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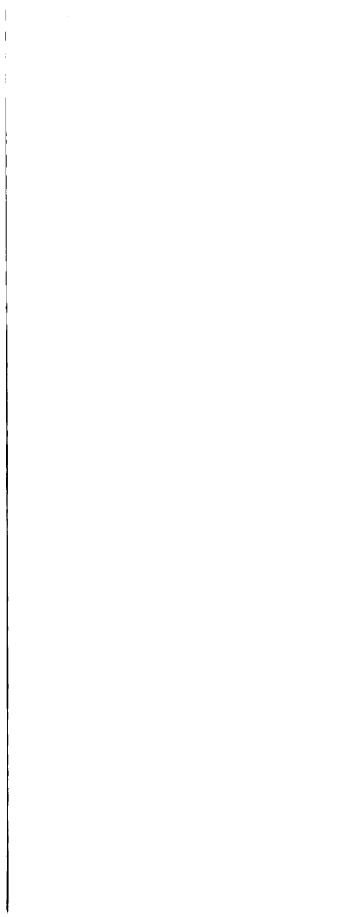
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ABSTRACT

THE RELATION BETWEEN STIMULUS DIMENSIONALITY AND COLOR-FORM MATCHING BEHAVIOR IN PRE-SCHOOL CHILDREN

By

Sandra M. Jørgensen

Thirty pre-school children, separated into two groups of 15, older group (4-8 to 5-5) and younger group (3-5 to 4-7), were each given 48 trials on a color-form matching task. Four kinds of stimulus forms were used: two-dimensional geometric, two-dimensional irregular, three-dimensional geometric and three-dimensional irregular. Each child received 12 trials under each of the four stimulus conditions. The stimuli were constructed in four colors (red, yellow, blue, green), four geometric shapes (circle, square, triangle, rectangle) and four irregular shapes.

Contrary to Brian and Goodenough's (1929) research indicating that younger children make more color matches and older children make more form matches, the older group made significantly more color matches than the younger group. This may be indicative of a later peaking period for the color response tendency in this sample, possibly attributable to cultural influences.

Among the four form conditions the only significant difference between number of color and form matches was on two-dimensional geometric stimuli. This finding was congruent

with the results of previous investigations which used only two-dimensional geometric stimuli.

There was no significant difference between color or form responses to irregular stimuli. This is consistent with Clapp and Eichorn's finding (1965) that the effect of redundancy of figure is negligible.

Brian and Goodenough's finding that children consistently matched three-dimensional forms more frequently on the basis of color than they matched two-dimensional on the basis of color was not replicated.

Kagan and Lemkin (1961) speculated that girls do more implicit verbal labelling than boys, and this labelling affects their matching behavior. In the present study there were no significant differences between boys and girls in mean numbers of verbal tags stated for stimuli. None of the differences observed in presence of verbal tags was reflected by a corresponding difference in number of color-form matches.

Girls did not show any observable differences in matching behavior with respect to the four form conditions; however, boys showed a significantly greater number of form than color responses for the two-dimensional and three-dimensional irregular and three-dimensional geometric conditions.

Analysis of variance did not reveal sex-age group or stimulus condition as accounting for variation in color and form matching behavior. It appears that color dominance is a complex mode of responding which is characteristic of pre-school children (3-6 to 5-5). Although there are differences

in responding, they cannot be categorized by any age group, sex, stimulus condition difference, or the ability to state labels verbally.

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AND COLOR-FORM MATCHING BEHAVIOR
IN PRE-SCHOOL CHILDREN

By

Sandra M. Jørgensen

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CHAPTER I

INTRODUCTION AND RELATED LITERATURE

The categorization of objects according to their attributes is a task which our society requires children to master before embarking on formal conceptual processes of reading and writing. A pre-school child is required to demonstrate knowledge of colors and shapes, i.e. forms (Suchman, 1966). This knowledge of attributes of objects can be termed "concepts" if a child can use them "to produce behavior meeting an accepted criterion" (Heidbreder, 1946). The ontogeny of color and form concepts in pre-school children has not been adequately documented. There were only two studies before 1930 (Descoudres, 1914; Brian and Goodenough, 1929); however, there has been a renewed interest in the area after 1960.

