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A matrix test was devised to assess cognitive skills associated with inferential reasoning. The format of the test requires the subject to choose, from among four alternatives, a figure which is related to other given figures on the basis of appearance, content, or spatial position in the matrix. The test consists of three perceptual matching items, 18 class membership items, 11 one- way classification items, and 12 two-way classification items. Only minimally dependent upon the communication of verbal instructions and requiring no verbal respons s from the subject, the test is suitable for use with young and disadvantaged children. To identify the factors that influence performance on the matrix test, comparative studies have been conducted with (1) lower and middle class urban populations from kindergarten and grades one, two, and three, (2) 4-year-old children from various Head Start programs and from a middle class nursery school program, and (3) 5-year-old children from Mount Olive, North Carolina and from Rome, Georgia. These studies have shown that the matrix test is a useful tool for obtaining data relevant to the early education of disadvantaged children. Refinement of the instrument and further analysis of the available data are projected. The project report contains detailed results of the various studies and includes five statistical tables. (JS)

HEAD START EVALUATION AND RESEARCH CENTER

Progress Report of Research Studies
1966 to 1967
(Documents 1 - 6)

Document 1

DEVELOPMENT OF THE MATRIX TEST

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DEVELOPMENT OF THE MATRIX TEST

The Matrix Test was devised to serve as a procedure for assessing classification, sorting and related cognitive skills associated with inferential reasoning. Based upon a format used by Inhelder and Piaget* (1964) to study classification behavior in young children, it consists mainly of newly constructed items combined with a few devised by Inhelder and Piaget. The test also resembles Raven's Progressive Matrices Test, but its format and content are more suited for use with young children -- it includes representational as well as abstract items, it requires a less abstract attitude, and it presents items individually, on separate cards (8" x 13"), rather than in a booklet.

Each item of the test presents a matrix of 2" x 2" or 2" x 3" squares in which all but one of the squares contain two-dimensional geometric figures or pictorial representations of familiar objects arranged in groups so that the figures form some relationship to each other on the basis of their appearance, content or spatial position in the matrix. The subject is asked to find the figure missing from the empty square on the basis of the pattern established by the figures in the remaining squares from among four alternatives that are presented alongside the matrix. The subject merely must point to the alternative that he believes to belong to the empty square. This format has the advantage of simplicity of administration and ease of communicating the essential requirements of the task. Unlike other procedures in which the intricacy of the procedure may elude the grasp of the young child, as in conventional sorting tasks, for example, in which the child may fail to understand the request to "choose the objects which are alike" or "which belong together," the conspicuousness of the vacant square in the Matrix Test almost invariably communicates to even the youngest child that

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*The Early Growth of Logic in the Child by Barbel Inhelder and J. Piaget. New York: Harper & Row, 1964.

the appropriate figure must be found. Further, after the task is presented initially, the test can proceed without any verbal interchange between examiner and child. The child need not utter a single word during the course of the administration of the test; the examiner, too, may remain silent after the task is introduced initially. For the young child who feels assaulted by the speech of adults, or who does not feel sufficiently comfortable with a strange adult to talk with him, a test that minimizes the need for such verbal interaction provides him with an opportunity to function with a minimum of disturbance and interference.

Content of the Matrix Test

The test is made up of 44 items. Although items were originally constructed to present one-way and two-way classification problems, in all, four different classes of items may be distinguished. These four classes of items have been called: Perceptual Matching, Class Membership, One-Way Classification, Two-Way Classification.

The Perceptual Matching items (N = 3) present the easiest task. They present a 2" x 2" matrix in which the figures in all three occupied squares are identical. The task then simply requires the child to find the figure among the four alternatives that is identical to those in the three occupied squares of the matrix. Both abstract and representational figures are included among the three Perceptual Matching items. It should be noted that these items merely require the child to find the matching figures; no abstraction or complex inference is entailed.

The Class Membership items (N = 18) present a 2" x 2" matrix in which the three occupied squares contain different figures that have a common feature. In some of the items containing abstract figures, it is their color or form that the figures have in common; in others, it is the internal relationship of a combination of variables such as size and color that constitute the common element among the figures. Among the items presenting representational figures, the figures depict

objects that may be subsumed under some common category of classification. These items vary in the degree of abstractness of the unifying category of classification.

The One-Way Classification items (N = 11) present 2" x 3" matrices (as well as some 2" x 2" matrices) of abstract or representational figures in which all the members of the vertical arrays (columns) or horizontal arrays (rows) are the same. Thus the identity of the missing figure is given by its column or row membership.

The Two-Way Classification items (N = 12) present matrices (all but two are 2" x 3") in which the row and column membership, in combination, determine the nature of the missing figure. Thus, whereas all the members of the same row or column (as the case may be) of the One-Way Classification items are identical, in the Two-Way Classification, no two squares contain identical figures.

Although countless variations in the sequence of presentation of all 44 items are possible, thus far the Matrix Test has for the most part been administered in a uniform order. The blocks of items are presented in toto, in the same order in which these four groupings have been presented here. During administration of the test, the child is not told of the transitions in task requirement of the blocks of items presented to him. In addition, there has been no attempt to conduct an inquiry following the child's response to an item. Variations in the sequence and mode of presentation of the items, and experimentation with a form of inquiry, are currently being contemplated.

Results

Several studies of the Matrix Test were conducted to identify the factors that influence test performance.

I. Variation in Matrix Test performance as a function of age and cultural background:

Children in kindergarten and grades 1, 2 and 3 of two public schools were given the Matrix Test. School A is located in a middle-class neighborhood and its children come from white, middle-class families predominantly. School B is located in Harlem; virtually all its children are from lower-class, Negro fami-

In each school, 40 children (20 boys and 20 girls) were tested in

kindergarten and each of the first three grades. Two examiners, one male, the other female, both white, tested half the children (10 boys and 10 girls) from each of the grade levels in each of the schools. In those grades in which there was homogeneous grouping, the sample was drawn in equal numbers from the upper, middle and lower levels of ability. In all, 320 children were tested.

Table 1 presents the findings item by item and Figure 1 presents the frequency distributions for total scores. It may be observed that the three Perceptual Matching items presented relatively few problems for even the youngest group. Performance on the first two items, the first of which presented a geometric figure (red circle) and the second, a representational figure (pocket watch), established that all the children understood the simple demands of the Matrix task -- to point to the figure among the alternatives that belonged in the vacant square. The third item (a line drawing of a cow) caused some difficulty because the alternatives included other four-legged animals (dog, horse) so that the impulsively responding child, or the one unfamiliar with the characteristic features of the cow, answered this item incorrectly. This item also illustrates how the difficulty of a Matrix Test item is determined as much by the nature of distractors (i.e., alternatives to the correct answer) as by the level of abstraction required to find the common element among the matrix members.

It may be observed that performance on the Class Membership items varied widely as a function of the difficulty level of the item. Thus, although these items may bear a formal resemblance to each other in that the S must in every case abstract the common element from three non-identical members of a 2" x 2" matrix, other characteristics of the group of items that affect their difficulty level, such as the nature of the abstraction required, vary greatly. Two items that were clearly too difficult for even the oldest children call for essentially identical solution patterns (items 11 and 15). Both require the subject to discern the fact

that the rank order of length of a set of differently colored bars is the same in all three occupied squares. These two problems are unique in that they require recognition that the internal relationship among elements within each square have a feature in common with all members of the matrix.

