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STIMULUS DEMAND QUALITIES AND REINFORCEMENT AS DETERMINANTS OF INTERROGATIVE STRATEGY

by

Geneva Leek Brown

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Approved by

Helen Canaday
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APPROVAL PAGE

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It was the purpose of this study to investigate the effectiveness of reinforcement and order of presentation of stimulus on question-asking strategy of nursery school, first-grade and third-grade children. It was hypothesized that the sophistication of interrogative strategies of the children would increase with age, that when the material was presented in an ordered form that the children would ask more constraint-seeking questions than when the material was randomly arranged. It was also hypothesized that when children were reinforced for asking constraint-seeking questions their use of such questions would increase. It was hypothesized that there would be no difference in the kind of interrogative strategies used by reflective and impulsive children and that intelligence would make no difference in the kinds of question-asking strategy employed by children.

Subjects were 32 children each of nursery school, first-grade, and third-grade level. The Twenty Questions Procedure, originally employed by Mosher and Hornsby (1966), was used.

A three-way analysis of variance was performed using the variables of age, stimulus array and consequences. The efficiency of interrogative strategy was found to increase significantly with the age of the children tested. Neither order of presentation of the stimuli nor reinforcement contingencies were found to make a significant difference.

An analysis of covariance, using mental age and cognitive styles as well as age, stimulus array and consequence, revealed mental age as well as chronological age as significant factors. The latency factor of the cognitive style measure was found to be significant while the error factor of the cognitive style measure was not significant. Again, order of presentation of stimulus array and consequences were not found to be significant. When latency and error scores were combined and subjected to a _t_ test the cognitive style was found to be insignificant.

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CHAPTER I

INTRODUCTION

The study of cognitive development in children is an area that has received an increased amount of attention over the past several years. An overview of the field is given by Ginsburg and Koslowski (1976). The major influences they see as having given impetus to the field are (a) Piaget's work, (b) the study of linguistics, deriving from Chomsky, and (c) E. J. Gibson's theory of perceptual development. As its subject matter, cognitive development has such interests as the growth of intellectual activities, remembering, thinking, perceiving, and using and understanding language. Although these problems can be and are approached from varying points of view, the cognitive approach assumes a distinct theoretical concern. The concern, in general, is how a person gets, creates, and uses knowledge about the physical and social worlds. Among the premises of the cognitive approach is one to the effect that internal psychological processes must be used to explain intellectual activities, and that internal processes often consist of hierarchical or other organizations, rather than simple associative chains. Most cognitive theorists also agree that development is an active process, but there is much less agreement on whether or not cognitive development involves qualitatively different stages and how any such stages should be conceptualized and described. Ginsburg and Koslowski observe that "the field seems to agree on the necessity for explanation in terms of cognitive processes but has not yet evolved a clear concept of what these processes are like or how they develop" (1976, p. 30).

Much of the effort involved in this area today is an attempt to identify and describe the cognitive processes taking place. How information is received, processed or mediated, and acted upon has received much attention. One line of research has been specifically involved in investigating cognitive organization. Eimas (1970b) found that the ability to code, recode, and retain information was positively related to the developmental level of the child and concluded that this ability or inability may result from a degree of deficiency in one or more of the component processes involved, such as a deficiency in memory or concept formation. Gangé (1968) had held a similar view of cognitive functioning in children.

Hypothesis testing can be seen as an extension of the work on cognitive organization. Bruner, Goodnow, and Austin (1956) used the term "focusing" to describe the systematic reduction of the size of the set of hypotheses used in problem solving tasks. In studying focusing behavior, Ingalls and Dickerson (1969) found that consistent focusing was not evidenced until the eighth grade. Eimas (1970a), using second grade children and college students, found that focusing responses could be improved when subjects were provided with memory and recoding aids. He concluded that difficiencies in focusing, instead of resulting from an absence of the necessary rules, as has often been assumed with young children, could be a function of the unavailability of relevant information.

The developmental changes in the kinds of questions asked by children to solve problems or obtain information has received attention from several researchers interested in information-processing (Denney, 1972, 1974, 1975; Denney, Denney, & Ziobrowski, 1973; Laughlin, Moss, & Miller, 1969; Mosher & Hornsby, 1966). Denney (1975) states that children solicit and control the information they receive from their environment largely through the questions they ask. There is evidence to suggest that children's question-asking strategies become more efficient as they go from the early school age to the early junior high years, with significant changes taking place between the years of six and eleven (Denney, 1974). The efficiency can be demonstrated by the use of a higher percentage of "constraint-seeking" questions which serve to narrow the possible alternatives and make use of negative information. With the increase of constraint-seeking there is usually a decrease in "hypothesis-scanning" questions which are less sophisticated in that they consider only one alternative at a time and do not make use of negative information.

As was noted earlier the study of question-asking strategies is a part of the larger literature dealing with hypothesis testing and other aspects of cognitive organization. The findings of definite changes in interrogative strategies during this time between six and eleven, are consistent with other findings in the literature relating to this period as a time of "cognitive shift" (Kendler, 1970; Luria, 1960; Piaget & Inhelder, 1969; Reese, 1962; White, 1965).

White (1965) summarized the behavioral changes that take place between the approximate ages of five and seven. In this transition period children change their patterns of learning from those resembling the ones used by animals in like procedures to patterns resembling those used by adult humans. The studies involving reversal-shift problems demonstrated this change (Kendler, 1970). Another important change is the increased influence of language on the child's behavior (Luria, 1960). One observation of White's (1965) that has direct application to the present study is his suggestion that discrimination learning improves up to the five-to-seven age range, but on simple problems declines thereafter. This fact suggests to him that older children adopt more complex hypotheses which may actually interfere with their performance on simple problems.

One issue that remains to be clarified is whether or not the ability to ask and use constraint-seeking questions is dependent upon some cognitive processes or abilities that are not yet present in young children, or whether young children could use this kind of interrogative strategy effectively if the demand qualities of the stimulus were such that this behavior could be elicited. Meaningful classification of stimulus objects might be one way to elicit such questions. If children can not yet categorize in a meaningful way this procedure could be used as a coding aid. Reinforcement of such questions might increase their use. Perhaps children have the cognitive abilities to ask efficient questions, but their environment does not sufficiently reward them for asking them.

Another approach, which might account for some of the individual differences found at different age levels, would be to assess the children's cognitive styles and the relationship of the styles to the questioning strategies used. Denney (1973) had conducted one study in which he investigated reflection and impulsivity as determinants of conceptual strategy, but further investigation is needed, and a more careful definition of the cognitive style would be appropriate.