Review of the Literature

In 1929 Brian and Goodenough conducted a study in which subjects matched stimulus objects either on the attribute of color or of form. The method used was adapted from Descoudres (1914). The subject was shown a group of three objects so selected that if any two objects were similar in form, they were dissimilar in color, and if they were similar in color they were dissimilar in form. The subjects were asked to

match one of the two comparison stimuli with the stimulus object.

Brian and Goodenough used three different groups of subjects: pre-school children ranging in age from 14 months to 5 years and 11 months, elementary school children ranging in age from 6 to 14 years, and adult women. Three sets of stimuli were used. The two sets used with pre-school children were: a three-dimensional set consisting of spheres, cubes, and cylinders; and a two-dimensional set, consisting of circles, squares, triangles, diamonds, stars, and oblongs with rounded ends. The forms in both sets were colored red, orange, yellow, blue, green, or purple. The third set of materials used with elementary school children and adults differed from the two-dimensional stimuli only in that the forms were pasted on sheets of white paper, thus permitting group testing.

Brian and Goodenough found that children under three years of age tended to use form as a basis for matching. From three to six years color was more often used, and after six years through the adult years form was more often used. Brian and Goodenough also found a consistently greater number of color matches to solid, or three-dimensional, stimuli than to surface, or two-dimensional, stimuli. No sex differences were reported.

Corah (1964) presented pre-school children and elementary school children with stimuli to be matched by either color or form choices. Corah's stimuli were all two-

dimensional and differed from those used by Brian and Goodenough. There were three types of figures. One set consisted of asymmetric colored geometric forms. The color match was a figure of the same color but of a different shape, and the form match was a black outline of the stimulus figure. The second group consisted of a red outline of a simple form (e.g., circle, rectangle) with complex line detail inside the figure. The color match was a red outline of the simple figure with only a suggestion of interior detail, and the form choice was a black outline replica of the stimulus. The third set consisted of red outline asymmetrical forms. The color choice was the same figure reversed left to right, and the form choice was a black outline replica of the stimulus. Although Corah's stimuli contained more complex variations in color and form than Brian and Goodenough's, his results were similar. His nursery school subjects matched more frequently on the basis of color than form, while his older subjects matched more frequently on the basis of form than on color.

Chen and Wong (1965) investigated color-form perception in a preference study with a sample of two groups of subjects, pre-school children and university students. The subjects were asked to rank colors and forms in order of preference. The two age groups did not differ on either color or form performance. However, pre-school children were more consistent in their preferences for colors than the university students. The order of preference for both age groups was

red, blue, green and yellow. The preferences of pre-school children for forms were less consistent than those of the university students. The circle was most frequently preferred to all other forms by both age groups. Next most frequently preferred by the children was the square and by the university students the rectangle. Chen and Wong observed that children seemed to form more concrete verbal images with form stimuli than with color stimuli. The university students, however, appeared to form distinctive verbal associations for colors.

Clapp and Eichorn (1965), using 24 pre-school children and tachistoscopic presentation of stimuli, studied perceptual investigatory responses in children.¹ Three different sets of stimuli were used: incongruous pictures, redundant pictures-geometric figures, and redundant pictures-meaningful objects (Berlyne, 1957). The set of redundant pictures-geometric figures consisted of figures and lines in a decreasing order of redundancy, according to Berlyne's definition (1957) that: "Redundancy varies directly with orderly arrangement, with symmetry, and with similarity between parts of a figure, and inversely with changes in contour." The set of stimuli which contained redundant pictures of meaningful objects consisted of three modifications of five basic stimuli. Type I objects were in color, Type II objects were the

¹"Tachistoscopic presentation"--presentation of stimulus objects on a screen by a tachistoscope which allows the experimenter to control the time of exposure precisely.

same as Type I only in black and white, and Type III were black and white stick drawings of the same objects. Thus in Type I similarity between parts of the figure was reduced by the use of color, and in Type III redundancy was decreased by eliminating all curvature.