The first two items in the Class Membership cluster are of interest because of the contrast in performance that they show. Both involve geometric figures in which the common element of the first item (4) is form and that of the second item (5) is color. Whereas the form item is dealt with easily, widespread difficulty was expressed with the color item. It is not clear whether this is a sequential effect, whether the greater difficulty of the color problem stems from the fact that it follows the form item and therefore requires a shift in the criterion for classification, or whether the two problems differ intrinsically in their difficulty level. Further study of this is being planned. Whatever the source of the variance, it may be observed that the middle-class group consistently performs substantially better than the disadvantaged group on the second (color) item. It is of interest to note that there are virtually no changes with age in the performance of the disadvantaged group on the second Class Membership item.

It may be observed that many of the Class Membership items presented no difficulties for even the youngest children. Several other items, however, were not consistently answered correctly and these showed the greatest difference between the disadvantaged and middle-class children. Among these was a pair of items, one of which presented "large things -- objects too large to hold" and the other "small things -- objects one could hold in one's hand." Both these items (17 and 20), involving more abstract categories, were responded to more effectively by the middle-class children. Another highly differentiating item required children to choose a picture of a fish to fill the matrix made up of pictures of animals (item 16). Here, too, the disadvantaged children performed less well; apparently

they were less accustomed to thinking of fish as belonging to the same category as four-legged animals. On most of the other items, involving such classes as vehicles, horses, infant objects, street objects, and same-sex people, differences between the functioning of the middle-class and disadvantaged groups were small at all the age levels studied.

Performance on the One-Way Classification task was more affected by age; older children consistently performed better than younger children (see Figure 2). In addition, a larger difference between the disadvantaged and middle-class groups is in evidence. Both groups performed least well when the problem presented horizontal rather than vertical arrays (items 27 and 32). Since vertical arrays were presented first, here, too, it is not clear whether one-way classification is easier for children when the task requires scanning down columns rather than across rows or whether it is merely the shift to a new set of conditions that is so disruptive to young children.

The Two-Way Classification problem seemed too difficult for virtually all the children. It is only in the middle-class groups that there is some evidence of success with this task. As the age of the group increases, there is a corresponding increase in the number of children who could cope effectively with this task. Among the relatively small numbers of children who performed successfully on these items, most were of middle-class background.

It may be observed from Figure 2 that the differences in performance on the Matrix Test between the disadvantaged and middle-class group increased steadily from kindergarten to the second grade. It is likely that this gap did not continue to increase in the third-grade group because there was an insufficient number of difficult items to differentiate the two groups. As may be seen from Figure 2, large numbers of third graders had reached the ceiling in several of the item clusters, so that only a handful of extremely difficult items prevented many

children from attaining perfect scores.

At the kindergarten level, there is great overlap between the two groups. The middle-class group begins to surge ahead in grade 1, and at grade 2 there is only a slight degree of overlap between them. This gap is narrowed slightly at the grade 3 level.

Among the youngest children in the sample, the kindergarten group, performance was best in the Class Membership items. A sizable difference between the middle-class and disadvantaged groups is already apparent at this age level in their performance on the One-Way Classification item cluster. A substantial number of disadvantaged children scored on the chance level in this cluster of items. Virtually none of the kindergartners could perform effectively on the Two-Way Classification cluster.

At the first-grade level, both groups continue to show effective performance on the Class Membership items, although the difference between the two groups begins to widen. A substantial number of disadvantaged children at this age level were still unable to cope with the One-Way Classification, thereby increasing the difference between the disadvantaged and the more rapidly advancing middle-class children. So, too, only a handful of disadvantaged children were able to deal with the Two-Way Classification problems, whereas more than twice as many middle-class children could manage these problems.

The second-grade group follows the same pattern observed among the first graders. Several disadvantaged children were still unable to perform the One-Way Classification problems, whereas none of the middle-class children showed real difficulty. At this level, too, more than half the middle-class children showed some mastery of the Two-Way Classification problem, whereas this skill was still relatively rare among disadvantaged children. The third-grade disadvantaged chil when compared with his counterpart second grader, shows some improvement in his

ability to solve One-Way Classification problems but little change in Two-Way Classification, whereas the middle-class child's greatest gains are in Two-Way Classification.

An examination of sex differences (see Figure 2) reveals no consistent pattern of findings. In the youngest group, the girls of the disadvantaged kindergarten sample performed better than the boys. An equivalent difference is not observable among the middle-class group. As a result, it appears that the relatively large difference in performance on the One-Way Classification items found between the disadvantaged and middle-class group is attributable to the boys' scores.

The girls score slightly higher than the boys again in the first-grade sample, but this time it is the middle-class group that shows a sex difference. In the second-grade sample, the girls from both groups performed better than the boys on the Class Membership and One-Way Classification items. Most of the low scores on these two sets of items were obtained by boys. However, this pattern was not at all continued in the third-grade group.

II. Performance on the Matrix Test in younger children (four year olds):

An earlier version of the Matrix Test, in which there were only three (rather than four) alternative answers from which S could choose, was administered to small samples of children from various Head Start programs and a middle-class nursery school program and the results compared with those obtained from other groups tested previously. Because the test administrator as well as the actual sequence and total of items which were administered varied from sample to sample, the data here presented should not be regarded as definitive. They nevertheless provide some indication of the character of performance of very young children on the Matrix Test. Because of their greater difficulty, and the limited tolerance for testing among young children, the Two-Way Classification items were not

administered.

From Table 2 it may be observed that most of the Perceptual Matching items were usually answered correctly. Thus it may be concluded that most of the young children in these sampleswere able to comprehend the nature of the task presented by the Matrix Test. It is apparent that they were able to answer many of the Class Membership items correctly too. Their performance on the One-Way Classification problems was more consistently and uniformly deficient. It would appear that the ability to solve One-Way Classification items is rare in such young children; thus skill in this area of functioning would appear to be indicative of a more advanced level of cognitive development.

Because so many of the proportions of correct responses approached a chance level (.33 with only 3 response alternatives), an analysis of consistency of performance was conducted by grouping items of highly similar content into small sets and determining the number of children who were able to answer all items correctly which had been grouped in the same set. These data are presented in Table 3. They indicate that consistency of performance is relatively rare, but does occur among these young children. In general, it was found more frequently among the middle-class group of children with the largest amount of preschool educational experience (Private Nursery School X).

III. <u>A study of regional differences in performance on the Matrix Test among five year olds</u>:

Two groups of five year olds, most of whom were in the evaluation sample of the Bank Street College Head Start Evaluation Study, from Mount Olive, North Carolina and Rome, Georgia, were given the Matrix Test shortly after they were post-tested toward the end of their first year of Head Start. These two groups, when paired with the kindergarten samples drawn from Schools A and B cited in a previous study, provide an opportunity to study the influence of regional as well

as social class differences on Matrix Test performance.

The Mount Olive sample consisted of 35 Negro children living in a rural, agricultural section of North Carolina. The Rome sample was made up of 25 children, 15 Negro, 10 white, living in a more urban, industrial setting in the South. Since all these children had qualified for participation in Head Start, it may be assumed that they were for the most part from deprived families. These two groups may be compared with School B group, a Northern urban Negro group of disadvantaged children, and with the School A group, a Northern, urban group of white, middle-class children.

The data presented in Table 4 emphasize the great degree of similarity among the four groups. Among the Class Membership items, differences among the four groups tended to be small. The middle-class group often performed best, but only by a slight margin. In general, when a Class Membership item was easy for the middle-class group, i.e., more than 75% of the group answered the item correctly, the other groups also performed well. When an item posed a problem for the middle-class group because of the greater level of abstractness of reasoning it required, it usually produced an even greater degree of failure among the other groups. These more difficult items were the ones that differentiated the groups the most. Differences in performance on the Class Membership items among the three disadvantaged groups, irrespective of what part of the country they were living in, were virtually negligible.

