1978

An Investigation of the Relationship between Seriation and Classification Skills in Young Children

R'Delle Marie Anderson
University of Northern Iowa

AN INVESTIGATION OF THE RELATIONSHIP BETWEEN SERIATION AND CLASSIFICATION SKILLS IN YOUNG CHILDREN

An Abstract of

A Thesis

Submitted

In Partial Fulfillment

of the Requirements for the Degree

Specialist in Education

UNIVERSITY OF NORTHERN IOWA

by

R'Delle Marie Anderson

July, 1978

ABSTRACT

The results of the Benziger Early Learning Assessment (BELA) classification and seriation subtests previously administered to 359 white, primarily middle-class preschool and primary grade school children were analyzed to determine the degree of relationship, interaction and parallelism between these two cognitive skills across age groups of children. In addition, the existence of any sex differences in performance was examined. The 359 children were grouped into three successive age groups at six-month intervals beginning with the age of four years and six months.

Results indicated that the relationship between seriation and classification, as measured by the BELA, was positive and quite low, although still significantly different from zero in all three age groups. The increase in mean scores in successively older age groups on both tasks indicated that the two interrelated skills developed in a parallel manner. No differential performance by sex was noted.

Some possible reasons for the lower than anticipated relationship between seriation and classification were suggested, such as variations between studies in the methods of defining and assessing the skills.

AN INVESTIGATION OF THE RELATIONSHIP BETWEEN SERIATION AND CLASSIFICATION SKILLS IN YOUNG CHILDREN

A Thesis

Submitted

In Partial Fulfillment

of the Requirements for the Degree

Specialist in Education

UNIVERSITY OF NORTHERN IOWA

by

R'Delle Marie Anderson

July, 1978

This Study by: R'Delle M. Anderson

Entitled: An Investigation of the Relationship Between Seriation and Classification Skills in Young Children

has been approved as meeting the thesis requirement for the Degree of Master of Arts in Education

Ralph Scott

July 19, 1978 — Date — Chairman, Thesis Committee

Barry J. Wilson

July 19, 1978 — Date — Member, Thesis Committee

Lawrence L. Kavich

July 19, 1978 — Date — Member, Thesis Committee

Upon recommendation of the Thesis Committee, accepted by

H. Ray Hoops

Dean of the Graduate College

7-21-78

Date

ACKNOWLEDGMENTS

I would like to express my appreciation to the members of my thesis committee, Dr. Barry Wilson, Dr. Larry Kavich, and especially to Dr. Ralph Scott, my thesis advisor, for their guidance and assistance in the preparation of this thesis.

I would also like to thank Dr. Harley Erickson for his assistance in the data analysis, and my family for their support and encouragement.

LIST OF TABLES

TABLE OF CONTENTS

Chapter 1

THE PROBLEM

Introduction

The ability to identify and measure the "readiness" skills with which individual children enter kindergarten is an integral part of formulating effective learning experiences for children. Jean Piaget theorizes that an interdependent relationship exists between the development of specific cognitive skills (Inhelder and Piaget, 1964, p. 290). If Piagetian theory is correct, then the knowledge of a child's performance on one cognitive task should be comparable to his/her performance on a task speculated to be interdependent on the first task, and as an indicator of their present stage of cognitive development.

In Jean Piaget's theory of cognitive development, intelligence involves "biological adaption, equalibrium between the individual and the environment, gradual evolution and mental activity" (Gronberg and Opper, 1969). Equilibrium is the term Piaget used to describe the harmonious relationship between the biological and psychological components of intelligence. This 'equilibrium' is maintained by adaptation or the tendency of all organisms to adjust to their environment, and it is accomplished through the cognitive processes of 'assimilation' and 'accomodation.' Thus, according to Piagetian theory, in cognitive

growth, bits of information are not simply added, but are integrated into the existing system which is then changed as a result of the new information. The theory is essentially based on biological development, and Piaget postulates that cognitive development occurs in four identifiable invariant sequences or stages, regardless of culture (Tuddenham, 1966). Although Piaget acknowledges the presence of individual differences in intellectual development, he assigns age-ranges in which the four sequential stages are most likely to occur. The stages and corresponding age-ranges are as follows:

1) the sensorimotor stage (0-2 years)

2) the preoperational stage (2-7 years)

3) the concrete operational stage (7-11 years)

4) the stage of formal operations (11-15 years)

Piaget states that certain cognitive skills can be used as indicators of general cognitive development, and more specifically as estimates of the child's current stage of development. Among these cognitive skills are two prominent ones, as pointed out by Inhelder and Piaget (1964), which are the primary focus of this study: classification and seriation.

Classification refers to the developing ability of the child to organize objects into classes and subclasses (Olmsted, 1970), while seriation refers to the ability to organize objects into an ordered series; for example, according to object magnitude (Siegel, 1972). Inhelder and Piaget (1964) hypothesized that the achievement of formal cognitive operations depends heavily on the progressive development of

seriation and classification skills during the sensorimotor, pre-operational and concrete operational stages. Because Piaget does acknowledge the presence of individual differences in cognitive development, differences in classification and seriation skill development should be noticeable across these three stages. Furthermore, since these two cognitive skills are developing during the same developmental stages, a relationship or synchrony between the two skills should be present.

Tests designed to assess the school readiness of preschool children usually include tasks which measure the child's ability to classify and seriate objects, a measure of the child's vocabulary skills, as well as visual motor and concept development tasks. The Benziger Early Learning Assessment Test (BELA) is one such instrument, developed during the spring of 1976 at the University of Northern Iowa by Dr. Ralph Scott, Mr. Mark Cunningham, Mrs. Carol Sensor and Mrs. Kathryn Syster. In this study two subtests of the BELA, classification and seriation, are used as a measure of the child's cognitive development.

Statement of the Problem

The purpose of this research is to investigate the extent of interaction and synchrony existing between the development of Piagetian classification and seriation skills as measured by the BELA classification and seriation subtests; these were administered previously to samples of white middle-class children ranging in age from four years six months

through five years eleven months broken down into three consecutive six-month age groups.

Hypotheses

The hypotheses developed for this study are all written in the null form. These hypotheses and their statistical inferences are described more specifically in Chapter 3.

The first null hypothesis states that there shall be no statistically significant correlations between BELA seriation and classification tasks within each of the three chronological age groups. The second null hypothesis states that there shall be no statistically significant difference between sets of BELA seriation and classification task intercorrelations for any of the three inter-age group comparisons. The third null hypothesis states that there shall be no statistically significant difference between either BELA seriation or classification scores for any of the three inter-age group comparisons. The last null hypothesis states that there shall be no statistically significant difference between mean BELA seriation and classification scores by sex within each of the three chronological age group.

Importance of the Study

Piagetian theory postulates that the development of the different cognitive skills interact and depend upon each other. According to Scott (1970) general cognitive abilities develop through the exchanges between classification and seriation tasks during the child's general learning experience. Thus, for example, experiences in classification

enhance the child's ability to understand seriation. If true, this is an important concept not only for the better understanding of cognitive development in general, but as assistance in the formulation of learning experiences for the young child which will support and complement classification and seriation skill development.

It would be important also to determine the existence of any sex differences in the development of classification and seriation skills or in the interactive relationship between the two skills, for any such differences would indicate the need for some differential learning experience by sex.

Assumptions

Several assumptions are made in the present research study. First, the belief that children develop in a regular and predictable fashion. A second assumption is that seriation and classification skills are separately identifiable and measureable. A third assumption is that the BELA is a valid and reliable instrument for measuring seriation and classification skills in four- and five-year-old children. A fourth assumption is that the experimental sampling of children at the three different age levels is fairly representative of the general four-and-a-half to six-year-old population.

Limitations of the Study

A limiting factor is the population of the study. The population is composed entirely of white midwestern children. Although both rural and urban students were included, the results and conclu-

sions of the study are limited in the extent to which they may be applied to other populations.

Operational Definitions

For the purposes of this study, classification, seriation, assimilation and accomodation are defined as follows:

Classification - comprised of a two-part task: 1) the child's ability to categorize items which are, for example, for eating, wearing, to ride in, or that grow, and 2) to identify shapes that are the 'same' or 'different' from other shapes.

Seriation - the child's ability to learn to choose a particular position of an object, for example, the 'biggest,' 'littlest,' or 'middle' object in a two- or three-object series, and the child's ability to put the objects in order from 'biggest' to 'littlest' in a three-, four- and five-object series.

Assimilation refers to the process by which information is taken into the cognitive schema or structure.

Accomodation refers to the process by which assimilated thought patterns are modified to adapt to reality.

In summary, the purpose of this research is to investigate the relationship between BELA seriation and classification skill performance of three chronological age groups of children ranging from four-and-one-half to six years of age. The results were analyzed using within and across age group correlations, and a one-way analysis of variance test of individual group and sex mean score differences on each of the variables.