The present study attempted to examine the saliency of the stimulus demands and reinforcement as these variables relate to question-asking strategies of children. The saliency of the stimulus demands refers to the random arrangement of pictures of common objects versus an arrangement which has been previously categorized in a meaningful way. Previous studies have used school-age children and college students almost exclusively, as subjects, and it was thought desirable to obtain some data on earlier development of interrogative strategies; accordingly, nursery school, first-grade, and third-grade children were included in this study. Since no significant sex differences have been found in the studies using both boys and girls as subjects, sex was not a variable for which differences in question-asking strategies were expected to be demonstrated (Denney, 1975). Sex differences, then, were not examined in the present study. Likewise, inasmuch as there was no basis for belief that race differences would be a pertinent factor, racial comparisons also were not in the sample of children studied.

It was expected that the number of constraint-seeking questions would increase with age; that there would be a greater number of constraint-seeking questions asked under the conditions in which (a) the pictures were classified by the experimenter in a presumably more meaningful way than when the pictures were arranged randomly. It was further expected that more constraint-seeking questions would be asked (b) under the reinforcement conditions than under the non-reinforcement conditions. Since there is little evidence on the effects of cognitive style on interrogative strategy no direction of effects was predicted for that variable; therefore, the relevant findings were examined in an exploratory manner. It was hoped that this exploration would give some indication as to how this variable might be investigated more meaningfully. The same is true for any differences in the intelligence scores as defined by the mental age of the children, within the normal range, therefore, these data were examined without prediction of any causal relationship. The following hypotheses were tested, then, in order to investigate the problem cited above.

Age:

The interrogative strategies of children increase in sophistication as their age increases.

Stimulus Presentation:

When the material is ordered according to a functional classification, children will ask more constraint-seeking questions than when the material is randomly arranged.

Reinforcement:

When reinforced for asking constraint-seeking questions children will increase their use of these questions.

Cognitive Style:

There are no differences in the kind of interrogative strategies used by reflective and impulsive children.

Intelligence:

There are no differences in the kinds of question-asking strategies used by children who score at different points within the normal range on an intelligence test.

CHAPTER II

RELATED LITERATURE

Several studies have investigated the developmental changes in the kinds of questions asked by children to solve problems or obtain information. Mosher and Hornsby (1966) investigated two aspects they saw to be involved in seeking information: (a) the questions asked and (b) the manner in which the answers received were compiled or integrated. They hypothesized that if information seeking reflects the way we organize our thoughts, one would expect developmental change in question-asking behavior. Their study was set up as two experiments. In Experiment I, Mosher and Hornsby presented children with an array of 42 pictures of common objects. The child's task was to find out which one of the objects the experimenter was thinking of by asking questions which could be answered with "yes" or "no." The first graders went about the game with an almost pure "hypothesis scanning" strategy--that is, naming a particular object in each question. By third grade only one-fourth of the questions were of this kind, with the remainder belonging to a "constraint-seeking" strategy which narrows the field of alternatives and which can also utilize both positive and negative answers. The sixth graders used almost entirely constraint-seeking questions. In Experiment II the child was asked to construct his own alternatives and solve the problem from among them.

Each child was presented questions for which he/she was to arrive at the solution the experimenter had in mind (e.g., "A man is driving down the road in his car, the car goes off the road and hits a tree. What happened?"). The questioning showed a steady increase, with age, of the use of questions related to, or based on, previous questions, with the sixth graders being able to verbalize, after having finished the task, how they approached the game through narrowing the alternatives. In this task the third graders performed more like the first graders than like the sixth graders, which had been the case in the earlier experiment when the alternatives had been set by the experimenter. This finding may indicate that a more efficient strategy is elicited when meaningful cues are available to the child.

Laughlin, Moss, and Miller (1969) studied the effects of the information processing of a model on children in the third, fifth, and seventh grades, finding that the model significantly influenced the questions asked by the children. The model was especially influential in elevating the number of constraint-seeking questions asked at the fifth-grade level. The older children asked these questions even without being exposed to the model, and the younger children continued to ask few constraint-seeking questions, even when exposed to the model. This study also considered the kinds of stimulus displays used and found no differences in the use of the pictures of objects and the verbal array of the objects, which consisted of the printed names for the objects.

The function of stimulus saliency in problem-solving behavior was assessed by Eimas (1970b) with children in grades two, four, six, eight and college students. He found increases in frequency of categorical responses and frequency of focusing solutions. The focusing of solutions increased the availability and use of categorical responses. With increasing developmental level increases in the dependent measures were also found, with the younger children profiting little from the cues provided.

Van Horn and Bartz (1968) studied the use of constraints in problem solving in a small group of kindergarten, first-grade and second-grade children who were judged above average in mental ability. Using a random and an ordered array presentation they concluded that young children lack the ability to impose order on an environment which is perceptually disordered. This study has somewhat limited generalizability because of the small number of subjects and because the children could not be considered to be in the average range of mental ability.

Denney (1972) studied the effects of modeling on the interrogative strategies of six-, eight-, and ten-year-old boys. His results indicate that eliciting effects were shown but that true observational learning of new behaviors was not shown. It seems from this study, as well as the previous study cited (Laughlin, Moss, & Miller, 1969), that children at different ages are differentially responsive to conceptual strategy models. This differential responsiveness may indicate that constraint-seeking questioning is not in the behavioral repertoire of younger children. It may be the case, however, that the model, in asking questions, does not have sufficient demand qualities to facilitate use of the behavior by younger children. Denney (1973) explored part of this question by having constraint-seeking models verbalize their strategy and remove eliminated alternatives from the stimulus array. Under these conditions his six-year-old experimental subjects asked a greater number of constraint-seeking questions than the control group which received no training.

In a later study Denney (1974) examined the capacities for recognition, formulation, and integration of constraint-seeking questions in kindergarten through fourth-grade normal children and in retarded children matched for mental age. He found that the abilities in question increased across grade levels and mental age levels and that normal children employed more constraint-seeking questions and used the information obtained more efficiently for problem solving than did the retarded children of the same mental age. While the ability sequence of recognition-formulation-integration seemed to characterize the move from hypothesis-scanning strategy to constraint-seeking strategy in some instances, the fit was not such that one could conclude a fixed, interdependent sequence.

In another study Denney (1975) found cognitive modeling, alone, to be the most efficient training procedure in increasing the use of constraint-seeking questions. He compared the efficiency of a cognitive model who verbalized her strategy before asking a constraint-seeking question, a cognitive model and self-rehearsal, and cognitive modeling alone. Self-rehearsal, it seems, actually served to distract, rather than enhance the increase in constraint-seeking questions.

One researcher who has investigated somewhat broader differences in conceptual style has been Kagan (1966, 1967). The two dimensions of cognitive style postulated by Kagan are "reflection" and "impulsivity." When the reflective child is presented with a problem to solve he takes longer to reach a solution but gives a correct answer. When the impulsive child must solve a problem he arrives at an answer quickly but is likely to be incorrect. It would seem that the quickness to respond might be related to the hypothesis-testing strategies used by young children in their interrogative strategies in that they may not pause long enough to think through the various alternatives available.

