assembled for activities with two successive experimental groups, etc. Subjects were presented with a new activity each time they came to a training session, except that one activity was repeated for both grade levels of the control and experimental groups, as noted on the activity records (Appendix G.)

The projected number of training sessions had to be reduced
from 30 to 18 due to factors such as a two-week long minimum day schedule for parent conferencing, upper grade field trips, assemblies, holidays with attendant excitement and preparation for special programs, and a flu epidemic.

By Friday of the fourth week it was decided that a reward condition was needed to sustain interest and provide incentive for behavior conducive to learning. Therefore, a small candy reward was given for good behavior on a fixed-ratio intermittent schedule, i.e. payoff occurred for the group of four if a six appeared on a die tossed at the end of each session. This reward schedule remained in effect for the remainder of the training and testing program with the exception of the two sessions of CTBS post-testing in which all subjects were present simultaneously. The reward effectively renewed enthusiasm for the program and maintained the desired behavior.

Each training session was ten minutes long, and five minutes were allowed for children to get to and from classrooms. Typically the day began with the experimenter delivering notes to each teacher requesting the children who would be in the first group of subjects. When the children arrived they were seated at four desks. These desks were separated by three cardboard dividers for individual activities, but the dividers were removed for group activities. The desks were arranged in an L-shaped array with the experimenter seated at the inner angle to permit maximum contact. Occasionally, when appropriate to the activity, the experimenter and the subjects sat in a circle on the floor, making the atmosphere more informal.
When the groups were engaged in individual activities, the subjects usually worked on a series of problems, and the experimenter circulated among them continuously, confirming and praising correct answer, and giving hints, encouraging, and explaining why a choice was wrong for incorrect answers. Solutions were not given by the experimenter unless the subject was completely stymied or the training session was at an end.

During group activities the participants were required to withhold their responses or to whisper their answer to the experimenter until all others had arrived at a solution, thereby encouraging careful consideration of each problem by each subject.

When the ten minute timer went off, notes for the next group to be run were given to the children to deliver, the dice were tossed for reward (after the fourth week), necessary record keeping was done, and training materials were assembled for the next group.

The regular training sessions ended on January 23, 1975, after seven non-consecutive weeks, followed by three days of make-up sessions for the many recent victims of the flu epidemic and other absentees. Experimental subjects were given the activities they missed; Control Group 1 subjects were grouped for practice on three new makeup activities, as time was short and equal sessions and attention were the essential features of their training. Each subject participated in at least 16 training or activity sessions; most participated in 18 sessions.

By the end of training, seven subjects had to be dropped from the study for the following reasons: three moved, three missed more
than two of the 18 training sessions, and one withdrew from the program with the support of her parents because she felt it interfered with her classwork, although she volunteered to come alone every day after school. The final number of subjects were eighteen in the Experimental Group, eight from the fifth grade and ten from the fourth grade; eighteen in Control Group 1, eight from the fifth grade and ten from the fourth grade; and seventeen in Control Group 2, seven from the fifth grade and ten from the fourth grade.

Post-testing.

The CAT post-testing was begun in groups of six on January 23rd for the Experimental and Control Group 1 subjects who had completed all training, and for Control Group 2 subjects. Subjects were brought to the small bungalow and tested in the same manner as they had received during the training sessions and the CAT pre-testing. Each subject took a different CAT subtest on three occasions and was eligible for a small candy reward for good behavior contingent upon the dice toss at the end of each session.

The CAT post-testing sessions continued thus except for a five-day interruption between February 3rd and 8th when the experimenter was bedridden with the flu.

The CTBS subtests were administered to all experimental and control groups together in the cafeteria; Language Mechanics and Study Skills subtests were administered on January 28th, and Arithmetic Concepts and Applications subtests were administered on January 29th.
The program was concluded when the last of the absentees were tested on February 19, 1975.
RESULTS

To test the hypothesis that discrimination training would improve concept formation skill, a 3 x 2 factorial analysis of variance was performed on the CAT pre-post test difference scores. The summary table for this analysis is given in Table 1. The analysis shows no significant main effect for the three groups or for the two grades used, but does indicate a significant group by grade interaction. Duncan's Multiple-Range Test for Nearly Equal ns performed on the individual group means indicates that the fifth grade experimental group made significantly higher gains on the CAT than any of the other groups except the two fourth grade control groups. Differences among the other groups were not significant. The means and standard deviations of the CAT pre-test, post-test and difference scores by group and by grade are listed in Table 2. Thus the hypothesis was only partially supported in the case of the fifth grade experimental subjects.

The 53 subjects in the experiment were taught by five different teachers. To see whether there were differences in the gains obtained on the CAT by the children in these classes, a one way analysis of variance was performed on the CAT difference scores. The F was 0.1274 (df=4, 48) and not statistically significant. The obtained CAT difference means are listed in Table 5. An analysis of variance was similarly conducted on the CAT pre-test scores, and the F was <1.0.