The subject could look at the stimulus if he produced a one word verbalization; i.e., a verbalization by the subject would produce a .14 second exposure of one of the above stimuli. The measure taken was frequency of one-word verbalizations. Clapp and Eichorn found that the redundancy attribute had no significant influence on responsiveness. However, color and incongruity in the pictures affected responsiveness in a negative way (i.e., produced fewer requests for exposure of the pictures) in contrast to the positive effects obtained by Berlyne (1957) and Minton (1963) with adults.

Coran (1966a), using pre-school children and children seven to nine years old, investigated the influence of varying some stimulus characteristics on color-form matching behavior. The task was similar to the task which Brian and Goodenough had used with pre-school children. There were seven sets of stimuli. The first set used three simple forms--square, circle, and equilateral triangle--and three saturated colors--red, blue, and green. The second set of stimuli was identical to the first set, except that the comparison figure of the same color as the standard was not a different figure but one similar to it. The same-color comparison choice for the square was a rectangle, an ellipse for the circle, and an

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isosceles triangle for the equilateral triangle. The third set consisted of asymmetric forms with five to seven sides. The comparison figure the same color as the standard retained the same 1 configuration as the standard, but was readily distinguishable from the standard in shape. All other characteristics of this set were the same as the first two sets. To test for the effects of the amount of surface color in the figures, each of the three basic sets of stimuli was designed as two subsets. In one, the figures were all solidly colored forms, while the other subset consisted of forms which were only outlined in color. Thus, there were six sets of stimulus figures with 18 plates in each set. Since it might be argued that set three figures, the asymmetric ones, were so difficult that only a color choice was open to the subject, a seventh set of figures was designed. This set was identical to the third set in outline color, except that both comparison figures on any given plate were the same color as the standard. Thus, there was only one correct response to each of these plates: the subject was forced to make a form discrimination.

Corah found that amount of color present (outline vs. saturation) and complexity of the figure were related to frequency of color choices by pre-school subjects. Significantly more color responses were obtained from the pre-school subjects than from the older subjects under all stimulus conditions. However, five of the six pre-school subjects were form dominant (i.e., more form than color responses). Only

those subjects who were given set three with saturated color were color dominant in their responses.

In a further exploration of color attributes in a color-form matching task, Corah and Gross (1967) used kindergarten children randomly assigned to eight groups. For seven of the groups, the form alternative differed from the standard and color alternative in hue, brightness, and saturation, or some combination of these color characteristics. The eighth group was a control group in which only a form match was correct. Difference in brightness produced the greatest frequency of color matching, while differences in hue had no significant effect on color matching. Corah and Gross suggested that contrast effects may be an important factor in focusing a child's attention on color to the exclusion of form.

Kagan and Lemkin (1961) investigated the effects of form, color, and size variations in a matching task with 79 children who ranged in age from three years-nine months to eight years-six months. The stimuli consisted of nine different plates on which were mounted two-dimensional geometric figures, differing in color, shape and size. The first three plates had two comparison forms at the top of the paper and a standard stimulus at the bottom. Stimuli four through nine had three comparison forms at the top and one standard at the bottom. For each standard stimulus only two of the three characteristics, color, form, or size could be matched. Kagan and Lemkin found that for both boys and girls form was

distinctly preferred to color as a basis for matching, and that color was preferred over size as a basis for matching behavior. Older girls were less likely than younger girls to use color as a basis for matching. Both older and younger boys preferred form over color and color over size as a basis for matching; however, older boys were more likely to use color than were older girls. Kagan and Lemkin, in a post hoc speculation, said that sex differences could be a function of the precocious verbal skills of girls. The girls may have implicitly labelled the form stimuli as square, triangle, or circle, which presumably would facilitate the use of form characteristics as a basis for matching.

