ACCELERATING CHILDREN'S

QUESTION-ASKING PERFORMANCE

by

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B.A., Sir George Williams University, 1968

A THESIS SUBMITTED IN PARTIAL FULFILLMENT

OF THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF ARTS

in the Faculty

of

Education

Accepted for the Faculty of Graduate Studies, [redacted] 18 June, 1971

We accept this thesis as conforming
to the required standard

[redacted]

[redacted]

UNIVERSITY OF VICTORIA

May, 1971

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ABSTRACT

The question-asking behavior of boys in grades 1, 3 and 5 was studied. Subjects were required to ask questions which would permit them to locate a preselected "correct" picture from a stimulus display of 3" by 5" picture cards. Pre and posttreatment measurement of the number of questions required to solve question-asking problems, and the proportion of guesses and constraints used was taken. Pretreatment measurement suggested that these 3 dependent variables were grade-related. The Solomon Four Group Design was followed in the experimental procedure. Practice with question-asking tasks was provided by two groups by pretreatment measurement. The other treatments consisted of modeling, which exposed subjects to a tape recording of relatively efficient question-asking and combined practice-modeling. Chi-square analysis suggested an association between the modeling treatment and the proportion of guesses and constraints. Treatment failed to reduce the number of questions required to reach solution. Following practice, both the proportion of constraints and the proportion of guesses used differentiated between grade 1 and grade 5 groups. Following combined practice-modeling, the proportion of guesses used differentiated between grade and grade 3 groups. Comparison of the three treatment methods on each of the dependent variables suggested that only the proportion of

constraints used was differentially affected by the three treatment methods. At the grade 1 level the modeling treatment was most effective. Both modeling and combined practice-modeling treatments were relatively effective at the grade 3 level. At the grade 5 level, no differences among treatments in terms of constraint use was found. It was tentatively concluded that modeling might prove a valuable teaching resource, although further study of modeling parameters would be required.

Examiners: [redacted]

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ACKNOWLEDGMENT

I am deeply grateful to the members of my committee, Don Knowles, Roger Ruth and Dick May, who gave so generously of their time and assistance. My thanks are extended also to Jean Money, whose affectionate investment has been warmly supporting.

CHAPTER 1

The Background of the Problem

The Development of Classificatory Behavior

Classification, or "the ability to recognize class identities and to use them in establishing logical relations" (Valett, 1967, Psychoeducational Program #48), has been described as "the process most central to conceptual behavior" (Furth and Milgram, 1965, p. 3). The ability to classify underlies a wide spectrum of cognitive processes and permits the processing of the complex contexts encountered in everyday situations. For example, classificatory ability is prerequisite to the appreciation of similarities and differences and the separation of relevant and irrelevant information (Anandalakshmy and Davidson, 1970).

Like many other cognitive processes, the ability to classify evolves gradually. A synopsis of the development of classificatory ability within the context of the Stage Theory (Inhelder and Piaget, 1958) may be appropriate to the present study since many of the reported classificatory studies are connected with issues related to Piagetian theory.

Piagetian research suggests that understandings of class and class inter-relationships are highly rudimentary in preoperational subjects (Ginsburg and Opper, 1968). Instead of forming groupings indicative of sensitivity to class and class membership, the young child's groupings are based on perceptual and egocentric factors. For example, the groupings formed by children in multidimensional block-sorting tasks tend to be randomly grouped "heaps" of blocks (Vygotsky, 1962). As children grow older, their ability to classify and group stimuli becomes increasingly sophisticated. This increased categorizing ability is reflected in extensive changes in the syntax, or formal structure, of their groupings, i.e., whether or not all the members of the group share a common attribute. The ability to base groupings upon the attributes of a set of stimulus elements differentiates preoperational and concrete sortings. For example, in multi-dimensional block-sorting tasks, children from about seven or eight to eleven or twelve years of age tended to produce groupings based on the perceptual and conceptual attributes of the blocks (Vygotsky, 1962).

Mosher and Hornsby (1966), Olver and Hornsby (1966) and Davey (1968) concurred in describing age-related grouping trends which demonstrated the major features of classificatory syntax generally reported in the literature (Flavell, 1970). Mosher and Hornsby presented six-to-eleven-year olds with a stimulus array consisting of colored pictures of familiar objects. Subjects were instructed to select a group of pictures they considered to be alike; subjects then explained how each of the items in the group were similar. There were ten such sorting trials. In Olver and Hornsby's study, six-to-eighteen-year olds were required to explain how sets of objects were alike. The initial set consisted of two items. A third item was then added to the initial pair, and subjects were asked to indicate how all three were alike. The same procedure was continued until there were eight items. The sets became increasingly diverse as objects were added. Davey's procedure was essentially the same as Mosher and Hornsby's, but involved six-to-thirteen-year olds from the island of Tristan de Cunham.

Mosher and Hornsby, Olver and Hornsby, and Davey all reported that thematic and complexive groupings occurred frequently in the concrete operations period. In thematic groupings, the elements of the group were interrelated in a story of thema; the same thema did not link all pairs of items. Complexive groupings seemed to include two or three items on the basis of equivalence or similarity. These groupings were nonexhaustive, i.e., they did not include all of the available stimulus items possessing the property chosen as the criterion for group membership. Complexive groupings were inconsistent; all group members failed to share the same common property or properties. Thematic groupings occurred more frequently among the younger subjects than did complexive groupings. Both thematic and complexive groupings declined in frequency with increasing age.

As children advance into the period of formal operations, they seem to develop the ability to systematically abstract stimulus array elements (Ginsburg and Opper, 1969). For example, in multidimensional block-sorting tasks, children formed groupings which were both exhaustive and consistent (Vygotsky, 1962). The Mosher and Hornsby and Olver and Hornsby studies reported that their older subjects used superordinate groupings almost exclusively, i.e., groupings in which all the objects in the class shared one or more common attributes. A substantial proportion of the superordinate groupings were conceptually based. Mosher (1962) suggested that a major factor underlying systematic abstraction is the child's new-found ability to initiate conceptual plans and appropriately transform them to suit the requirements of the problem solving task.

While developmental status is an important variable in the development of classificatory behavior, it is not the sole determinant of the types of groupings that will be formed. Item groupings are partially determined by stimulus properties.

The Semantics of Classificatory Behavior

The "semantics" of classification concerns the effects of perceptual and conceptual stimulus attributes upon subsequent item groupings (Olver and Hornsby, 1966). While the groupings of younger children appear to be heavily influenced by the saliency of perceptual cues, the classificatory behavior of older children is largely conceptually oriented. The attributes upon which children's categorizations are based seem to undergo an age-related perceptual-to-conceptual shift. The most frequently studied aspect of this shift is the transition from color-based to form-based grouping (Mitler, Harris and Schaller, 1969). Children from about three to six years of age tended to use color as the basis for their groupings; from about six years of age and on, form became dominant over color (Kagan and Lemkin, 1961; Mitler, Harris and Schaller, 1969).

Various explanations of the color-to-form shift have been suggested. There would appear to be two schools of thought: one group suggested that age-related changes in the meaning of stimuli underlie the color-form shift (Sigel, 1954), while others suggested that developmental changes in verbal ability underlie this shift (Osgood, 1953; Kagan and Lemkin, 1961; Olver and Hornsby, 1966; Reich and Woolford, 1970). Sigel (1954) suggested that the color-form shift reflected the development of increasing sensitivity to the conceptual aspects of objects and decreasing concern for their perceptual characteristics. To test this hypothesis, Sigel had boys seven to eleven years of age form groupings of stimuli which were presumed to represent different levels of symbolism. These stimuli (toy objects, black and white photographs of the same objects, and word names of the objects) permitted both conceptually and perceptually based groupings. Sigel reported that perceptual groupings declined while conceptual groupings increased in frequency with age. He concluded that conceptual meaning assumed an increasingly dominant role in classification.

Several studies suggest that increasing verbal ability and the emergence of conceptually based groupings are directly related. Kagan and Lemkin (1961) postulated that with increasing age, children tend to categorize on the basis of implicitly applied labels rather than on the basis of physical qualities.

Olver and Hornsby (1966) reached a similar conclusion, suggesting that "from age six on, linguistic structures increasingly guide what and how things will be judged alike (p. 84)." With increasing age and linguistic ability, a greater variety of mediating responses might be expected to become associated with familiar stimuli; such mediation might be reflected in classificatory tasks. Support of this assumption is offered by Reich and Woolford (1970), who reported that familiar stimuli were categorized according to their physical properties. Apparently linguistic experience helped determine the type of mediational processes which occurred.

The more general sorting and classifying studies in the literature agree with the color-form studies in suggesting a developmental shift from perceptually based to more abstractly and verbally based classificatory behavior (Bruner, Olver and Greenfield, 1966; Davey, 1968; Goldman and Levine, 1963; Wenar, 1961). Mosher suggested that since the young child's groupings appeared to be sensitive primarily to the perceptual attributes of stimuli, the child would be unable to arrive at a common basis for grouping objects lacking obvious perceptual similarity (Mosher and Hornsby, 1966). Groupings based on functional similarity, which would require conceptually based equivalences, might be expected in older subjects.

A study conducted by Wenar (1961) confirmed this expectation. Wenar studied the ability of four-to-eight-year olds to respond conceptually. Subjects were first taught to recognize a group of target items. These items were then presented with variations in color and spatial orientation. Only the older subjects equated the altered items with the original targets.

To date there has not been sufficient research to demonstrate the superiority of any one of the suggested explanations of the perceptual-conceptual shift.

Question-Asking Techniques

A variety of indicator responses are available for studying cognitive processes. Question-asking techniques are among the most interesting of these methods. Several question-asking techniques have been developed which permit fairly direct investigation of children's problem solving (Eimas, 1970; Levine, 1966; Neimark and Levine, 1967). For example, Bruner, Goodnow and Austin (1956) and Bruner, Olver and Greenfield (1966) developed question-asking procedures which indicated the hypotheses being tested and the sequence in which they were used. Their method required subjects to ask the experimenter information-seeking questions in order to provide information necessary for problem solution. The sensitivity of the Bruner question-asking technique to emerging forms of cognitive development has been demonstrated by several studies (Rigney, 1962; Olsen, 1966; Eimas, 1970).

Rigney (1962) showed pictures of forty-two real life objects to boys in grades one, three and six. Subjects played a question-asking game in which they attempted to determine which one of the stimuli the experimenter had selected as the target by asking information-seeking questions which the experimenter answered "yes" or "no". Rigney grouped the questions into four categories. Constraints consisted of questions general enough to refer to two or more pictures. Specific hypotheses specified particular pictures connected with previous constraints or pseudoconstraints. Guesses consisted of specific hypotheses unrelated to previous restraints or pseudoconstraints. Pseudoconstraints were phrased like constraint questions, but referred to only one picture.

As an illustration of these four response categories, consider a stimulus array consisting of pictures of the following items: dog, goat, shirt, vest, jacket, truck, hammer, saw. The following sequence of questions, if obtained in a single question-asking game, would consist of constraint, specific hypotheses, guess and pseudoconstraint questions: "Is it a tool?" "Is it a hammer?" "Is it the dog?" "Is it something you would use to cut wood?"

Two general information-seeking strategies emerged in the Rigney study. One strategy involved constraint-seeking. Constraint seekers typically began their questioning with a general question that grouped a large number of items into two domains and then further ordered the remaining items, narrowing in on the target using further constraints. Constraint-seeking occurred infrequently among first graders and gradually increased in frequency with age. Constraint-seeking insured sufficient problem solving since either a "yes" or "no" answer provided information to the questioner and reduced uncertainty. Bruner, Olver and Greenfield (1966) suggested that since the constraint-user must impose order over the stimulus array, a certain amount of cognitive strain might be involved. If this strain became too great, strategies involving less strain would be used.