The hypothesis that improvement in academic achievement
<table>
<thead>
<tr>
<th>Source</th>
<th>M.S.</th>
<th>df</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>133.325</td>
<td>52</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between</td>
<td>247.922</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group</td>
<td>71.307</td>
<td>2</td>
<td>0.5887</td>
<td></td>
</tr>
<tr>
<td>Grade</td>
<td>42.114</td>
<td>1</td>
<td>0.3477</td>
<td></td>
</tr>
<tr>
<td>Grade x Group</td>
<td>527.440</td>
<td>2</td>
<td>4.3542</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Within</td>
<td>121.134</td>
<td>47</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### TABLE 2

**MEAN CAT SCORES**

<table>
<thead>
<tr>
<th></th>
<th>Grade 4</th>
<th></th>
<th>Grade 5</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Experimental</td>
<td>Control 1</td>
<td>Control 2</td>
<td>Total</td>
</tr>
<tr>
<td></td>
<td>Mean S.D.</td>
<td>Mean S.D.</td>
<td>Mean S.D.</td>
<td>Mean S.D.</td>
</tr>
<tr>
<td>PRE-TEST</td>
<td>76.15 11.4</td>
<td>68.70 13.5</td>
<td>72.05 15.2</td>
<td>72.30 6.1</td>
</tr>
<tr>
<td></td>
<td>(n=10)</td>
<td>(n=10)</td>
<td>(n=10)</td>
<td>(n=10)</td>
</tr>
<tr>
<td>POST-TEST</td>
<td>78.30 7.3</td>
<td>80.15 9.3</td>
<td>78.50 12.7</td>
<td>78.98 7.2</td>
</tr>
<tr>
<td></td>
<td>(n=10)</td>
<td>(n=10)</td>
<td>(n=10)</td>
<td>(n=10)</td>
</tr>
<tr>
<td>DIFFERENCE SCORES</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(post-test minus pre-test)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Experimental</td>
<td>Control 1</td>
<td>Control 2</td>
<td>Total</td>
</tr>
<tr>
<td></td>
<td>Mean S.D.</td>
<td>Mean S.D.</td>
<td>Mean S.D.</td>
<td>Mean S.D.</td>
</tr>
<tr>
<td></td>
<td>2.15 14.3</td>
<td>11.40 9.9</td>
<td>6.45 8.0</td>
<td>6.67 8.8</td>
</tr>
<tr>
<td></td>
<td>(n=10)</td>
<td>(n=10)</td>
<td>(n=10)</td>
<td>(n=10)</td>
</tr>
<tr>
<td></td>
<td>16.44 15.0</td>
<td>4.75 6.7</td>
<td>4.21 9.0</td>
<td>8.65 9.1</td>
</tr>
<tr>
<td></td>
<td>(n=8)</td>
<td>(n=8)</td>
<td>(n=8)</td>
<td>(n=8)</td>
</tr>
</tbody>
</table>

**Control 2**

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
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<td>Experimental</td>
<td>Control 1</td>
<td>Control 2</td>
<td>Total</td>
</tr>
<tr>
<td></td>
<td>Mean S.D.</td>
<td>Mean S.D.</td>
<td>Mean S.D.</td>
<td>Mean S.D.</td>
</tr>
<tr>
<td></td>
<td>80.64 15.9</td>
<td>16.44 15.0</td>
<td>11.40 9.9</td>
<td>78.69 14.7</td>
</tr>
<tr>
<td></td>
<td>(n=8)</td>
<td>(n=8)</td>
<td>(n=8)</td>
<td>(n=8)</td>
</tr>
<tr>
<td></td>
<td>70.64 15.9</td>
<td>4.75 6.7</td>
<td>4.21 9.0</td>
<td>84.94 9.0</td>
</tr>
<tr>
<td></td>
<td>(n=7)</td>
<td>(n=8)</td>
<td>(n=8)</td>
<td>(n=8)</td>
</tr>
</tbody>
</table>

**Total**

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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<tbody>
<tr>
<td></td>
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<td>Control 1</td>
<td>Control 2</td>
<td>Total</td>
</tr>
<tr>
<td></td>
<td>Mean S.D.</td>
<td>Mean S.D.</td>
<td>Mean S.D.</td>
<td>Mean S.D.</td>
</tr>
<tr>
<td></td>
<td>72.30 6.1</td>
<td>72.70 6.7</td>
<td>72.05 15.2</td>
<td>78.30 7.3</td>
</tr>
<tr>
<td></td>
<td>(n=30)</td>
<td>(n=23)</td>
<td>(n=10)</td>
<td>(n=10)</td>
</tr>
<tr>
<td></td>
<td>81.35 8.6</td>
<td>81.35 8.6</td>
<td>78.98 7.2</td>
<td>84.94 9.0</td>
</tr>
<tr>
<td></td>
<td>(n=23)</td>
<td>(n=23)</td>
<td>(n=10)</td>
<td>(n=10)</td>
</tr>
</tbody>
</table>

**Total Mean**

- Grade 4: 72.30
- Grade 5: 84.94

**Total Mean**

- Grade 4: 72.70
- Grade 5: 81.35
would occur between pre and post testing was tested by a 3 x 2 factorial analysis of variance of the CTBS difference scores. The result of this analysis is shown in Table 3. The analysis shows a significant main effect for grade with the fourth grade showing superior gains in academic achievement over the fifth grade. Multiple comparisons (Duncan's) among these means showed that only fourth grade Control Group 1 differed significantly from the fifth grade Control Group 2. All of the other comparisons were not significant. Table 4 shows the means and standard deviations of CTBS pre-test, post-test, and difference scores by group and by grade.