Corah (1966b), in an attempt to clarify a criticism of the Kagan and Lemkin (1961) study, investigated the effects of instructional set on performance on a color-form matching task. Whereas Kagan and Lemkin had used instructions which stressed the form characteristics of the stimuli, Corah used three types of instruction: instructions which stressed color, instructions which stressed form, and neutral instructions which stressed neither color nor form. Performance set was varied by presenting pre-test tasks which emphasized color, form, or neither characteristic. The subjects were kindergarten children. Corah found that instructional-sets had no effect on color-form matching, the performance-color-set induced a high level of color matching, while the performance-form-set induced a weak tendency toward form matching. The control groups favored form over color.

Although the subjects responded primarily to form, the ease with which color matching was reinforced implies that the tendency to respond to color is strong.

Questions for Research

Corah did not demonstrate that the results of Kagan and Lemkin were invalid because of a prejudice in the instructions. Rather his work reiterates an important factor in experimentation with perception and concept formation processes: an assumption must always be made that concepts (whether they are concepts of color, form, or size) are really the subject matter being investigated in psychological research. Heidbreder (1946) defined concepts as "the means by which certain psychological activities are investigated." A subject is said to use a concept whenever, during the course of an experiment, he produces behavior meeting accepted criteria. Thus in all of the cited research on color-form matching, from the observed responses it is inferred that the subject is using concepts of color, form, or size. In fact the subject may be reacting according to some totally different index from the index imposed by the experimenter.

Although in many of the studies reviewed a greater frequency of color matches was found in pre-school children than in older children, there has not been an investigation of the differences among specific age levels within the pre-school age group.

If there is a clear shift from form dominance to color dominance and then back to form dominance as described by

Brian and Goodenough (1929), at what age levels do the shifts occur? Suchman (1966) raises the question, what conditions would cause a child to react by matching on the basis of one stimulus attribute (color or form) if his basal response level showed predominant use of another stimulus attribute (color or form)?

Why have so few of the researchers used three-dimensional stimuli? Would the redundancy attribute of Clapp and Eichorn (1965) have an effect on performance on a matching task? Most of the experimenters have used different groups of children for each modification in stimulus presentation. What would be the effect of using the same subjects in several experimental conditions?

Finally, would it be possible to verify the speculation of Kagan and Lemkin (1961) that implicit verbal labelling of stimulus objects facilitated form matching by asking subjects for verbal tags for the forms and colors used?

Objectives and Hypotheses

To partially answer these questions, the present study was undertaken. It had as its objectives:

1. To observe the performance of pre-school children on a color-form matching task.
2. To determine the relative frequency of color vs. form matching at a specific age level.
3. To observe the effects of variation in the form attributes of dimensionality and regularity of figures on the frequency of color and form choices.

4. To observe the presence or absence of verbal tags for the stimuli presented and the effect of verbal tags on matching behavior.

The following assumptions were made:

1. Pre-school children are capable of performing a matching task with both two- and three-dimensional stimuli.
2. Children who show positional methods of responding are not performing the matching task.
3. Children who are performing the task are matching on the basis of color when they are not matching on the basis of form and are matching on the basis of form when they are not matching on the basis of color; i.e., every response can be classified as either a color match or a form match.

On the basis of research discussed above, the following hypotheses were formulated:

1. There is a difference in the matching behavior of younger (3-5 to 4-7) pre-school children and older (4-8 to 5-5) pre-school children when presented with color-form choice.
2. Irregularity of forms is related to matching behavior. There is a difference in using color attributes with respect to the regularity-irregularity form dimension.
3. Dimensionality affects color matches.

Three-dimensional figures would more often be matched on the basis of color than will two-dimensional figures. (Brian and Goodenough, 1929).

4. Form matches are affected by the geometric and irregular conditions.

Under the geometric condition there should be differences between the performance of boys and girls. (Sigel, 1954; Kagan and Lemkin, 1961).

5. Presence of verbal labels affects form matching.
6. Boys and girls exhibit differences in verbal tags for forms and colors. (Chen and Wong, 1965).
7. Order of presentation of stimuli (two-dimensional then three-dimensional or three-dimensional then two-dimensional) does not affect matching behavior.
8. There is an interaction between sex-age group and stimulus in determining number of color and form matches.