In summary, studies investigating question-asking strategies in children have attempted to determine if modeling, self-rehearsal, and, in some cases, restriction of alternatives affect the performance of school-age normal and retarded children. Findings clearly indicate that interrogative strategies become more efficient as age increases. Normal children ask more constraint-seeking questions than do retarded children. Efforts to induce younger children to ask more efficient questions have yielded mixed results with children responding to various aids, such as models and restriction of alternatives, differentially.

A line of investigation seemingly needed is more attention to the stimulus demands. Under exactly what circumstances will children ask constraint-seeking questions? Another part of the question needing exploration is reinforcement for such questions. The consequences of various interrogative behaviors have been ignored by previous investigators. Also, it seems especially productive to study younger children as well as children who have gone through the supposed "cognitive shift." If indeed this is a transition time when intellectual functioning is undergoing a marked change, then the area of interrogative strategies should show changes as well.

CHAPTER III

METHODS AND PROCEDURE

Subjects and Design

The experiment used a 3 x 2 x 2 repeated measures design with the following variables: age (nursery school, first grade, third grade), order of stimulus array (random, blocked), and consequences (reinforcement, nonreinforcement). Subjects at each grade level were randomly assigned to one of the four treatment conditions at that level: (a) nonreinforced, random array presentation (NR-Ra); (b) nonreinforced, blocked array presentation (NR-Bl); (c) reinforced, random array presentation (R-Ra); and (d) reinforced, blocked array presentation (R-Bl). The assignment of conditions is shown in Table 1. Randomization was accomplished by, first, assigning each of the four conditions a number, (NR-Ra=1, NR-Bl=2, R-Ra=3, R-Bl=4). Then a table of random numbers was used to order the conditions. As each number appeared, the condition which that number represented was placed next in the order. A complete list of 32 trials, using each condition eight times, was developed and used at each of the three grade levels. This previous randomization of subjects allowed the experimenter to take whatever student the teacher wished to send at a particular time, and assign the child to whatever condition was next on the list, and proceed immediately with the

Table 1

Assignment to Conditions at Each Grade Level

Number	Condition
1	R-Ra
2	NR-Bl
3	NR-Bl
4	R-Bl
5	NR-Bl
6	R-Ra
7	NR-Ra
8	R-Ra
9	NR-Bl
10	R-Bl
11	R-Bl
12	NR-Ra
13	NR-Ra
14	R-Bl
15	R-Ra
16	NR-Bl
17	NR-Ra
18	R-Bl
19	R-Bl
20	NR-Ra
21	NR-Bl
22	R-Ra
23	NR-Ra
24	NR-Bl
25	NR-Ra
26	R-Ra
27	NR-Ra
28	R-Ra
29	R-Ra
30	R-Bl
31	R-Bl
32	NR-Bl

procedure involved in that condition. This procedure of randomizing the conditions was used because it was not feasible, due to the practical problems involved in the schools, to randomly assign students.

Subjects were 32 children each of nursery school, first-grade, and third-grade level. The average age of the preschool subjects was four years, eight months. For the first graders the average age was seven years, and the third-grade subjects averaged nine years. Preschool subjects were sampled from the nursery school at the University of North Carolina at Greensboro, and the first- and third-grade children were selected from classes at Moore Laboratory School in Winston-Salem, North Carolina.

Since pretesting for intelligence was not practical, all subjects were considered in the normal intelligence range as indicated by their placement in a regular classroom. Scores obtained on the Peabody Picture Vocabulary Test were used to describe the developmental level of the children in terms of mental age. The average MA for the nursery school subjects was six years and seven months. The first graders' mean MA was eight years, and subjects in the third grade had a mean MA of ten years and five months. Characteristics of subjects are summarized in Table 2.

Task and Materials

A shortened version of the 42-item pictorial array of common objects used by Mosher and Hornsby (1966) was used in

Table 2

Characteristics of Subjects, By Age Levels

Age Level	Sex		Race			CA			
	M	F	White	Black	Other	Mean	SD	Mean	SD
Nursery School	17	15	31	0	1	4.67	1.22	6.64	1.45
First Grade	16	16	25	7	0	7.04	.29	8.02	1.23
Third Grade	16	16	20	12	0	9.06	.42	10.07	3.86

the present study (see Appendix A). The array consisted of 20 objects selected because of their adaptability to be classed according to function into five columns of four related items (see Appendix B). The pictures, reproduced in color on white, 3 x 3-inch cards, were arranged on an 18 x 24-inch white display board. Preliminary procedure required the children to name the objects pictured to insure the experimenter that names for all the objects were known by the children. The experimenter accepted the name supplied by the child. If the child was unfamiliar with an object the name was supplied by the experimenter.

The Twenty Question Procedure described earlier and employed by previous investigators was used. In this procedure, the child was engaged by the experimenter to play a game in which the subject was asked to try to figure out which of the pictures, on the board, the experimenter was considering. The child was told to ask questions that could be answered "yes" or "no", and to arrive at the correct answer by asking as few questions as possible. If, after 20 questions, the child had not reached the solution he was given the correct answer. Two Twenty Questions games were played with each subject so that each subject served as his own control. One of these games was always the control procedure, which was the NR-Ra condition. The other game was one of the four experimental conditions, either NR-Ra, NR-Bl, R-Ra, or R-Bl. For the first game the correct item was "bicycle," and for the second game "saw" was the correct item. These same two items were used under each condition. The same directions were given before each game in all conditions.

Also administered during the session was the Peabody Picture Vocabulary Test, which was used to define the intellectual normality of the subjects and to make post hoc comparisons related to intellectual level and interrogative strategies. The Matching Familiar Figures Test (Kagan, 1964) was also administered in order to obtain a measure of reflection and impulsivity.

The administration of tasks was randomly assigned for each subject using the same procedure used to randomly assign condition. Task administration was randomized to control for order effect. The order at each grade level is given in Table 3.

Procedure

The subjects were tested individually in their own school buildings in an undistractive setting. Each subject was seated beside the experimenter at a table. After the child had been seated and after rapport had been established through general questioning and conversation, the child was told that he was going to play some games with the experimenter.

