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ABSTRACT

In order to investigate diffusion effects within families involved in an intervention program, 80 disadvantaged children were divided into four groups, three of which were made up of younger siblings of preschool children in the intervention program. In two of these three groups, the mother was also involved in the program. The fourth group was for control. The diffusion effects studied were those that related to concepts (defined as knowledge that can be shown by matching, recognition, or identification behavior). The measurement instrument was the Basic Concept Test, whose content was drawn from the curriculum material used in the intervention program. It was hypothesized that the two groups having both sibling and maternal involvement would show greater conceptual development, and that these groups would also have the information necessary to recognize and identify the test stimuli. Results from Orthogonal Comparisons supported both the hypotheses. Superior performance by the maternal involvement groups was recognized as a manifestation of a level of conceptual development directly associated with intra-family diffusion effects. Maximum intervention effects appear to result when mothers are involved in a program and vertical diffusion affects the younger siblings of children in the program. (MH)

INTRA-FAMILY DIFFUSION OF SELECTED COGNITIVE SKILLS AS A FUNCTION OF EDUCATIONAL STIMULATION [1]

Demonstration and Research Center for Early Education
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Introduction

The decade of the 1960's has witnessed an increasing interest in improving the educability of young children from deprived circumstances. A primary objective of preschool intervention programs has been to ameliorate the educational deficits of the children through building competencies in skill areas necessary for academic success. Apart from this common goal, the programs have varied in content, focus, and implementation methodology. Overriding the variation has been a concern as to how to achieve maximal effectiveness and under what conditions this is most readily obtainable. Akin to this is a second issue involving the economics of intervention as related to the manpower required and the question of sustained treatment effects.

One example of an attempt to answer these problems began with the intervention program of Klaus and Gray (1968). They found unexpected program effects which appeared to be associated with the attention given to the mothers of their preschool treatment populations. The younger siblings in these families scored significantly higher on Stanford-Binet IQ scores than their counterparts in comparison groups. These results were recognized as vertical diffusion effects from the involvement of the older sibling and the mother of the family.

These implications from the vertical diffusion findings appeared to afford means for obtaining maximal effectiveness within a viable economic framework. A field research program was designed to investigate this potential (Gray, 1968). The Demonstration and Research Center for Early Education (DARCEE) employed a major intervention study to

specify the conditions and responsible agents for promoting conceptual development in young children. There were three treatment methods involved. The first group consisted of mother and child combinations who participated in a preschool program. The second group had a home visiting teacher who worked with the mother and her child using similar material. In the third group only the target child in the family participated in a preschool program which was a replication of that of the first group. All of the families in the study had other children who were younger than the ones involved in the program. A primary concern of the DARCEE study was to investigate the type of treatment which fostered maximal vertical diffusion effects upon the younger siblings who were not direct participants in the intervention.

The research concern in the present study was focused on measuring vertical diffusion effects on the younger siblings of the families involved in the intervention treatment programs. The writer is aware of no other research programs concerned with vertical diffusion effects in early education. The problem of measurement is essentially the same as that encountered in preschool programs in general. Fowler (1966) described the growing concern focused on cognitive processes and how to measure this in the preschool child. He described the current research interest as encapsulated within two limiting frameworks. The first approach has been to characterize, while the other has leaned toward measuring intellectual processes. Two of the reasons for the problems inherent in cognitive research were attributable to lack of common definition (Wallace, 1965), and to variability of approaches (Getzels & Elkins, 1964).

As for relying on measuring intellectual processes, the use of global psychometric measures was criticized and a need for specialized instruments of an analytical nature aimed at specific skill achievement has been stressed by Deal and Wood (1968), Deutsch and Deutsch (1968), Stake (1968), and White (1968).

This study proposed to measure skill achievement within a specific area of conceptual development. A necessary factor was to provide an operational definition. For the purposes of this study, concept was defined as knowledge about an object or event which could be manifested through matching, recognition and identification behavior. An instrument was designed to measure these conceptual processes as applied to stimuli representative of shape, color, size, position, direction, and number. For project purposes it was called the Basic Concept Test.

The particular skills measured were from the curriculum of the DARCEE preschool program. An example of the types of skills included in the instructional program is described.

In introducing new objects and relationships to a child, various attributes and dimensions are discussed. Labels and definitions are given. The sequence of steps begins with the teaching of an initial gross discrimination between two very different stimuli. The progression of instruction proceeds from the child's comprehending likenesses and differences to a stage of recognition of objects from verbal labels previously furnished for him. This recognition stage is a preliminary step to the child's use of the word in the context of identification. Wohlwill (1962) explained the transition from perception to conception

as occurring when the amount of redundant information required for an appropriate response decreases, and when the amount of spatial and temporal separation over which information can be integrated can be increased.

In this study it was proposed that the performance of a child who could recognize and identify the test stimuli was an index of conceptual development.

Purpose

The purpose of this study was to investigate the diffusion effects within families involved in a field research model of intervention programs. These diffusion effects were studied as they related to the conceptual development of the younger siblings in these families. The level of conceptual development was measured by an instrument, the Basic Concept Test, which was designed for this study.

The primary purpose was to ascertain the presence of diffusion effects and the extent to which there was differentiation between the groups of younger siblings as related to the type of intervention treatment. It was predicted that the two groups having maternal participation would achieve an overall higher performance level than the two groups which had only older sibling treatment or no treatment.

A second issue concerned the establishment of the hierarchical nature of the Basic Concept Test subtests as a measure of conceptual development. It was expected that the performance of all four groups would be more alike on the subtest of Matching, and that there would be increasing differentiation, in favor of the groups having maternal

involvement, on the subtests of Recognition and Identification. This prediction was based on the assumption that the correct responses for the subtests of Recognition and Identification would be available to the young deprived child only through diffusion of educational stimulation.