Chapter 2

REVIEW OF LITERATURE

In the review of literature pertaining to the Piagetian skills of seriation and classification, it was noted that the bulk of the literature was devoted to studies involving the development and interaction of both of these skills. Literature reports dealing with the isolated treatment of one or the other were few in number. The attempt is made in the following material to review the literature pertaining first to classification skills, then to seriation skills, and finally to review those studies dealing with the interaction between these two skills.

Literature Related to Classification Concept Development

As defined by Olmsted, et al (1970), classification is "the grouping of instances on the basis of one or more observable or inferred characteristics." The development of classification skills is revealed in the way children use judgements about similarities and differences--the ability to see commonalities among diverse stimuli.

The acquisition of conceptual skills is not an all-or-none phenomenon. "The developmental sequence of classification behavior begins in the sensori-motor period" (Olmsted et al, 1970). At this time the child is developing the concept of object permanence and is learning to differentiate himself from his environment. The preoperational phase of development is the language acquisition period. An increasing facility with language enables the child to deal symbolically with the world instead of more directly through motor activity. In the early stages of

preoperational development the child pays attention to one aspect and neglects others in a task. For example, two objects are grouped on the basis of one attribute. As the child progresses through this stage "both the number of objects grouped and the number of characteristics used increases" (Olmsted et al, 1970). Olmsted (op cit) also stated that the child proceeds from sorting by observable characteristics to sorting on inferred characteristics.

Along with the hypothesis that cognitive development proceeds in an invariant sequence, Piaget's theory also holds that the development of the concrete operations is influenced very little by direct verbal training (Aldrich, 1970). Aldrich (op cit) researched these two hypotheses dealing specifically with classification skill development in the stage of concrete operations. Using 90 white middle-class kindergarten children, his primary focus was on the efficacy of training children in skills associated with the mastery of the concrete operations of classification; a second concern was the consistency of the child's level of performance on the tasks. He found that for 29% of the kindergarten children, verbal training procedures involving Piaget's criteria--response plus reason--were effective in maintaining operational functioning up to six weeks after training on one of the skills studied. Aldrich (op cit) also stated that ". . . the children's newly established skill appeared to be more of an 'isolated scheme' (i.e., isolated demonstration of a skill) than a 'concrete operational structure' (i.e., a more permanent construct). Consequently, there was limited transfer to other types of experimental tasks. This finding is consistent

with Piaget's limited expectations for verbal training in the development of concrete operations; it also lends some support to the efficacy of direct verbal training for some children. Aldrich (op cit) reported that the low but significant consistency of the individual child's performance across tasks in general supported Piaget's theory of the invariant sequence of cognitive development; however, it was found that on some specific tasks the sequence appeared to be much more complex, deviating from Piaget's postulated sequence. In summary, the results of Aldrich's study in general supported both of the Piagetian hypotheses under examination.

Literature Related to Seriation Concept Development

"The ability to order objects in a series according to some dimension, such as size, is recognized as an important aspect of a child's ability to understand logical concepts" (Siegel, 1972). According to Alward and Black (1977) seriation concerns the way children reason about relationships between elements of a series of sequenced objects. Inhelder and Piaget (1964, p. 248-249) noted that a child is able to reconstruct a series of objects before he or she is able to recognize one. Piaget later spoke of "the relative ease of recognition as opposed to reconstruction on the basis that the latter requires better developed imagery" (Blackstock and King, 1973). Blackstock and King (op cit) tested the hypothesis that reconstruction preceeds recognition and found that in four- and five-year-old white middle-class children the ability to recognize a seriated configuration clearly preceded in development the ability to reconstruct one. These results

are supported by a more recent study by the same authors (1975); however other variables influencing the difficulty of both tasks make these findings "conditional upon the characteristics of the testing situation." When the number of objects in the task was increased, the difficulty of the task also increased. This finding is supported in a study by Siegel (1972) in which seriation tasks required the child to identify a specific position or size, for example, the smallest in a two, three or four object series. Using 90 middle-class white children equally represented in three-, four- and five-year-old age groups, Siegel found that "a child's performance in a seriation task depended on the particular position which they were required to identify and on the length of the series" (1972). While even the three-year-olds could identify the end positions of a two-object series, only the five-year-olds were able to identify the inner positions on a longer series. A study by Moscovitch (1975) showed that while a three-year-old's perception of seriated sticks is inadequate, four-year-olds "perceive and store information that is accurate enough for correct recognition." The implications of these findings to theories of concept development that the abilities to perform seriation tasks do not appear in an all-or-none fashion.

The importance of seriation skills in a child's general intellectual achievement can be seen from the results of a further study by Scott (1970) in which kindergarten Learning Readiness System (Seriation Test) scores (Scott, 1968) were correlated with all of the subtests of the Iowa Test of Basic Skills (ITBS) administered in third grade. The sample

included children from both middle and lower class income families and included a proportionate number of minority group children. It was found that the kindergarten Seriation Test results were significantly related to all of the areas measured by the ITBS. More specifically, while the findings suggested that a low perceptual score obtained in kindergarten was predictive of later potential reading difficulties, a high performance on the Seriation Test was not as clearly related to later reading achievement. According to Scott (1970), "the evidence that children with limited perceptual skills in kindergarten will predictably encounter difficulties in later years on conceptual learning tasks such as reading is not surprising. This is consistent with the widely held belief that perceptual skills are vital to conceptual learning." These results offer further support for the position that seriation skills are an important aspect of general intellectual ability.

Literature Related to the Interaction Between Classification and Seriation Concept Development

Inhelder and Piaget (1964, p. 290) state that "the most striking instance of parallelism in development is that between classification as a whole and seriation as a whole." Furthermore, they (op cit) state that "the development of classification and seriation is marked by similar turning points, at ages which are roughly parallel."

According to Inhelder and Piaget (1964) some kind of language is essential for the full development of classification and seriation skills

since these operations do involve a symbolic operation in understanding, for example, what is meant by the terms "all," "some," or "place in order," and "biggest." They (op cit) also point out that certainly language is not enough, and that classification and seriation skills require cognitive skills beyond the mere understanding of the words involved.

Several research investigations have been concerned with the interactive and parallel relationship between the developing skills of classification and seriation. Scott (1970) hypothesized that performance on seriation tasks would be significantly associated with performance on an established classification test. The Seriation Test was administered to 356 kindergarten children who had also been administered the Metropolitan Reading Readiness Test (MRRT) which was considered to be a classification measure. The sample included children from both middle and lower class income families and included a proportionate number of minority children. The author reported that the correlation between the Seriation Test and the MRRT was sufficient ($r=.82$) to support the view that, in kindergarten children, seriation and classification skill learning are closely related. A similar finding was reported in the same study concerning the relationship between the Seriation Test and the Number Readiness subtest of the MRRT, which further supported the Piagetian postulate that cognitive processes are highly interactive, facilitating mutual growth of each respective skill. In the same study it was reported that black children scored consistently lower than was anticipated on the Seriation Test. Since enrichment emphasis for dis-

advantaged children has been mainly in the area of classification skills, this finding regarding low seriation performance suggests that the importance of enrichment in this area may have been overlooked.

Marchand (1974) studied children's use of classification and seriation operations in dealing with problems concerning inanimate objects and social events. Only females ages five through ten years of age were included in the sample. Results of this study supported the thesis that there is an order in the acquisition of classification and seriation operations across domains, but the development of these skills in the solution of problems in the social domain tend to lag behind the ability to solve problems in the physical domain.

Achenback and Weisz (1975) administered tests of conceptual identity, seriation and transitivity involving color, number, and length to pre-schoolers. The researchers found that contrary to a strict interpretation of Piaget's theory, the three tasks do not develop simultaneously among the three different types of conceptual problems. Instead, the findings indicated that identity preceded seriation which preceded transitivity in all three problem areas. The authors postulate that the reason Piaget found synchrony among these operations is because the verbal skills needed for his tasks do not emerge until all three operations have already developed. Burke-Merkle and Hooper (1973) studied the comparative efficiency of instructional programs designed to enhance the learning of classification and seriation skills in four- to five-year-old children. Seriation skill training was found

to be effective, but classification skill training was generally ineffective. The authors suggest that these differential results indicate that cognitive functioning during the transition phase between preoperational and concrete operational stages is nonunitary; which conflicts with Piagetian theory concerning interdependence of classification and seriation skills.

In summary, the majority of the research reported in this review supports the existence of a developmental relationship between seriation and classification skills. One of the criticisms held that the reason Piaget found synchrony between these two skills was because language was required for an adequate performance on each, and that the necessary language emerged later than the actual skills. However, Piaget himself (1964, p. 290) acknowledged the necessity of a certain amount of language; he went on to say that language was not enough and that the development of these skills required more--they required more advanced cognitive skills beyond the mere understanding of the words involved.

Chapter 3

DESIGN OF THE STUDY

This chapter provides a description of the sample and the methodology used in collecting and analyzing the data employed in this study. The results obtained from the testing of the specific hypotheses yielded within and between age group correlations as well as one-way analysis of variance results of significant mean score differences.