CHAPTER II

METHOD

The methods used in the study will be discussed under the following headings: Operational Definitions, Apparatus, Subjects, and Procedure.

Operational Definitions

1. Irregularity of figure is defined as having many unequal straight sides or many unequal curvilinear segments.
2. A positional method of responding is defined as a response to the same stimulus position six times in succession.

Apparatus

The apparatus consisted of two sets of stimuli, one two-dimensional and the other three-dimensional. The two-dimensional stimuli were a set of 24 8 1/2 by 11 inch white cards on which cut-out colored figures were mounted. The first 12 cards had groups of three regular geometric figures; the remaining 12 had groups of irregular forms. On each card the figures were arranged in an equilateral triangle with the base closest to the subject (Doerhing, 1960). The geometric forms used were circle, square, rectangle, and equilateral triangle. All figures had an area of four square inches.

The four irregular forms were constructed by cutting either a circle (for the curvilinear figures) or a square (for the straight-sided figures) which had an area of four square inches and recombining the pieces. The procedure yielded two straight-sided forms and two curvilinear forms. The stimuli were produced in four colors--red, yellow, blue, and green.

The three-dimensional stimuli consisted of 12 geometric figures--sphere, cube, rectangular solid, and equilateral prism. These figures were constructed of posterboard with the exception of the spheres, for which rubber balls were used. The three-dimensional irregular figures were so constructed that they would be three-dimensional analogues of the two-dimensional irregular figures, in the sense that the frontal plane of the three-dimensional figure was the same as its two-dimensional correlate. Each irregular three-dimensional figure was constructed from eight cubic inches of clay. Rubber molds were constructed from the clay models and the figures were cast in plaster. All three-dimensional figures were sprayed with a fixative and painted in the four selected colors. The three-dimensional stimuli were mounted on white cardboard (8 1/2 by 11 inches), supported by press-board. The colors used were nearly identical in hue to those used for the two-dimensional figures.

Subjects

The subjects were 30 pre-school children in two groups of 15 each. The older group ranged in age from 4 years

8 months to 5 years 5 months and had a mean age of 5 years 2 months. The older children (8 boys, 7 girls) were enrolled in the summer session of the Michigan State University Laboratory Pre-School. The younger children (7 boys, 8 girls) ranged in age from 3 years 5 months to 4 years 7 months ($\bar{x}=4-2$). These children had attended Laboratory Pre-School during the previous academic year. The older subjects were selected because of their availability for research and pre-kindergarten age range. The younger subjects were selected because of their similarity in general background to the older group and because they represented young children within the pre-school age range.

Procedure

Each child was given 48 successive trials on which he was required to point to the one on the comparison figures which "goes with" or "belongs with" the stimulus figure at the top of the card (Corah, 1966b). The responses were recorded by the experimenter as the subject made them. At the conclusion of each section, two-dimensional and three-dimensional, each subject was asked to name the colors and forms in the set as the experimenter pointed to them. The children's statements about either colors or forms were recorded. In the presentation order, form, color, and position of the comparison stimulus were randomized for the first 12 presentations. The order for the second set of 12 trials was generated from the order of the first 12 trials by

reversing the 1 to 12 sequence. Thus the order of the first 24 trials was 1 to 12, 12 to 1. The order for the first 24 trials was repeated unchanged for the second 24 trials (see Appendix, Figures 2 and 3). Half of each age group received the three-dimensional stimuli first; the other half was given the two-dimensional stimuli first.

CHAPTER III

RESULTS

In order to clarify results this section has been subdivided into eight sections. Each of the following sections refers to the corresponding numbered hypothesis stated on pages 11 and 12.

1. A z-score for difference between uncorrelated proportions was obtained. The proportions were: color matches/total number of matches made by the younger group and color matches/total number of matches made by the older group. The z-score was not significant at the .05 level ($z = -1.08$; Table 1).

2. In the irregular form condition (two-dimensional and three-dimensional stimuli combined) the difference between the proportion of color matches/total matches and the proportion of form matches/total matches was not significant at the .05 level ($z = .96$; Table 2).