A much larger and more consistent difference between the middle-class group of School A and the remaining three disadvantaged groups may be seen in the results of performance on the One-Way Classification items. Here substantial differences may be found on virtually every item. Only when the One-Way Classification problem presented columns with representational figures with distinct countours that were markedly different from each other (item 26) did the

disadvantaged groups perform with great success on these items.

With a single exception, performance was uniformly poor for all four groups on all the Two-Way Classification items. Only item 42, which presented a Two-Way Classification problem involving number sequence, produced successful performance, and this surprisingly came only from the disadvantaged groups, particularly those from the South. However, since these groups failed to perform well on an equivalent item (36), or on any other Two-Way Classification items, no great significance can be attached to the isolated area of success that was found.

IV. Response latency to the Matrix Test

As presently constituted, administration of the Matrix Test includes provision for recording the time it takes for the child to respond to each item following its presentation. Such data present a record of the pace of the test, and through a comparison of the time a child took to respond to difficult and easy items, provide some indication of how adaptively he was functioning during the course of the test.

The data presented in Table 5 are based upon the comparative study of children from Schools A (predominantly white middle class) and B (Negro disadvantaged) cited previously. The data are in the form of the mean number of seconds elapsing between the time of presentation of the problem and the response to it. Data are presented separately for successful and unsuccessful responses. Analysis of these data is made difficult by the fact that the number of cases contributing to each mean varies as a function of the difficulty of the item.

The most clearcut trend is that of decreasing latency as a function of age; children required less time to respond correctly as they grew older. Among the youngest group of successful respondents, it would appear that the middle-class children took longer to respond than the disadvantaged. But from first grade on, the response latency of the middle-class group was less than that of the disadvantaged group. It would appear that the middle-class children work more rapidly

when they are on the road to the proper solution of the problem. Further, the middle-class group seemed to function more adaptively in that there tended to be a greater discrepancy between the time it took them to respond to a problem that they could solve and one which they could not solve. They allowed themselves more time proportionately to deal with problems they could not solve.

The data also suggest that the children took much more time solving the Class Membership items than the One-Way and Two-Way Classification items. Here, too, it is important to establish whether this difference is a sequence effect or one that is related to the cognitive demands of the task. Further analysis of the latency data are currently being planned.

V. Cognitive correlates of the Matrix Test:

All or part of the sample of five year olds from North Carolina and Georgia that had been administered the Matrix Test were also given the short form of the Stanford-Binet Intelligence Scale, the Caldwell-Soule Preschool Inventory and three items of the Conservation Pictures Test, a quasi-test of conservation of number ability. The data are presented in Table 6 below:

Table 6

	N.C. sample (N = 24) r	Georgia sample (N = 24) r
Stanford-Binet (MA)	.25	.60
Stanford-Binet (IQ)	.39	.51
Caldwell-Soule (raw score)	.46	.53
Conservation Pictures		.29

These data indicate that the Matrix Test variance is associated with substantial portions of variance obtained from other measures of intellectual functioning. Further investigation of the construct validity of the Matrix Test, with

other cognitive measures, and children of other ages, is being planned.

Discussion

Thus far, studies of the Matrix Test have shown that it is a test that presents a task which even a four year old can readily understand and with which he can experience moderate degrees of success. At the same time, it includes a set of items too difficult for most eight year olds, so that the age range of its applicability is wide.

Comparative studies of middle-class and disadvantaged children indicate the presence of a great deal of overlap at age five, with middle-class children performing somewhat better. This difference, however, is widened in the first grade and perpetuated during the following two years so that overlap in performance on the Matrix Test between the middle-class and disadvantaged children diminishes from kindergarten to second grade. This advancing gap appears to be attributable to several factors, all of which affect performance on the more difficult items of the Matrix Test. The more abstract Class Membership items tend to be passed by the middle-class children substantially more often.

Further, the One-Way Classification task appears to be a prime differentiator between middle-class and disadvantaged children. Whereas both groups are adept at finding the common element among diverse figures, the concept of group membership based upon the spatial organization of a set of figures eludes many more disadvantaged children, even at age eight or more. Whether it is the nature of the concept underlying One-Way Classification that presents special difficulties for the disadvantaged child, or whether it is the shift in concept application required by the sequence in which the test items are presented which is largely responsible for the greater deficit in performance recorded by the disadvantaged group is something that will have to be established by further study.

Finally, the Two-Way Classification problems proved to be too difficult even for most of the oldest children. However, in contrast with the mixed performance among middle-class children, there was almost universal failure on these problems among the disadvantaged children. Here, too, it will be important to establish whether it was their inability to shift concepts or their greater vulnerability to boredom or fatigue that contributed significantly to their failure on these items.

Since changes in performance as a function of age were not great, particularly in the 6-8 age range, it appears to exaggerate the difference between middle-class and disadvantaged children to say that the disadvantaged children seem to be two years behind in their performance on the Matrix Test. Nevertheless, the data presented in Figure 1 do suggest that the performance of the second-grade disadvantaged group most closely resembles the performance of the kindergarten middle-class group and, correspondingly, the results of the third-grade disadvantaged group appear most similar to the results of the first-grade middle-class group.

Sex differences in performance were not marked. Where they occurred, they tended to favor the girls.

The data so far available regarding regional differences in scores suggest that there is considerable uniformity in the patterns of performance observed in diverse settings. Many parts of the test appear to transcend regional differences in style of functioning as well as language behavior.

Additional Work to be Done

The Matrix Test presents a format for the study of cognitive functioning whose full potential has not been tapped. At the same time, it has already generated a set of findings that need to be better understood. The most fruitful approach to understanding what the Matrix Test is measuring is to continue the comparative

studies of middle-class and disadvantaged children and the evaluation of performance as a function of age. Additional items need to be developed for the younger age levels by increasing the variety of Class Membership items so that the test will yield more differentiated information about the cognitive functioning of very young children. In this regard, the responsiveness of Matrix Test performance to Head Start experience, in order to determine whether the test can be used as an index of cognitive change, attributable to Head Start, is yet to be established.

Experimentation needs to proceed with a three-dimensional form of the test to determine the influence of the mode of presentation of test stimuli. Sigel's data suggest that the difference between representational and real objects is likely to be critical for the performance of young disadvantaged children. The generality of his findings can be established by experimentation with three-dimensional matrices.

In addition, variation in the sequence of presentation of items must be studied to determine whether the difficulty levels of Class Membership and One-Way and Two-Way Classification items have been influenced by sequence effects. This is important to establish in order to determine whether it was the unique item content or the need to modify a mode of responding which caused so much more difficulty for the disadvantaged groups.

Finally, the correlates of the Matrix Test need to be further identified. This needs to be done for all the item clusters separately so that the relationship of the item clusters to each other can be better understood.