Figure 1 shows the difference in the mean rate of gain on the CTBS test between the three fourth and the three fifth grade subjects in each group who scored the lowest on the CTBS pre-test and the three who scored the highest in each group on the pre-CTBS. From this figure it can be seen that the lowest scoring subjects in the Experimental Group and the Control Group 1 seemed to make greater gains than did the high scoring subjects of these groups. It was these two groups who had actual contact with the experimenter. An indication of the opposite trend is evident in Control Group 2, which received no training from the experimenter. (No statistical tests of these differences in trends were performed).

Academic achievement was significantly affected by assignment to teacher. A one way analysis of variance of the CTBS difference scores by teacher revealed an $F = 13.3$ (df=4, 48, $p < .05$). Individual means of the difference scores showing this teacher effect
### TABLE 3

**SUMMARY OF ANALYSIS OF VARIANCE**

**CTBS DIFFERENCE SCORES**

<table>
<thead>
<tr>
<th>Source</th>
<th>M.S.</th>
<th>df</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>2419.493</td>
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<td></td>
</tr>
<tr>
<td>Between</td>
<td>6149.066</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group</td>
<td>1361.618</td>
<td>2</td>
<td>0.6732</td>
<td></td>
</tr>
<tr>
<td>Grade</td>
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<td>&lt; .0012</td>
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<td>1207.197</td>
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<td>0.5968</td>
<td></td>
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<tr>
<td>Within</td>
<td>2022.730</td>
<td>47</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### TABLE 4

**MEAN CTBS SCORES**

#### PRE-TEST

<table>
<thead>
<tr>
<th></th>
<th>Experimental Mean S.D.</th>
<th>Control 1 Mean S.D.</th>
<th>Control 2 Mean S.D.</th>
<th>Total Mean S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 4</td>
<td>349.62 36.7 (n=10)</td>
<td>344.95 29.2 (n=10)</td>
<td>352.80 25.6 (n=10)</td>
<td>349.12 (n=30)</td>
</tr>
<tr>
<td>Grade 5</td>
<td>387.66 39.5 (n=8)</td>
<td>385.44 30.4 (n=8)</td>
<td>397.25 27.9 (n=7)</td>
<td>389.80 (n=23)</td>
</tr>
</tbody>
</table>

#### POST-TEST

<table>
<thead>
<tr>
<th></th>
<th>Experimental Mean S.D.</th>
<th>Control 1 Mean S.D.</th>
<th>Control 2 Mean S.D.</th>
<th>Total Mean S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 4</td>
<td>410.48 26.4 (n=10)</td>
<td>416.70 46.2 (n=10)</td>
<td>416.60 44.5 (n=10)</td>
<td>414.59 (n=30)</td>
</tr>
<tr>
<td>Grade 5</td>
<td>416.66 40.37 (n=8)</td>
<td>419.22 35.6 (n=8)</td>
<td>400.71 63.9 (n=7)</td>
<td>412.70 (n=23)</td>
</tr>
</tbody>
</table>

#### DIFFERENCE SCORES

(post-test minus pre-test)

<table>
<thead>
<tr>
<th></th>
<th>Experimental Mean S.D.</th>
<th>Control 1 Mean S.D.</th>
<th>Control 2 Mean S.D.</th>
<th>Total Mean S.D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 4</td>
<td>60.88 42.1 (n=10)</td>
<td>71.75 52.6 (n=10)</td>
<td>66.75 33.7 (n=10)</td>
<td>66.46 (n=30)</td>
</tr>
<tr>
<td>Grade 5</td>
<td>29.00 54.7 (n=8)</td>
<td>27.25 35.1 (n=8)</td>
<td>3.39 49.0 (n=7)</td>
<td>22.87 (n=23)</td>
</tr>
</tbody>
</table>
Figure 1. Comparison of the mean CTBS difference scores obtained by the three highest or lowest scoring subjects in each group.
are listed in Table 5. Multiple comparisons (Duncan's) among these means showed that the scores of Teacher 3 subjects were higher than those of the other teachers. There were no significant differences between the other teachers.

A product-moment correlation analysis revealed a correlation of $r = -0.24$ between the pre and post CAT scores for the experimental group, but a fairly high positive pre-post CAT correlation $r = 0.78$ and $r = 0.84$ for the two control groups. The correlations between the CTBS pre-post test scores, however, were notably low: $r = 0.13$, $r = 0.20$, and $r = 0.36$ for the experimental, control 1 and control 2 groups respectively.