In the nonreinforced random array condition (NR-Ra), the subject was shown the display board on which the 20-item

Table 3

Task Administration Order at Each Grade Level

Number	Condition	Peabody	MFF	Control Procedure	Experimental Procedure
1	R-Ra	3	2	1	4
2	NR-Bl	4	2	1	3
3	NR-Bl	2	4	3	1
4	R-Bl	2	1	4	3
5	NR-Bl	1	2	3	4
6	R-Ra	1	2	3	4
7	NR-Ra	4	3	1	2
8	R-Ra	1	4	2	3
9	NR-Bl	2	3	1	4
10	R-Bl	4	2	1	3
11	R-Bl	2	3	4	1
12	NR-Ra	3	2	1	4
13	NR-Ra	1	4	2	3
14	R-Bl	2	3	4	1
15	R-Ra	4	3	2	1
16	NR-Bl	3	4	2	1
17	NR-Ra	1	3	2	4
18	R-Bl	4	2	1	3
19	R-Bl	4	3	1	2
20	NR-Ra	1	4	2	3
21	NR-Bl	1	3	4	2
22	R-Ra	1	4	2	3
23	NR-Ra	1	4	3	2
24	NR-Bl	4	3	2	1
25	NR-Ra	4	1	3	2
26	R-Ra	4	1	3	2
27	NR-Ra	3	1	2	4
28	R-Ra	1	4	2	3
29	R-Ra	3	4	2	1
30	R-Bl	2	1	4	3
31	R-Bl	1	2	3	4
32	NR-Bl	1	4	3	2

array of common objects had been randomly arranged (see Appendix C). The arrangement was determined by assigning a number to each of the objects and ordering them as their number appeared in a table of random numbers. The following instructions were given:

> We are going to play a question-asking game. I am thinking of one of these cards, and it is your job to guess which one. The way you guess is by asking questions which I can answer either "yes" or "no"--any question at all as long as I can answer it either "yes" or "no". So go ahead and ask me a question and try to guess which picture I am thinking about in as few questions as possible. (Denney, 1975, p. 479)

The child was then allowed to ask 20 questions, and if the object had not been guessed was told the correct answer.

The child's questions were recorded as "hypothesis scanning" (HS) if they referred to only one object in the array (e.g., "Is it the doll?") and as "constraint seeking" (CS) if they referred to more than one object (e.g., "Is it a toy?"). They were scored as "pseudo-constraint" (PC) if they referred to only one item but were phrased as if they referred to more than one (e.g., "Does it have sails?"). A CS question was further categorized by what attributes of the objects the child referred to in the question. Perceptual (CP) and functional (CF) attributes were noted. If the question referred to another attribute it was scored as "other" (CO). (See Appendix D for a sample score sheet.) Control and experimental procedures were the same in this condition, both Twenty Questions games being in NR-Ra condition.

In the nonreinforced blocked array condition (NR-Bl), the same administration and scoring procedures were employed as in the NR-Ra condition. Instead of being randomly arranged, however, the pictures on the board had been previously arranged by the experimenter into five columns of four items related to each other by function. For example, all the objects in the first column could be eaten. The control procedure in this condition was the Twenty Questions game played as described in the NR-Ra condition.

In the reinforced random array condition (R-Ra), the child was presented the random array and given the instructions as in the NR-Ra condition but each time he asked a CS question he was praised by the experimenter and given a piece of candy. The control procedure was, again, the Twenty Questions game without reinforcement and with a random stimulus array.

The reinforced blocked array condition (R-Bl) required that in the experimental procedure the subject be presented the previously arranged array as in the NR-Bl condition and was praised and given candy for each CS question he asked. The control procedure was again NR-Ra.

CHAPTER IV

RESULTS

In terms of age x order of stimulus array x consequences, an analysis of variance, using arcsin transformation so that percentage data could be treated, was performed. The results of this analysis are presented in Table 4.

The efficiency of interrogative strategies was found to increase with the age of the children tested. Analysis of variance revealed age as a significant factor in relation to use of constraint-seeking questions, $F(2,84) = 36.85$, p .001. The proportion of constraint-seeking questions asked by nursery school children was 4 percent; for the first grade subject, 11 percent of the questions were of the constraint-seeking category; and third-graders asked a total of 42 percent. A breakdown of the various kinds of questions is shown in Table 5 and in Figure 1. As can be seen, although some change in strategy did occur between the preschool age children and the first graders, the greatest amount of change took place between the first- and third-grade subjects. These results supported the hypothesis that constraint-seeking questions would increase with age.

No other significant main effects were found. Neither order of presentation of the stimuli nor reinforcement contingencies made a significant difference in the percentage of constraint-seeking questions asked by the subjects. The

Table 4

Analysis of Variance with Repeated Measure:
Influence of Age, Stimulus Array and Reinforcement
on Percent of Constraint Seeking Questions

Source of Variation	df	Mean Square	F
Factors			
Age	2	23.78	36.85**
Order of Stimulus Array	1	.46	.70
Reinforcement	1	1.45	2.20
Interactions			
Age x Reinforcement	2	.07	.11
Age x Order of Stimulus Array	2	.28	.43
Order of Stimulus Array x Reinforcement	1	.25	.38
Age x Reinforcement x Order of Stimulus Array	2	1.01	1.53
Error Between Groups	84	.66	
Within Subjects, Repeated			
Repeated Measure	1	.07	.58
Age x Repeated Measure	2	.06	.49
Reinforcement x Repeated Measure	1	.04	.40
Age x Reinforcement x Repeated Measure	1	.03	.25
Age x Order of Stimulus Array x Repeated Measure	2	.18	1.56
Reinforcement x Order of Stimulus Array x Repeated Measure	1	.10	.84
Age x Reinforcement x Order of Stimulus Array x Repeated Measure	2	.58	5.03*

*p .01
**p .001

Table 5

Comparison of Kinds of Questions by Different Ages

	Frequency and Percentages of Questions Asked						
	Total Number of Questions	No. HS	% HS	No. CS	% CS	No. PC	% PC
Nursery School	509	455	89%	24	4%	30	6%
First Grade	613	523	85%	70	11%	20	3%
Third Grade	572	233	41%	244	37%	95	17%