Table 1

Proportion of Children Answering Each Item Correctly
by Grade and School (N=40)*

Item	School A Kind.	School B Kind.	School A Grade 1	School B Grade 1	School A Grade 2	School B Grade 2	School A Grade 3	School B Grade 3
1	1.00	1.00	.97	.97	.97	1.00	1.00	1.00
2	1.00	.95	.97	.97	.92	1.00	1.00	1.00
3	.82	.77	.92	.77	.97	.92	1.00	.80
4	.90	.72	.95	.90	.95	.95	1.00	.97
5	.55	.45	.62	.52	.72	.50	.72	.45
6	.85	.75	.97	.92	1.00	.95	1.00	.97
7	.95	.92	1.00	.92	.97	.92	.97	.97
8	.92	.92	1.00	.95	.97	.92	1.00	1.00
9	.87	.90	.97	.90	.95	.97	1.00	.95
10	.60	.62	.82	.75	.80	.87	.90	.82
11	.27	.12	.25	.27	.30	.45	.25	.32
12	.70	.62	.90	.67	.85	.85	.82	.82
13	.92	.72	.97	.92	.97	.92	1.00	.92
14	.80	.65	.87	.72	.92	.92	.92	.90
15	.10	.22	.25	.25	.22	.35	.17	.30
16	.50	.35	.82	.55	.82	.52	.82	.72
17	.50	.37	.77	.42	.82	.45	.92	.65
18	.77	.82	.92	.90	.92	.87	.92	.97
19	.92	.70	.97	.90	.97	.87	.97	.92
20	.67	.50	.77	.62	.85	.62	.87	.80
21	.97	.67	.80	.80	.97	.80	.95	.80
22	.82	.67	.90	.65	.95	.67	1.00	.80
23	.82	.60	.97	.72	.97	.82	1.00	.92
24	.80	.57	.95	.67	.87	.72	1.00	.82
25	.80	.60	.92	.85	.95	.77	1.00	.90
26	.87	.75	1.00	.90	.97	.87	.97	.87
27	.47	.17	.55	.35	.67	.27	.50	.27
28	.57	.45	.77	.32	.72	.57	.80	.70
29	.65	.32	.65	.47	.72	.70	.77	.72
30	.80	.52	.95	.77	.97	.87	.95	.92
31	.90	.50	1.00	.82	.92	.87	.97	.90
32	.50	.20	.67	.37	.87	.52	.87	.42
33	.20	.05	.35	.12	.50	.20	.50	.35
34	.47	.37	.75	.50	.70	.47	.85	.60
35	.25	.10	.47	.12	.40	.20	.62	.20
36	.20	.22	.22	.20	.27	.15	.52	.20
37	.20	.20	.45	.17	.60	.25	.52	.35
38	.12	.07	.25	.12	.52	.05	.50	.22
39	.40	.40	.55	.40	.50	.37	.42	.42
40	.17	.15	.40	.15	.42	.10	.30	.12
41	.15	.02	.50	.15	.45	.25	.30	.10
42	.25	.55	.20	.42	.35	.32	.40	.22
43	.15	.12	.40	.10	.57	.15	.45	.17
44	.30	.22	.25	.20	.27	.25	.27	.10

*There were 40 children at each grade level in each school.

Frequency Distribution of Total Scores by Grade and School

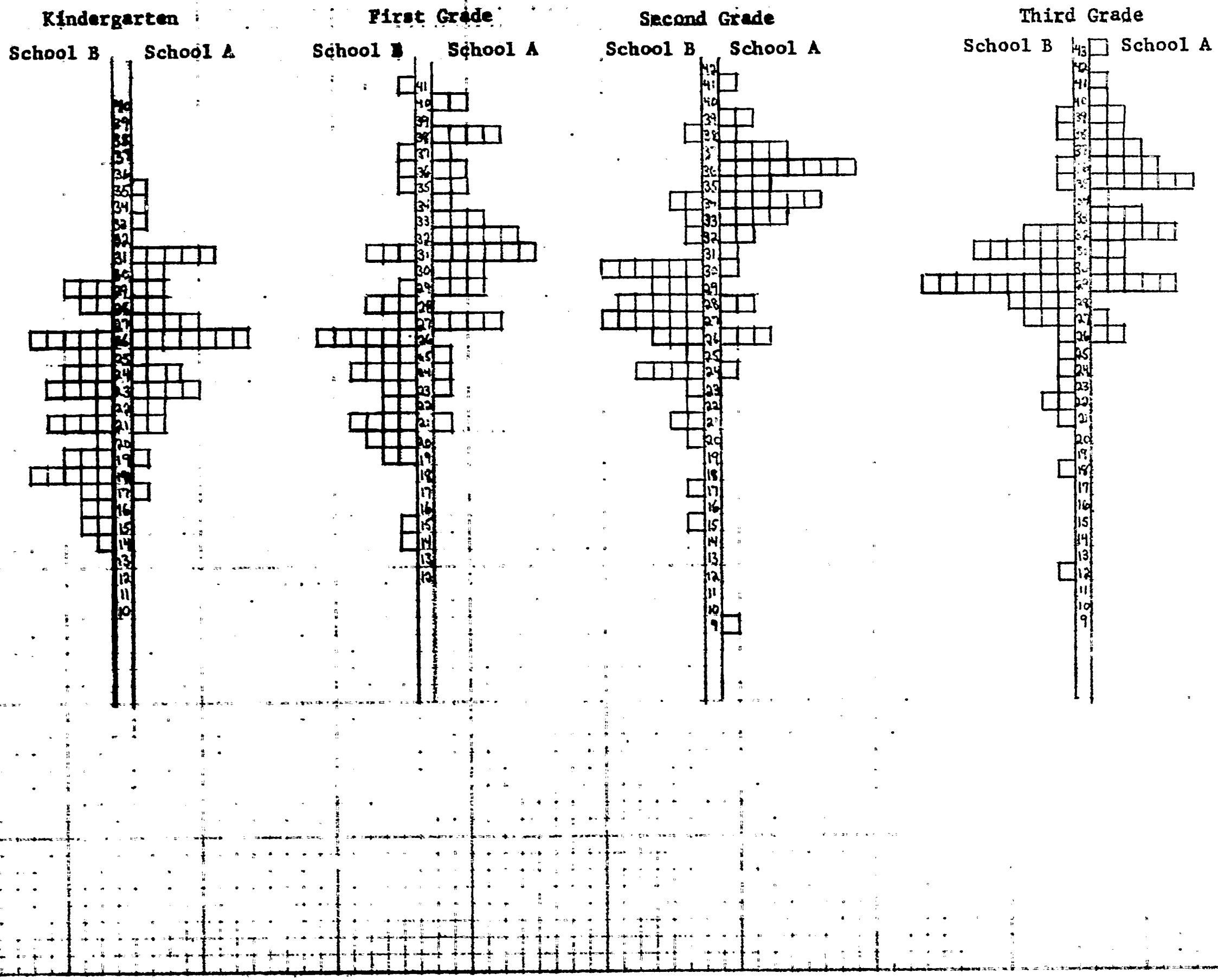
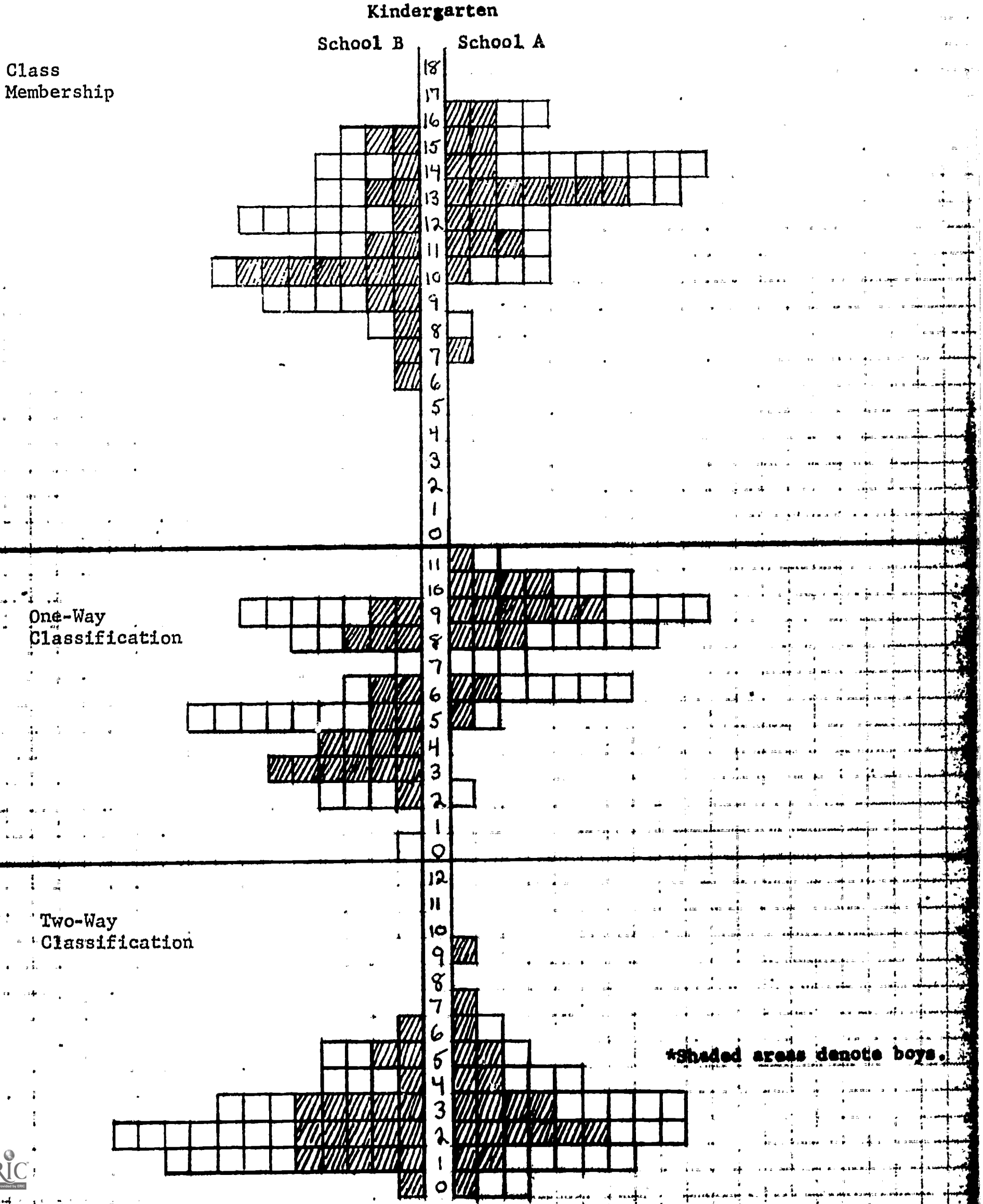