Subjects

Three-hundred and fifty-nine white, largely middle-class children were included in this study. These children had previously participated in the standardization of the BELA, an instrument standardized in 1976 on a sample of over 500 preschool and kindergarten children (Sensor, 1977). This study's sample was further broken down into the following three chronological age groupings:

Group 1 - 4 years 6 months to 4 years 11 months
(N=127; 73 males and 54 females)

Group 2 - 5 years 0 months to 5 years 6 months
(N=138; 62 males and 76 females)

Group 3 - 5 years 6 months to 5 years 11 months
(N-94; 54 males and 40 females)

Instrumentation

The BELA is an individually administered readiness test designed to facilitate individualized early enrichment programs. The test yields a

total score, as well as scores for each of five subtests: seriation, visual-motor, classification, vocabulary, and concepts. The two subtests of particular interest in this study were seriation and classification.

Methodology

Seven tasks of increasing difficulty included in the seriation subtest of the BELA require the child to identify objects by size (big, middle-sized, little); order a series of four and five stimulus objects of varying sizes into a progression; and to match two sets of different sized stimulus objects into identical progressions according to size. (See Appendix A for a copy of the seriation subtest.)

Classification tasks: 1) require the child to select objects from a page of stimuli according to usage; for example, the child must identify things for eating, or that grow; and 2) ask the child to discriminate among five similar pictured objects, choosing one which matches a key figure. (See Appendix B for a copy of the classification subtest.)

Data Collected

Scores for both the classification and seriation subtests were obtained from the original BELA standardization test protocols; subtests were rescored to assure scoring accuracy. Socioeconomic status (SES) ratings were also recorded, but because of incomplete SES information this variable was not employed in the study. For each subject the following data were coded and placed on computer cards: sex; age in months; and raw scores earned on 1) the seriation subtest, and 2)

the classification subtest.

Statistical Analysis

Experimental data were analyzed by the use of the Statistical Package for the Social Sciences (SPSS) computer system at the University of Northern Iowa Computer Center which yielded the following statistics: means and standard deviations of all subtest and parts of subtest scores for each age group; the statistical significance of the mean differences between age groups; Pearson product-moment correlations between subtest scores within each age group; the statistical significance of and between each correlation; means and standard deviations for males and for females in each age group on both variables; and the statistical significance of mean sex differences at each age group.

Specific Hypotheses

Data analysis reported above permitted the testing of the following specific hypotheses:

H_0 1. There shall be no statistically significant correlation ($p < .05$) between BELA seriation and classification tasks within each chronological age group.

a. r_{sc1}

b. r_{sc2}

c. r_{sc3}

H_0 2. There shall be no statistically significant differences ($p < .05$) between sets of BELA seriation and classifi-

cation task intercorrelations for the following chronological age group comparisons (i.e., the intercorrelations of Group 1 will be equal to those of Group 2 and 3; and the intercorrelations of Group 2 will be equal to those of Group 3).

a. $r_{sc1} = r_{sc2}$

b. $r_{sc2} = r_{sc3}$

c. $r_{sc1} = r_{sc3}$

H_0 3. There shall be no statistically significant difference ($p < .05$) between mean BELA seriation and classification scores for the following age group comparisons (i.e., the mean seriation and classification scores of Group 1 will equal those of Group 2 and 3; and the mean scores of these tasks for Group 2 will equal those of Group 3).

a. $\overline{X}_{s1} = \overline{X}_{s2}$

b. $\overline{X}_{s2} = \overline{X}_{s3}$

c. $\overline{X}_{s1} = \overline{X}_{s3}$

d. $\overline{X}_{c1} = \overline{X}_{c2}$

e. $\overline{X}_{c2} = \overline{X}_{c3}$

f. $\overline{X}_{c1} = \overline{X}_{c3}$

H_0 4. There shall be no statistically significant difference ($p < .05$) between mean BELA seriation and classification scores by sex within each chronological age group (i.e., the within group mean seriation and total classification scores will be equal for males and females).

a. $\overline{X}_{sm1} = \overline{X}_{sf1}$

b. $\overline{X}_{sm2} = \overline{X}_{sf2}$

c. $\overline{X}_{sm3} = \overline{X}_{sm3}$

d. $\overline{X}_{cm1} = \overline{X}_{cf1}$

e. $\overline{X}_{cm2} = \overline{X}_{cf2}$

f. $\overline{X}_{cm3} = \overline{X}_{cf3}$

---

* The symbols noted above stand for the following: r - correlation coefficient; 2 - seriation; c - classification; 1, 2, & 3 - the three age groups from youngest to oldest (see page 15); $\overline{X}$ - the mean score; and m and f for male and female.

Chapter 4

RESULTS

Pearson product moment correlations obtained between the seriation and classification subtest scores are noted in Table 1; the intercorrelations are reported for each age level.

Table 1

Correlations Between Seriation and Classification By Age Group (Raw Scores)

	Group 1	Group 2	Group 3
	4-6 to 4-11	5-0 to 5-5	5-6 to 5-11
	(N=127)	(N=138)	(N=94)
seriation to classification	.34	.32	.38

Note: All correlations are significant at the .001 level.

While the intercorrelation between seriation and classification is strongest for the oldest group, all of the intercorrelations are statistically significant from zero at the .001 level of confidence. Therefore, a relationship does exist between seriation and classification within each age group. The first null hypothesis which states that the correlation coefficients for each within group seriation and classification comparison will not be statistically significant (p .05) must be rejected.

Fisher's z_r transformation was used to convert the correlation coefficients to z_r's (Ferguson, 1976, p. 184). Then a test of the signi-

ficance of the difference between two sets of correlation coefficients was computed for each of the three age group comparisons (i.e., Group 1 to Group 2; Group 2 to Group 3; and Group 1 to Group 3). The sampling distribution of z is approximately normal, and the resulting z scores are interpreted as unit-normal-curve deviates. "Values of 1.96 and 2.58 are required for significance at the 1 and 5 percent levels" (Ferguson, op cit). The obtained z scores are reported in Table 2.

Table 2

Significance of Differences (z_r transformation)

Between Correlations Across Age Groups (z scores)

	Groups 1:2	Groups 2:3	Groups 1:3
seriation to classification	.18	.50	-.33

Note: Values of 1.96 and 2.58 are required for significance at the .01 and .05 levels.

None of the differences between the intercorrelations are statistically significant for any of the comparisons ($p < .05$). Therefore, the relationship between seriation and classification is similar at each age level despite increasing chronological age (Ferguson, 1976, p. 184). On the basis of these findings the second null hypothesis which states that there shall be no statistically significant difference ($p < .05$) between sets of BELA seriation and classification task intercorrelations must be accepted in entirety.

The one-way analysis of variance (one-way ANOVA) procedure was used to test the significance between the mean scores on seriation and classi-

fication across the three age groups. The resulting F ratios reported in Table 3 are both highly significant (.001), and indicate the presence of a statistical significance between at least two of the three means for both variables (Ferguson, 1976, p. 233).

Table 3

Analysis of Mean Differences for Each Variable

Within and Across Age Groups (Raw Scores)

		Group 1	Group 2	Group 3	(one-way ANOVA)
		(N=127)	(N=138)	(N=94)	F ratio
seriation	$\bar{X}$	15.87	19.01	19.51	
	S.D.	4.88	6.21	6.56	13.47
classification	$\bar{X}$	32.94	37.47	38.59	
	S.D.	8.50	6.20	6.10	21.08

Note: The symbol $\bar{X}$ denotes the mean; S.D. the standard deviation.

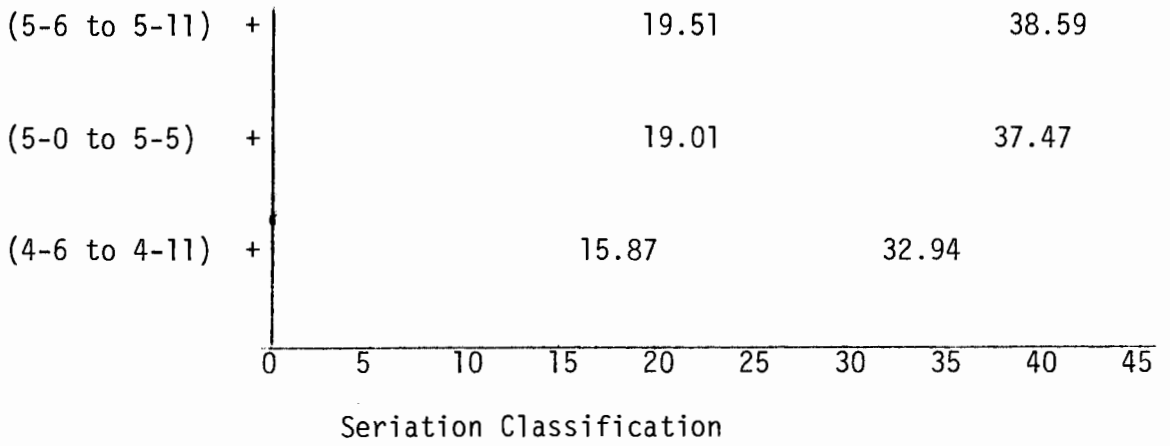
It can be seen from Table 3 that mean increases on both variables are considerably more between Group 1 and Group 2, and Group 1 and Group 3 than between Group 2 and Group 3.