Method

The Ss were 80 male and female Negro children between the ages of three years, seven months and five years, eight months who resided in the same low-income public housing project in Nashville, Tennessee. Fifty-six of the Ss were younger siblings of target children who had been involved from one to two years in a DARCEE preschool program. The remaining 24 Ss were selected to constitute a group for comparison purposes.

Miller (1967) described the general design of the study. There were four groups. In the first group, the mother and target child were brought to the preschool center for a training program. The mother came once a week, the child five half-days a week. The mother's program was a sequential process of skill development. The children's program was a comprehensive developmental curriculum designed to foster socialization for competence. It centered about the development of skills for environmental mastery and the development of attributes necessary for continuing growth.

The second group had no direct contact with the preschool center. The family was visited once a week by a home visiting teacher who worked directly with the mother and used the target child to demonstrate techniques and procedures used in the preschool classroom.

In the third group, the target child was the only member of the family enrolled. These children participated in a classroom program which was a replication of that of the first group.

The fourth group was for comparison purposes. For this study, the comparison group was constituted of mothers and their children who were equivalent in age to the mothers and the younger siblings of the other three groups. Other selection criteria were as follows: length of residency in the same housing project, family size and ordinal position of the child, and the father's presence or absence in the home. Twenty families were selected. Four of the mothers had two children within the appropriate age range, bringing the number of children in this group to 24.

The original plan of the DARCEE program was to test the younger siblings of each of the target children as they became three years and six months of age and once annually thereafter for the duration of the program. The three treatment groups of younger siblings differed in size because of the individual variation in becoming the pre-determined testing age. Group 1 had 20 Ss; Group 2, 17 Ss; Group 3, 19 Ss; Group 4, 24 Ss. The total N of this subject population was 80.

The Basic Concept Test was administered to all of the subjects. The Stanford-Binet Intelligence Scale, Form L-M, was administered in the same testing session.

Instrumentation

The Basic Concept Test was designed to provide an estimate of a preschool child's attainment of three specific conceptual processes.

These processes, matching, recognition, and identification, were measured as they were applied to stimuli representing shape, color, size, direction, position, and number.

The test consisted of 25 sets of response and stimulus cards. The response cards were 10 by 5 inches. The stimulus cards were 3 1/4 by 3 1/4 inches. Some of the cards were used for more than one item. The majority of the response cards had the potential for three responses. The total number of possible responses was 93. Each S was administered all of the items.

The test was administered to each S individually. The S was brought into the room and seated at a table to the left of the E. The cards were presented one at a time to the S, the response card first, followed by the appropriate stimulus card. The E requested the S to "Show me the one that is the same as, like, (varying with the addition of the cue as to color, shape, size, etc.) this one." The stimulus card was indicated and then a sweep of the hand across the response card directed the S's attention to how the task was to be performed. All of the Ss could follow directions well enough to give appropriate responses.

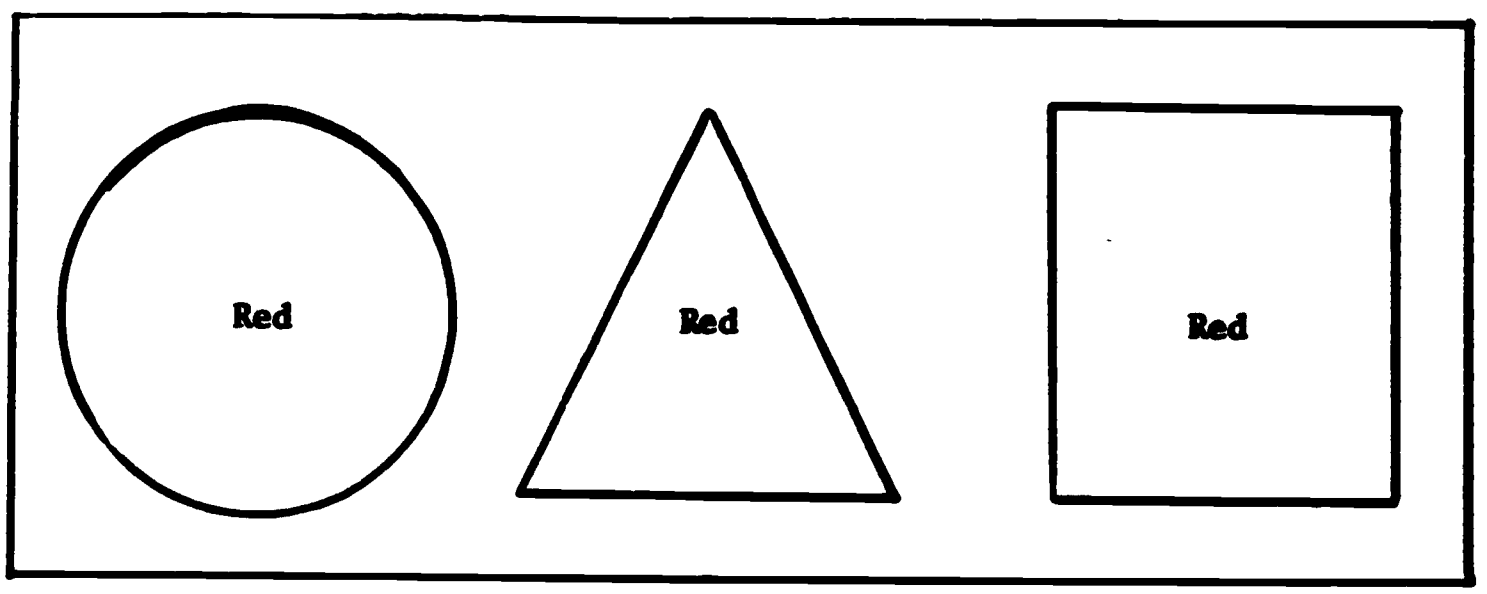
The cards were packaged in separate envelopes for each item and only one item was shown at a time. They were replaced immediately in the envelope to avoid the possibility of distracting stimuli other than the one needed for the immediate response. To control for positional perseveration, the stimulus cards were presented in an alternating order. As each item was administered, the score sheet was marked. Final scoring consisted of tallying the correct responses and assigning the number correct to the appropriate subtests.