Rigney reported "hypotheses-scanning" to be a second and less efficient information-seeking strategy. Scanners asked a series of unrelated questions, with guesses predominating. This strategy was used almost exclusively by grade one subjects and declined in frequency with age. Several plausible explanations of the widespread use of scanning among younger children have been suggested. Mosher (1962) suggested that scanning reflected the young child's lack of time perspective and his inability to forego immediate gratification. Mosher also hypothesized that scanning involved little cognitive strain because the scanner needn't organize the array under a conceptual schema. Bruner (1968) commented on the young child's inability to use negative information, i.e., the experimenter replies "no" to the subject's question. Bruner suggested that while such information is logically usable, it is psychologically valueless. Inability to use negative information might result in subjects tending to aim for "yes" responses. Scanning could be used to this end.

Olsen (1966) used a modified form of the Bruner question-asking technique. He presented three, five and seven year olds with a circuit board. Light bulbs were arranged on the board in a matrix pattern; some of the bulbs would not light. Subjects were provided with two diagrams relating to the on-off operation of the lights and were to determine which one of the two diagrams described the apparatus. Their circuit testing, which was analogous to question-asking, involved pressing the individual bulbs to see whether they would light. The three year olds tested the circuit board independently of the diagrams, while the five year olds tested the matrix against the diagrams somewhat systematically. The seven year olds selectively matched key bulbs to the diagrams. Olsen noted that "the component skills of mapping, locating and utilizing information change with the growth of the child's powers of representation (p. 152-153)." Olsen suggested that his subjects' performances represent

> a development that bears striking resemblance to performance in earlier experiments--to the hypothesis testing and constraint locating in Twenty Questions, and to the progress from pure guessing, through estimated guessing, to constraint guessing in the perceptual tasks. (p. 193)

A study by Eimas (1970) agreed substantially with the Rigney and Olsen findings. Eimas reported the development of three successive stages in the ability to use efficient information-seeking strategies. Subjects in grade two used a guessing strategy and employed few constraints; subjects in grades four and six used proportionately fewer guesses and more constraints. Adolescents and adults were able to focus on the solution using constraints almost exclusively.

The Rigney, Olsen and Eimas studies would seem to suggest that the development of information-seeking ability can be reflected using question-asking techniques. However, information-seeking strategies may be dependent, at least in part, on other variables such as the specific stimulus material being studied, the type of instructions used, the modality in which the information is presented and the complexity of the stimulus array (Kagan and Kogan, 1970). At present, insufficient knowledge of the potential effects of these factors prohibits accurate estimation of their influence and limits the extent to which the Olsen, Rigney and Eimas findings can be meaningfully generalized.

Accelerating Question-Asking Ability

Several studies have suggested that children's cognitive processing can be facilitated by training procedures (Darnell, 1969; King, 1966; Nowak, 1969; Sigel and Olmsted, 1967). For example, research attempting to determine the effects of linguistic training upon the transition from preoperational to concrete operational performance in conservation tasks reported that such training facilitated the encoding and decoding of information and the ability to focus on relevant aspects of the task (Inhelder, Bovet, Sinclair and Smock, 1966). Relatively brief training periods of a few weeks in duration have enabled children to formulate questions more efficiently and readily (Suchman, 1961; Blank and Covington, 1966).

Imititative learning (modeling) and experience with item groupings (practice) are two training procedures which could be used in the classroom to accelerate the development of more sophisticated information-seeking strategies.

Practice in dealing with categorization-type tasks is assumed to facilitate the development of classifying ability. Valett suggested that "experience in dealing with likeness or differences in many varied sequential learning situations provides the foundation for later development of formal logical thought (Valett, 1967, Psychoeducational Program #48)." The "ability to recognize class identities and to use them in establishing logical relationships" may be facilitated through programs involving the matching of identical elements, or the categorization of similar elements (Valett, 1967).

The ability to classify may be accelerated through imitative learning. Debus suggested that modeling might be an effective treatment method because

> the experimental procedures employed in modeling studies may be regarded as analogies of children's everyday experience in which they observe siblings and peers, as well as adults, receiving positive reinforcement contingencies following behavior that differs from the child's own customary pattern (Debus, 1970, p. 23-24).

Modeling might provide a means of focusing the child's attention on relevant types of information (Grotsburg, 1969). Modeling might also expose subjects to patterns of question-asking. Such exposure may be useful because

> questions exert an essential influence on the very processes by which the child solves a practical task, imparting to his actions a striving for a correct solution and imparting to the thought process a definite direction. (Berlyne, 1970, p. 971)

The model can induce subjects to engage in new behavior patterns or encourage his use of specific behaviors already in his repertoire (Grotsburg, 1969).

CHAPTER II

Method

Purpose and Relevance of the Present Study

The present study attempted to accelerate the question-asking performance of boys in grades one, three and five. Subjects were shown a multidimensional stimulus array and were to determine which one of the items the experimenter had selected as the target. Information necessary for solution of the problem was supplied by the experimenter's "yes" or "no" answers to the subjects' questions. As in the Mosher & Hornsby (1966) study, the proportion of constraints and guesses used was expected to reflect the frequency of conceptually or perceptually based information-seeking strategies. The total number of questions required to reach solution was assumed to reflect the overall efficiency of the information-seeking strategy.

The effectiveness of practice, modeling and combined practice-modeling treatments was assessed. Practice consisted of pretesting subjects; there were several reasons for expecting gains following practice. Familiarization with the experimental task could have induced a "warm-up" effect. Since immediate feedback was provided to all questions, the practice condition might have increased the possibility of subjects "learning-to-learn". Subjects have failed in some concept-attainment tasks because they did not clearly understand what solution of the problem would involve (Bem, 1969). Bem demonstrated that providing subjects with a symbolic representation of the problem facilitated correct responding. Practice could have provided such training.

The modeling procedure exposed subjects to relatively efficient question-asking. This exposure could have provided subjects with labels that might have offered opportunity for the facilitation of more sophisticated groupings. As well, modeling could have suggested a variety of types of questioning. According to Dwyer (1970), instructions direct attention and guide thinking toward criterion performance. The modeling procedure might have provided additional instructions to subjects and enabled them to focus on relevant aspects of the stimulus array. Both the practice and modeling treatments were expected to facilitate subjects' question-asking performance. There was insufficient empirical evidence to suggest which of the treatment methods would prove most effective.

The Experimental Design

An experimental design was required which could enable the assessment of practice, modeling and combined practice-modeling effects, as well as provide a comparative baseline along each of the three dependent variables. The Solomon Four Group Design was chosen as it could fulfill these requirements (Solomon, 1949; Campbell and Stanley, 1966). The Solomon design is represented in Figure 1. Subjects in groups 1 and 2 were given the practice treatment, while subjects in groups 1 and 3 received the

GROUP NUMBER	METHOD OF SUBJECT ASSIGNMENT	PRETEST (PRACTICE TREATMENT)	TRAINING (MODELING TREATMENT)	POSTTEST
1	Random	0_1	X	0_2
2	Random	0_3	-	0_6
3	Random	-	X	0_5
4	Random	-	-	0_4

Figure 1

Schematic Representation of the Solomon Four Group Design modeling treatment. The effects of modeling, practice and combined modeling-practice treatments were assessed by the method of score comparisons suggested by Solomon and Lessac (1968). The effect of modeling was assessed by comparison of the pooled pretest scores in groups 1 and 2 (0_1 and 0_3) with posttest scores in group 3 (0_5). The effect of practice was determined by comparing group 4 (0_6) with group 2 (0_4). The effect of combined practice-modeling treatment was assessed by comparing group 1 (0_2) and group 3 (0_5) scores.

Subjects

One hundred and twenty boys from Margaret Jenkins Elementary School in Victoria, B.C. formed the sample. Ten boys from each of grades one, three and five were randomly assigned to each of the experimental groups. Reported sex differences in the development of question-asking ability (Taylor, 1962) were avoided by using male subjects only. The mean ages of grade one, three and five subjects were 6.7 (SD = .52), 8.8 (SD = .84), and 10.9 (SD = .55) years of age. While school records could not provide an accurate estimate of subjects' socio-economic status, the principal and teachers concurred in suggesting that the subjects were from a predominantly middle-class, semi-managerial background. The school staff estimated that seventy-five percent of the subjects' parents were employed in either civil service or merchandizing positions, while twenty percent were professionals, four percent were officers in the armed services and the remaining one percent were laborers.

Postulates and Hypotheses

Assessment was made of the effects of grade level, treatment methods, grade treatment interaction and the comparative effects of the treatment methods upon each of the dependent variables.

Grade Level and Pretreatment Performance

The means of the pooled group 1 and 2 pretest and group 4 scores were assumed to be the best estimates of pretreatment performance on each of the dependent variables at each grade level. It was hypothesized that the number of questions required to reach solution and the proportion of guesses used would decline with increasing grade level. The proportion of constraint usage was expected to increase with grade level. These hypotheses were operationally defined in the following manner:

(1) in decreasing rank, the mean number of questions required by subjects to reach solution would be ordered grade 1, grade 3 and grade 5;

(2) in decreasing rank, the mean proportion of guesses would be ordered grade 1, grade 3 and grade 5;

(3) in ascending rank, the mean proportion of constraints would be ordered grade 1, grade 3 and grade 5.

The Effects of Training Procedures

It was anticipated that each of the practice, modeling and combined practice-modeling treatments would significantly facilitate performance, as measured on each of the dependent variables. It was expected that each of the treatment methods would be associated with higher performance levels among the grade three and grade five subjects than among the grade one subjects; i.e., grade 3 and 5 performance would involve fewer questions to solution, a greater proportion of constraints and a smaller proportion of guesses.

Effects of Modeling

In order to assess the effects of the modeling treatment, scores in grades 1, 3 and 5 were pooled and the pooled pretreatment scores of groups 1 and 2 (0_1 and 0_3) were compared with the posttest scores of subjects in group 3 (0_5) who received the modeling treatment. Subjects who received the modeling treatment, compared to pretested subjects in groups 1 and 2 were expected to demonstrate the following facilitation in task performance:

(4) significantly fewer trials to reach solution in three question-asking games;

(5) significantly smaller proportion of guess-type questions;

(6) significantly greater proportion of constraint-type questions.

In order to assess the possibility of grade-modeling interaction, scores of subjects in grades one, three and five who had received the modeling treatment (0_5) were compared. The following effects of grade level were anticipated:

(7) grade 1 subjects would require a significantly greater number of questions to reach solution than grade 3 and grade 5 subjects;

(8) grade 1 subjects would use a significantly greater proportion of guesses than grade 3 and 5 subjects;

(9) grade 1 subjects would use a significantly smaller proportion of constraints than grade 3 and 5 subjects.

Effects of Practice

In order to assess the effects of practice, the pooled grade 1, 3 and 5 scores of subjects who had received practice (group 2 (0_4)) were compared with the scores of subjects who had received none of the experimental treatments (group 4 (0_6)). Subjects who had received the practice treatment compared to subjects in group 4 were expected to demonstrate the following facilitation in task performance:

(10) significantly fewer trials to reach solution in three question-asking games;

(11) significantly smaller proportion of guess-type questions;

(12) significantly greater proportion of constraint-type questions.

In order to assess the possibility of grade-practice interaction, scores of subjects in grades one, three and five who had received the practice treatment (0_4) were compared. The following effects of grade level were anticipated:

(13) grade 1 subjects would require a significantly greater number of questions to reach solution than grade 3 and grade 5 subjects;

(14) grade 1 subjects would use a significantly greater proportion of guesses than grade 3 and grade 5 subjects;

(15) grade 1 subjects would use a significantly smaller proportion of constraints than grade 3 and grade 5 subjects.