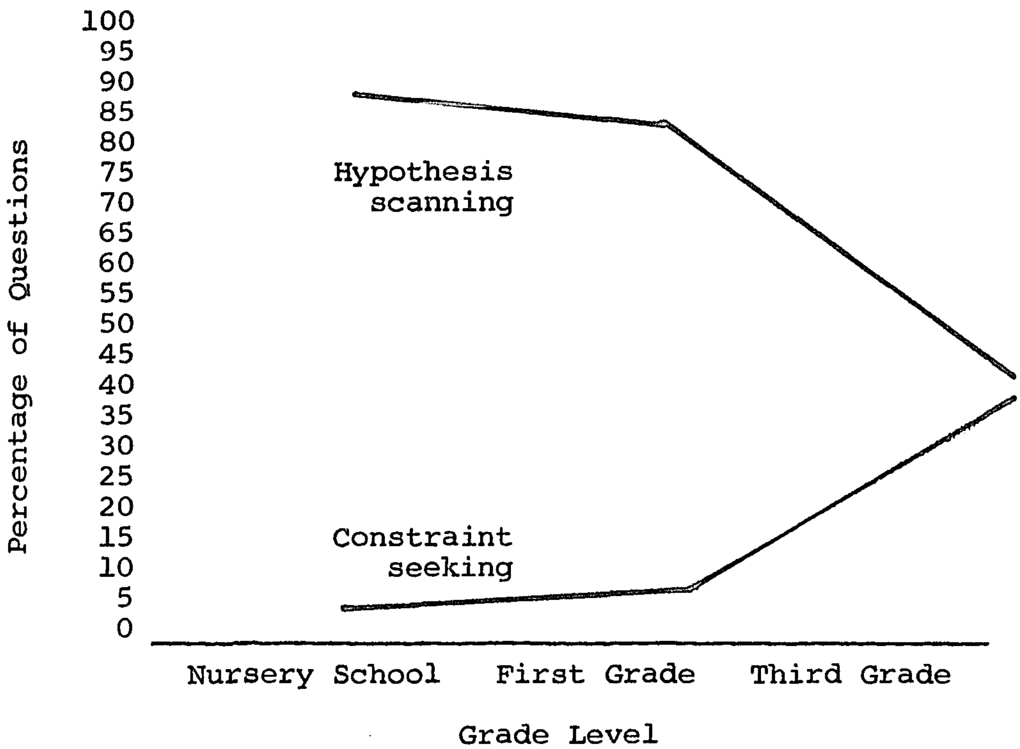

Figure 1. Percentages of constraint-seeking and hypothesis-scanning questions asked at each grade level.

only significant interaction found here was the age x reinforcement x order of stimulus array x the repeated measure. Since no significant main effects had been revealed for these factors this interaction was considered to have occurred by chance.

Because task presentation was completely randomized, so that some subjects received the control procedure before the experimental procedure and other subjects received the experimental procedure before the control procedure, an analysis of variance was performed which included order of presentation of tasks, as a factor, as well as age, order of stimulus array, and reinforcement. Order of presentation was not found to interact significantly in this study. Results of this statistical analysis are given in Appendix E.

An additional part of this study involved an exploratory investigation of the relationship of mental age and cognitive style to question-asking strategies. In order to understand the possible influence of the cognitive style and mental age factors, an analysis of covariance was performed using these factors as well as those earlier subjected to the analysis of variance. Since the cognitive style measure was actually a label resulting from particular combinations of latency, or the time required by the child to make a response, and error scores, resulting from the number of errors made by the subject before the correct selection, the latency and error scores were entered as separate factors. Mental age, latency, and error, then, were the covariates which were controlled statistically. Results of the analysis of covariance are shown in Table 6. This analysis again revealed age to be a significant factor, F(2,82) = 11.47, p .001. Mental age was also found to be significant, F(1.82), p .001. The error factor was found to be insignificant, but the latency factor was found to be significant, F(1,82) = 19.61, p .001. When analyzed in this way the short latency would include not only the impulsive children, who made errors, but the "fast" children who gave correct answers quickly. The long latency would include the "slow" children who gave incorrect answers, but did so after a long pause. Because of separating the two components of the cognitive style measure in this way, the significance may be partly due to an intelligence factor.

When the latency and error scores were combined and two groups formed representing the reflective (N=34) and impulsive (N=28) children, the comparison resulted in an insignificant difference in means of constraint-seeking questions, t=.1852. The mean for the impulsive group was 3.57 with a standard deviation of 4.42. The mean for the reflective group was 4.55 with a standard deviation of 3.47. Table 7 gives information showing the cognitive style composition at each grade level.

As indicated earlier, constraint-seeking questions were scored according to the attributes of the objects used by the subject in phrasing the question. A tabulation was made of the particular kinds of constraint-seeking questions asked by the subjects. The results of this tabulation indicate

Table 6

Analysis of Covariance:
Effect of Age, Stimulus Array, Reinforcement, Mental Age and Cognitive Style on Proportion of Constraint-Seeking Questions

Source of Variation	df	Mean Square	F
Covariates			
Error	1	1.27	2.19
Latency	1	11.21	19.61**
Mental Age	1	28.58	49.45**
Factors			
Age	2	6.65	11.47**
Reinforcement	1	1.04	1.79
Stimulus Array	1	.51	.88
Interactions			
Age x Reinforcement	2	.01	.02
Age x Stimulus Array	2	.04	.07
Reinforcement x Stimulus Array	1	.26	.45
Age x Reinforcement x Stimulus Array	2	.99	1.71
Error Between Groups	82	.58	
Within Subjects, Repeated			
Repeated Measure	1	.07	.58
Age x Repeated Measure	2	.14	.62
Reinforcement x Repeated Measure	1	.05	.40
Age x Reinforcement x Repeated Measure	2	.11	.48
Stimulus Array x Repeated Measure	1	.03	.24
Age x Stimulus x Repeated Measure	2	.37	1.65
Reinforcement x Stimulus Array x Repeated Measure	1	.10	.88
Age x Reinforcement x Stimulus Array x Repeated Measure	2	1.15	4.92*

**p .001
*p .01

Table 7

Distribution of Subjects by Cognitive Style

	Impulsive	Reflective	"Fast"	"Slow"
Nursery School	5	13	8	6
First Grade	11	9	6	6
Third Grade	12	12	3	5
	N=28	N=34	N=17	N=17

that perceptual constraint-seeking questions (CP) were asked much more frequently at all grade levels than were the functional constraint-seeking questions (CF). Percentages in Table 8 show that the frequency of CP questions was highest for the children of nursery school age and decreased with first-grade subjects and further decreased for third-grade subjects. On the other hand, the frequency of the CF questions was low for the nursery school subjects but showed an increase with age. This information is presented graphically in Figure 2.

Table 8

Percentage of CP and CF Questions Asked
at Each Grade Level

Grade Level	Kind of Constraint-Seeking Questions	
	Perceptual	Functional
Nursery School	88%	12%
First Grade	83%	17%
Third Grade	69%	31%