The three subtests were interspersed throughout the test and the difficulty level was varied in the same manner. A problem of pictorially representing a particular concept in some of the dimensions resulted in the subtests having an unequal number of items. The Matching subtest had 56 possible items, Recognition 18, and Identification 19. Because of the inequality of subtest items, the raw scores were converted to proportions and transformed scores were used for analysis of variance purposes.

The advantages of the test include the short time required for administration, approximately ten minutes. The scoring and administration simplicity requires minimal training. The test is untimed. It may be administered to Ss ranging in age from three years and six months to year six.

The item selection was based on the DARCEE preschool curriculum content. An example of an item from each subtest is described.

In Matching, a response card contained three figures. For matching shapes on a simple level, the card contained three different geometric figures. Color and size were held constant. Three stimulus cards were presented to the S one at a time, and he was asked to match the stimulus card with the appropriate figure on the response card. In Recognition, the same card was used to ask the subject to indicate the figure on the response card for which the E had furnished the label. In Identification, at some later point in the test, the S was asked to give the verbal label for a figure indicated by the E (see Figure 1).



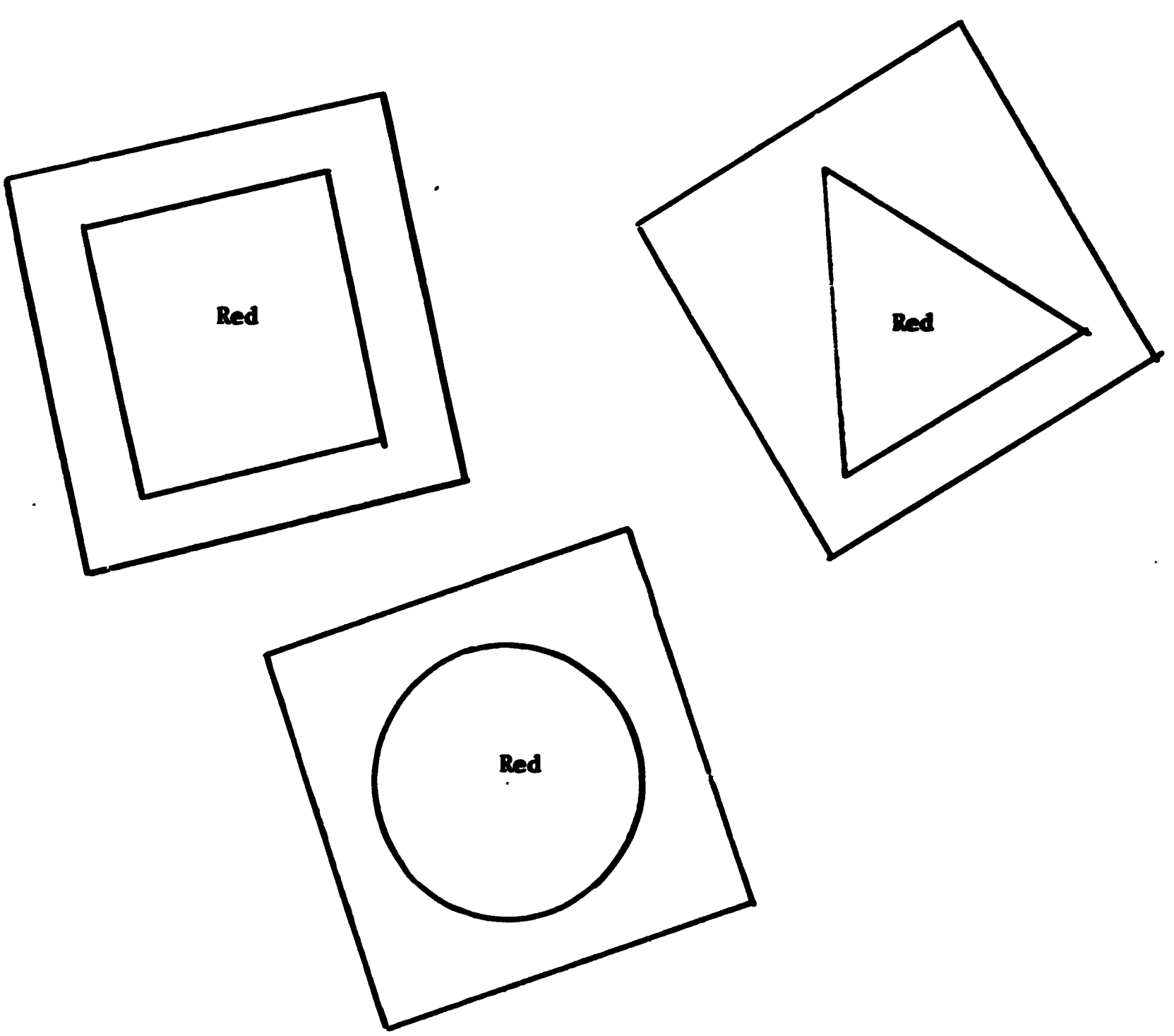


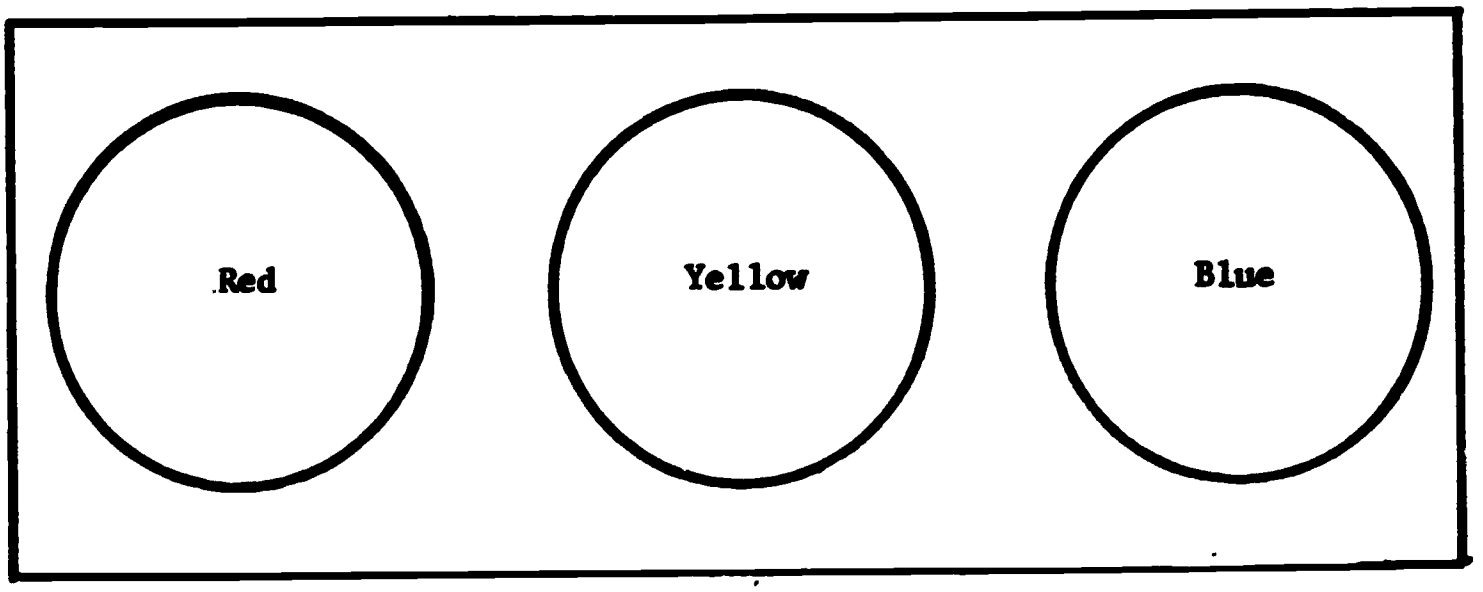
Figure 1. Basic Concept Test sample response and stimulus cards as used in matching, recognition, and identification of shape.

Figure 2 illustrates a simple response for color skills. The only dimension varied was color. In Figure 3, an illustration of a more complex item is given. The three dimensions of color, shape, and size were varied. The S was asked to indicate the one on the response card that was the same color, shape, and size as the one presented to him on the stimulus cards.

The illustrations on the cards were of two types. Some of the response and stimulus cards contained figures which were cut from colored paper and pasted on the cards. Other cards were representative drawings of objects. The final preparation was by the DARCEE staff artist.

For analysis pertaining to reliability purposes, the three part items were counted as one item. A S was given credit only if he successfully responded to all three parts. It was recognized that an analysis using the three related parts separately could influence reliability indices in a spurious manner.

Because of the nature of the research involved, preplanned periods of criterion testing were built into the program. It was necessary to obtain estimates of reliability from the one test administration. To investigate item homogeneity, the Kuder-Richardson Formula 20 was applied, and yielded a reliability coefficient of .88. The second reliability estimate was obtained by dropping one item and applying the Spearman-Brown correction for attenuation to the correlation of the two test halves. A correlation of .98 was found between the halves. The standard error of measurement was .93.