A method for comparing means which may be used on a posteriori basis, the Scheffe procedure for unequal N's, provided a more specific breakdown of significant mean differences (Ferguson, 1976, p. 296). Using this procedure, data analysis show that a significant difference was only found between the means of Group 1 and Group 3 for the seriation subtest, and between the means of Groups 1 and 2, and Groups 1 and 3 for the classification subtest. A graphic representation of mean scores for each age group on both variables is provided in Figure A to present the

results in a manner which enables the age level increases to be more readily noted.

Figure A

Seriation and Classification Mean Age Group Raw Scores
(raw scores)



On the basis of these findings the third null hypothesis which states that there would be no statistically significant difference between mean BELA seriation and classification scores is partially rejected. More specifically, parts a, b, and e are accepted, while parts c, d, and f are rejected.

The results of the one-way ANOVA of sex differences by age group are presented in Table 4. The means and standard deviations of both variables by sex are presented in Table 5 for each age level.

Table 4

One-way ANOVA Results of Sex Differences

on Both Variables for Each Group

		Group 1	Group 2	Group 3
(N male: N female)		(73:54)	(62:76)	(54:40)
seriation	F ratio	1.37	2.32	0.01
classification	F ratio	.88	.22	.94

One-way ANOVA results reported in Table 4 indicate that no significant sex differences were found between the two variables within the different age levels. Therefore, the fourth null hypothesis which states that no basic sex differences would be evidenced at any of the three age levels is accepted in entirety.

Table 5

Mean Seriation and Classification Scores

by Sex for Each Age Level (Raw Scores)

			Group 1	Group 2	Group 3
(N male: N female)			(73:54)	(62:76)	(54:40)
seriation	(M)	$\bar{X}$	15.45	18.10	19.45
		SD	4.46	5.74	6.19
	(F)	$\bar{X}$	16.47	19.72	19.59
		SD	5.40	6.50	7.14
classification	(M)	$\bar{X}$	32.34	37.75	38.07
		SD	9.27	6.07	6.13
	(F)	$\bar{X}$	33.77	37.26	39.31
		SD	7.28	6.32	6.05

Note: The seriation subtest has 29 possible points with an obtained range of 3 to 29 points. The classification subtest has 56 possible points with an obtained range of 6 to 52 points.

Because no significant sex differences were found to exist at any age level the resulting mean scores and variances for each sex, presented in Table 5, are similar for each variable within each age level.

Because the BELA was designed to identify vulnerable learners, many children did top out as the ceiling was not adequate.

In summary regarding all the hypotheses, it was found that the relationship between the seriation and classification skills examined in this study was statistically significant within each of the three chronological age levels employed. Further, it was found that this relationship between the two skills was similar at all three age levels. Overall, the mean performance of the three groups on each variable was found to be similar in spite of increasing chronological age. No differential performance by sex was noted in any of the three age groups.

Chapter 5

SUMMARY, CONCLUSIONS, & RECOMMENDATIONS

Summary

This research study investigated the extent of interaction and synchrony existing between the development of Piagetian classification and seriation skills in white middle-class four-and-a-half to six-year-old children; the sample population was further broken down into three groups with six-month intervals. The relationship between these two tasks was examined within each of the three age levels as well as across chronological age; differential performance on both tasks by sex was also investigated at each age level.

The first null hypothesis pertaining to the presence of a statistically significant correlation between BELA seriation and classification tasks within each chronological age group was rejected since statistically significant correlations between classification and seriation were found within each age level, but these correlations were of such low magnitude that their practical significance is questionable. Even with the large sample size employed (Total N=359), the correlation between seriation and classification for the total sample accounts for only ten to fourteen percent of the variance.

The second null hypothesis which stated that there would be no statistically significant difference between sets of intercorrelations of seriation and classification among the three age groups was tested and accepted. None of the correlation differences for any of the three

comparison groups were statistically significant. These results indicate that the relationship between seriation and classification is about the same for all three age groups; the relationship between these two skill areas did not become stronger or weaker with increasing chronological age.

The third null hypothesis which stated that no statistically significant difference between mean seriation and classification scores would be found among the three age groups was accepted for three of the six comparisons, but rejected for the other three. Statistically, significant differences were noted between the means of the youngest and oldest age groups (1 & 3) for the seriation subtest, and between the means of the youngest and the two older groups (1 & 2; 1 & 3) for the classification subtest.

The fourth null nypothesis pertaining to the absence of sex differences in seriation and classification performance was accepted; no sex differences were found to exist at any age level on either task.

Conclusions

In light of the extensive research that has been done on the various types of seriation and classification tasks, it is difficult to interpret the theoretical importance of the findings obtained in this study. For instance, the results pertaining to the rejection of the first hypothesis account for only a ten to fourteen percent overlap between the two skills, indicating that other variables not included in this study affect the relationship between these two tasks (i.e., vocabulary, general intelligence, other stimulus items, sensory modes of presenting

the stimuli, etc.). Moreover, a statistically significant correlation, however low, was found at all three age levels indicating that some type of relationship exists between the two skills. Furthermore, the acceptance of the second null hypothesis which states that there shall be no statistically significant difference between the correlations obtained at each age level indicates that the relationship between the two skills is similar at each age level.

Although no correlations are presented in their discussion, Inhelder and Piaget (1964, p. 290) stated that the parallelism in development between seriation and classification is "striking," and further that "the development of classification and seriation is marked by similar turning points at ages which are roughly parallel" (op cit). The magnitude of the correlations between seriation and classification are not "striking" for any of the age groups employed in this study and yet this study supports the Inhelder-Piaget formulations since the findings indicate that a relationship exists in all age groups; this relationship is similar at all three age levels and mean increases are roughly parallel. General intelligence alone could account for much of the ten to fourteen percent overlap between the two skills found in this study.

Aside from variables not considered in this study, another possible explanation for the resulting low correlations between the two tasks is that perhaps the two BELA subtests do not measure the same seriation and classification concepts tested by other researchers. It was noted in the review of literature, for example, that several researchers have equated vocabulary tests with the measurement of classification skills.

While vocabulary tests may be considered an aspect of classification skills, and may be important for any verbal test-taking performance, they do not bear much resemblance to the classification skills measured by the BELA, which primarily involves receptive language. It may also be that the two BELA subtests measure a narrower aspect of the two cognitive skills with an insufficient variety and/or range of tasks utilized in each major skill area.

Because Piaget's research in the area of cognitive development is cross-cultural, the fact that the sample employed in this study was homogeneous (white, midwestern, four-and-a-half to six-year-old children) as opposed to a more heterogeneous group, should not have limited the magnitude of the correlation.

The third null hypothesis which states that there would be no statistically significant mean differences could not be entirely rejected because statistically significant differences were found between mean BELA seriation and classification scores for three of the six comparisons. Thus, the development and mastery of skills necessary for performance on the seriation subtest appears more gradual than the development and mastery of classification skill performance, as more significant increases were displayed with each succeeding age group. Figure A (page 23) provides a graphic representation of this relationship; considerable parallelism is denoted in the configuration. Although the means continually increase with age, some significantly, it should be noted from previous discussion that the correlations, and thus the relationship, between seriation and classification remained about the same at each age

level. Findings thus far jointly lend some support to the concept of the interactional and parallel nature of development in these two cognitive functions.

Since no statistically significant differential performance by sex was noted for either task at any of the age levels, the fourth null hypothesis was accepted. However, it should be noted that the variability in seriation was greater among females than males at all age levels and that the variability among males in classification was considerably higher than females in the youngest age group, yet quite similar to females in the two older groups; these variabilities may be entirely due to sampling error and not indicative of sex characteristics.

In summary, the results of this research study lend only minimal support to the Piagetian postulate that cognitive processes are interactive and develop in synchrony. More specifically, the interactive and parallel development of seriation and classification skills found in this study indicate that these skills do develop together, and although the facilitation of one by the other was not specifically studied in this paper, it is surmised that some facilitation and interdependence may occur. No support was found for providing differential learning experiences for boys and girls since no significant sex differences were found in seriation and classification performance.

Recommendations

Findings of this study present opportunities for further investigation of the relationship between seriation and classification skill development.

1. The results obtained in this study should be used as a basis for comparison of the BELA techniques of measuring seriation and classification with other methods of assessing these same skills. Currently there are several different types of discrimination tasks, e.g., size, color; intensity; texture, weight; number or object series, employed within each of several different modes of presentation, e.g., visual, sound, touch and oral abstractions--all used by tests purporting to measure seriation and classification skills. Because the assessment techniques involved in the measurement of these skills are so many and varied, it is important that researchers come to a consensus on procedures for measuring these skills.

2. Data from this thesis should be used as a basis for comparison when the BELA is administered to samples of populations with different characteristics such as students from minority groups, rural settings, and all socio-economic levels. Data from such diverse populations would also serve to enhance the employability of the BELA with more heterogeneous populations.