Effects of Combined Practice-Modeling Treatment

In order to assess the effects of the combined practice-modeling treatment, scores in grades 1, 3 and 5 were pooled and the scores of subjects receiving both practice and treatment (group 1 (0_2)) were compared with the posttest scores of subjects in group 3 (0_5) who had received the modeling treatment. Subjects who had received the combined practice-modeling treatment, compared to subjects in group 3, were expected to demonstrate the following facilitation of task performance:

(16) significantly fewer trials to solution in three question-asking games;

(17) significantly smaller proportion of guess-type questions;

(18) significantly greater proportion of constraint-type questions.

In order to assess the possibility of grade-combined practice-modeling interaction, scores of subjects in grades one, three and five who had received the combined practice-modeling treatment (0_2) were compared. The following effects of grade level were anticipated:

(19) grade 1 subjects would require a significantly greater number of questions to reach solution than grade 3 and grade 5 subjects;

(20) grade 1 subjects would use a significantly greater proportion of guesses than grade 3 and grade 5 subjects;

(21) grade 1 subjects would use a significantly smaller proportion of constraints than grade 3 and grade 5 subjects.

<u>The Comparative Effectiveness of the Treatment Methods</u>

Groups 1, 2 and 3 posttest scores were taken as indecies of the effects of each of the treatment methods. Pooled grade 1, 3 and 5 scores following each of the treatment methods were compared. Lack of relevant empirical evidence prohibited the anticipation of specific outcomes regarding the relative effectiveness of each of the treatment methods.

Statistical Analysis

Three successive question-asking games were played in practice and posttest conditions. The experimenter rated subjects' tape recorded questions as "constraint", "guess", or "other". The total number of questions to solution was ascertained. These scores from each of the three games were pooled to give one rating of each 3 game sequence on each of the dependent variables. Questions linking at least two items were classed as constraints. Questions unrelated to previous constraints and referring to single items were scored as guesses. These criteria were applied to five randomly selected 10-question samples of subjects' question-asking games. Interrater correlations of .86, .89 and .92 between the experimenter and two independent judges were obtained.

The dependent variables failed to meet the assumptions for parametric statistical analysis. Variance heterogenity and a disproportionately large number of zeros were found. Chi-square analysis was used to evaluate all hypotheses. The variables considered in the X^2 analysis were treatment group (A), grade level (B) and the frequency of responses (C) categorized into specific score categories (i.e., high and low scores). Pretreatment response categories trichotmized the observed score distributions; posttest score distributions were dichotomized at the medians. Partitioning of X^2 contingency tables followed the Sutcliffe (1957) model. Chi-square total partitioning into X^2AC, X^2BC and X^2ABC comparisons was permitted.

The total X^2 values were assumed to reflect the degree of association between treatment methods, grade levels and the frequency of observed scores falling into each response category. The X^2AC values were assumed to reflect the degree of association between treatment method and response categories. The X^2BC values were assumed to reflect the degree of association between grade level and response categories. Interaction between grade level and treatment in associations with response category were indicated by X^2ABC values.

The Question-Asking Task

Stimuli were selected from pictures of real-life objects and animals found in the Peabody Pictorial Vocabulary Test (Dunn, 1965), the Pictorial Test of Intelligence (French, 1964), and the Picture Vocabulary Test (Van Alstyne, 1961). Items were selected for the stimulus arrays on the basis of information obtained from two pilot studies involving twenty boys in each of grades 1, 3 and 5 in Sooke and Colwood Elementary Schools in British Columbia School District #62. In these pilot studies, pictures were presented to subjects prior to their playing question-asking games. Seventy-five easily-recognized items inducing minimal epistemic curiosity were selected by having subjects name all of the stimulus items and having them indicate which of the items "look funny", and which were the "most fun" and the "least fun" for them to look at. The seventy-five pictures were split into three twenty-five item stimulus arrays. Each array included one five-item set of each of five different conceptual relationships. These conceptual relationships included similarity of color, form and function (abstract, homogenous and relational functions, as defined by Crager and Spriggs, 1969).

Administration of the Question-Asking Games

One set of prerecorded instructions was used in each of the four groups at all grade levels. All subjects were shown and asked to name each of the stimulus items to which they would be exposed during the study. They were then told that the question-asking game involved two rules--subjects were expected to work carefully and use as few questions as possible. Subjects then answered several questions testing their comprehension of the rules. Three subjects were eliminated because of failure at this point.

The three stimulus arrays are illustrated in Appendix B. Stimulus array B-1 was used in all practice games, array B-2 was used in the modeling games and B-3 in the posttest games. Each question-asking game was comprised of three subsections. Subjects first worked with the 10 uppermost items, then with the remaining 15 items, and finally with the entire array. Items were in view only when in use. Target items used in each of the subsections were randomly selected and recorded on each subject's protocol prior to testing. The sequence of instructions presented to each of the four experimental groups is illustrated in Figure 2, while the verbatim instructions are reported in Appendix A.

Group	Picture Identification	Explanation of the Rules	Comprehension of the Rules	Pretest	Modeling	Posttest
	Procedure					
1	X	X	X	X	X	X
2	X	X	X	X	-	X
3	X	X	X	-	X	X
4	X	X	X	-	-	X

Figure 2

Schematic Representation of the Instructions Presented to Each of the Experimental Groups

CHAPTER III

Results and Discussion

Pretreatment Performance

An initial concern was to test for the association between grade level and question-asking performance. As indicated in Table 1, the mean number of questions to solution and the mean proportion of constraints and guesses used in groups 1, 2 and 4 prior to treatment were considered for each of the grade levels. It was hypothesized (hypothesis 1) that the mean number of questions required to reach solution would decline with age. Table 1 offers support for this hypothesis, indicating that the mean number of questions to solution decreased from grades one to five. The number of grade 1, 3 and 5 subjects using a high, medium and low number of questions is indicated in Table 2. Chi-square analysis of the association between grade level and number of questions to solution was computed, and the X^2 values are reported in Table 3.

The number of questions asked differentiated between the grade 1 and 3 groups, while the number of questions asked by grade 3 and grade 5 subjects did not differ significantly. As indicated in Figure 3, the number of subjects using a low number of questions increased with grade level, while the number of subjects using a high number of questions declined with age. The overall pretreatment question-asking efficiency, as measured by the number of questions required to reach solution, increased with grade level. This finding is consistent with the age-efficiency relationships reported by Eimas (1970), Mosher and Hornsby (1966) and Rigney (1962).

A second concern was to determine whether the mean pre-treatment proportion of guess usage would decline with grade level. As indicated in Table 1, the proportion of guesses used decreased from grade 1 to grade 5. The number of subjects using high, medium and low proportions of guesses in grades 1, 3 and 5 (Table 2) were compared with X^2 analysis. As indicated in Table 3, an overall association between grade level and proportion of guesses was found. Further partitioning revealed that the proportion of guesses used differentiated between grade 1 and both grade 3 and 5 groups. The grade 3 and 5 proportions did not differ significantly. Figure 5 indicates that the number of subjects using a low proportion of guesses increased with grade level, while the number of subjects using a medium proportion of guesses remained relatively constant across the grade levels. High proportions of guess usage declined with grade level. The direct relationship between grade level and the proportionate use of guessing as an information-seeking strategy found in the present study is consistent with the Eimas (1970), Olsen (1966), Mosher and Hornsby (1966) and Rigney (1962) results.

A third concern was to determine whether the mean pretreatment proportion of constraint usage would increase with grade level (hypothesis 3). As indicated in Table 1, this hypothesis was supported. High, medium and low proportions of constraint use are reported in Table 2. Chi-square analysis indicated an overall association between proportion of constraint usage and grade level. Further X^2 partitioning suggested that constraint usage differentiated between the grade 1 and both the grade 3 and grade 5 groups (see Table 3). The proportion of constraints used in grades 3 and 5 did not differ significantly. The number of subjects using a low proportion of constraints was highest in grade 1, and declined with grade level, while medium and high proportions of constraint use increased with grade level.

The proportion of constraint use, like the proportion of guesses and the number of questions to solution, appeared to be an age-related measure. The consistency of the pretreatment performance with the literature adds support to the efficacy of the use of these dependent variables in further developmental study.

Assessment of Treatment Methods

A second general concern was to assess the effects of the practice, modeling and combined practice-modeling treatments upon each of the dependent variables. It was anticipated that each of the treatment methods would significantly facilitate performance on each of the dependent variables as indicated by

TABLE 1

Pretreatment Means and Standard Deviations for Grades One, Three and Five for Each of the Dependent Variables.[a]

GRADE LEVEL	NUMBER OF QUESTIONS TO SOLUTION		PROPORTION OF CONSTRAINTS USED		PROPORTION OF GUESSES USED	
	M	SD	M	SD	M	SD
1	27.83	11.89	.12	.19	.77	.37
3	22.70	6.58	.22	.20	.39	.43
5	21.53	7.23	.37	.26	.29	.41

[a] Based on pooled group one, two and four scores

TABLE 2

Number of Subjects Categorized by Grade Level and Frequency of Scores on Each of the Dependent Variables.[a]

DEPENDENT VARIABLE	SCORE CATEGORY	GRADE		
		1	3	5
Number of Questions to Solution	High (26-60)	15	9	8
	Medium (19-25)	10	11	8
	Low (0-18)	5	10	14
	Total	30	30	30
Proportion of Constraints Used	High (.4-1.0)	3	8	16
	Medium (.02-.39)	7	12	7
	Low (.0-.01)	20	10	7
	Total	30	30	30
Proportion of Guesses Used	High (.4-1.0)	21	9	6
	Medium (.02-.39)	7	9	6
	Low (0-.01)	2	12	18
	Total	30	30	30

[a] Based on pooled group 1, 2 and 4 pretreatment scores.

TABLE 3

Chi-square Values[a] Obtained Comparing Grade Level Scores on Each of the Dependent Variables.

DEPENDENT VARIABLE	COMPARISONS	X^2	df	P
	Total Group	7.49	4	NS
Number of Questions Asked	Grades 1-3	3.21	2	NS
	Grades 1-5	6.61	2	.05
	Grades 3-5	1.19	2	NS
	Total Group	18.95	4	.01
Proportion of Constraints Used	Grades 1-3	6.92	2	.01
	Grades 1-5	15.15	2	.01
	Grades 3-5	4.51	2	NS
	Total Group	14.89	4	.01
Proportion of Guesses Used	Grades 1-3	12.19	2	.01
	Grades 1-5	21.21	2	.01
	Grades 3-5	2.40	2	NS

[a] Based on pooled group 1, 2 and 4 pretreatment scores.