The scores for the individual subjects on the CAT pre and post tests are given in Appendix H, for the CTBS pre and post tests in Appendix I, and for the CAT and CTBS difference scores in Appendix J.
**Table 5**

Mean Pre-test and Difference Scores Showing Teacher Effect

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Grade</th>
<th>n</th>
<th>Pre-test</th>
<th>Differences</th>
<th>CAT Mean Scores</th>
<th>CTBS Mean Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5</td>
<td>11</td>
<td>77.36</td>
<td>9.05</td>
<td>387.16</td>
<td>39.70</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>12</td>
<td>68.42</td>
<td>8.29</td>
<td>392.23</td>
<td>7.44</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>4</td>
<td>78.12</td>
<td>7.38</td>
<td>334.81</td>
<td>135.44</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>12</td>
<td>71.95</td>
<td>8.03</td>
<td>353.65</td>
<td>62.27</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>14</td>
<td>70.93</td>
<td>5.25</td>
<td>350.20</td>
<td>50.34</td>
</tr>
</tbody>
</table>
DISCUSSION

The first hypothesis proposed in this study was that training in discrimination and concept formation skills would improve the performance of low achieving experimental subjects beyond that which might occur from maturation alone in three months time. This attempt to develop concept formation skills was apparently successful with fifth graders, since their CAT difference scores were significantly higher than either of the two fifth grade control groups. However, the evidence is clear that this did not occur with the fourth grade experimental subjects, whose CAT difference scores were not significantly different than those of the two fourth grade control groups.

It is not known why fourth graders should respond differently to the training program than did the fifth graders. The possibility that teachers differentially affected the CAT scores seems unlikely, since the mean CAT pre-test scores and the mean CAT difference scores as shown on Table 5 were not significantly different between teacher groups. Possibly the younger, less mature subjects require more training than older ones.

The second hypothesis proposed in this study was that a habit of looking for discriminating cues might enhance the learning of academic subjects, and thereby increase gains on the CTBS measure of academic achievement. Since the fifth grade experimental subjects improved in concept formation skills and the fourth grade subjects did not, only significant gains by the fifth grade experiment-
al subjects in their achievement scores would be expected.

The data confirm that the fourth grade experimental group did not make greater gains on the CTBS than the fourth grade control groups, but the data do not substantiate the expected superior gains by the experimental fifth grade subjects.

As shown by the analysis reported in Table 3, the mean CTBS difference scores of all fourth grade groups were higher than those of the fifth grade groups. Teacher effect may be a factor here. The CTBS mean difference scores for fourth grade teachers are consistently higher than those of fifth grade teachers, however, only scores of Teacher 3 (a fourth grade teacher) is significantly higher than those of other teachers.

The indication that for the Experimental and Control 1 groups the initially lowest scoring subjects made greater gains than did the initially highest scoring subjects cannot be entirely due to regression effects since the opposite trend appeared to occur for Control Group 2. This suggests the possibility that interaction with the experimenter had a differential effect on those who initially scored the lowest on the CTBS pre-test as compared with those scoring the highest. That is, possibly those who scored the lowest did so because they were not motivated and did not do their best. Since the experimenter explicitly stated to the Experimental and Control 1 groups during training that the activities would make them do better on the post test, they may have been better motivated to do their best on the post test than the lowest scoring Control Group 2 subjects who had not been given that expectation. Such an interpretation or
others that might be offered are purely speculative, however, since no statistical tests were performed to ascertain whether the differences were indeed significant.

The surprising lack of correlation found in this study between pre and post CTBS tests, the same form of which was given three months apart, suggests that this test may not be a reliable measure of achievement, and therefore insensitive to any possible achievement effects the training program might have produced.

In spite of the fact that clear cut facilitation of cognitive skills by the training program was not found, the present experimenter believes that such a training program could well have positive effects on both cognitive and on academic skills. It is suggested that the following modifications might increase the chances of success for future experiments on this topic:

1. Training on each task should be to an established criterion of performance, with as many sessions given as necessary to achieve that criterion. An equivalent number of sessions should be scheduled for each "attention" control subject.

2. Training sessions should be most frequent at the beginning of the series and be reduced in frequency as learning is strengthened. Frequent sessions initially should reduce the likelihood that slow learners will forget objectives and methods between sessions before they are well established. Less frequent sessions thereafter should maintain the skill until it becomes habitual, without losing the subject's interest.

3. Additional training tasks should be prepared which are
designed for specific transfer to the CAT and to facilitate general 
transfer to the standardized achievement test. At least four activ-
ities similar to each of the CAT subtests should be prepared, rang-
ing from very easy to more difficult. In addition, more tasks should 
be prepared tapping concepts the students might encounter in their 
daily academic program, such as Experimental Activities #16 and 
#18 described in Appendix G., but avoiding those used on the 
standardized achievement test.

4. Duration of training sessions should be lengthened to at 
least 15 minutes, so that each subject will have sufficient time to 
orient himself and have some measure of success with the task 
before the session is terminated. Subjects who finish before the 
end of the training period should begin the next task in the series. 
To prevent the faster learning subjects from thus completing the 
entire training program before the slower ones, a given number of 
tasks could be scheduled for completion by all subjects each week, 
with slow subjects perhaps receiving more than one session per day 
and faster subjects receiving fewer than one per day.

5. Selection by pre-test achievement scores might be more 
reliable if the children were unaware of the selection process, e.g. 
if subjects were chosen on the basis of teacher-administered tests, 
or if experimenter-administered tests were ostensibly given as part 
of school routine.