3. Some subskills of seriation and classification develop earlier than the four-and-a-half-year-old age employed in this study. A lower extension of this study would include two- to four-year-old children, thus providing more comprehensive data and greater understanding of the relationship between the development of seriation and classification skills hypothesized by Piaget.

4. This study should be used by preschool and primary grade teachers and related professional school personnel to enhance their

understanding of the development of seriation and classification skills. Such understanding would enable them to plan appropriate learning experiences conclusive to the development of these cognitive skills which are indicative of cognitive development in general.

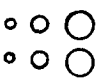
In conclusion, while the results of this study do not provide strong evidence of a parallel and interactive relationship between the development of seriation and classification skills, they do lend some support for the Piagetian postulate that seriation and classification skills bear some relationship to each other in their development and provides a means of measuring essential school readiness competencies.

APPENDIX A

TASK I SERIATION

Discontinue: after 2 successive task failures. There is no partial credit: the items are either all right or all wrong.

This is a power and not speed test but it should move briskly; generally it takes less than 1 minute for children to complete these individual tasks.

These tasks are based on the theory of Jean Piaget who considers seriation skills essential to early learning. In general, young children seriate by size (organizing objects from smallest to largest  and by pattern seriation or organizing objects by pattern  .

Materials needed: five Hamburger cards
five Pickle cards
stop watch (or wrist watch with sweep hand)

Directions: Enter on the record form the order in which the child arranges the cards for each item attempted. Record a plus to the right of the response if the answer is correct and a minus for an incorrect response. Since this is a screening test, it is important to note if the child grasps the nature of the task and the extent to which special remedial help may be needed to assist the child in acquiring mastery of seriation skills.

Place the cards before the child from his/her left to right, approximately 6 inches from the edge of the table with 1 inch separating

the cards, unless otherwise indicated.

A. Place Hamburger Cards A and C in that order before child.

SAY: Show me the big one.

Now point to the little one.

Point to the little one.

Now point to the big one.

B. Place Hamburger Cards A, C, and E before the child in that order.

SAY: Point to the little one.

Now point to the middle-sized one.

Show me the little one.

C. Place Hamburger Cards A and C before the child.

SAY: Now let's put the Pickle Cards where they belong.

Place Pickle Cards A and C before the child. Mix the Pickle Cards and then SAY: Watch me. The big pickle goes with the big hamburger. In this task the Pickle Cards go under the Hamburger Cards; thus, the cards form a vertical line to the child 

. Then the little hamburger and the little pickle go together (place Pickle Card C under Hamburger Card C). See how it goes? The big hamburger and the big pickle go together (point) and the little hamburger and little pickle go together (point).

Leaving Hamburger Cards A and C in their positions, scramble and then hand Pickle Cards A and C to child. Now you do it. Put the Pickle Cards where they belong. Remember, the big pickle goes with the big hamburger. Score as correct if the child makes the correct

pairings, although vertical alignment as demonstrated is desired; credit is given if the child merely makes the correct pairings.

D. Place Hamburger Cards A, C, and E before child in that order from child's left to his/her right.

SAY: Watch me. We are going to put these cards in order (place Hamburger Card A at the child's left). You see, we start here with the biggest hamburger. Next, we put the middle-sized hamburger (place Hamburger Card C one inch from Card A and perpendicular to the child's line of vision). And finally the smallest hamburger (place Hamburger Card E one inch to the right of Card C). Allow the child to observe 10 seconds. Remove Hamburger Cards A, C, and E. Place the cards in the following order before the child: C E A.

SAY: Now you do it. Put them in order. Begin here (point to the left of the child's midpoint) with the biggest hamburger and put them in order.

Occasionally a child will begin the seriation at the right instead of the usual beginning at the left. When observing this, note it on the record form and ask the child, Where is the biggest one? If the seriation is correct according to the starting point indicated, the item is passed.

E. Place Hamburger Cards in the following order from the child's left to his right: D A B E. SAY: Put them in order. Start here (indicate a point on the table to the left of the child's midpoint) with the biggest hamburger. Start with the biggest here (point) and go to the smallest there (point to where the smallest hamburger will go).

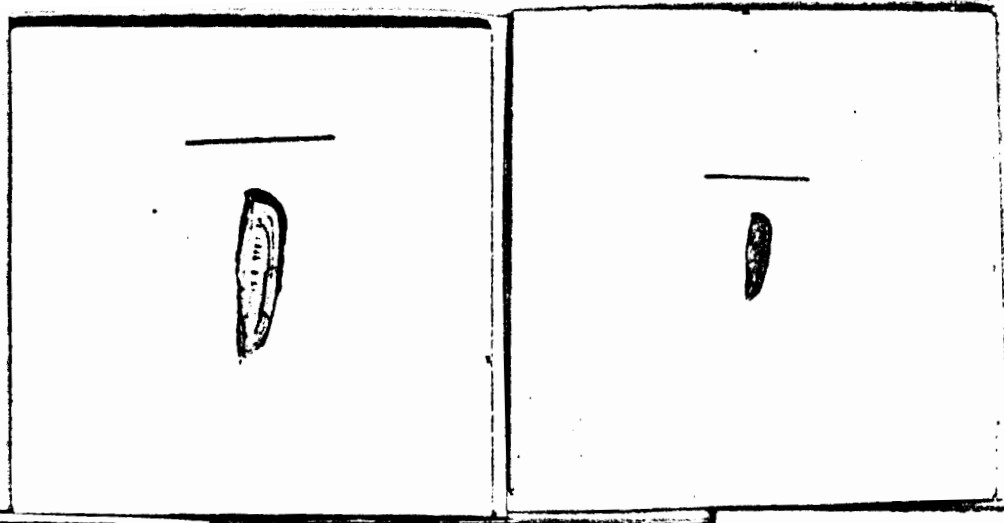
F. Place Hamburger Cards in the following order from the child's left to his right: E B A D C. SAY: Put them in order. Start here (point to the table to the left of the child's midpoint) with the biggest hamburger and work from biggest to smallest.

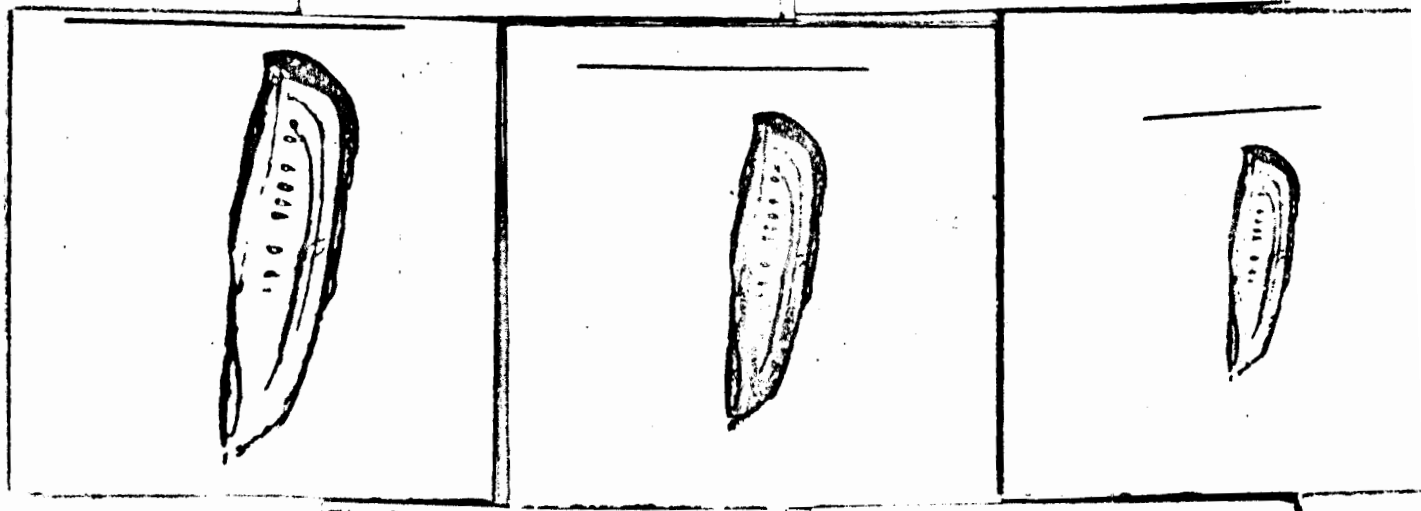
G. Place Hamburger Cards before the child from his left to his right in the following order: B C A C E. The cards should be directly before the child, approximately 10 inches from the edge of the table and 1 inch apart. SAY: This time you are to find which pickle goes with which hamburger. Watch me (place Pickle Card A directly under, but not touching, Hamburger Card A). The biggest pickle goes with the biggest hamburger. Allow the child to observe for 10 seconds. Remove Pickle Card A. Place Pickle Cards directly under but not touching the Hamburger Cards in the following order from the child's left to his right: A E C D B. SAY: Now put each pickle under the hamburger that goes with it. Remember, you should begin by putting the biggest pickle under the biggest hamburger. Go ahead.