3. The difference between proportion of two-dimensional color matches/total number of two-dimensional matches and proportion of three-dimensional color matches/total number of three-dimensional matches was not significant at the .05 level ($z = -.054$; Table 3).

4. Chi square tests were performed to determine the differences in the number of form matches in the geometric and irregular conditions (two-dimensional and three-dimensional) by boys and girls. Significant difference was found between girls and boys on two-dimensional irregular ($\chi^2=10.10$, $p=.01$, $df=1$); three-dimensional geometric ($\chi^2=7.48$, $p=.01$, $df=1$); three-dimensional irregular ($\chi^2=5.64$, $p=.05$, $df=1$; Table 4).

5. Chi square tests were performed to estimate differences between number of color and number of form matches in each of the four form conditions (two-dimensional geometric, two-dimensional irregular, three-dimensional geometric, three-dimensional irregular). The results are summarized in Table 5. Only the difference between two-dimensional geometric color matches and two-dimensional geometric form matches was significant ($\chi^2=16.8$, $p<.01$, $df=1$; Table 5).

T tests were performed on the mean numbers of verbal tags elicited from girls and boys under each of the four stimulus conditions: two-dimensional geometric, two-dimensional irregular, three-dimensional geometric, three-dimensional irregular. The t's are shown on Table 6. None of the t's were significant under the two-dimensional conditions. Under the three-dimensional conditions the only significant differences were between mean number of three-dimensional color tags and mean number of three-dimensional form tags ($t=3.44$, $p=.01$, $df=29$) and the difference between

mean number of verbal tags for three-dimensional form geometric and three-dimensional form irregular ($t=3.19$, $p=.01$, $df=29$; Table 6).

6. T tests were performed to compare mean number of verbal tags elicited for colors and geometric and irregular forms in both two-dimensional and three-dimensional conditions. None of the t 's were significant at the .05 level (Table 7).

7. The effect of order of presentation of stimuli (two-dimensional then three-dimensional or three-dimensional then two-dimensional) on matching behavior was examined by computing a chi square for the total number of color matches and form matches made by each group (i.e., those who received the two-dimensional then the three-dimensional, and those who received the three-dimensional then the two-dimensional). The results are shown in Table 8 ($\chi^2=1.17$, $p>.05$, $df=1$).

8. An analysis of variance was done to test for the age-sex group and stimulus interaction effect on number of color-form matches. No significant F ratios were found. See Table 9.

Table 1.--Frequency of color and form matches distributed
by age.

	Older Group	Younger Group	Total	z
Color Matches	440	339	799	
Total Matches	720	717 ^a	1437	1.08

^aTotal for younger group reflects no response on three trials for one subject.

Table 2.--Frequency of irregular color and form matches
distributed by dimensional condition.

	Two-Dimensional Stimuli	Three-Dimensional Stimuli	Total	z
Color Matches	197	186	383	
Form Matches	161	174	335	
Total			718	.96

Table 3.--Frequency of color matches distributed by
dimensional conditions.

	Two-Dimensional	Three-Dimensional	z
Color Matches	414	365	
Total	717	720	-.054

Table 4.--Frequency of color and form matches in each condition distributed by sex of subjects.

Condition	Matches by Boys	Matches by Girls	Chi Square
Two Dimensional:			
Geometric,			
Color	100	118	
Form	80	62	1.62
Irregular			
Color	83	114	
Form	95	66	10.10 ^a
Three Dimensional:			
Geometric			
Color	71	108	
Form	109	72	7.48 ^a
Irregular			
Color	77	109	
Form	103	71	5.64 ^b

^a.01 level.

^b.05 level.

Degrees of freedom in all above tests equaled one.

Table 5.--Frequency of color and form matches compared with respect to color and form conditions.

Two-Dimensional Forms		Total Matches	Chi Square
Color Matches- Geometric	Form Matches- Geometric		
219	141	360	16.8 ^a
Color Matches- Irregular	Form Matches- Irregular		
195	162	357	3.43
Form Matches- Geometric	Form Matches- Irregular		
141	162	303	1.45

Three-Dimensional Forms		Total Matches	Chi Square
Color Matches- Geometric	Form Matches- Geometric		
179	181	360	0.01
Color Matches- Irregular	Form Matches- Irregular		
185	175	360	0.43
Form Matches- Geometric	Form Matches- Irregular		
181	174	355	0.14

^aSignificant at .01 level.