6. Reliability of the CTBS test as a measure of achievement 
should be further examined. If it is found to be unreliable, another 
measuring instrument for achievement should be used.
REFERENCES


Meeker, Mary N. The structure of the intellect; its interpretation and use. Columbus, Ohio: Merrill, 1969.


APPENDIX A

October 4, 1974

Dear Parents,

As a fourth and fifth grade teacher at Elmhurst the last four years, I frequently observed children with a certain learning problem which seemed to hinder their progress in several academic areas. After much study of the professional literature on concept learning I have formulated a training method which I hope will help children to learn concepts more efficiently.

I am currently enrolled in the master's program at the University of California, Northridge, and have chosen this problem as the topic for my thesis. With the aid of a committee of professors, I have designed an experiment which will put my theory to a rigid scientific test.

My plan is to test all fourth and fifth grade students and then randomly select a group of about 60 whom I will train two or three times a week for 15-minute intervals. After 12-15 weeks, post-tests will be given to see if the training program was effective. My training schedule will be flexible to assure that no child will be taken from his class when important teacher-directed learning is in progress.

This plan has been discussed with the principal and all teachers of fourth and fifth grade students at Elmhurst, and all have been kind enough to give me their enthusiastic support. If successful this study should make a significant contribution to current educational methods.

The preliminary testing will begin the week of October 7th. Please let me know if for some reason you prefer not to have your child participate.

Sincerely yours,

Mrs. Mary Ingalls
Do these items the same way you did the Sample Items. Mark on your answer sheet:

A - for a period ( . )  
B - for a comma ( , )  
C - for a question mark ( ? )  
D - for quotation marks ( " )

Now do Items 1-13. Be sure to start with Item 1 in the heading of the letter.

Dear Uncle Frank

Thank you for the pair of roller skates. They came just before Christmas, and they are the nicest skates I've ever had. When I opened the package, I said, "How did Uncle Frank know I wanted roller skates?"

Did you get the Christmas card I sent you?
Each sentence of the stories below is divided into four underlined parts. If there is a mistake in capitalization in one of these parts, mark the space on your answer sheet that goes with the letter of that part. If there is no mistake in capitalization, mark the space on your answer sheet that goes with "None."

In the Sample Item below, the name “carol” should begin with a capital letter, so the correct answer is D.

A My three B friends are C named Ann, D carol, and Sue. E None

Now do Items 14–25 the same way.

14 F This selection G comes from H “the heroic age of american invention” J by L. Sprague DeCamp. K None

15 A Alexander g. Bell is known B for inventing the telephone, the C first instrument to send the D human voice electrically over wires. E None

16 F Many people don't know G that at one time Bell H was a teacher of the J deaf in england. K None

17 A In march, 1876, B Bell sent a message C up two flights D of stairs. E None

18 F People became interested G at the Centennial Exposition H when Bell exhibited J his telephone. K None
APPENDIX B (continued)

TEST 7 Arithmetic Concepts

Do these items the same way you did the Sample Items.

1. Four thousand seven is the same as
   A  407
   B  4,007
   C  4,070
   D  47,000

2. The numeral 9 in 19 stands for
   F  9 ones
   G  9 tens
   H  19 ones
   J  19 tens

3. One week after June 3 is
   A  June 4
   B  June 9
   C  June 10
   D  June 13

7. Which has the smallest value?
   A  85%
   B  75%
   C  60%
   D  50%

8. Which is the longest distance?
   F  1 ft. 3 in.
   G  16 in.
   H  14 in.
   J  1 ft. 6 in.

9. Which is greater than 77,733?
   A  77,373
   B  77,737
   C  77,733
   D  77,337
APPENDIX B (continued)

TEST 8 Arithmetic Applications

Do these items the same way you did the Sample Items.

31 Lynn had 8 peanuts. Sally had 2 times as many. How many peanuts did Sally have?
   A 10
   B 12
   C 16
   D 24

32 John worked for one-half hour. How many minutes did he work?
   F 20 min.
   G 30 min.
   H 40 min.
   J 80 min.

33 Sam needed a board 6 feet long. Boards cost 24¢ for 2 feet. How much would the board cost?
   A 12¢
   B 24¢
   C 48¢
   D 72¢

36 A sales tax is 3¢ on each dollar. What is the tax on $10?
   F 3¢
   G 13¢
   H 30¢
   J 33¢

37 Pencils cost 7¢ each. The best way to find out how much 14 pencils cost is to
   A add 7¢ and 14
   B subtract 7¢ from 14
   C multiply 14 by 7¢
   D divide 14 by 7¢

38 Jerry had 12 problems correct. His score was 50%. How many problems were there in all?
   F 6
   G 24
   H 38
   J 62
APPENDIX C

This information may help you answer questions in Test 3 LANGUAGE MECHANICS

Periods (.) should be at the end of sentences that tell something.

Question marks (?) should be at the end of sentences that ask something.

Commas (,) are used in sentences, addresses, dates, and at the beginning and ending of letters.

Quotation marks (" "') should be put before and after the exact words someone is saying.