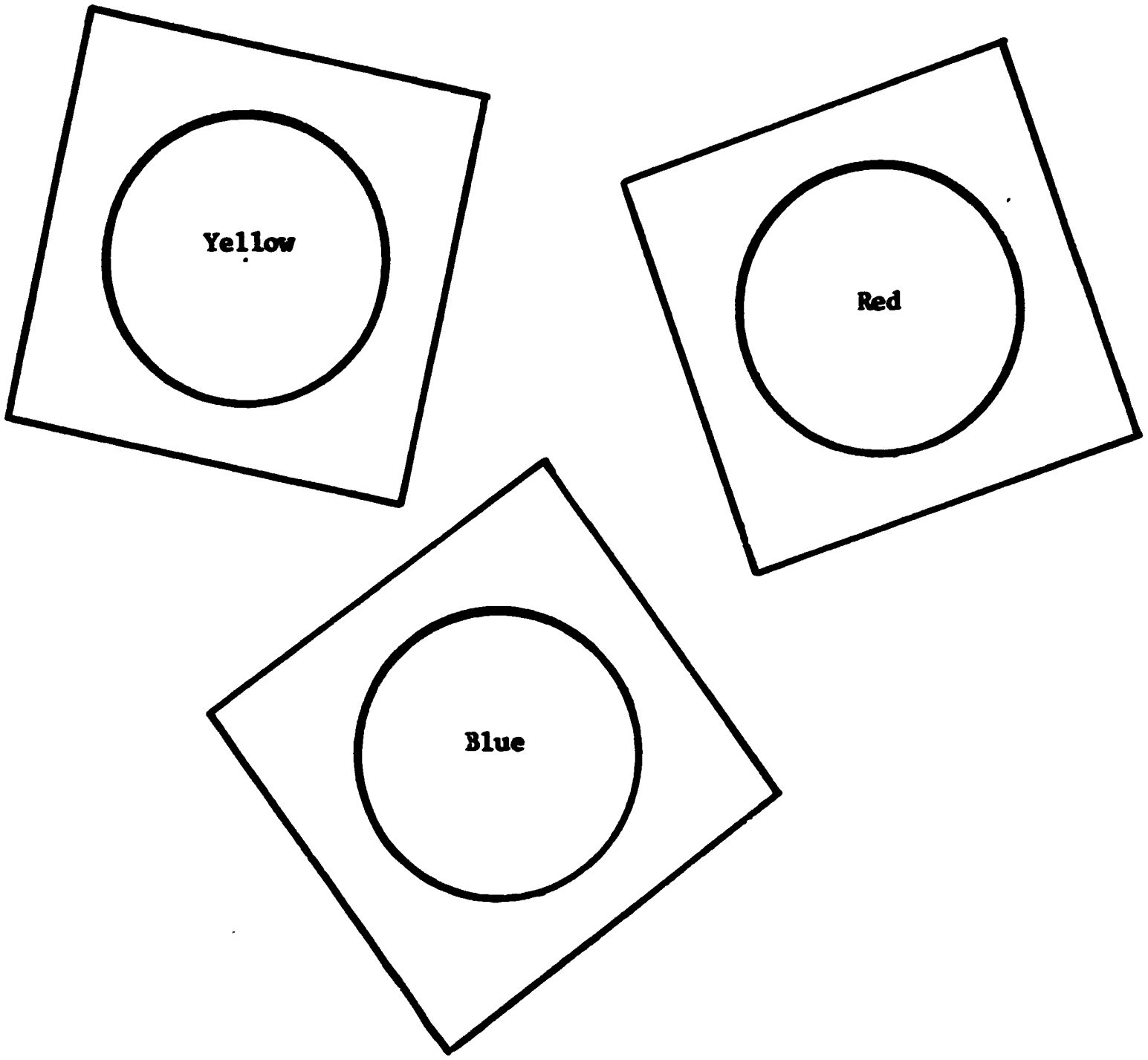
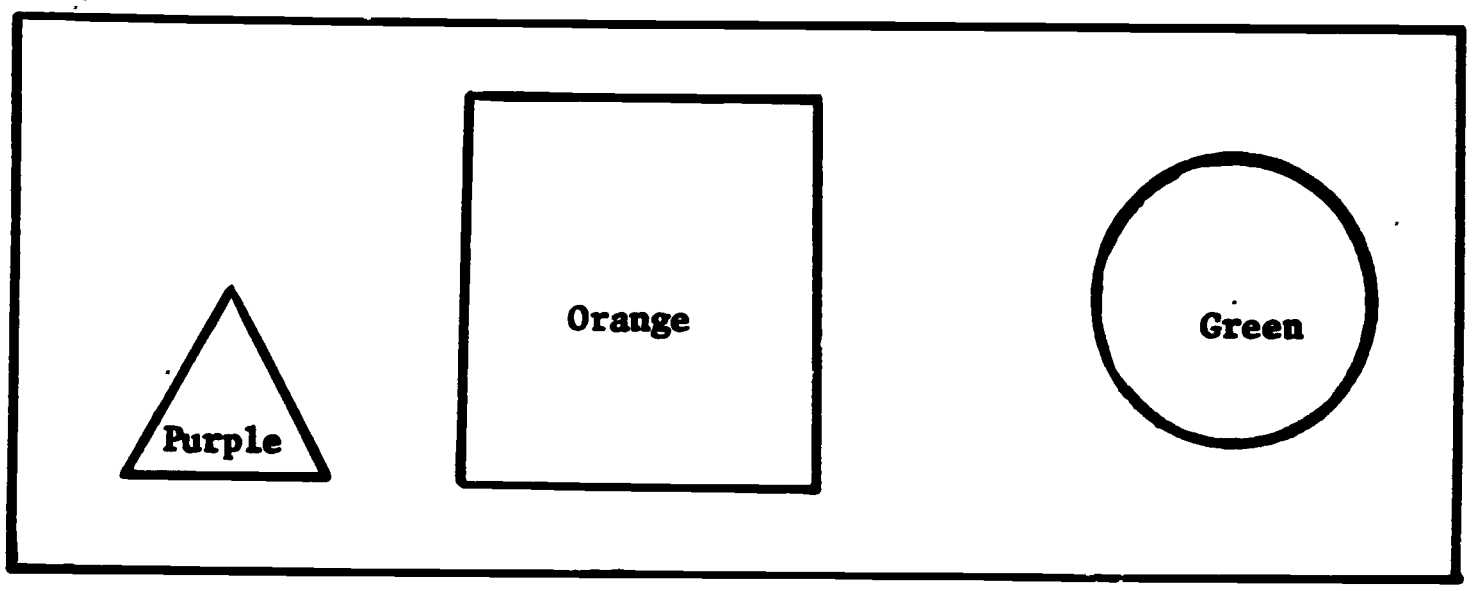