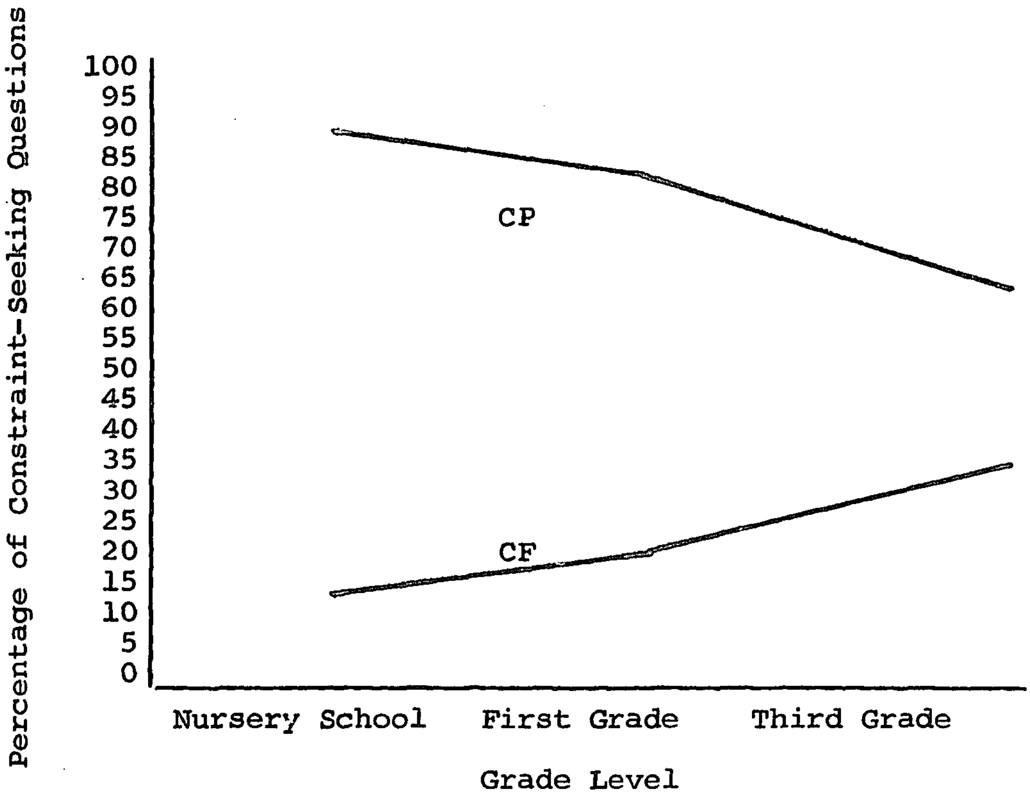

Figure 2. Percentages of CP and CF questions asked at each grade level.

CHAPTER V

DISCUSSION

The results obtained in this study support the first hypothesis advanced, that the sophistication of children's interrogative strategies, in terms of the use of constraint-seeking questions, increases with age. These findings are consistent with those of Denney (1974) and of Laughlin, Moss, and Miller (1969), who found that the efficiency in question-asking strategy increased from the early school years to the junior high years. The present findings identify this trend at an earlier age, indicating that third graders are better at narrowing alternative solutions to a problem through their questions than first graders, and that first graders are better than nursery-school children. It seems then, that, for whatever reasons, the efficiency in question-asking undergoes positive developmental changes.

The second and third hypotheses dealt with the possible reasons why developmental changes in interrogative strategy may come about. The second hypothesis indicated that children would ask more constraint-seeking questions when material presented to them was ordered, according to a functional classification, than when it was presented in a random arrangement. This hypothesis was not substantiated by the results obtained in the present study. One possible explanation as to why the ordered presentation did not facilitate more efficient question-asking strategies may be that the functional classification chosen was not the preferred form of categorization of the subjects tested. It is possible that the children were operating on a lower level of conceptualization than that required to make use of this particular form of classification. Although so few constraint-seeking questions were asked by the nursery-school children that it would be unwise to generalize, it is obvious that only 12 percent of the constraint-seeking questions they did ask were of the functional variety. The others were all perceptual questions. Although higher proportions were asked by the first and third graders their preferred classification was still the more obvious perceptual rather than the functional kind. Perhaps a simpler perceptual ordering of objects would have been more appropriate. A possible basis for such an ordered array might be color or shape.

Another explanation for the young children's not making use of the ordered stimulus array may be related to their memory abilities. Possibly, they did not have the ability to retain in memory the information received from the questions they asked. The preschool children would sometimes make the same guess more than once so that, apparently, they had forgotten that they had already ascertained that that particular item was not the correct choice. An even more interesting occurrence with the first-grade children, particularly, involved a series of questions. Sometimes a child would ask a constraint-seeking question (e.g., "Is it smaller than a dog?") and, in response to a negative answer, make use of the information gained on the following trial or so (e.g., "Then, is it the shoe?"). Then he would follow with a question which disregarded the information obtained about size (e.g., "Is it the cow?"). From such sequences it seems that either the child forgot that he had learned that the correct object was smaller than a dog, or that the size question was actually a pseudo-constraint question--that is, that the child's unstated hypothesis was that the correct item was the shoe and that he asked the size question in relation to the shoe only. When he received a negative response to his shoe hypothesis the size question was disregarded as having been a part of the shoe hypothesis.

Support for the role of memory comes from some work by Trabasso (1975), not on the particular problem of interrogative strategies but from some information-processing studies he and others have done with the problem of transitive inference (Bryant & Trabasso, 1971; Trabasso, Riley, & Wilson, 1975). Their investigations were based on the reasoning process involved in the solution of a kind of problem that has received attention for a long time in the cognitive literature. An example of transitivity is stated by Piaget (1955) as an ordered syllogism (e.g., Edith is fairer than Suzanne; Edith is darker than Lili; who is the darkest, Edith, Suzanne, or Lili?). The problem chosen in the Trabasso studies was in a more concrete form. They asked children to make inferences involving the comparison of lengths of different colored sticks. Their results revealed that, with training, four-year-olds could perform the inference task as well as the six-year-olds who had not had training. The training involved visual and verbal feedback to the child by the experimenter to help the child encode and retain premises in a relational way so that the solution of the problem could be more easily reached. These findings are in line with those described earlier by Eimas (1970a) showing that both second-grade and college students improved their performance in a focusing task when they were supplied recoding and memory aids. Upon the basis of these results it seems logical to assume that some kind of memory aid could be useful in the Twenty Questions procedure to assure that the child remembered the questions he had asked previously, so that he could more efficiently make use of the information obtained from them. A possible way to do this would be to remove from the display board the items as he eliminates them as the possible answer. If the question were an hypothesis-scanning question, then the particular item named would be removed. If the question were a constraint-seeking question then all the items it eliminated would be removed. Going back to the example used earlier, if the child asked, "Is it smaller than the dog?", all items smaller than the dog would be removed from the board.

Redesigning the experiment so as to use a simpler classification in the ordered array and to include a memory aid to insure retention of information obtained might give a clearer answer to the hypothesis dealing with order as a variable.

The third hypothesis, stating that children would increase their constraint-seeking responses when they were reinforced for those responses deserves some attention.

The most obvious observation in respect to reinforcement is that for it to be effective it must occur. Many of the subjects in the reinforcement condition in this study asked no constraint-seeking questions at all and, therefore, were never reinforced. Some method of eliciting such questions, perhaps through coaching from the experimenter in a training period, might be used. Also, with the total number of trials set at 20, it may be that, even when reinforcement was received, there were not enough trials to make it effective. The very effectiveness of the constraint-seeking questions also limited the field of alternatives quickly and, thus, made fewer trials available for reinforcement. A greater number of games played could be helpful in providing a greater number of trials for reinforcement. More than one sitting would probably be desirable to insure that the young children did not become fatigued.

Another slight change in the design that could, possibly, have made some difference would be the wording in the instructions. Subjects were told, "I am thinking of one of these cards and it is your job to guess which one." The word "guess" was used twice more in the instructions, so that it might be supposed that, following Orne's (1969) expectations about the demand characteristics of an experiment, the subjects were simply following instructions when they guessed or used hypothesis-scanning questions. It would certainly be feasible to write the instructions so that any implication that the subject was supposed merely to guess would be avoided.