Capital letters should be used in proper names, in titles, and at the beginning of sentences.
APPENDIX C (continued)

This information may help you answer questions in Test 7 ARITHMETIC CONCEPTS and Test 8 ARITHMETIC APPLICATIONS

123,456,789

In the problem:

\[
\begin{array}{ccc}
\text{2} & \text{2} & \text{is a factor} \\
\times \text{3} & \text{3} & \text{is a factor} \\
\hline
\text{6} & \text{6} & \text{is a product}
\end{array}
\]

2 is the divisor
3 is the quotient
6 is the dividend

A dollar has 100 pennies.
A half dollar has 50 pennies.
A quarter has 25 pennies.
A dime has 10 pennies.
A nickel has 5 pennies.

\[
\begin{align*}
100\% &= \text{all of something} \\
75\% &= \frac{3}{4} \text{ of something or 3 of every 4 of something} \\
50\% &= \frac{1}{2} \text{ of something or 1 of every 2 of something} \\
25\% &= \frac{1}{4} \text{ of something or 1 of every 4 of something}
\end{align*}
\]

A yard is 3 feet or 36 inches.
A foot is 12 inches, or 1/3 of a yard.
An inch is 1/12 of a foot, or 1/36 of a yard.

\[
\begin{align*}
\frac{1}{2} &= \text{or 1 of 2} \\
\frac{1}{3} &= \text{or 1 of 3} \\
\frac{2}{3} &= \text{or 2 of 3} \\
\frac{1}{4} &= \text{or 1 of 4} \\
\frac{3}{4} &= \text{or 3 of 4}
\end{align*}
\]
When a number has a decimal point (.) in it, all the numbers to the left of the decimal point stand for whole numbers, and all of the numbers to the right stand for less than one, that is, part of something.

For example:

$1.02$ means one dollar and $2/100$'s
or one dollar and 2 pennies.

$1.20$ means one dollar and $20/100$'s
or one dollar and 20 pennies.

$1.1$ means one whole and $1/10$
or one whole and one of ten pieces of one.

$1.01$ means one whole and $1/100$
or one whole and one of a hundred pieces of one.

$1.001$ means one whole and $1/1000$
or one whole and one of a thousand pieces of one.

A quart has 2 pints.

A gallon has 4 quarts.

There are 60 minutes in one hour.
There are 24 hours in one day.
There are 7 days in one week.
There are 365 days in one year.
There are 12 months in one year.
# APPENDIX D

**CTBS Pre-test Score Averages, Rank Ordered by Teacher**

<table>
<thead>
<tr>
<th>Teacher 1</th>
<th>Teacher 2</th>
<th>Teacher 3</th>
<th>Teacher 4</th>
<th>Teacher 5</th>
</tr>
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<tr>
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<td>BM 417.25</td>
<td>RA 414.50</td>
<td>LT 382.75</td>
<td>GJ 382.50</td>
</tr>
<tr>
<td>AP 421.50</td>
<td>BF 402.50</td>
<td>SL 379.25</td>
<td>SB 381.25</td>
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<td>GP 400.50</td>
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<td>DD 386.00</td>
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<td>HA 383.25</td>
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- *n=53.* Subjects who dropped out during the experiment are not listed.
APPENDIX E
SAMPLE ITEMS - COGNITIVE ABILITIES TESTS

Quantitative Battery - Test 2

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<td></td>
<td></td>
<td>L</td>
<td>M</td>
<td>N</td>
<td>P</td>
<td>Q</td>
</tr>
</tbody>
</table>

Nonverbal Battery - Test 1

Nonverbal Battery - Test 2
PROPOSED TRAINING SCHEDULE
Part I

Testing order as determined by twelve consecutive coin tosses:

1. October 21 - control
2. October 28 - control
3. November 5 - control
4. November 12 - experimental
5. November 19 - experimental
   (Thanksgiving vacation)
6. December 2 - control
7. December 9 - control
8. December 16 - experimental
   (Christmas vacation)
9. January 6 - experimental
10. January 13 - experimental
11. January 20 - control
12. January 27 - experimental
PROPOSED TRAINING SCHEDULE
Part II

Training Patterns for Weeks Beginning With

<table>
<thead>
<tr>
<th>Control Groups</th>
<th>Experimental Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mon. Tu W Th F</td>
<td>Mon. Tu W Th F</td>
</tr>
<tr>
<td>12:30-12:45</td>
<td>E2 C1 E4 E2 C2</td>
</tr>
<tr>
<td>12:45-1:00</td>
<td>C3 E1 C5 C3 E3 C1 E5</td>
</tr>
<tr>
<td>1:00 - 1:15</td>
<td>E3 C2 E5 E3 C3 E2 C5</td>
</tr>
<tr>
<td>1:15-1:30</td>
<td>C4 E2 C4 E4 C3 E2 C5</td>
</tr>
<tr>
<td>1:30-1:45</td>
<td>E4 C1 E1 E4 C4 C1 E4</td>
</tr>
<tr>
<td>1:45-2:00</td>
<td>C1 C5 C3 C2 C5 E1 E5</td>
</tr>
<tr>
<td>2:00-2:15</td>
<td>E1 E3 E5 C1 C3 C5</td>
</tr>
<tr>
<td>2:15-2:30</td>
<td>C2 E5 C4 E2 C5 E4</td>
</tr>
</tbody>
</table>