Figure 2

Frequency Distributions for Total Scores on Each of Three Item Clusters -- Class Membership, One-Way Classification, Two-Way Classification -- According to Grade, School and Sex*



*Shaded areas denote boys.

Figure 2 (cont.)

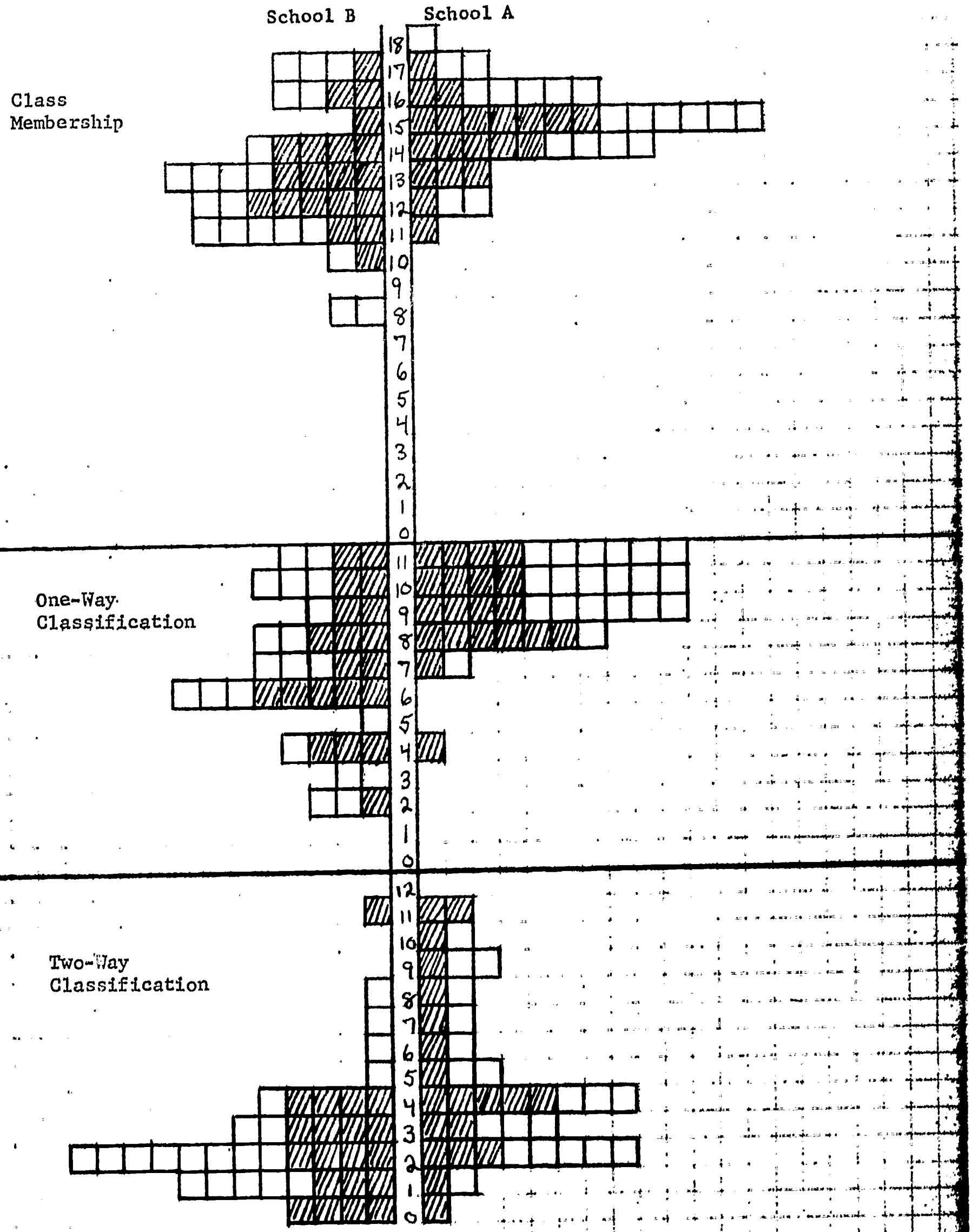


Figure 2 (cont.)