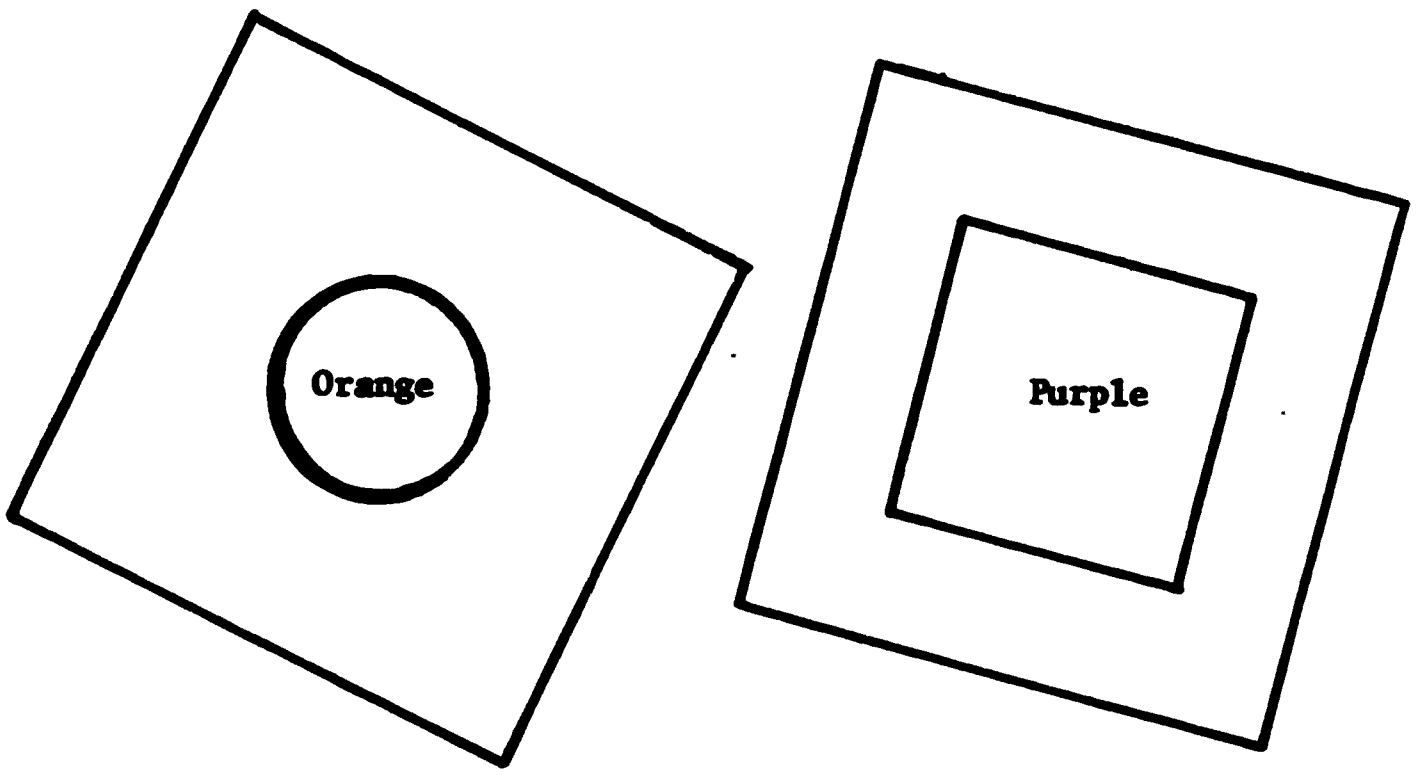