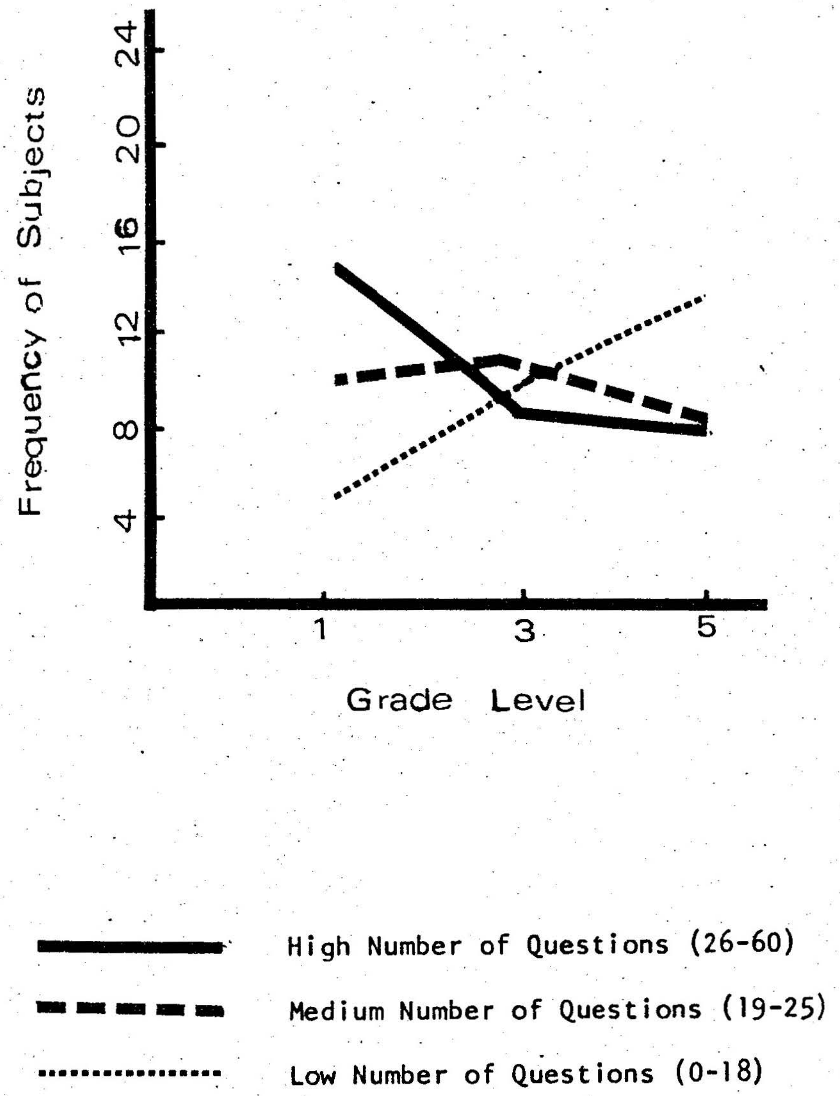

Figure 3

Subjects in Grades One, Three and Five Categorized by the Number of Questions Asked Prior to Experimental Treatment

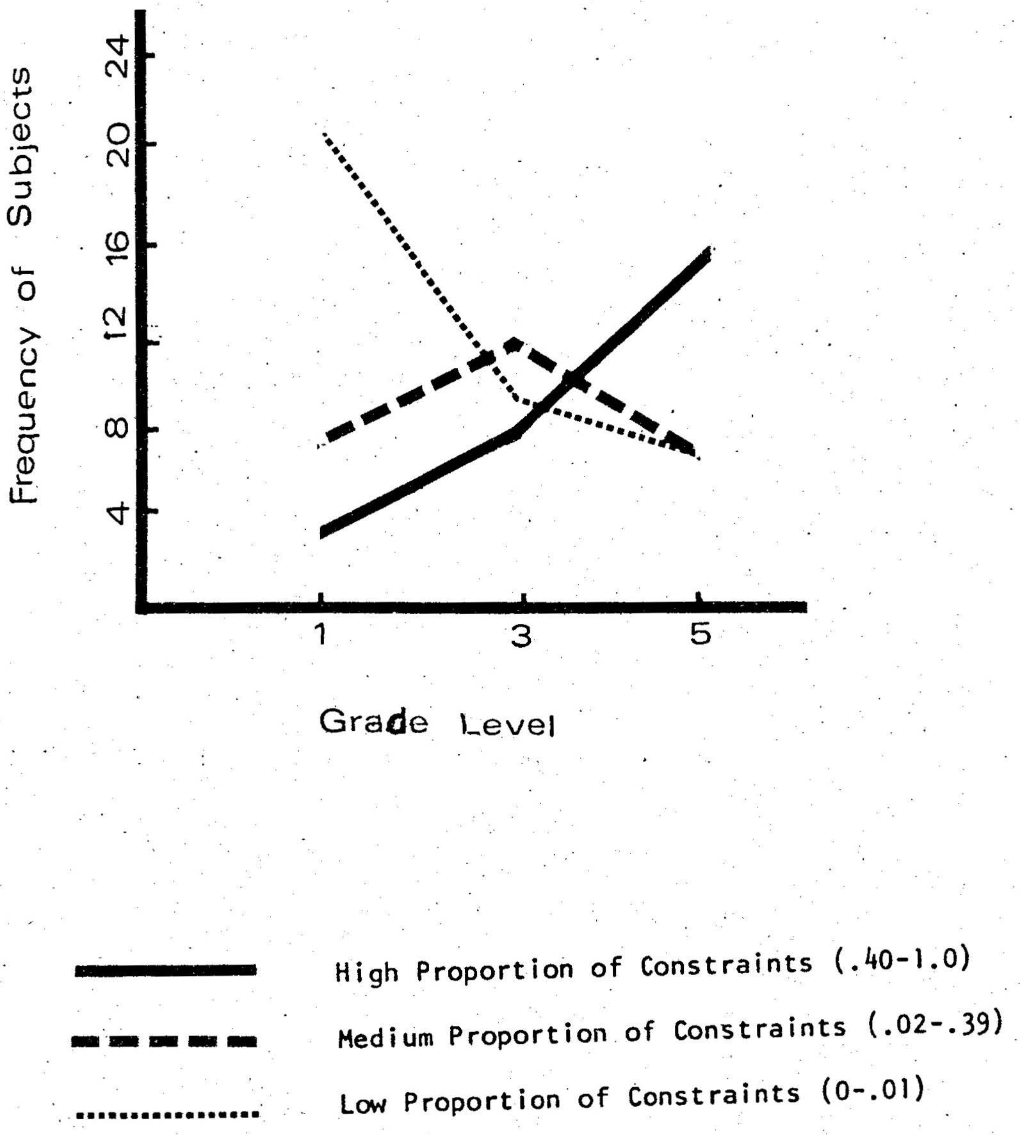

Figure 4

Subjects in Grades One, Three and Five
Categorized by the Proportion of
Constraints Used Prior to
Experimental Treatment

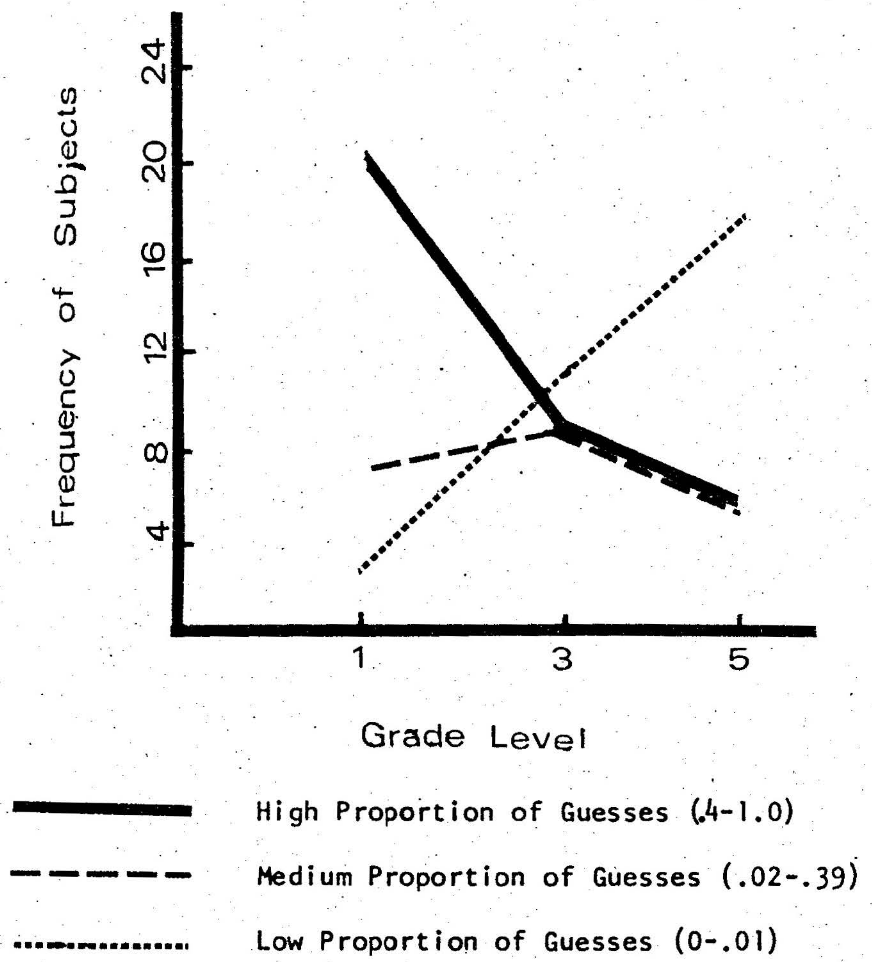

Figure 5

Subjects in Grades One, Three and Five Categorized
by the Proportion of Guesses Used
Prior to Experimental Treatment

the superior performance of subjects following treatment, compared to untreated subjects. As suggested by Solomon and Lessac (1968), the posttest scores following practice, modeling and combined practice-modeling treatments were compared, respectively, to the posttest group 4 scores, pretreatment scores in pooled groups 1 and 2, and posttest group 3 scores. Contingency tables (Tables 4, 5 and 6) report the number of treatment and comparison group subjects using high and low numbers of questions and proportions of guesses and constraints. Chi-square values are reported in Table 7. The X^2 total values were assumed to reflect the degree of association between treatment method, grade level and the number of subjects whose responses fell into high and low response categories. Four X^2 total values reached significance, suggesting an association between the proportion of constraints used following both the modeling and practice treatments, and the proportion of guesses used following modeling and combined practice-modeling treatments. Each of these X^2 total values were partitioned into X^2 treatment comparisons, which were assumed to reflect the effects of each of the treatment methods. Grade 1, 3 and 5 scores were pooled, and X^2 treatment comparisons were based on the number of subjects whose scores fell into high and low response categories in the treatment and comparison groups. Chi-square treatment comparisons were used to evaluate hypotheses 4, 5, 6, 10, 11, 12, 16, 17 and 18. Three X^2 treatment values reached significance, suggesting an association between the proportion of guesses (hypothesis 5) and constraints (hypothesis 6) used following modeling. The proportion of constraints used also differentiated between combined practice-modeling and modeling groups.

Comparison of the percentage of constraints used by comparison (i.e., pretreatment performance in pooled groups 1 and 2) and modeling groups revealed that only 32% of the subjects in the comparison group used a high proportion of constraints, compared to 90% of the subjects in the modeling group. Sixty-eight percent of the subjects in the comparison group used a low proportion of constraints, compared to 10% in the modeling group. Comparison of the proportion of guesses used by subjects in the comparison (i.e., pooled pretreatment scores in groups 1 and 2) and modeling groups indicated that 64% of the comparison group used a high proportion of guesses, compared to 24% in the modeling group. Thirty-six percent of the comparison group subjects used a high proportion of guesses, compared to 76% of the modeling.

The combined practice-modeling group used fewer constraints than the comparison group (i.e. modeling group). Sixty-six percent of the comparison group subjects used a high proportion of constraints, compared to 33% of the combined practice-modeling group. Only 33% of the comparison group subjects used a low proportion of constraints, compared with 66% of the practice-modeling group.

It is interesting to note that treatment failed to increase question-asking efficiency, i.e., the number of questions required to reach solution. Presumably, the respective increase and decrease in the proportion of constraints and guesses used following the modeling treatment represents an increase in the overall efficiency of subjects' information-seeking strategies; subjects used relatively few tests of discrete hypotheses, instead grouping pictures and asking questions about these groups. The total number of questions used did not reflect this refined information-seeking strategy. In previous research, study of the sequence of questions asked suggested to Mosher and Hornsby (1966) that "narrowing" differentiated between younger and older children.