In summary, although this study demonstrated positive developmental changes in the use of constraint-seeking questions, neither order of stimulus array nor reinforcement were found to be effective. Some changes in the design--memory aids; perceptual, rather than functional ordering of stimulus array; a greater number of games; and clearer instructions--might have yielded more meaningful results.

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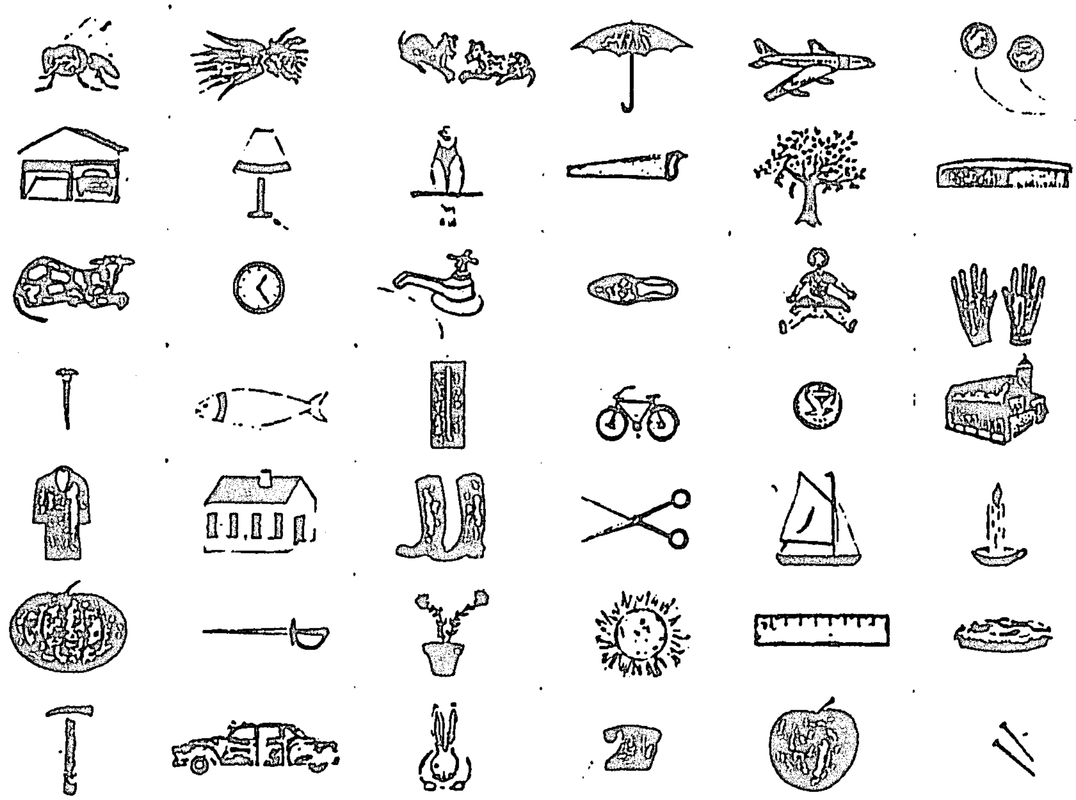
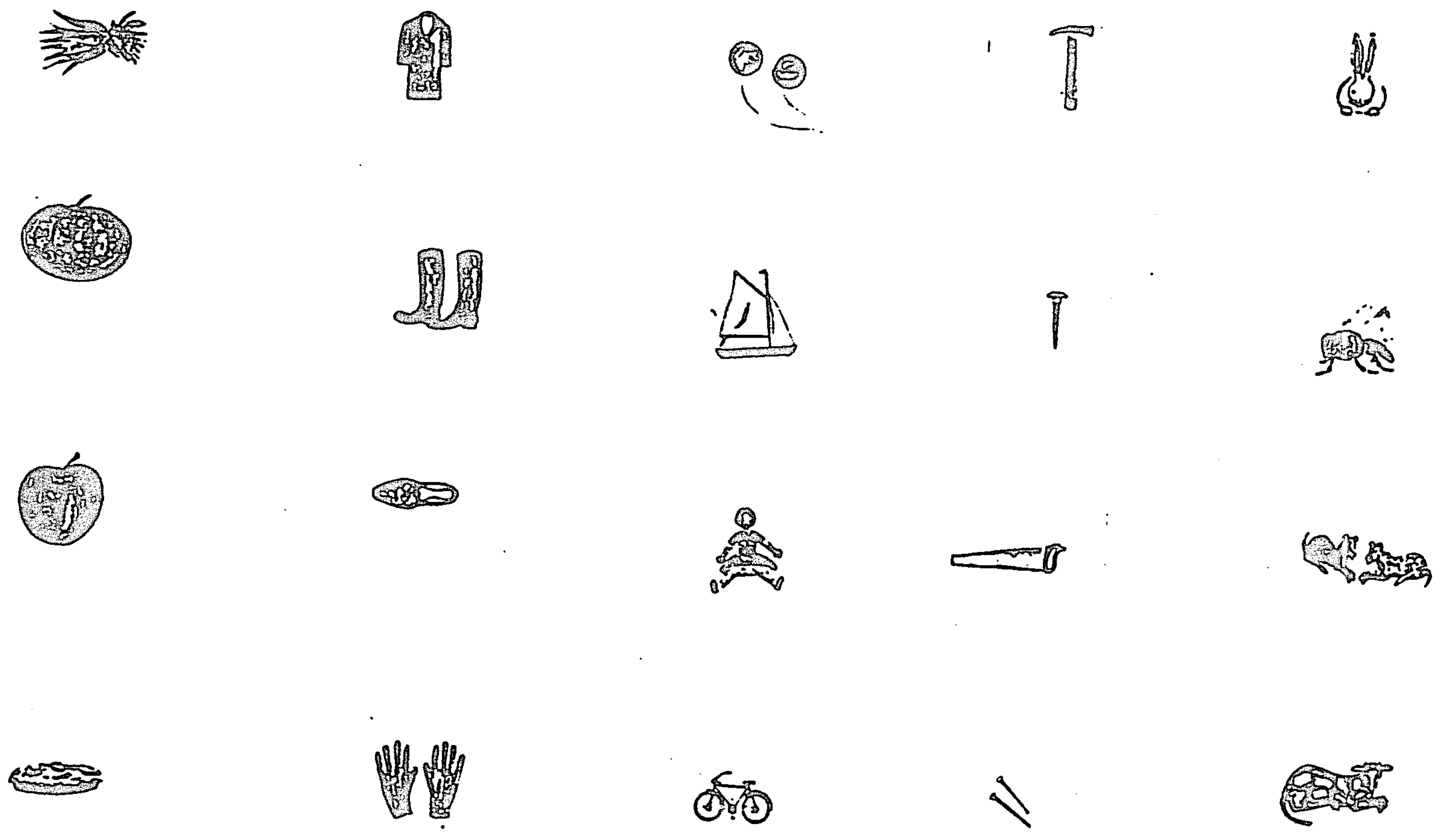
APPENDIX A