Figure 2. Basic Concept Test sample response and stimulus cards as used in matching, recognition, and identification of color.





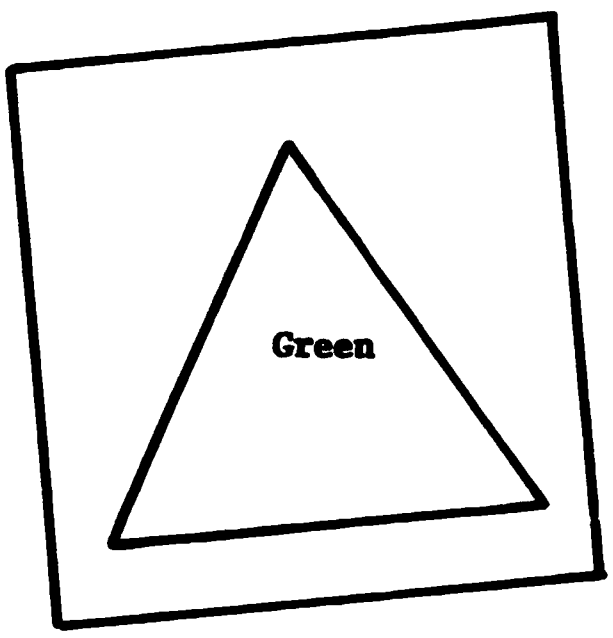


Figure 3. Basic Concept Test sample response and stimulus cards as used in matching of shape, color, and size.

Validity indices were obtainable only in a concurrent fashion. A Pearson product moment correlation between the Ss total raw score and his Binet IQ score gave a positive correlation of .53. The predictive validity of the instrument will be examined as the children enter school and their achievement results become available.

Results

The inequality of numbers of items within the subtests of the Basic Concept Test necessitated changing the raw scores to proportions correct for each subject. An arcsin transformation was performed and the appropriate phi scores used (Walker & Lev, 1953, p. 423). The alpha level for all analysis of variance tests was set at .05.

A Type I mixed design analysis of variance (Lindquist, 1953) was conducted to compare the performance of the four groups on the three subtests. Table 1 gives the results. There were significant differences on the interaction of groups by subtests, and in both main effects. The interaction is diagrammed in Figure 4. Table 2 shows mean subtest scores for each group.

The simple effects of the groups by separate subtests were analyzed with three simple randomized design analyses of variance (Lindquist, 1953). The results are reported in Tables 3, 4, and 5. There were significant differences between the groups on all three subtests. The next step was to conduct Orthogonal Comparisons for each subtest. The two groups having maternal involvement (G 1 and G 2) were compared to the two groups having no maternal involvement (G 3 and G 4), and the two groups in each half of these comparisons were compared to each other.

The performance of Groups 1 and 2 was superior to Groups 3 and 4 on all three subtests. No other significant differences were obtained. The results are reported in Table 6.

Table 1

Analysis of Variance: Performance of Groups on Basic Concept Test

Source	df	MS	F
Between Subjects	79	.75	
Groups (B)	3	9.43	23.00***
Error (b)	76	.41	
Within Subjects	160	.23	
Subtests (A)	2	10.58	149.01***
Subtests by Groups (AxB)	6	.88	12.39***
Error (w)	152	.071	
Total	239	.040	