> Narrowing refers to what one can do having established some prior constraint--particularly whether one asks a further constraint question or shifts to hypothesis testing. The older children were more likely to narrow the remaining possibilities with further constraint questions, whereas the eight-year olds tended to leap immediately to specific hypotheses (p. 91).

Narrowing might explain why the number of questions to solution required by the younger children seemed independent of increased proportions of constraint and guess usage. Mosher and Hornsby (1966) also suggested that older subjects "consider specific hypotheses inelegant. They prefer pseudoconstraints to such a degree that sometimes pseudoconstraints replace out-and-out guesses, even when specific hypotheses are more efficient than constraints (p. 92)." Such misinterpretation of the "rules" could have prohibited increased question-asking efficiency among Mosher and Hornsby's older subjects. It is possible that question-asking efficiency in the present study was affected by factors suggested by Mosher and Hornsby. This might account for the apparent independence of the number of questions to solution and constraint and guess usage.

While the practice treatment familiarized subjects with the question-asking task and the modeling treatment exposed subjects to relatively efficient question-asking, subjects were not taught how to transform these training experiences into efficient question-asking strategies. The posttreatment efficiency gains reported in the literature differ from the treatment methods used in the present study in at least two ways. Efficiency gains typically require extended training (Blank and Covington, 1966) or the provision of information-seeking strategies which assure efficient processing (Klausmier and Mienke, 1968).

Treatment X Grade Interaction

A third general concern was to assess the possibility of grade-treatment interaction. It was hypothesized (hypothesis 7, 8, 9, 13, 14, 15, 19, 20, 21) that the performance levels of grade 3 and 5 subjects would be higher than grade 1 levels. More specifically, following each of the practice, modeling and practice-modeling treatments, it was expected that grade 1 subjects would require relatively more questions to reach solution, and would

TABLE 4

Number of Subjects Categorized by Number of Questions Required to Reach Solution Following Practice, Modeling and Combined Practice-Modeling Treatment Methods, Compared with Differentially Treated Groups.[a]

Treatment Method	Score Category	Grade 1 Comparison	Grade 1 Treatment	Grade 3 Comparison	Grade 3 Treatment	Grade 5 Comparison	Grade 5 Treatment
Modeling	High (23+)	13	6	10	2	7	5
	Low (0-22)	7	4	10	8	13	5
	Total	20	10	20	10	20	10
Practice	High (22+)	5	6	6	4	6	2
	Low (0-21)	5	4	4	6	4	8
	Total	10	10	10	10	10	10
Combined Practice-Modeling	High (21+)	7	7	4	5	6	3
	Low (0-20)	3	3	6	5	4	7
	Total	10	10	10	10	10	10

[a] Assessment involved the score comparisons suggested by Solomon and Lessac (1968). Posttest scores following modeling, practice and practice-modeling were compared to pooled pretreatment scores in groups 1 and 2, posttest group 4 and posttest group 3 scores.

TABLE 5

Number of Subjects Categorized by the Proportion of Constraints used Following Practice, Modeling and Combined Practice-Modeling Treatment Methods Compared with Differentially Treated Groups.[a]

Treatment Method	Score Category	Grade 1 Comparison	Grade 1 Treatment	Grade 3 Comparison	Grade 3 Treatment	Grade 5 Comparison	Grade 5 Treatment
Modeling	High (.34+)	0	7	6	10	13	10
	Low (0.0-.33)	20	3	14	0	7	0
	Total	20	10	20	10	20	10
Practice	High (.34+)	5	1	3	5	7	8
	Low (0.0-.33)	5	9	7	5	3	2
	Total	10	10	10	10	10	10
Combined Practice-Modeling	High (.56+)	6	2	8	3	7	5
	Low (0.0-.55)	4	8	2	7	3	5
	Total	10	10	10	10	10	10

[a] Assessment involved the score comparisons suggested by Solomon and Lessac (1968). Posttest scores following modeling, practice and practice-modeling were compared to pooled pretreatment scores in groups 1 and 2, posttest group 4 and posttest group 3 scores.

TABLE 6

Number of Subjects Categorized by the Proportion of Guesses used Following Practice, Modeling and Combined Practice-Modeling Treatment Methods Compared to Differentially Treated Groups.[a]

Treatment Method	Score Category	Grade 1 Comparison	Grade 1 Treatment	Grade 3 Comparison	Grade 3 Treatment	Grade 5 Comparison	Grade 5 Treatment
Modeling	High (0.09+)	19	4	12	0	14	3
	Low (0.0-.08)	1	6	8	10	6	7
	Total	20	10	20	10	20	10
Practice	High (.28+)	7	8	5	4	4	2
	Low (0.0-.27)	3	2	5	6	6	8
	Total	10	10	10	10	10	10
Combined Practice-Modeling	High (.56+)	6	9	1	3	3	6
	Low (0.0-.55)	4	1	9	7	7	4
	Total	10	10	10	10	10	10

[a] Assessment involved the score comparisons suggested by Solomon and Lessac (1968). Posttest scores following modeling, practice and practice-modeling were compared to pooled pretreatment scores in groups 1 and 2, posttest group 4 and posttest group 3 scores.

TABLE 7

Partitioned X^2 Values for Each of the Dependent Variables Following Practice, Modeling and Combined Practice-Modeling Treatment

TREATMENT METHOD	DEPENDENT VARIABLES											
	NUMBER OF QUESTIONS TO SOLUTION				PROPORTION OF CONSTRAINTS USED				PROPORTION OF GUESSES USED			
	Source	X^2	df	P	Source	X^2	df	P	Source	X^2	df	P
Modeling	X^2 total[a]	7.44	5	NS	X^2 total[a]	46.52	5	.001	X^2 total[a]	32.16,	5	.001
	X^2 treatment[b]	0.13	1	NS	X^2 treatment[b]	24.95	1	.001	X^2 treatment[b]	10.27	1	.01
	X^2 grade[c]	4.36	2	NS	X^2 grade[c]	17.12	2	.001	X^2 grade[c]	14.48	2	.001
	X^2 grade x treatment[d]	2.95	2	NS	X^2 grade x treatment[d]	4.45	2	NS	X^2 grade x treatment[d]	7.39	2	.05
Practice	X^2 total[a]	5.16	5	NS	X^2 total[a]	13.16	5	.05	X^2 total[a]	9.60	5	NS
	X^2 treatment[b]	1.06	1	NS	X^2 treatment[b]	00.00	1	NS	X^2 treatment[b]	0.06	1	NS
	X^2 grade[c]	0.96	2	NS	X^2 grade[c]	8.96	2	.02	X^2 grade[c]	8.40	2	.05
	X^2 grade x treatment[d]	3.04	2	NS	X^2 grade x treatment[d]	4.20	2	NS	X^2 grade x treatment[d]	1.14	2	NS
Combined Practice-Modeling Treatment	X^2 total[a]	5.37	5	NS	X^2 total[a]	10.76	5	NS	X^2 total[a]	16.60	5	.01
	X^2 treatment[b]	0.06	1	NS	X^2 treatment[b]	6.67	1	.01	X^2 treatment[b]	3.28	1	NS
	X^2 grade[c]	3.36	2	NS	X^2 grade[c]	1.76	2	NS	X^2 grade[c]	12.19	2	.01
	X^2 grade x treatment[d]	1.95	2	NS	X^2 grade x treatment[d]	2.33	2	NS	X^2 grade x treatment[d]	1.13	2	NS

[a] Chi-square total assessed the degree of association between treatment method, grade level and frequency of subjects whose scores fell into high and low response categories.

[b] Chi-square treatment pooled grade 1, 3 and 5 scores and compared the number of subjects whose scores fell into high and low response categories following treatment compared to differentially treated subjects. The method of score comparison suggested by Solomon and Lessac (1968) was used.

[c] Chi-square grade values were derived by comparing the pooled treatment and comparison group scores at each of the grade levels.

[d] Chi-square grade x treatment values were used to assess interaction between grade level and treatment method in association with high and low response categories.

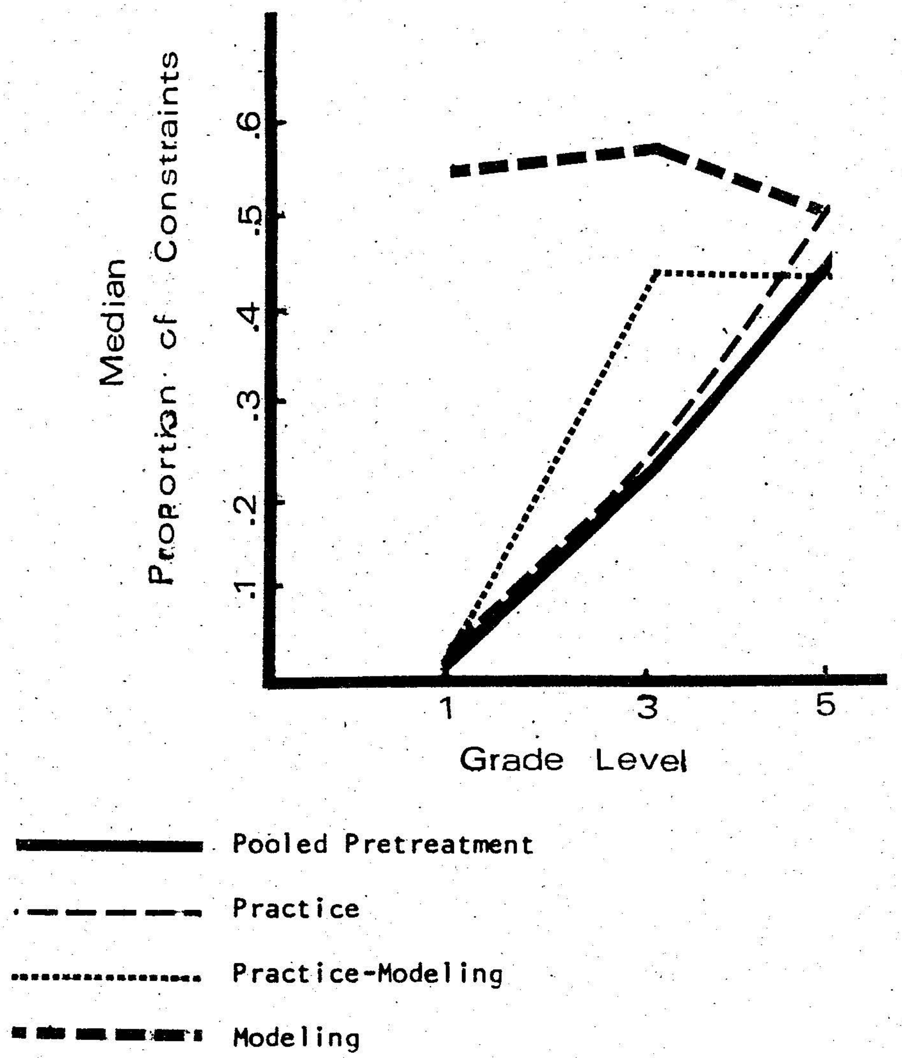

Figure 6

Median Constraint Proportions Used by Grade One, Three and Five Subjects Following Treatments, Compared to the Pooled Pretreatment[a] Proportions

[a] Based on pooled group 1, 2 and 3 pretreatment scores.

use a smaller proportion of constraints and a greater proportion of guesses. These assumptions were assessed by comparing the various posttreatment scores from grade 1, 3 and 5 groups on each of the dependent variables. As indicated in Table 7, there was only one significant grade X treatment value; this overall value was used to indicate an interaction between grade level and the modeling treatment in association with high and low categories of guess usage.