Second Grade

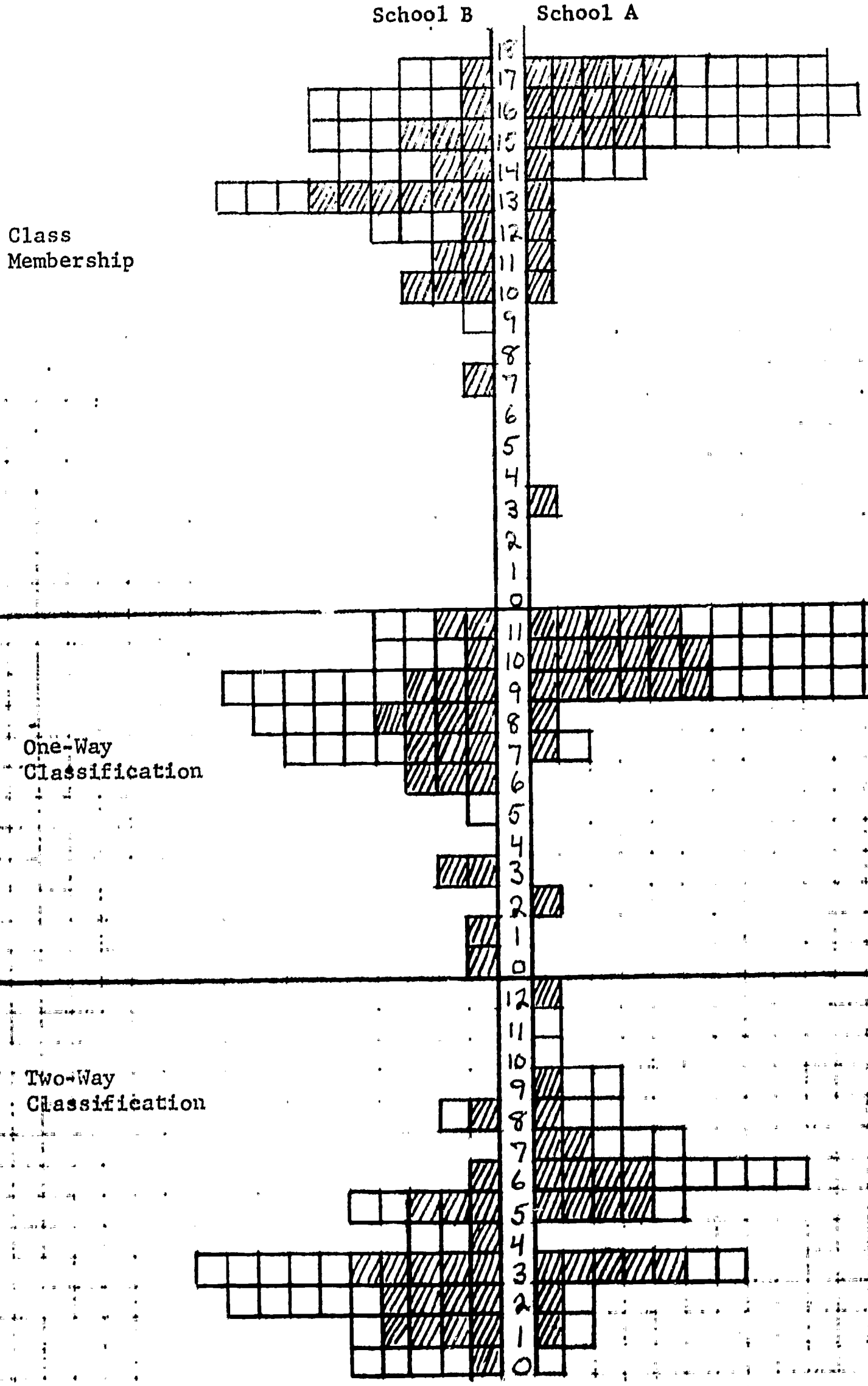
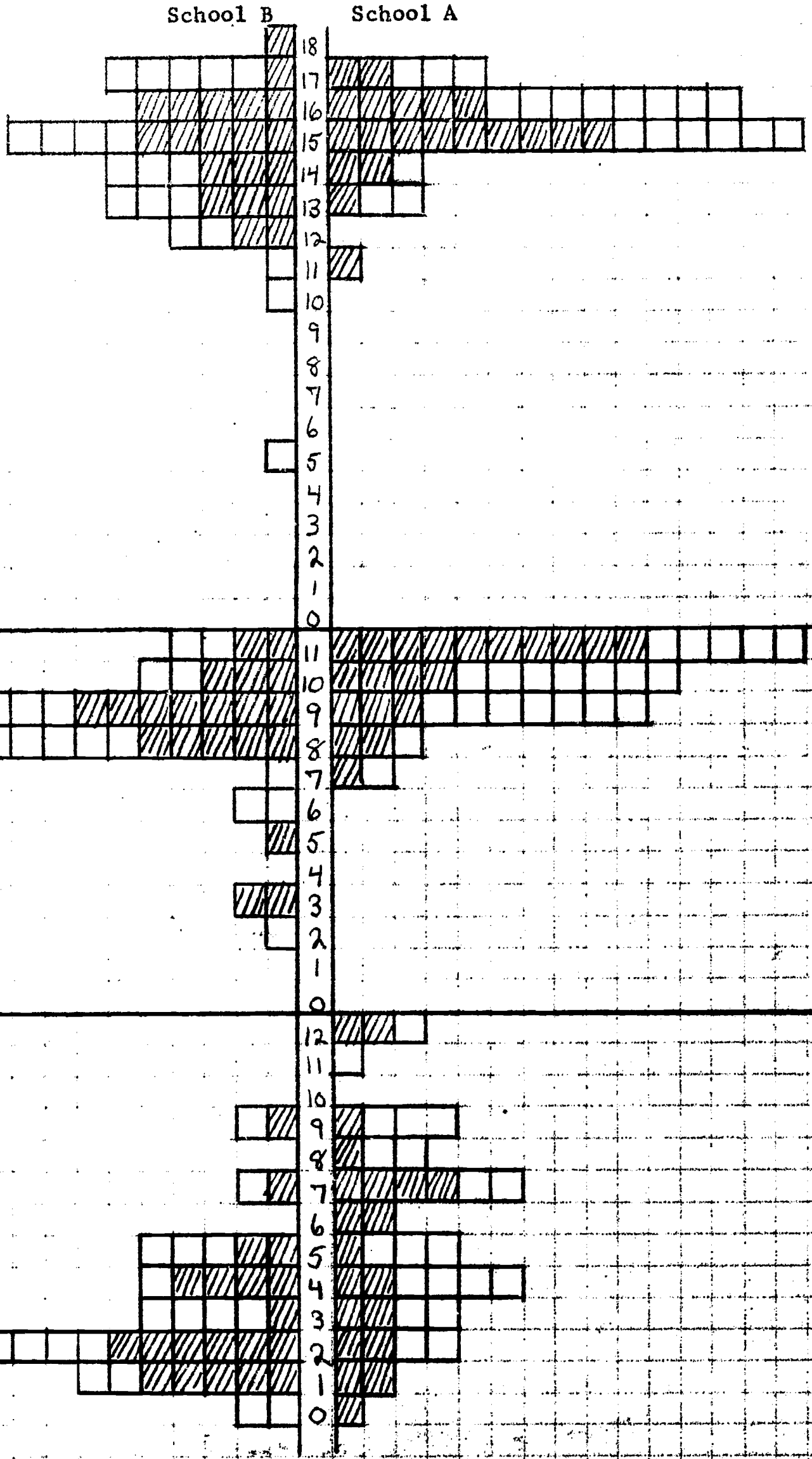


Figure 2 (cont.)