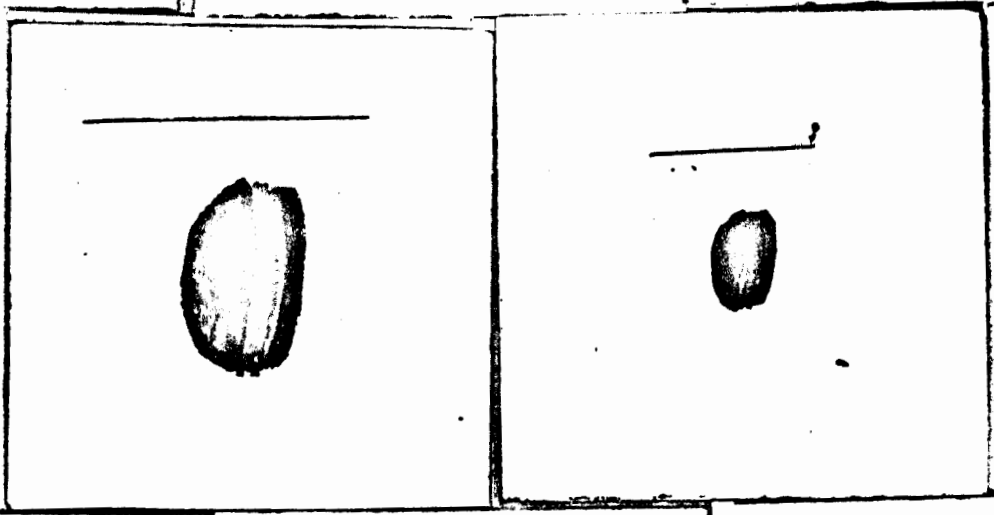
SCORING

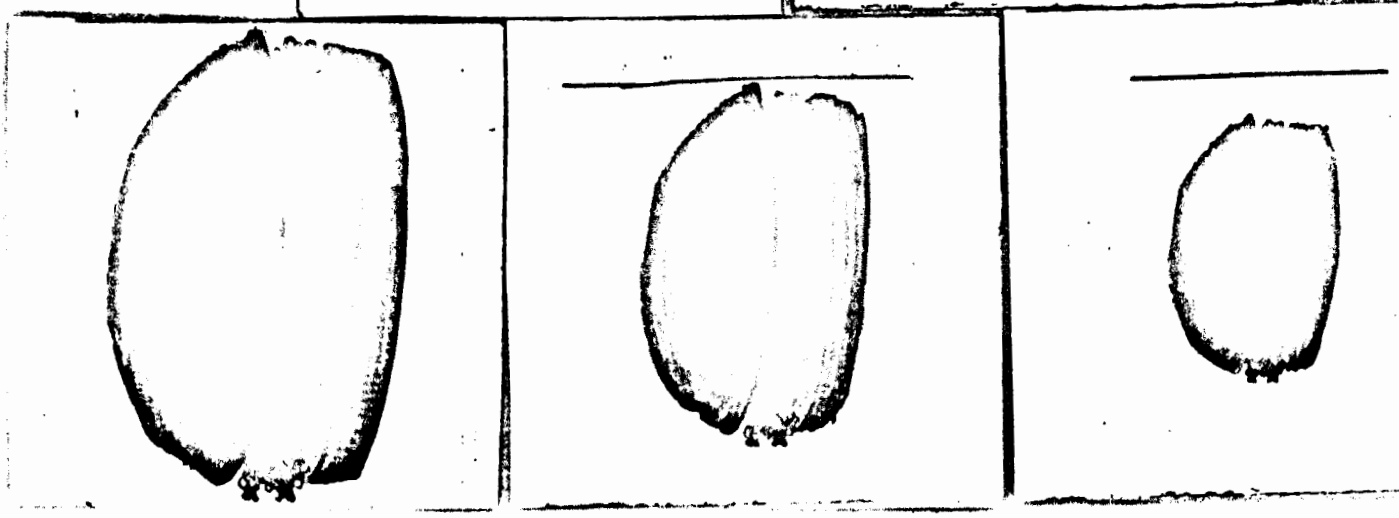
Items A, B, and C: The child receives 1 point credit for each correct response. Thus, a child may receive a maximum of 4 points on Item A, 6 points on Item B, and 2 points on Item C.

Items D, E, F, and G: If the task is successfully completed, full credit is given. If the task is partially seriated, for example ABCED instead of ABCDE, or totally incorrect, NO CREDIT is given. Therefore, Item D has a score of 3 or 0 points, Item E has 4 or 0 points, Item F has 5 or 0 points, and Item G has 5 or 0 points.









APPENDIX B

TASK III CLASSIFICATION

Classification A: GROUPING

Materials needed: Fun at the Pond Book - page 69

stop watch

Directions: Make sure the child understands the nature of the task and where necessary repeat directions (for example, Point to the things we eat). If the child is obviously finished before the 1 minute time limit expires, proceed to the next grouping question. If the child recalls a correct response after a grouping is completed, no additional credit is given.

Open test materials to page 69. Place the page directly in front of the child and SAY: Which things are for eating? Allow 1 minute; only one encouragement is allowed (see page 2 of the manual for a reminder on permissable encouragements). Which things are for wearing? Allow 1 minute; only one encouragement is allowed. Which things do we ride? Allow 1 minute; only one encouragement is allowed. (Note: It may be necessary to repeat the word "ride" if the child first points to a pencil. SAY: No, listen very carefully. Which things do we ride?) Which things grow? Allow 1 minute; only one encouragement is allowed.

SCORING:

Scoring emphasizes quick recognition of classifying; therefore, strict time limits are observed. The child may indicate by naming or pointing;

examiner (E) should note in the space provided on the record form which approach is used. Mark correct responses by placing a check (✓) beside the answer given on the record form. Record all incorrect responses by writing what the child has said or indicating which picture he selected on the additional lines provided on the record form.

Some flexibility is provided in scoring, based on similarity of object and on logic which can be used. For example, full credit is given if child says "chicken" instead of "turkey," "sandwich" instead of hamburger," or "parsnip" instead of "carrot." However, NO CREDIT is given if child states the carrot is an onion, the cake a pie, or the grapes are cherries. If the child grasps a complex relationship such as "cherries grow on trees and are in pies," CREDIT IS GIVEN.

SCORING:

The total number of correct responses minus the total number of errors yields the score. In no case is the child given a score of less than zero.

Classification B: SIMILARITIES AND DIFFERENCES

Materials needed: Fun at the Pond Book - pages 28, 33, 7, 6
marker
stop watch

Discontinue: when child passes no items on a page

General Directions: Children should move briskly along; in general, these items can be quickly administered and require no more than one minute per page. On no occasion should more than one encouragement be given per item.

Instructions may be shortened when the child clearly understands what to do. If the child gives two answers, SAY: Which one is it? For each item, the marker should be placed immediately below the row to which the child is to respond.

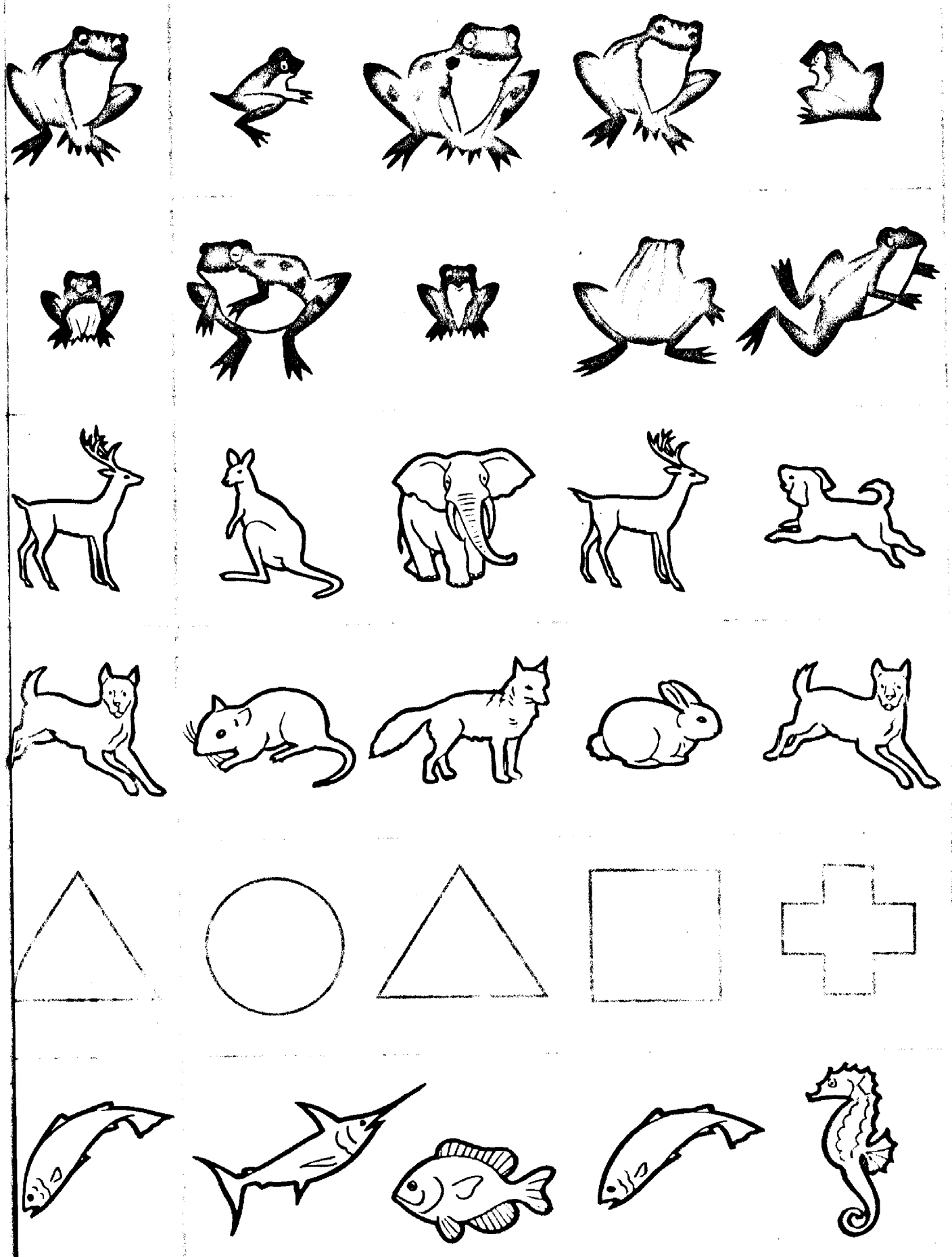
Place page 6 directly in front of the child. The marker should be placed below the row in which the child is expected to respond. Move the marker under line 2. SAY: Look at the frog here (point to shape in small box at upper left hand section). One of the frogs in this row is exactly like the one here (sweep hand over the long box and then point again to the short box). Find the frog here (indicate long box with a sweeping motion) that is exactly like this one (point to short box again). Use lines 3 and 5 in the same manner, substituting "animal" and "shape" as the cue words.