However, grade 1-3, 1-5 and 3-5 comparisons of each of the dependent variables following each of the treatment methods indicated several grade X treatment interactions. Following the practice treatment, both the proportion of guesses ($X^2 = 5.00$, df = 1, $p < .05$) and constraints ($X^2 = 7.27$, df = 1, $p < .01$) used differentiated between grade 1 and grade 5 groups, providing partial support for hypotheses 14 and 15. Following the combined practice-modeling treatment ($X^2 = 5.20$, df = 1, $p < .05$), the proportion of guesses differentiated between grade 1 and grade 3 groups, providing partial support for hypothesis 20.

Assessment of the relative effectiveness of the 3 treatment methods on each of the dependent variables suggested grade X treatment interaction in the association of the modeling treatment and constraint usage. Figure 6 compares the posttreatment proportion of constraints used following each of the treatment methods. Only the modeling treatment seemed to be effective at the grade 1 level.

Post-hoc comparison of the number of subjects using high and low proportions of constraints following modeling and combined practice-modeling treatments suggested the superiority of the modeling treatment ($X^2 = 5.05$, df = 1, $p < .05$). The effectiveness of the practice and combined practice-modeling treatments increased with grade level. Post-hoc comparison of modeling and combined practice-modeling groups at the grade 3 level suggested that the proportion of constraint use was higher following modeling than it was following combined practice-modeling ($X^2 = 10.76$, df = 1, $p < .01$). It should be noted that these post-hoc analyses may have raised the probability of alpha error, and consequently only tentative interpretation of these findings is possible.

The relative effectiveness of the modeling treatment at the grade 1 and 3 levels may be related to the differences in model-subject information-seeking sophistication. All subjects given the modeling treatment were exposed to efficient question-asking games played by a grade 3 boy who had been given extended question-asking training. Since older children (Bandura and Kupers, 1964) of the same sex (Lippitt and Lohman, 1965) demonstrating high competence (Rosenbaum and Tucker, 1962) are "likely to command more attention and to serve as more influential sources of social behavior than models who lack these qualities" (Bandura, 1970, p. 136), grade 5 subjects may not have attended to or attempted to emulate the modeled question-asking games to the same extent as subjects in grades 1 and 3.

Further study would be required to determine the cause of the significant performance differences following combined practice-modeling and modeling treatments. These differences may be related to several factors. For example, the combined practice-modeling treatment was more time consuming and may have resulted in a fatigue effect. Again, practice may have induced a "set", reducing subjects' ability to attend to relevant aspects of the model's performance.

Grade Comparisons

The X^2 total values reported in Table 7 were partitioned into X^2 grade comparisons. The X^2 grade comparisons pooled treatment and comparison group scores and compared these scores at each of the grade levels (See Tables 4, 5 and 6). These grade values were assumed to reflect the degree of association between grade level and observed response categories. As indicated in Table 7, five X^2 grade comparisons reached significance; subsequent partitioning into grade 1-3, grade 1-5 and grade 3-5 comparisons resulted in 6 values which reached significance.

Chi-square comparison of the pooled modeling and comparison groups suggested that the grade 1 group was associated with a significantly lower proportion of constraint use than either the grade 3 ($X^2 = 4.51$, df = 1, $p < .05$) or grade 5 groups ($X^2 = 15.00$, df = 1, $p < .001$). Comparison of the pooled modeling and comparison group scores suggested that the grade 1 group was associated with a significantly greater proportion of guess use than either the grade 3 ($X^2 = 6.86$, df = 1, $p < .01$) or the grade 5 group ($X^2 = 11.32$, df = 1, $p < .001$). Chi-square analysis of the pooled practice and comparison groups suggested that the grade 5 group was associated with a significantly greater proportion of constraint use than the grade 1 group ($X^2 = 6.42$, df = 1, $p < .02$). Chi-square comparison of the pooled combined practice-modeling and comparison groups suggested that the grade 1 group was associated with a significantly higher proportion of guess use than the grade 3 group ($X^2 = 10.02$, df = 1, $p < .01$).

The pattern of X^2 grade comparisons obtained would seem to suggest that grade level and the sophistication of information-seeking strategies (as measured in terms of constraint and guess use) are directly related.

<u>Comparison of the Treatment Methods</u>

The final general concern was to assess the relative effectiveness of the three treatment methods. Pooled grade 1, 3 and 5 scores following practice, modeling and combined practice-modeling treatment methods were compared on each of the dependent variables. One X^2 value reached significance ($X^2 = 9.17$, df = 2, $p < .02$), suggesting an association between the proportion of constraints used and the treatment methods. Subsequent X^2 partitioning of this value suggested the superiority of the postmodeling performance compared to performance following the combined practice-modeling treatment ($X^2 = 3.88$, df = 1, $p < 0.5$) and compared to performance following the practice treatment ($X^2 = 7.33$, df = 1, $p < .01$) (See Table 8). As indicated in Figure 6, the median proportion of constraint use was highest following the modeling treatment, and at a lower level following the combined practice-modeling treatment. Constraint use following the practice treatment was higher than only the pretreatment level.

Conclusions

The results of the treatment comparisons have some implications for the classroom situation. The comparative effectiveness of the modeling treatment in accelerating information-seeking strategies lends support to the proposed use of imitative learning as a teaching resource (Lippitt and Lohman, 1966). Two instances in which such training may be useful include the acceleration of classificatory skill in remedial work and improvement of the quality of question-asking, i.e., inquiry training. While modeling is being used in classroom settings with apparent success in other countries (Bronfenbrenner, 1962), it is used infrequently in Canadian schools. Educators might reconsider a statement made by Lippitt and Lohman (1966), which suggests that:

> We may not be making the best use of the powerful educational resources represented by cross-age relationships among children. It is an observed fact that children, with proper training and support from adults, are able to function

> effectively in the role of helpers and teachers of younger children--and that the older children find this type of experience meaningful, productive and a source of valuable learning for themselves (p. 113).

Experimental study of modeling in classroom situations would be required to enable educators to evaluate the role of modeling in classificatory and inquiry-type training. Among the important modeling parameters to study might be the maximally effective age-sex relationship between student and model, and the content of the model-student interaction.

TABLE 8

Medians, Means and Standard Deviations of the Proportion of Constraints Used by Grade One, Three and Five Subjects in Posttest and Pretreatment[a] Question-Asking.

GRADE LEVEL	POOLED PRETREATMENT			PRACTICE			MODELING			COMBINED PRACTICE MODELING		
	Md	M	SD	Md	M	SD	Md	M	SD	Md	M	Sd
1	.00	.12	.19	.00	.13	.21	.55	.43	.31	.00	.14	.26
3	.25	.22	.20	.25	.28	.22	.58	.59	.10	.45	.47	.11
5	.48	.37	.26	.53	.49	.13	.53	.58	.08	.45	.53	.16

[a] Based on pooled group 1, 2 and 4 scores.

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APPENDIX A

Verbatum Instructions Used in

Each of the Experimental Treatments

Picture Identification

I played this game with many of the boys in your school, and they all said they enjoyed it. Now I'm going to show you the pictures. There are lots of pictures on this page. I'm going to ask you to name each one and tell me what they are as I point to them.

Explanation of the Rules

Okay, now that we've named the pictures, let's go over the rules for the question-asking game that we are going to play.

Before you came in, I picked one of the pictures on this page to think about. I didn't just pick my favorite picture. I picked one picture by closing my eyes and dropping my hand onto one of the pictures on this page. I 'm not going to tell you which picture I'm thinking of. Your job will be to figure out which picture it is. You should figure out which picture I'm thinking about by asking me questions about the pictures. I will only answer "yes" or "no" when you ask me a question.

There is one important rule you must try to use--you must try to figure out which picture I'm thinking about without using very many questions--so you are not allowed to use too many questions. I'll give you an example of how this rule works. Suppose one boy who played this game used a lot of questions and another boy used much fewer questions. The boy who used much fewer questions used the rule better.

Now, you don't have to rush. I want you to just look at the pictures and choose your questions carefully.

Let's go over your part and my part in the game just to make sure we both know the rules the same way. I'm thinking of one picture, and you don't know which one it is. Now, what will you be trying to find out? Should you rush to finish quickly? I told you there was one important rule. The rule is that you must use just as few questions as you can to try to figure out which picture I'm thinking of, so you shouldn't use very many questions.

Comprehension of the Rules

I'm going to ask you a few more questions, so listen carefully. Does it matter how many questions you ask? Should you use as many as you want or as few as you can? If I played the game with two boys, and one boy used a lot of questions and the other boy didn't use so many questions, who used the rule best?

Now are there any questions you want to ask me about the game before we begin?

Pretest

Now let's play the game, starting with these pictures.

Modeling

I'm going to give you an example of how another boy played this game. A while ago, another boy played the question-asking game with me. I've made a recording of what he said and what I said as we went through the game. Now look at the pictures on page 2. You can keep looking at the pictures while I turn on the machine (tape recorder).

<u>Tape Recorded Question-Asking Games used in the Modeling Procedure</u>

Game #1, played with ten items

Now I'm thinking of one picture here and I'd like you to find out which one it is. Could you look at them and ask me questions about them?

Subject (S): Is it alive?

Experimenter (E): No, it's not alive.

S: Is it brown?

E: No, it's not brown.

S: Red?

E: No, it's not red.

S: Can you wear it?

E: No you can't wear it.

S: Does it move?

E: No it doesn't move.

S: Is it yellow?

E: Yes, it's yellow.

S: Can you sit on it?

E: Yes you can sit on it.

S: Is it a stool?

E: Yes.

Game #2, played with 15 items

E: Now I'd like you to look at the rest of these pictures here. Again, I'm thinking of one picture, and you have to figure out which one it is, according to the rules. Okay? Would you like to begin now?

S: Is it yellow?

E: No, it's not yellow.

S: Does it have wheels?

E: No, it doesn't have wheels.

S: Can you wear it?

E: No, you can't wear it.

S: Is it alive?

E: Yes, it's alive.

S: Does it live on a farm?

E: Yes, it lives on a farm.

S: Does it go moo?

E: Yes, it goes moo.

S: Is it a cow?

E: Yes, it's a cow.

Game #3, played with 25 items

E: Now, this is the whole card, with all of the pictures. Let's do this thing the way we've done all the others. Just remember the rules, and pick your questions carefully. I'm thinking of one picture and I'd like you to try to figure out which one it is. Okay? You can begin now.

S: Does it move?

E: No, it doesn't move.

S: Is it alive?

E: No, it isn't alive.

S: Does it have wheels?

E: No, it doesn't have wheels.

S: Is it brown?

E: No, it's not brown.

S: Is it black?

E: No, it isn't black.

S: Is it yellow?

E: Yes, it's yellow.

S: Can you measure with it?

E: Yes, you can measure with it.

S: Is it the ruler?

E: Yes, it's the ruler.