***p<.001

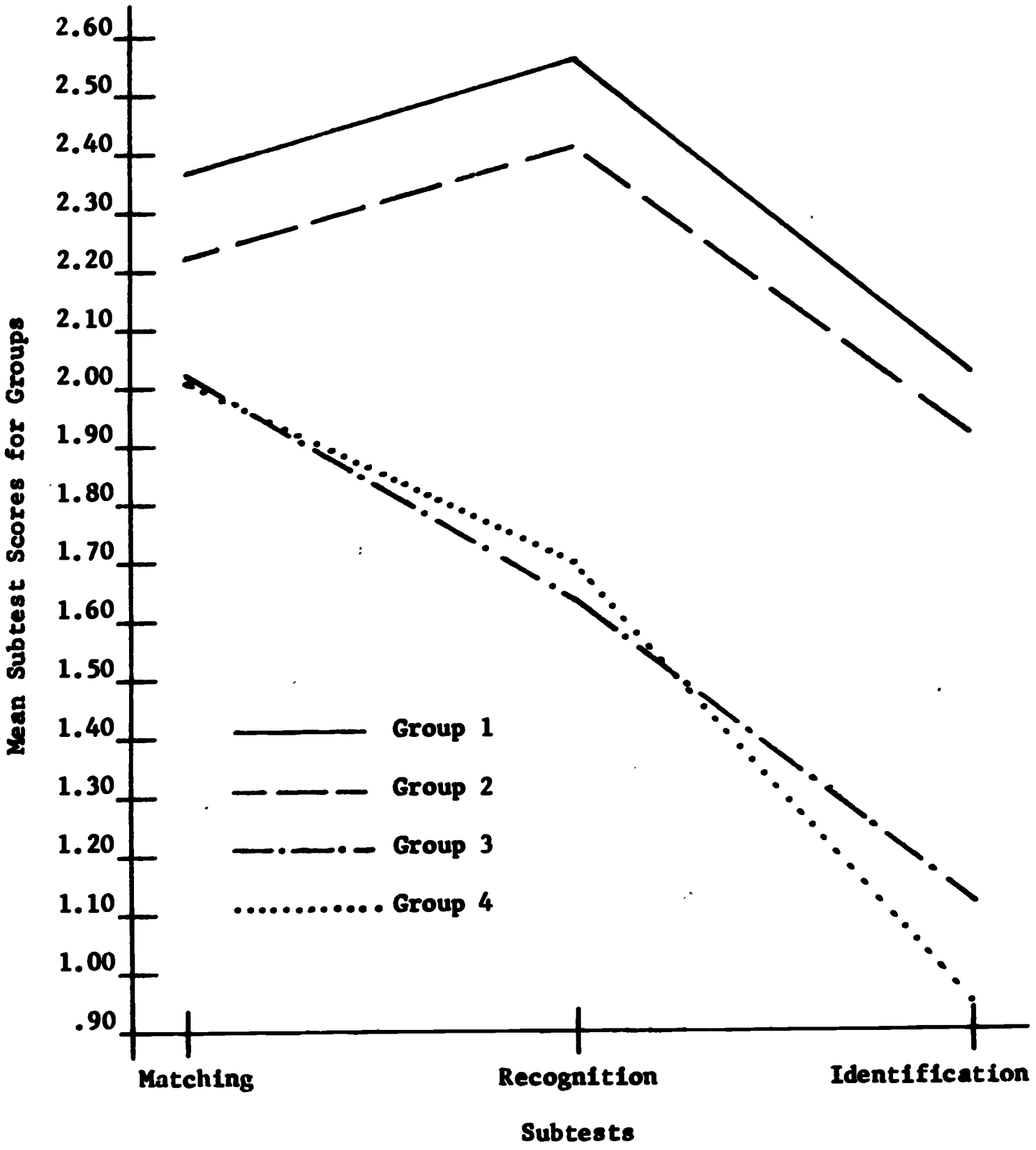


Figure 4. Interaction between subtests and performance of groups.

Table 2

Mean Scores of Groups on Subtests*

Groups	Subtests		
	Matching	Recognition	Identification
G1	2.36	2.55	2.02
G2	2.22	2.41	1.92
G3	2.02	1.64	1.12
G4	2.01	1.70	.95

*phi scores from arc-sin transformation

Table 3

Analysis of Variance: Performance of Groups on Subtest Matching

Source	df	MS	F
Between Groups	3	.58	5.98**
Within Groups	76	.097	
Total	79	.12	

**$p < .01$

Table 4

Analysis of Variance: Performance of Groups on Subtest Recognition

Source	df	MS	F
Between Groups	3	4.40	24.44***
Within Groups	76	.18	
Total	79	.34	

***p<.001

Table 5

Analysis of Variance: Performance of Groups on Subtest Identification

Source	df	MS	F
Between Groups	3	6.22	22.21***
Within Groups	76	.28	
Total	79	.50	

***p<.001

Table 6

Orthogonal Comparisons Summary Table: Basic Concept Test Subtests

Source of variation	df	MS	F
	Subtest Matching		
H_1: $G_1+G_2=G_3+G_4$	1	1.57	16.18***
H_2: $G_1=G_2$	1	.006	< 1.00
H_3: $G_3=G_4$	1	.002	< 1.00
Error (w)	76	.097	
	Subtest Recognition		
H_1: $G_1+G_2=G_3+G_4$	1	12.94	71.88***
H_2: $G_1=G_2$	1	.004	< 1.00
H_3: $G_3=G_4$	1	.05	< 1.00
Error (w)	76	.18	
	Subtest Identification		
H_1: $G_1+G_2=G_3+G_4$	1	18.29	65.32***
H_2: $G_1=G_2$	1	.0001	< 1.00
H_3: $G_3=G_4$	1	.28	1.00
Error (w)	76	.28	

***p<.001

The simple effects of performance on subtests within groups were investigated to inspect the proposed hierarchy of the subtests as related to the type of intervention treatment. A critical difference means comparison (Lindquist, 1953) was conducted and the analysis results are reported in Tables 7, 8, 9, and 10. There were differences within each group supporting the hierarchical nature of the subtests.