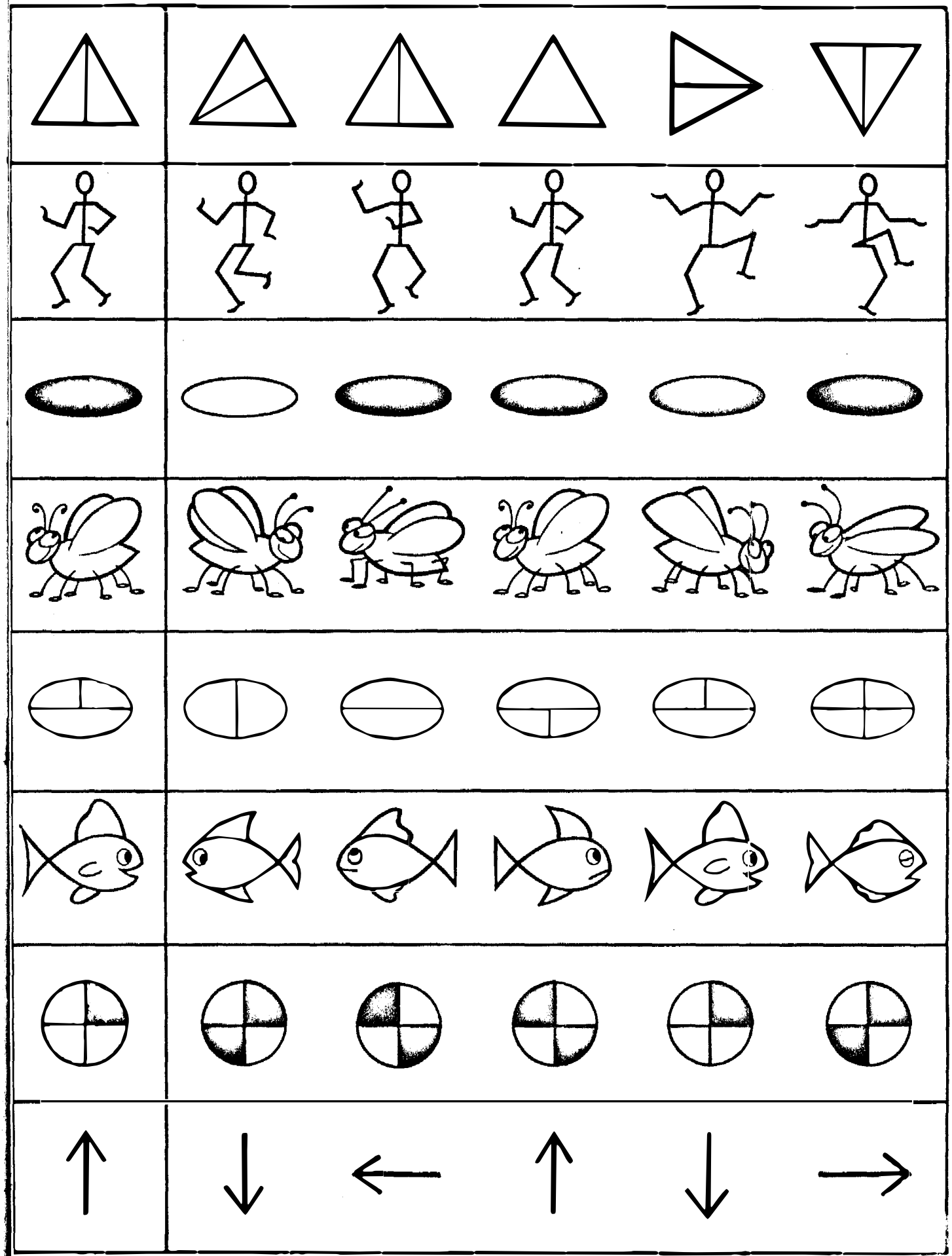
Turn to page 7 and administer items in the procedure described above, using lines 1, 6 and 8 and the words "triangle," "fish," and "arrow."

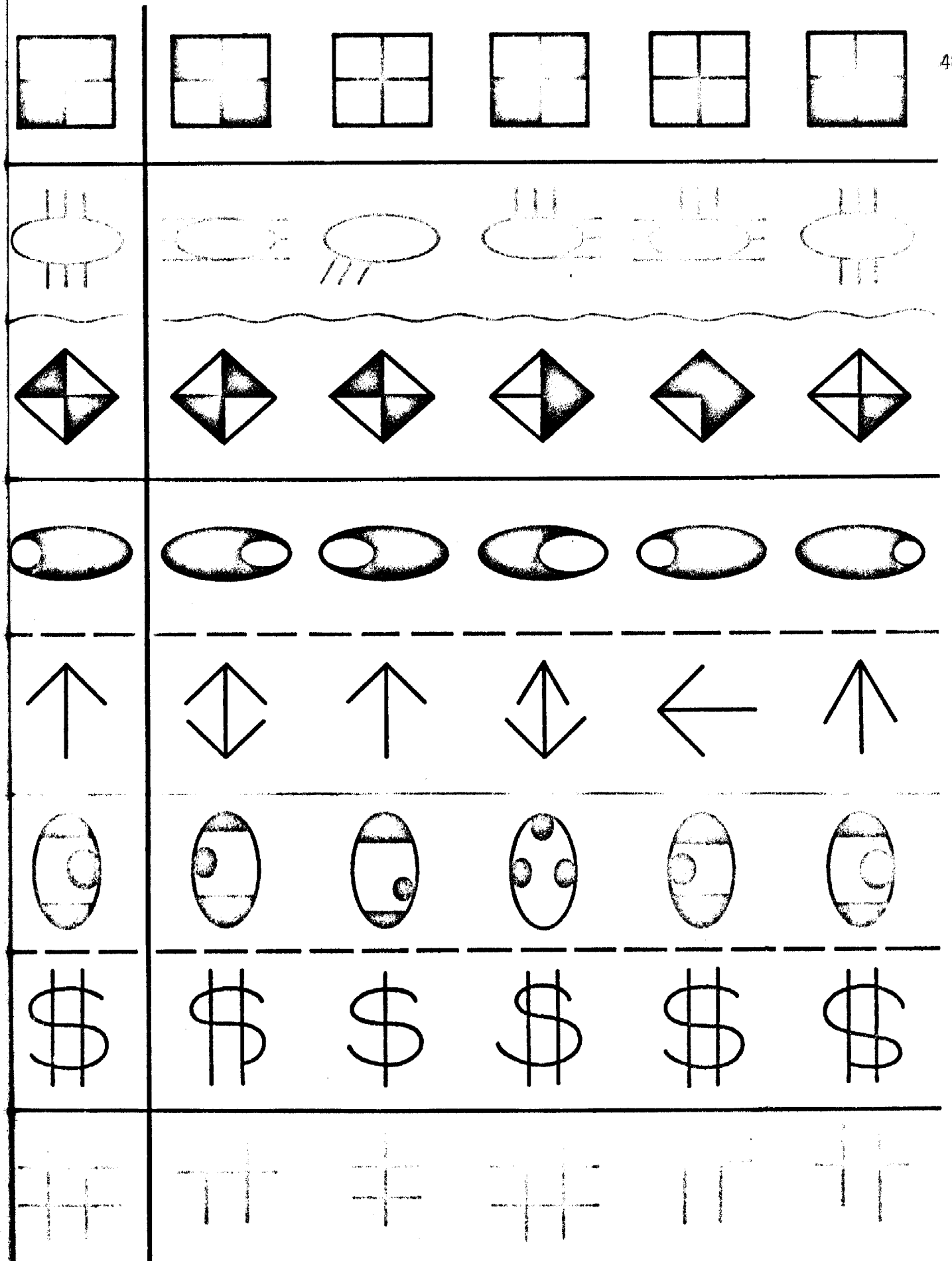
Follow the same procedures for lines 1, 3, 4, 5 and 6 on page 28, using the words "shape" or "form."