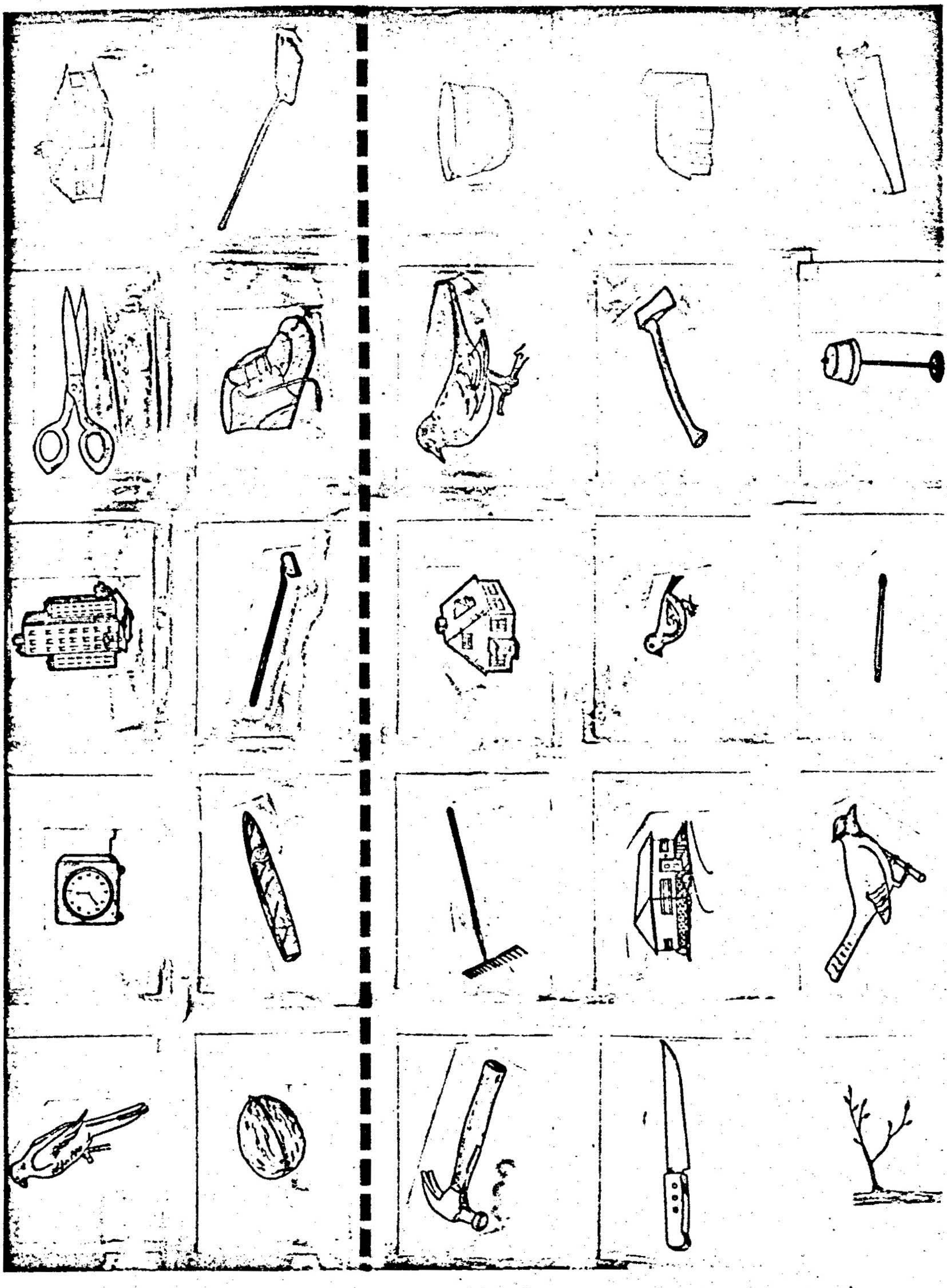
E: Now that game is over. We'll go on now and play another game. You should use the rules; work carefully and use as few questions as you can. You can work like the boy on the recording if you want to.

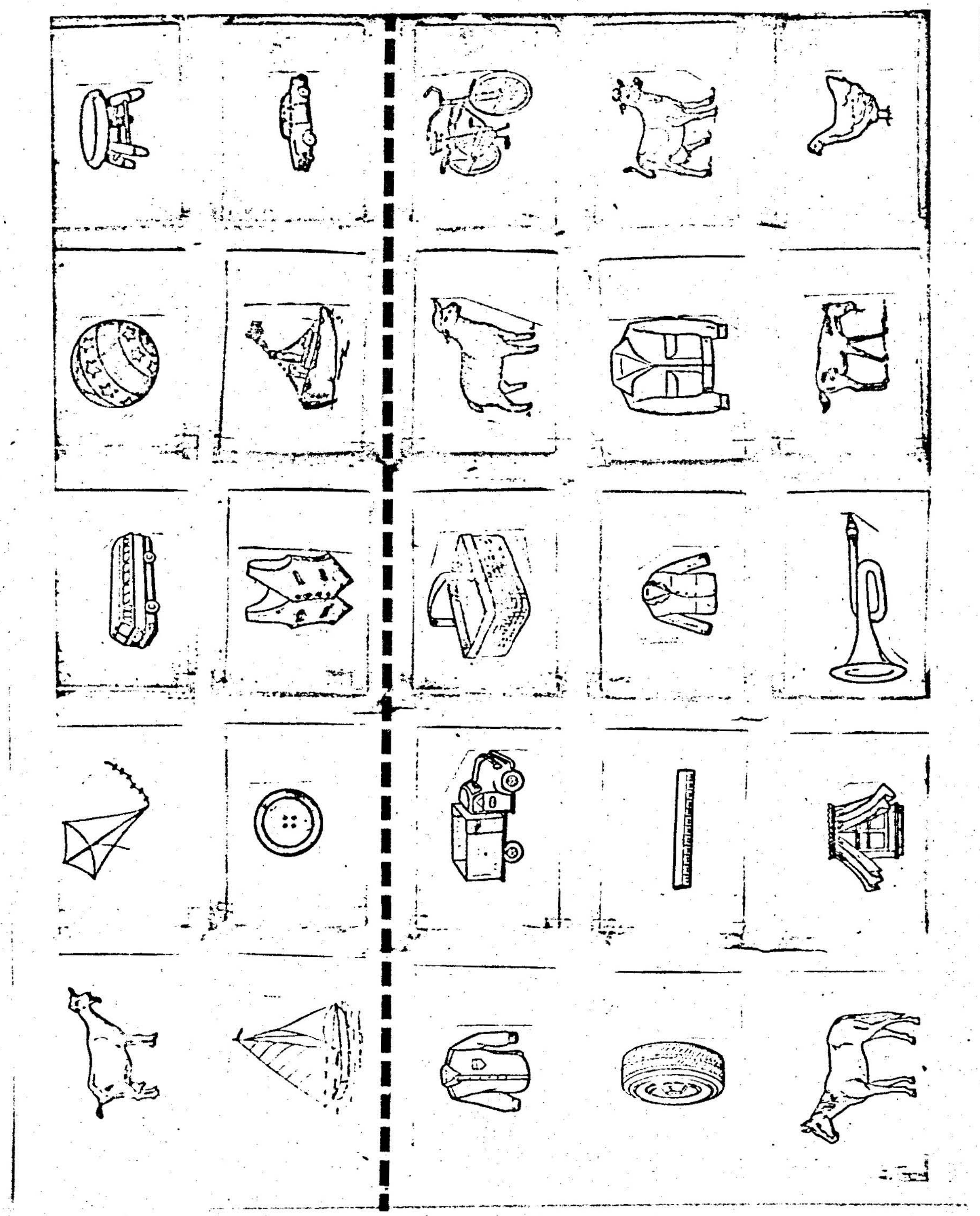
<u>Posttest</u>

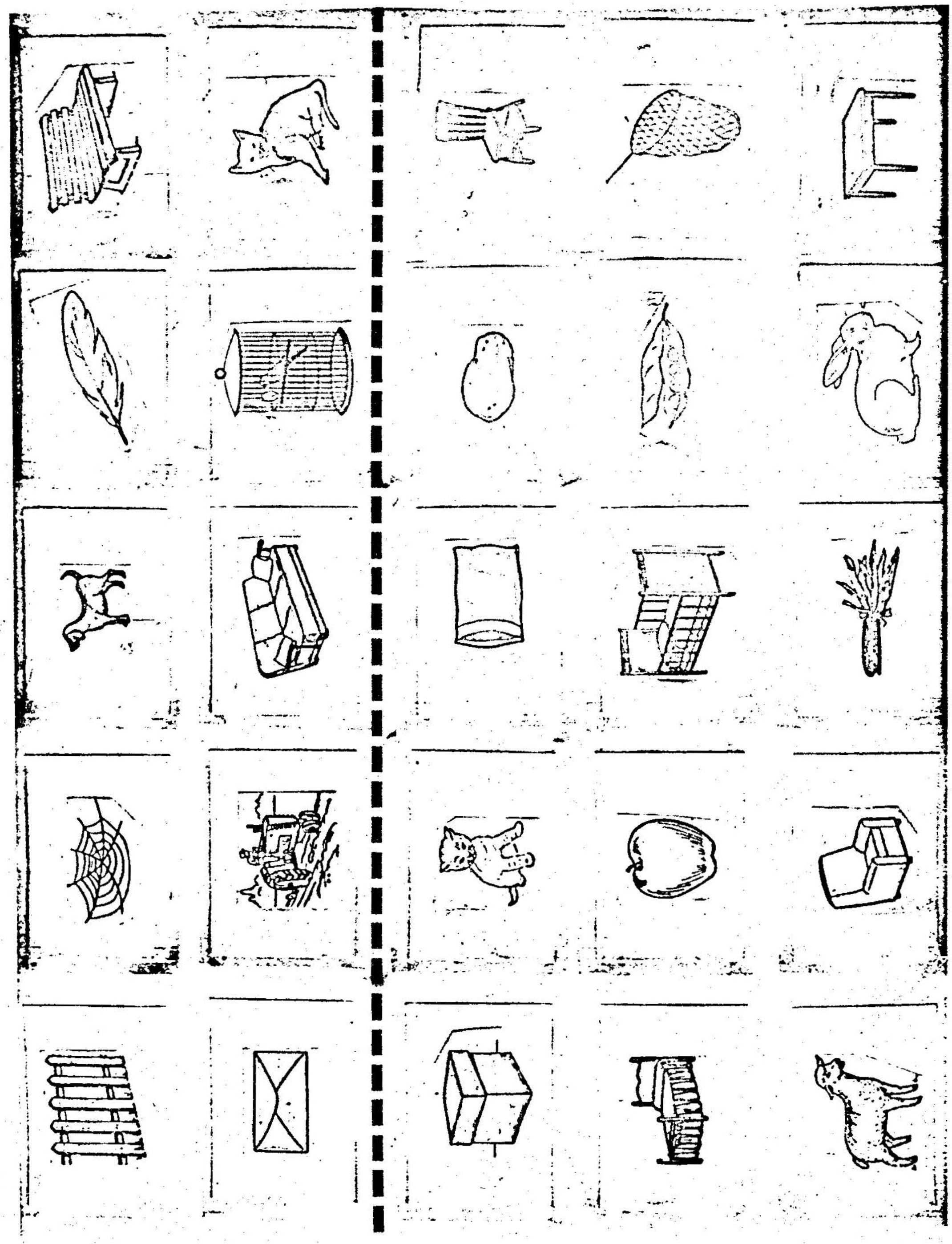
Now let's play the game, starting with these pictures.

APPENDIX B

The Stimulus Arrays







RAW DATA

APPENDIX

RAW DATA

The chronological age (C.A.), frequency of constraing usage (F.C.), frequency of guess usage (F.G.), and the total number of questions asked (T.) are listed below.