**After all subjects have completed a training session, cards bearing names of experimental subjects will be shuffled and new "groups" will be formed by calling each subject as his card appears. Control subjects will be handled the same way. Although the time schedule may vary occasionally due to unforeseen events (meetings, school assemblies, fire drills, etc.), the sequence will be followed exactly.
APPENDIX G

ACTIVITY RECORD OF
TASKS FOR EXPERIMENTAL SUBJECTS

1. Club members (Individual task). Introduction: Children look at each other while Experimenter names members of "my club" and Subjects guess the reason, e.g. Tim and John are members because they are both wearing blue shoes. Game: Subjects are given cards with three rows of objects. The first row, in which all the objects have a common dimension, is labeled, "These are members of the club." The second row, containing similar objects without the significant dimension is labeled, "These are not members." The third row, containing some objects with and some without the significant dimension is labeled, "Which of these are members?"

2. Secret messages (Individual task). Subject is given a coded message (a vertical row of letters, each followed by arrows) and a 5 x 5 array of letters of the alphabet. Subject is told, "See if you can look for clues on both papers and find the message. At brief intervals clues are given as necessary: a) "The order of the chart is important." b) The arrows tell you the direction to follow." c) "Start with each letter and follow the arrows." d) "The first letter of the answer is..."

3. Concept sorting (Group task). Using an assortment of 3 x 5 cards with cutout pictures of a variety of objects pasted on them, the experimenter sorts the cards into two arrays, one array for cards with common elements and one array for cards without the common element. Subjects try to guess the concept.

4. Counting fun (Group task). Experimenter begins counting. The children are asked to join the Experimenter in counting aloud when they discover the pattern the experimenter is slowly reading aloud, e.g. 2, 5, 8, 11..., 4, 7, 10, 13, 16..., 56, 54, 42, 50....

5. Concept sorting (Group task). This activity is the same as Activity 3, except that a new assortment of cards is used and the subject who first guesses the concept is allowed to select a concept for the other subjects to guess, and he can sort the cards.

6. Finding Missing Figures - Set A (Individual task). Subjects are given sheets on which are mounted pages of problems from H. J. Eysenck's book Check your Own IQ. Subjects write their answers on paper as the Experimenter circulates continuously to give feedback.

7. Cattle Brands (Individual task). Subjects are given sets of cards showing various cattle brands which they are to match to another set of cards containing the ranch names.

8. IPAT Pages (Individual task). Subjects are given pages from
IPAT Tests 1 and 2.

9. Flower classification (Group task). Subjects are given an assortment of Hovland's flower figures which vary in the dimensions of color, number of leaves, shapes of blossoms, and shapes of leaves. Subjects take turns sorting the flowers into four rows on the basis of the dimension of their choice, for others to guess.

10. Button classification (Pairs task). Pairs of subjects are given an assortment of buttons. They take turns sorting the buttons for their partner to guess. Buttons were to be arranged either in a continuum, e.g. small or large, or into groups on the basis of the dimension of their choice, e.g. all metal buttons in one stack, plastic in another, etc.

11. Word pair completion (Group activity). Experimenter shows the group a series of cards, each of which contains two related words on the top line and another word on the bottom. Subjects are to write a word which is related to the third word in the same way the first two words are related, e.g. bed, house or bed sleep car, _____ car _____

12. Word classification (Pairs task). Pairs of subjects are given a set of cards containing words. Subjects take turns sorting cards into categories for the partner to guess, e.g. all words with two vowels, all words beginning with p, etc.

13. Where Am I? (Group task). Experimenter thinks of a place and writes on the chalkboard the names of two items he would see if he were in that place, e.g. at the beach he would see water, sky. Subjects name other items and the experimenter tells them if those items would be in the place he is thinking of. Correct and incorrect responses are recorded on the chalkboard. The first person to guess the place gets to choose a place for the others to try.

14. Two concept draw (Group task). Cards used in Activities 3 and 5 are used in a card game. Four cards are dealt to each subject and the remainder of the deck is placed in the center of the group with one card up. In his turn each subject draws a card from the deck or picks up the card that is showing. The objective is to find two cards with a common dimension to make a pair. The winner is the person who has the most pairs.

15. Find the Missing Figures - Set B. (Individual task). Subjects are given a different set of sheets with Eysenck's book, as in Activity 6.

16. Word classification (Group activity). Cards used in Activity 12 are sorted by the experimenter by word meaning into categories of nouns, verbs, adjectives, exclamations, or prepositions, and emphasis of the relevance of this activity and past training to
academic subjects is made.

17. Subjects are given sheets of problems similar to those in the Q-2 subtest of the CAT. (Individual task).

18. Math sentence classification (Group activity). Similar to Activity 16, except that cards contain math sentences illustrating distributive, commutative, associative, identity, etc. properties of math, e.g. $3 \times (2 - 4) = (3 \times 2)(3 \times 4)$ or $(1 \times 2) \times 3 = 1 \times (2 \times 3)$. Emphasis is again made to relevance of this activity to academic subjects.