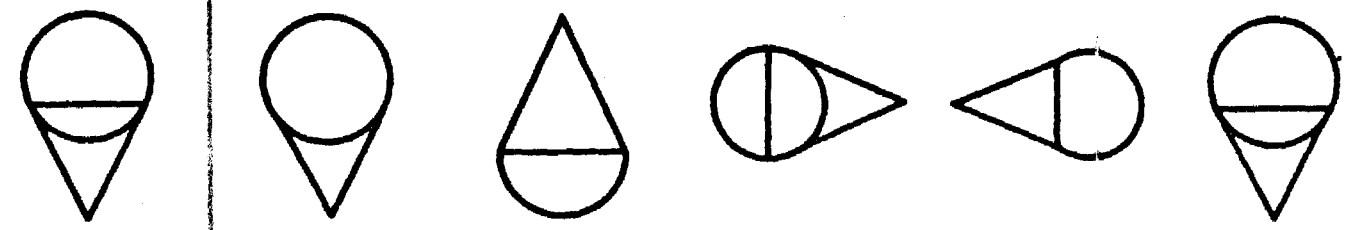
Repeat procedures for lines 2, 3, 4, 5 and 6 of page 33, again using the cue words "shape" or "form."

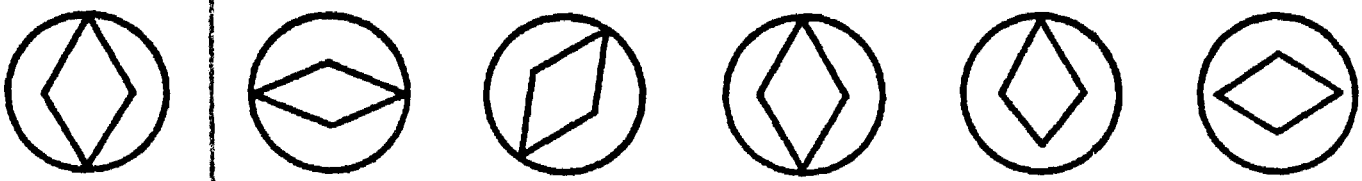
SCORING: One point credit is given for each response. The maximum score is 16.

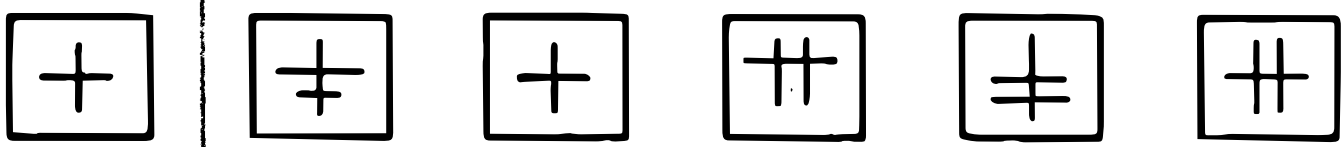


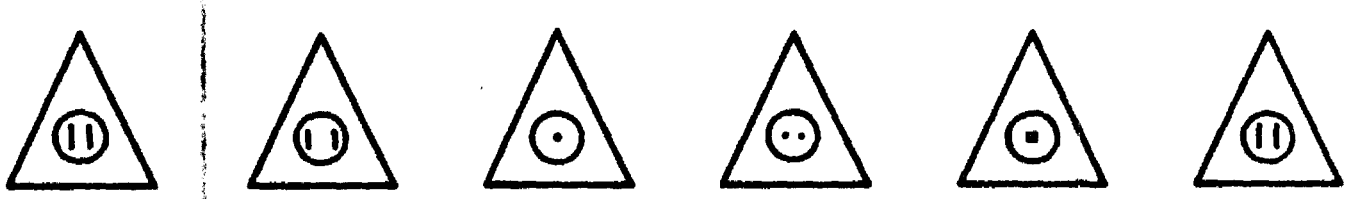


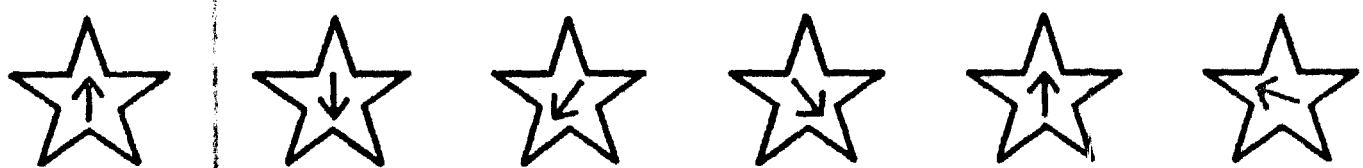


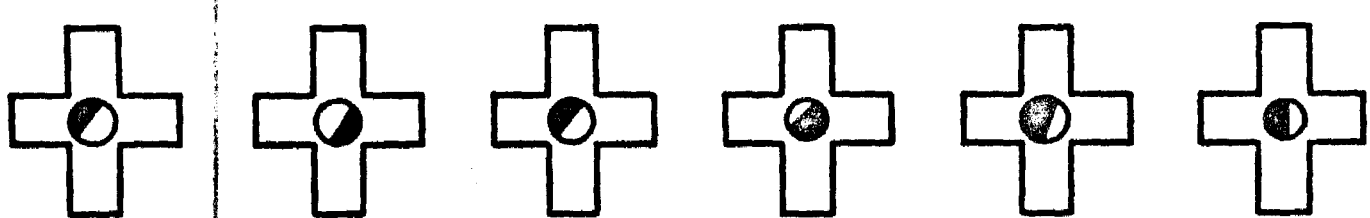












Kaufman, A. S. and Kaufman, N. L. Tests built from Piaget's and Gesell's tests as predictors of first grade achievement. Child Development, 1972, 43, 521-535.

Marchand, A. A Comparison of Children's Use of Classification and Seriation Operations in the Physical and Social Domains. Child Study Journal, 1974, 74 (4), 179-193.

Melton, R. S. et al. Cognitive Growth in Preschool Children. A study conducted by the Educational Testing Service, Princeton, N.J. June 1968.

Moscovitch, I. J. How Young Children Represent and Reproduce Organized Visual Material. Accounting for Difficulty in Drawing an Array of Seriated Sticks. Dissertation Abstracts International, November 1975, 36 (5-B), 2502-2503.

Olmsted, P. P., Parkes, C. V., and Rickel, A. The Development of Classification Skills in the Preschool Child. International Review of Education, 1970, 16 (1), 67-80.

Scott, R. Perceptual readiness as a predictor of success in reading. The Reading Teacher, 1968, 22 (1), 36-39.

Scott, R. Social-class, race, seriating and reading readiness. A study of their relationship at the kindergarten level. Journal of Genetic Psychology, 1969, 115 (1) 87-96.

Scott, R. Perceptual skills, general intellectual ability, race, and later reading achievement. The Reading Teacher, April 1970.

Scott, R. and Kobes, D. A. The Influence of Family Size on Learning Readiness Patterns of Socioeconomically Disadvantaged Preschool Blacks. Journal of Clinical Psychology, January 1975, 31 (1), 85-88.

Sensor, M. Carol. The Benzinger Early Learning Assessment Test: A Study of Predictive Validity. Unpublished Ed. S. Thesis, University of Northern Iowa Library. 1977.

Siegel, L. S. Development of the Concept of Seriation. Developmental Psychology, 1972, 6 (1), 135-137.

Sinclair, H. and Kamii, C. Some Implications of Piaget's Theory for Teaching Young Children. School Review, February 1970, 78 (2), 169-183.

Timmons, S. A. Attentional Training and Its Effects on the Seriation Abilities of Kindergarten Children. Dissertation Abstracts International, May 1975, 34 (11-B), 5724.

Tuddenham, R. D. Jean Piaget and the World of the Child. American Psychologist, 1966, 21, 207-217.

Wadsworth, B. J. Piaget's Theory of Cognitive Development. David McKay Company, Inc. New York, 1971.

Walden, T. A. The Classification Skills of Five, Six, and Seven Year Old Children Who are Bilingual, Biliterate, or Monolingual. June 1974.