Third Grade



Class Membership

One-Way Classification

Two-Way Classification

Table 2

Proportion of Four-Year-Old Groups Answering Each Item Correctly*

Item	Private Nursery School X (White Middle Class) Mean age: 4-5 N=13	Private Nursery School Y (White Middle Class) Mean age: 4-6 N=8	Head Start Class M (Jewish) Mean age: 4-7 N=7	Head Start Class N (Negro) Mean age: 4-6 N=9	Head Start Class O (Negro) Mean age: 4-8 N=18	Head Start Class P (Negro) Mean age: 4-6 N=26
1	.85	.75	.86	.89	.72	.70
2	1.00	1.00	.86	.66	.89	.92
3	.62	.50	.57	.22	.56	.75
4	.92	.88	.71	.78	.72	.70
5	.62	.63	.71	1.00	.61	.92
6	.85	.75	.86	.89	.78	.89
7	.77	.50	.43	.56	.33	.42
8	.92	.63	.71	.67	.61	.77
9	.69	.25	.43	.33	.33	.77
10	.77	.88	.43	.56	.83	.42
11	.00	.25	.43	.11	.28	.20
12	.77	.50	.29	.44	.44	.62
13	.69	.63	.57	.56	.61	.55
14	.62	.50	.57	.22	.50	.54
15	.69	.63	.43	.67	.67	.53
16	.62	.25	.71	.56	.17	.72
17	.31	.38	.57	.22	.22	.40
18	.69	.63	.43	.44	.11	.80
19	.54	.25	.57	.11	.22	.35
20	.69	.38	.71	.67	.72	.65
21	.46	.63	.14	.22	.50	.35
22	.62	.25	.14	.67	.17	.60
23	.62	.38	.43	.56	.28	.70
24	.46	.63	.43	.22	.44	.27
25	.62	.50	.57	.56	.44	.72
26	.69	.88	.57	.56	.72	.50
27	.85	.63	.14	.56	.56	.80
28	.15	.25	.29	.33	.11	.12
29	.31	.50	.43	.56	.17	.58
30	.38	.50	.29	.56	.17	.65
31	.38	.63	.43	.22	.06	.50
32	.23	.38	.43	.00	.44	.45

*With three alternatives, the chance value is .33.

Table 3

Proportion of Children Answering All Members of a Set of Items Correctly

Item Clusters	Chance Probability	Private Nursery School X (White Middle Class) Mean age: 4-5	Private Nursery School Y (White Middle Class) Mean age: 4-6	Head Start Class M (Jewish) Mean age: 4-7	Head Start Class N (Negro) Mean age: 4-6	Head Start Class O (Negro) Mean age: 4-8	Head Start Class P (Negro) Mean age: 4-6
1. Class Membership Sets of Items							
A. Outdoor and indoor things (#19 & 21)	1/9	4/13	2/8	1/7	0/9	1/18	5/26
B. Large things and small things (#17 & 20)	1/9	1/13	1/8	2/7	1/9	3/18	5/26
C. Items involving noun family membership, i.e., fruit birds, vehicles, dogs, houses, animals (#6, 7, 8, 12, 13, 16)	1/729	4/13	1/8	0/7	1/9	0/18	0/26
D. Member of sex items (#9, 10, 14)	1/27	6/13	0/8	1/7	1/7	5/18	4/26
E. Abstract items (form or color) (#4 & 5)	1/9	8/13	4/8	4/7	7/9	9/18	16/26

Table 3 (cont.)

Item Clusters	Chance Probability	Private Nursery School X (White Middle Class) Mean age: 4-5	Private Nursery School Y (White Middle Class) Mean age: 4-6	Head Start Class M (Jewish) Mean age: 4-7	Head Start Class N (Negro) Mean age: 4-6	Head Start Class O (Negro) Mean age: 4-8	Head Start Class P (Negro) Mean age: 4-6
2. One-Way Classification Sets of Items							
A. Items presenting abstract figures (#22, 23, 24, 30)	1/81	3/13	1/8	1/7	2/9	0/18	3/26
B. Representational items presenting clear distinctions between column members (#25 & 26)	1/9	6/13	3/8	2/7	3/9	6/18	7/26
C. Representational items presenting <u>less</u> clear distinctions between column members (#28, 29, 31)	1/27	2/13	1/8	1/7	1/9	0/18	0/26
D. All representational items (B+C) (#25, 26, 28, 29, 31)	1/243	2/13	1/8	1/7	0/9	0/18	0/26
E. Items involving row membership (#27 & 32)	1/9	3/13	2/8	0/7	0/9	4/18	1/6

Table 4

Proportion of Five Year Olds from Different Regions
Answering Each Item Correctly

Item	Schl. X N=40	Schl. Y N=40	Mt. Olive N.C. N=35	Rome Ga. N=25	Item	Schl. X N=40	Schl. Y N=40	Mt. Olive N.C. N=35	Rome Ga. N=25
1	1.00	1.00	.94	1.00	22	.82	.67	.31	.36
2	1.00	.95	1.00	1.00	23	.82	.60	.51	.52
3	.82	.77	.94	.80	24	.80	.57	.57	.60
					25	.80	.60	.51	.48
4	.90	.72	.86	1.00	26	.87	.75	.80	.64
5	.55	.45	.23	.60	27	.47	.17	.40	.32
6	.85	.75	.86	.92	28	.57	.45	.23	.52
7	.95	.92	.94	.96	29	.65	.32	.31	.32
8	.92	.92	.91	.92	30	.80	.52	.69	.76
9	.87	.90	.77	.96	31	.90	.50	.49	.68
10	.60	.62	.69	.68	32	.50	.20	.20	.28
11	.27	.12	.31	.16					
12	.70	.62	.80	.68	33	.20	.05	0	.16
13	.92	.72	.86	.96	34	.47	.37	.43	.48
14	.80	.65	.83	.64	35	.25	.10	.03	.04
15	.10	.22	.29	.12	36	.20	.22	.29	.12
16	.50	.35	.29	.56	37	.20	.20	.14	.32
17	.50	.37	.29	.28	38	.12	.07	.08	.12
18	.77	.82	.89	.76	39	.40	.40	.51	.28
19	.95	.70	.89	.80	40	.17	.15	.03	.08
20	.70	.50	.54	.56	41	.15	.02	.08	.04
21	.97	.67	.69	.68	42	.25	.55	.69	.88
					43	.15	.12	.20	.12
					44	.30	.22	.37	.24