Table 7

Critical Differences in Mean Subtest Scores for Group 1

	Subtests	
	Recognition	Identification
Matching	-.19	.34*
Recognition		.53*

*critical difference = .22

Table 8

Critical Differences in Mean Subtest Scores for Group 2

	Subtests	
	Recognition	Identification
Matching	-.19	.30*
Recognition		.49*

*critical difference = .22

Table 9

Critical Differences in Mean Subtest Scores for Group 3

	Subtests	
	Recognition	Identification
Matching	.38*	.90*
Recognition		.52*

*critical difference = .24

Table 10

Critical Differences in Mean Subtest Scores for Group 4

	Subtests	
	Recognition	Identification
Matching	.31*	1.06*
Recognition		.75*

*critical difference = .19

The Stanford-Binet IQ scores of the Ss were compared using a simple randomized design. Table 11 gives the results. The significant difference between groups was analyzed with Orthogonal Comparisons. The results are given in Table 12. The two groups having maternal involvement (G 1 and G 2) were compared to the two groups having no maternal involvement (G 3 and G 4), and the two groups in each half of these comparisons were compared to each other. The performance of Groups 1 and 2 was superior to Groups 3 and 4. No other significant differences were obtained. The mean scores for each group are in Table 13.

Table 11

Analysis of Variance: Binet IQ Scores

Source	df	MS	F
Between Groups	3	747.63	5.66**
Within Groups	76	131.86	
Total	79	155.24	

**p<.01

Table 12

Orthogonal Comparisons Summary Table: Binet IQ Scores

Source of Variation	df	MS	F
H_1: $G_1+G_2=G_3+G_4$	1	1961.18	14.87***
H_2: $G_1=G_2$	1	70.89	<1.00
H_3: $G_3=G_4$	1	210.84	1.60
Error (w)	76	131.86	

***$p<.001$

Table 13

Mean Binet IQ Scores for Groups

Groups	Mean Binet IQ
G1	92.25
G2	94.94
G3	86.35
G4	81.75

Concern over the possible difference in maternal performance on the Wechsler Adult Intelligence Scale prompted a comparison of the four groups' Full Scale IQ scores. A simple randomized design was performed and the results are reported in Table 14. There were no differences between groups.

Table 14

Analysis of Variance: WAIS FSIQ Scores of Mothers

Source	df	MS	F
Between Groups	3	77.56	.51
Within Groups	74	150.87	
Total	77		

Discussion

The purpose of this study was to determine the type of intervention program which would maximize diffusion effects. It was predicted that Groups 1 and 2, the younger siblings which had direct maternal participation in the program, would perform consistently higher on the Basic Concept Test. The mean scores of these two groups were significantly higher on all three subtests. The second prediction involved establishing the hierarchical nature of the subtests as a measure of conceptual development. It was expected that the performance of the four groups would be more alike on the subtest of Matching. This subtest did not require knowledge beyond perceptual discrimination of likenesses and

differences. The inclusion of items which required only gross discrimination was used as a standard against which to measure the properties required in the subtests of Recognition and Identification. It was expected that the ability to respond correctly to appropriate shape, color, size, position, direction, and number properties using recognition and verbal identification would be within the deprived preschool child's repertoire only if he had been exposed to these concepts.

The superior performance of Groups 1 and 2 is offered as evidence of diffusion effects directly associated with the mothers' participation in the program. The performance of Group 3, which had only older sibling involvement, was not different from Group 4 whose families had no intervention treatment. The performance of Groups 1 and 2 was not different on any of the comparisons. From these results, the effectiveness of intervention programs in stimulating the younger children in the home is attributable to the variable of maternal involvement

The Stanford-Binet IQ scores of the groups were analyzed using the same group comparisons as were used in the Basic Concept Test. In the first comparison of the IQ scores, the combination of Group 1 and Group 2 was significantly higher than the combination of Group 3 and Group 4. The comparison of Group 1 to Group 2 did not yield differences, nor was the comparison of Group 3 to Group 4 statistically different. The vertical diffusion effects for Groups 1 and 2 are supported by the performances on the Basic Concept Test and the Stanford-Binet. This differentiation in favor of the performances of Groups 1 and 2 on both instruments is seen as evidence of construct validity in light of the .53 correlation between the two tests.

The analysis of the WAIS FSIQ scores of the four groups of mothers revealed no differences between groups. The scores for the three treatment groups in this analysis were obtained in the beginning of the intervention program. The comparison group mothers were tested at the same time their children were tested, some two years later. The demographic equivalence of the four groups points to the conclusion that the effects of intervention upon the younger siblings were not attributable to differences in the mother's intellectual abilities.

The intent of the DARCEE program to investigate the potential for maximizing the benefits of an intervention program has been realized in this one area. The similarity of the diffusion effects manifested in the two groups of younger siblings is a case in point for the economical concerns of intervention programs. The home visiting teacher is the only paid manpower in one of the groups. This is opposed to a much larger group of personnel necessary for running a preschool. Perhaps the factor contributing most to the economy of mother involvement in both Group 1 and Group 2 is the potential for the still younger children in the family to benefit from the same type of educational stimulation. Only longitudinal examination will reveal this.

The results of this study are generalizable to other low-income families living in a similar setting. The characteristics of these families include housing of at least minimal standards, and the cases of extreme deprivation were in the minority. The ceiling amount of income that a family is allowed to earn and still maintain residency in the housing project varies according to the number of children in the

family. However, the limit for a family with two children is approximately 3,000 dollars a year. The increments permitted for additional children are very small. This figure is by no means an average income. Many of the families in this study are father-absent, and some rely on public assistance for support.

There are two major implications for further research in this area. Programs of an intervention nature concerned with the disadvantaged preschool child should investigate the relationship between parental involvement and achievement level of the child. These same effects should be examined in other children within the family. The potential for increase in parental concern with achievement motivation could be a realistic approach to amelioration of the progressive academic failure typically exhibited within the disadvantaged subculture.

Individual programs should attempt to provide adequate instrumentation designed to assess the specifics of their program content. This would aid in defining the appropriateness of the instructional material used. Individual and group skill weaknesses could be determined and remediated. The same type of instrumentation would allow program results to be investigated for follow-on purposes. The use of comparison groups would indicate the presence and type of differences that the intervention had effected in the treatment groups. This type of measurement would enable more effective preschool program planning and implementation.

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