GROUP I

Subject Number	Grade	C.A.	Game 1 F.C.	Game 1 F.G.	Game 1 T.	Game 2 F.C.	Game 2 F.G.	Game 2 T.	Game 3 F.C.	Game 3 F.G.	Game 3 T.	Game 4 F.C.	Game 4 F.G.	Game 4 T.	Game 5 F.C.	Game 5 F.G.	Game 5 T.	Game 6 F.C.	Game 6 F.G.	Game 6 T.
1	1	6.8	0	9	9	0	9	9	0	23	23	0	9	9	0	4	4	0	4	4
2	1	6.8	0	7	7	0	4	4	0	24	24	0	4	4	0	1	1	6	22	30
3	1	6.3	0	10	10	0	14	14	0	20	20	0	9	9	0	8	8	0	3	3
4	1	6.2	0	4	4	0	10	10	0	8	8	3	0	6	6	0	7	5	0	10
5	1	6.7	0	7	7	0	16	16	0	24	24	0	11	11	0	3	3	0	22	24
6	1	6.10	0	4	4	0	4	4	0	2	2	0	5	5	0	26	26	0	11	11
7	1	6.4	0	10	10	0	3	3	0	9	9	2	0	3	6	2	10	6	0	8
8	1	6.2	0	9	9	0	12	12	1	22	24	0	5	5	0	1	1	0	7	7
9	1	7.0	0	8	8	0	5	5	0	17	17	0	11	11	0	4	4	0	16	16
10	1	7.7	0	5	5	0	6	6	0	15	16	0	8	8	0	6	6	0	5	5
1	3	8.10	0	9	9	0	3	3	0	8	9	4	0	7	2	0	3	6	4	11
2	3	8.10	0	0	5	4	1	8	5	2	15	2	0	3	1	0	4	4	0	8
3	3	6.7	2	3	8	2	0	4	6	1	11	1	0	4	3	0	5	1	0	6
4	3	8.10	2	1	4	0	2	2	4	18	23	0	0	2	2	0	7	6	8	15
5	3	8.6	2	0	9	1	0	8	2	0	9	1	0	5	3	0	5	7	0	9
6	3	9.0	3	0	7	8	0	15	6	0	12	2	0	12	4	0	13	6	0	11
7	3	8.5	0	2	2	0	6	6	0	15	15	3	0	6	5	0	9	5	0	9
8	3	10.7	1	0	7	5	0	9	1	0	2	1	0	3	1	0	2	2	0	4
9	3	8.2	0	1	1	0	12	12	0	11	11	4	0	7	4	0	8	7	0	8
10	3	9.1	3	0	10	2	7	11	2	6	9	1	1	2	3	0	5	2	0	4
1	5	11.0	0	1	1	0	14	14	0	13	13	1	0	4	1	0	3	2	0	6
2	5	10.7	0	1	1	0	11	11	0	10	10	4	0	5	3	0	6	4	1	5
3	5	10.3	2	0	3	3	0	4	1	0	4	5	0	7	6	0	7	3	0	4
4	5	12.5	0	9	9	0	10	12	0	6	8	2	0	4	4	0	12	4	1	7
5	5	10.9	6	2	14	8	1	15	5	0	6	4	0	5	5	0	6	7	1	12
6	5	11.4	0	0	2	4	2	8	3	4	10	3	0	4	3	0	4	6	0	12
7	5	10.7	0	9	9	0	11	11	0	5	5	2	0	4	5	0	8	2	0	4
8	5	10.8	3	0	6	1	0	6	1	0	3	2	1	7	3	0	5	4	0	7
9	5	11.1	0	0	3	1	0	2	2	0	4	2	2	5	2	0	8	2	0	6
10	5	12.0	0	5	5	0	6	6	1	6	9	2	0	4	5	1	8	8	4	20

RAW DATA

GROUP 2

Subject Number	Grade	C.A.	Game 1 F.C.	Game 1 F.G.	Game 1 T.	Game 2 F.C.	Game 2 F.G.	Game 2 T.	Game 3 F.C.	Game 3 F.G.	Game 3 T.	Game 4 F.C.	Game 4 F.G.	Game 4 T.	Game 5 F.C.	Game 5 F.G.	Game 5 T.	Game 6 F.C.	Game 6 F.G.	Game 6 T
1	1	6.11	0	4	4	0	10	10	0	16	16	0	5	5	0	15	15	0	0	4
2	1	6.9	1	3	5	3	3	7	3	0	11	0	3	3	3	9	12	5	0	9
3	1	6.2	0	4	4	0	5	5	0	12	12	0	3	3	0	1	1	0	4	4
4	1	6.4	3	1	8	1	6	9	3	0	4	2	0	3	3	3	6	3	0	4
5	1	6.11	3	0	10	2	0	8	1	0	2	1	0	4	2	0	13	2	6	31
6	1	6.2	1	3	5	2	14	17	4	13	17	3	1	4	0	3	3	1	2	8
7	1	7.2	0	9	9	0	4	4	0	15	15	0	8	8	0	4	4	0	3	3
8	1	7.0	0	10	10	0	10	10	0	18	18	0	9	9	0	5	5	0	19	19
9	1	7.0	0	1	1	0	8	8	0	13	13	0	10	10	0	14	14	0	11	11
10	1	7.5	0	1	1	0	2	2	0	6	6	0	8	8	0	3	3	0	13	13
1	3	8.7	0	8	8	0	2	2	0	10	10	0	8	8	0	13	13	0	8	8
2	3	10.4	0	4	4	0	7	7	0	6	6	0	6	6	0	3	3	0	2	2
3	3	9.1	2	0	4	4	0	7	1	0	4	2	0	5	3	0	5	2	0	4
4	3	8.4	1	0	4	4	0	6	3	0	7	0	0	9	1	0	9	5	0	9
5	3	8.11	6	3	13	3	0	5	3	0	6	3	0	4	4	0	7	4	4	11
6	3	8.7	0	0	5	1	0	4	1	0	4	2	0	7	1	0	3	2	0	3
7	3	8.0	1	0	4	3	1	9	2	0	9	3	0	5	7	0	14	2	0	6
8	3	8.4	0	1	2	0	9	9	0	4	4	0	8	8	0	6	6	0	1	1
9	3	9.1	0	10	11	0	1	4	1	4	10	0	1	1	1	6	8	3	0	6
10	3	9.11	1	0	4	4	1	10	4	0	7	1	0	5	4	0	6	5	0	10
1	5	11.2	3	0	6	1	0	5	2	0	4	1	1	4	2	0	8	1	5	6
2	5	10.8	6	0	8	3	0	4	3	0	4	1	0	3	2	0	3	3	0	6
3	5	11.2	2	0	5	2	0	4	3	0	9	3	1	8	4	0	5	2	0	5
4	5	11.3	4	0	5	3	0	5	3	0	5	2	0	7	2	0	4	5	0	10
5	5	11.3	5	0	10	4	0	9	4	1	10	1	0	5	3	0	6	12	1	18
6	5	11.9	3	0	6	4	2	11	9	0	16	1	0	3	3	0	5	6	0	10
7	5	10.7	0	0	7	3	0	7	8	0	17	2	0	6	5	0	8	5	0	6
8	5	12.0	1	0	3	1	0	2	4	1	10	1	0	3	1	0	6	3	9	20
9	5	11.9	2	0	5	5	0	8	3	0	5	3	0	6	2	0	5	5	0	7
10	5	11.7	3	0	4	3	0	4	4	0	6	3	0	6	3	0	6	4	0	7

RAW DATA

GROUP 3

Subject Number	Grade	C.A.	Game 1			Game 2			Game 3			Game 4			Game 5			Game 6		
			F.C.	F.G.	T.	F.C.	F.G.	T.	F.C.	F.G.	T.	F.C.	F.G.	T.	F.C.	F.G.	T.	F.C.	F.G.	T.
1	1	6.8										3	0	5	3	0	5	1	0	2
2	1	6.5										4	0	5	5	0	7	8	1	13
3	1	6.4										0	1	1	0	14	14	0	15	15
4	1	6.2										0	8	8	0	10	10	0	7	7
5	1	7.6										1	0	4	6	4	15	3	0	10
6	1	7.10										4	0	5	4	0	8	3	0	5
7	1	8.1										4	0	5	4	0	6	5	0	8
8	1	7.8										5	0	7	5	0	8	4	1	6
9	1	7.3										0	17	17	0	3	3	0	11	11
10	1	7.6										5	0	9	6	0	8	7	0	8
1	3	8.2										3	0	4	6	0	7	2	0	5
2	3	8.10										5	1	8	4	1	5	6	0	9
3	3	8.10										4	0	8	2	0	5	4	0	7
4	3	9.1										3	0	5	6	0	8	4	0	6
5	3	12.0										4	0	7	3	0	6	3	0	4
6	3	9.6										1	0	5	2	0	7	8	0	17
7	3	8.8										4	0	6	7	0	8	4	0	7
8	3	8.5										0	0	2	5	0	7	4	0	7
9	3	9.9										3	0	5	3	0	6	3	0	5
10	3	9.2										3	0	6	6	0	12	9	0	15
1	5	11.0										4	0	6	6	2	11	3	0	5
2	5	10.1										2	0	5	4	0	7	2	1	6
3	5	10.1										8	0	12	5	0	6	5	0	7
4	5	11.1										2	0	4	4	0	8	7	0	14
5	5	10.6										5	0	7	4	0	5	1	0	3
6	5	10.10										3	0	4	4	0	7	8	0	12
7	5	10.3										1	0	3	5	0	8	4	2	8
8	5	11.5										4	0	6	3	0	6	6	0	13
9	5	10.4										3	0	5	2	0	4	5	0	8
10	5	10.11										3	0	4	10	0	18	3	0	5

RAW DATA

GROUP 4

Subject Number	Grade	C.A.	Game 1 F.C.	Game 1 F.G.	Game 1 T.	Game 2 F.C.	Game 2 F.G.	Game 2 T.	Game 3 F.C.	Game 3 F.G.	Game 3 T.	Game 4 F.C.	Game 4 F.G.	Game 4 T.	Game 5 F.C.	Game 5 F.G.	Game 5 T.	Game 6 F.C.	Game 6 F.G.	Game 6 T.
1	1	7.2										4	3	8	3	2	5	5	1	8
2	1	6.2										3	0	9	3	0	4	4	11	17
3	1	6.10										6	2	10	2	0	3	3	1	15
4	1	6.10										2	0	3	2	0	7	4	2	7
5	1	6.7										0	10	10	0	1	1	0	9	9
6	1	6.4										0	9	9	0	14	14	0	1	1
7	1	6.8										0	4	4	0	5	5	0	3	3
8	1	6.9										3	0	8	4	0	4	2	0	4
9	1	6.9										0	1	1	0	13	13	0	17	17
10	1	7.0										0	9	9	0	14	14	0	38	38
1	3	8.3										1	0	2	4	0	9	3	0	6
2	3	8.7										0	10	10	0	7	7	0	15	15
3	3	9.2										0	2	2	0	7	7	0	30	30
4	3	8.8										0	7	7	0	12	12	0	10	10
5	3	8.5										2	0	5	3	0	7	3	5	12
6	3	8.4										1	0	3	3	4	7	2	0	4
7	3	8.9										2	0	3	3	0	5	3	0	4
8	3	8.2										0	8	8	0	9	9	0	12	12
9	3	9.0										1	0	5	2	0	9	3	0	4
10	3	8.5										2	1	8	1	0	5	2	1	10
1	5	10.5										4	0	5	5	0	9	4	0	10
2	5	10.5										5	2	9	2	0	3	3	0	5
3	5	10.8										0	4	4	0	6	6	0	14	14
4	5	11.0										2	0	4	3	0	5	3	0	6
5	5	10.2										0	9	9	0	7	7	0	18	18
6	5	11.6										3	0	4	2	0	6	12	4	24
7	5	10.9										3	0	4	2	0	5	4	0	5
8	5	11.2										0	12	12	0	2	2	0	10	10
9	5	10.8										2	2	5	3	3	6	4	4	11
10	5	11.0										1	0	5	3	0	5	4	0	6

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