Table 5

Mean Response Latencies* for Each Item
According to Grade and School

Item	School A Kind.	School B Kind.	School A Grade 1	School B Grade 1	School A Grade 2	School B Grade 2	School A Grade 3	School B Grade 3
1	3.5 --	3.7 --	2.7 (7.0)	2.6 (6.0)	2.5 (6.0)	2.0 --	1.9 --	2.0 --
2	4.1 --	4.5 (6.5)	3.2 (4.0)	4.2 (4.0)	2.8 (5.0)	3.2 --	2.3 --	3.1 --
3	5.4 (4.1)	4.8 (5.2)	3.9 (4.3)	5.0 (3.3)	3.3(10.0)	3.9 (3.3)	2.9 --	3.7 (3.0)
4	4.1 (6.3)	4.8 (5.4)	3.5 (5.5)	4.8 (3.3)	2.7 (8.0)	3.2 (7.0)	2.4 --	2.7 (5.0)
5	4.3 (6.1)	4.1 (4.6)	3.2 (6.3)	4.0 (5.9)	2.8 (5.6)	3.9 (4.7)	2.9 (3.1)	2.6 (3.5)
6	6.2 (3.2)	4.9 (5.9)	4.1 (4.0)	5.3 (3.3)	3.6 --	5.0(10.0)	2.4 --	3.8 (2.0)
7	5.2 (5.5)	4.2 (7.7)	2.8 --	4.5 (4.0)	2.6 (5.0)	3.4 (5.7)	2.6 (3.5)	2.9 (4.0)
8	4.3 (4.0)	3.8 (5.3)	2.7 --	4.3 (7.5)	2.6 (9.0)	3.0 (4.3)	2.2 --	2.1 --
9	5.7 (7.8)	3.9 (6.3)	3.7(10.0)	4.8 (4.8)	4.1 (7.5)	3.3 (5.0)	3.6 --	2.8 (3.0)
10	5.3 (5.8)	4.0 (4.1)	3.5 (7.0)	4.7 (6.5)	3.2 (3.6)	4.4 (5.0)	3.9 (2.8)	2.9 (5.3)
11	7.1 (6.0)	4.2 (3.7)	6.7 (6.8)	6.4 (4.9)	6.3 (5.6)	7.0 (5.1)	3.9 (5.3)	5.2 (2.8)
12	5.1 (4.9)	3.4 (5.6)	3.6 (5.5)	4.9 (4.5)	3.1 (6.0)	3.6 (6.2)	2.9 (3.3)	3.5 (4.0)
13	3.6 (6.0)	3.4 (5.2)	2.5 (8.0)	4.1 (3.7)	2.6 (8.0)	2.8 (5.0)	2.1 --	2.5 (3.0)
14	4.9 (8.3)	4.4 (4.5)	3.7 (5.3)	4.1 (6.2)	3.4 (3.0)	3.8 (2.7)	3.2 (7.0)	3.1 (3.0)
15	8.0 (6.3)	3.1 (4.0)	8.0 (6.1)	7.0 (5.7)	7.0 (6.4)	5.2 (4.7)	3.1 (5.5)	5.7 (4.8)
16	5.5 (6.4)	4.1 (4.7)	4.6 (5.9)	5.4 (6.3)	3.1 (4.6)	4.0 (5.3)	2.9 (4.0)	4.2 (3.5)
17	7.4 (7.9)	4.4 (5.0)	6.0 (6.2)	5.5 (6.3)	5.3 (6.6)	6.5 (5.1)	5.1(10.0)	5.8 (5.0)
18	4.4 (6.6)	3.7 (4.6)	3.8 (6.0)	4.1 (6.5)	3.4 (3.7)	3.3 (5.6)	2.7 (5.7)	3.2 (3.0)
19	4.7 (8.5)	4.2 (3.8)	3.1 (8.0)	3.9 (8.3)	2.8 (4.0)	3.7 (2.1)	2.6 (3.0)	2.9 (2.7)
20	6.9 (8.4)	4.2 (4.5)	5.5 (7.1)	5.0 (8.2)	5.0 (5.6)	4.5 (6.0)	4.0 (6.3)	4.3 (6.9)
21	8.4(10.0)	4.0 (3.8)	4.9 (8.3)	4.6 (5.3)	4.6 (5.0)	4.7 (5.3)	3.5 (2.5)	2.7 (4.9)

* When item was failed, mean response latencies are given in parentheses.

Table 5 (cont.)

Item	School A Kind.	School B Kind.	School A Grade 1	School B Grade 1	School A Grade 2	School B Grade 2	School A Grade 3	School B Grade 3
22	3.1 (5.4)	3.4 (3.8)	2.8 (3.0)	3.5 (4.6)	2.4 (2.0)	3.4 (3.7)	2.2 --	2.7 (2.3)
23	2.5 (4.3)	2.9 (3.4)	2.2 (4.0)	2.7 (5.[illegible])	1.9 (4.0)	2.2 (3.7)	1.9 --	2.1 (3.0)
24	3.2 (4.0)	3.0 (3.3)	2.3 (2.5)	2.9 (4.2)	2.3 (3.0)	2.5 (3.5)	1.9 --	2.3 (2.0)
25	4.0 (5.9)	3.8 (3.4)	2.6 (7.3)	3.1 (4.2)	4.0 (4.0)	2.8 (3.6)	2.0 --	2.4 (2.6)
26	3.0 (6.4)	3.7 (3.7)	2.5 --	3.3 (3.0)	2.4 --	2.6 (4.2)	1.7 (5.0)	2.1 (4.6)
27	4.8 (6.3)	4.0 (3.1)	4.8 (3.6)	4.8 (4.2)	3.1 (4.5)	3.8 (3.4)	3.3 (3.5)	2.5 (3.4)
28	4.4 (3.5)	3.6 (3.2)	4.1 (4.0)	4.0 (4.0)	3.3 (2.6)	3.8 (3.5)	2.7 (2.5)	3.1 (2.8)
29	5.1 (2.7)	3.9 (3.9)	4.7 (4.4)	4.8 (5.0)	4.0 (4.0)	3.9 (4.3)	3.2 (3.7)	2.9 (5.0)
30	2.5 (4.5)	3.1 (2.6)	2.4 (3.0)	3.1 (4.7)	2.1 (4.0)	2.3 (3.6)	1.9 (2.0)	2.2 (2.0)
31	4.5 (4.3)	3.4 (3.9)	3.4 --	3.7 (3.9)	2.6 (3.0)	2.9 (4.6)	2.1 (2.0)	2.5 (5.3)
32	4.1 (3.8)	2.8 (3.3)	2.2 (3.7)	3.2 (3.7)	2.4 (3.0)	3.1 (2.5)	2.2 (2.4)	2.2 (3.1)
33	5.8 (4.4)	8.0 (3.1)	4.3 (3.5)	2.4 (3.9)	2.6 (3.1)	4.6 (3.5)	2.6 (2.4)	2.8 (3.2)
34	4.3 (4.7)	3.5 (3.4)	3.3 (4.2)	3.6 (5.3)	2.9 (4.0)	3.3 (3.4)	2.6 (2.2)	3.1 (3.2)
35	4.5 (4.5)	3.8 (3.3)	3.5 (3.6)	3.2 (3.5)	3.6 (3.4)	2.0 (3.6)	3.0 (2.3)	2.8 (3.4)
36	5.4 (5.4)	4.5 (3.4)	5.2 (4.7)	4.8 (4.2)	5.5 (4.1)	7.4 (4.1)	4.2 (3.7)	5.0 (3.9)
37	4.7 (4.1)	3.5 (3.3)	2.8 (2.6)	2.4 (4.2)	3.1 (3.1)	3.3 (3.2)	2.5 (2.3)	3.2 (3.0)
38	5.6 (4.7)	2.8 (4.2)	6.5 (4.1)	3.2 (4.2)	4.2 (3.7)	6.0 (3.6)	3.6 (3.3)	4.9 (3.8)
39	5.1 (6.0)	2.6 (4.0)	3.9 (5.9)	5.5 (5.1)	2.5 (4.9)	3.7 (5.5)	3.7 (3.8)	4.1 (4.4)
40	4.9 (4.5)	3.5 (2.5)	3.3 (3.7)	3.7 (3.9)	3.5 (3.5)	4.3 (4.4)	3.2 (2.1)	2.2 (3.8)
41	4.7 (5.7)	6.0 (3.3)	4.5 (4.5)	5.7 (4.4)	4.0 (4.5)	5.2 (4.5)	3.3 (3.1)	3.8 (3.6)
42	4.0 (5.7)	3.2 (3.7)	5.3 (5.3)	5.4 (5.0)	3.2 (4.0)	4.4 (4.7)	3.4 (3.1)	4.0 (3.6)
43	6.2 (5.7)	4.6 (3.3)	5.3 (4.8)	5.5 (4.4)	4.6 (4.2)	3.7 (4.6)	3.7 (2.8)	3.6 (3.6)
44	7.2 (5.9)	4.9 (3.9)	7.1 (5.6)	4.8 (5.1)	5.4 (4.0)	5.5 (5.2)	6.8 (3.8)	4.3 (4.0)