ACTIVITY RECORD OF TASKS FOR CONTROL SUBJECTS

1. Fifteen. (Pairs task). Pairs of subjects take turns removing one, two, or three counters at a time. The winner is the one who leaves exactly one counter for the opponent.

2. Five in a row. (Pairs task). Pairs of subjects roll dice and move their markers on a grid according to the numbers which appear on the dice. The winner is the first with five markers in a row.

3. Count down. (Group task). All subjects sit in a circle and take turns responding with the next number in a stated series, e.g. "Count by 3's to 30." Those who respond incorrectly stand up. The last person seated is the winner.

4. Sentence builder. (Individual/group task). Each subject is given small cards containing words and phrases. They compete to see who can make the greatest number of sentences in 60 seconds.

5. Count up high. (Pairs task). Players roll dice, add, and place markers on one's and ten's column to indicate score. The winner is the first person to reach 100.

6. Advanced Grab - Orange deck. Commercial reading card game, copyright 1954 by Dorothea Alcock, Covina, Calif., played with "Old Maid" rules. Winner is the person who gets most books of three cards.

7. Difference Skills. (Group task). Take turns tossing a pair of dice. Compete to see who can name the difference between each die on each throw.

8. Bottle top math sentences (Individual task). Subjects are given milk bottle tops on which are printed numerals 0 through 9 or mathematical signs. The winner is the one who can use the most.
bottle tops in correct math sentences within 2 minutes or before the first contestant finishes.

9. **Advanced Grab - Purple deck.** (See activity 6 above).

10. **Math worm race.** Subjects are given a card with a continuous math problem in segments of a worm, e.g. $5 \times 5 - 3 + 7 \div 3 \ldots$ Pairs of subjects compete against another pair to see who can compute two cards first and correctly. Subjects change partners and repeat.

11. **Fifteen (Pairs task).** Repeat of Activity 1.

12. **Find the Odds.** (Individual task). Each subject toss a pair of dice and records the results in series of three tosses to determine the odds of getting a six on one die in three tosses.

13. **ESP.** Cards used in Activity 3 for Experimental Subjects are given to one of the group of four to decide which one of a pair is the most interesting. The pair of cards is returned to the experimenter with the most interesting on top. The rest of the subjects guess which of the pair was selected as most interesting.

14. **The Winning Touch.** (Group task). A commercial game by Educational Fun Games, 1962, similar to Scrabble, but using multiplication facts.

15. **Password.** (Pairs task). A commercial game by Milton Bradley. A word game; using synonyms or other one-word clues subject tries to help his partner guess the word he has in mind.

16. **Smarty** (Group task). A commercial game by Educational Ideas, Chicago, Ill, 1958, similar to Bingo, but using math facts.

17. **Syllable game.** (Group task). A commercial game by Garrard Publishing Co., Champaign, Illinois.

18. **Dice multiplication.** (Group task). Players take turns tossing two dice; all compete to call out the product of the numbers on the dice.

Make-up games:

19. **Three dice addition.** Similar to Activity 18, above, except three dice are used, and the numbers are added.

20. **Vowel graphing** (Individual task). Subjects look at a paragraph in a book and estimate the numbers of a's e's and i's in the paragraph, then count the actual number and graph the results.

21. **Split word game** (Group task). Commercial game by Holiday.
**APPENDIX H**

**CAT PRE AND POST AVERAGE UNIVERSAL SCALE SCORES FOR INDIVIDUALS**

<table>
<thead>
<tr>
<th>Grade 4</th>
<th>Pre</th>
<th>Post</th>
<th>Pre</th>
<th>Post</th>
<th>Pre</th>
<th>Post</th>
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<tbody>
<tr>
<td>KB-5</td>
<td>80.00</td>
<td>88.50</td>
<td>MV-4</td>
<td>70.00</td>
<td>80.50</td>
<td>LT-3</td>
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<td>72.00</td>
<td>DW-4</td>
<td>84.50</td>
<td>89.50</td>
<td>GJ-5</td>
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<td>90.00</td>
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<td>PB-4</td>
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<th>Pre</th>
<th>Post</th>
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<tr>
<th>M (G4)</th>
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<th>78.30</th>
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<tbody>
<tr>
<td>M (G5)</td>
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<td>76.68</td>
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### APPENDIX I

**CTBS PRE- AND POST AVERAGE EXPANDED STANDARD SCORES FOR INDIVIDUALS**  
(rank ordered by pre-test score)

<table>
<thead>
<tr>
<th>Experimental Group</th>
<th>Control Group 1</th>
<th>Control Group 2</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
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<td>M (Total)</td>
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</table>
APPENDIX J

DIFFERENCE SCORES FOR INDIVIDUALS
(Post minus Pre)

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<th>Control Group 1</th>
<th>Control Group 2</th>
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</tr>
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<td></td>
<td>-2.50</td>
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<td></td>
<td>11.00</td>
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</tr>
<tr>
<td></td>
<td>-4.50</td>
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M (G5) 16.44 29.00 4.75 33.78 4.21 3.39
M (Total) 9.29 44.94 8.08 52.77 5.33 35.07