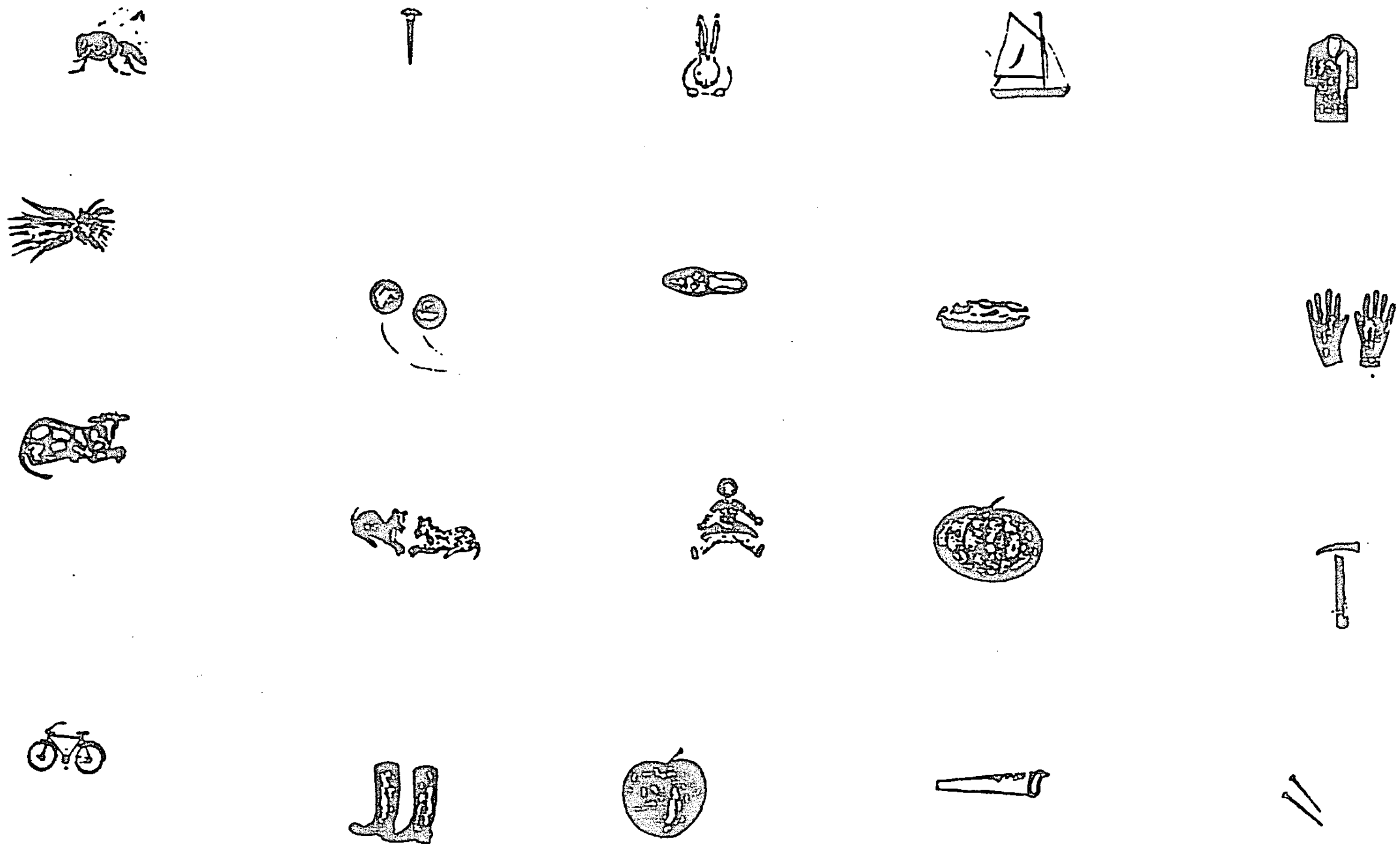


II-6 Pictures used in equivalence task with pictorial material.

APPENDIX B



APPENDIX C



APPENDIX D

Sample Score Sheet*

Twenty Questions Game

Question	CS			HS
	CP	CF	Other	
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

*Check marks were placed in the appropriate box as each question was asked.

APPENDIX E

Effect of Age, Reinforcement, Order of Stimulus Array and Order of Task Presentation on Constraint-Seeking Questions

Source of Variation	df	Mean Square	F
Age	2	23.92	40.85**
Reinforcement	1	1.15	2.55
Stimulus Array	1	.46	.80
Order of Task Presentation	1	.84	1.44
Age x Reinforcement	2	.08	.13
Age x Stimulus Array	2	.28	.48
Age x Order of Task Presentation	2	.59	1.00
Reinforcement x Stimulus Array	1	.39	.66
Reinforcement x Order of Task Presentation	1	.58	.99
Stimulus Array x Order of Task Presentation	1	1.77	3.02
Age x Reinforcement x Stimulus Array	2	.89	1.43
Age x Reinforcement x Order of Task Presentation	2	1.36	2.32
Age x Stimulus Array x Order of Task Presentation	2	.17	.29
Reinforcement x Stimulus Array x Order of Task Presentation	1	3.06	5.22
Age x Reinforcement x Stimulus Array x Order of Task Presentation	2	.53	.90
Within groups	72	.58	
Repeated Measure	1	.08	.65
Age x Repeated Measure	2	.07	.61
Reinforcement x Repeated Measure	1	.05	.46
Stimulus Array x Repeated Measure	1	.03	.26
Order of Task Presentation x Repeated Measure	1	.04	.33
Age x Reinforcement x Repeated Measure	2	.05	.47
Age x Stimulus Array x Repeated Measure	2	.18	1.57
Age x Order of Task Presentation x Repeated Measure	2	.17	1.49
Reinforcement x Stimulus Array x Repeated Measure	1	.12	1.03
Reinforcement x Order of Task Presentation x Repeated Measure	1	.00	.02
Stimulus Array x Order of Task Presentation x Repeated Measure	1	.15	1.34

APPENDIX E

(Continued)

Source of Variation	df	Mean Square	F
Age x Reinforcement x Stimulus Array x Repeated Measure	2	1.32	5.70*
Age x Reinforcement x Order of Task Presentation x Repeated Measure	2	.02	.17
Reinforcement x Stimulus Array x Order of Task Presentation x Repeated Measure	1	.21	1.87
Age x Stimulus Array x Order of Task Presentation x Repeated Measure	2	.14	1.24
Age x Reinforcement x Stimulus Array x Order of Task Presentation x Repeated Measure	2	.05	.51

* p .01
** p .001