Degrees of freedom in all above tests equals one.

Table 6.--Differences between mean numbers of verbal tags elicited from subjects under each form condition.

Two-Dimensional Mean Number of Tags		Standard Error of the Difference	Mean Difference	t^a
Color	Form Geometric			
3.30	3.17	.16	.13	.81
Color	Form Irregular			
3.30	2.77	.63	.53	.84
Form Geometric	Form Irregular			
3.17	2.77	.18	.40	2.22

Three-Dimensional Mean Number of Tags		Standard Error of the Difference	Mean Difference	t^a
Color	Form Geometric			
3.27	3.13	.24	.13	.54
Color	Form Irregular			
3.27	2.43	.27	.83	3.44 ^b
Form Geometric	Form Irregular			
3.13	2.43	.22	.70	3.19 ^b

^aDegrees of freedom in each of the above tests equaled 29.

^bSignificant at the .01 level.

Table 7.--Mean number of verbal tags elicited in each condition distributed by sex of subjects.

Condition	Boys	Girls	t ^a
Two-Dimensional Color Tags	2.93	3.33	0.79
Geometric Form Tags	3.00	3.33	0.70
Irregular Form Tags	3.13	2.67	0.84
Three-Dimensional Color Tags	2.87	3.67	1.68
Geometric Form Tags	3.40	2.87	1.77
Irregular Form Tags	2.60	2.40	0.36

^aDegrees of freedom in all above tests equaled 29.

Table 8.--Number of color and form matches distributed by order of presentation of stimuli.

Order	Color Matches	Form Matches	Total	Chi Square
Two-dimensional to Three-dimensional	412	356	769	
Three-dimensional to Two-dimensional	391	278	669	
Total	803	634	1437	1.17 ^a

^aDegrees of freedom equaled 1.

Table 9.--Analysis of variance for color matches.^a

Source of Variation	Degrees of Freedom	Mean Square	F
Sex-Age	3	108.18	4.70 ^b
Stimulus	3	5.07	.22 ^b
Interaction	9	.45	.02 ^b
Within	104	23.02	
Total	119		

^aSee Table 11, page 52 for raw data.

^b($p > .05$).

CHAPTER IV

DISCUSSION

The discussion has been subdivided into individual treatments of the eight hypotheses stated on pages 11 and 12. Each is restated in each sub-section.

Hypothesis 1.--There is a difference in the matching behavior of older and younger pre-school children when presented with a color-form choice.

Although the subjects in the present study were all of pre-school age (ranging from three years and six months to five years and five months), it was expected that there would be differences in performance between the younger group (ranging from three years and six months to four years and seven months) and the older group (ranging from four years and eight months to five years and five months). Since four years six months represents the peak of the color response (Brian and Goodenough, 1929), it would be expected that the younger children in this sample would show more color responses and that the older children would show more form responses. However, the results were in the opposite direction. The older group made significantly more color responses than the younger group, indicating that the color response tendency is stronger above four years six months

for this sample than below four years six months. The samples are different in age range. Brian and Goodenough's subjects ranged from 14 months to 5 years 11 months, where those in the present study ranged from three years six months to five years five months. Serious question arises concerning the capability of a 14-month-old child choosing a color or form. It seems strange that children in 1929 at age four years six months would have already shifted to adult form dominance, whereas children of the same age in 1967 had not yet made this shift from color dominant to form dominant.

After examining the results of the present study it appears that children at age four years six months, in the process of learning colors and names for colors, seem to have at this time more interest in colors than shapes. The children in the present study had attended or were attending a nursery school, an environment in which colors are more emphasized than forms. That is, a teacher of a three- and four-year-old group would expect children to "learn" colors, probably, before forms (shapes) which are usually emphasized with five-year-olds (kindergarten).

Hypothesis 2.--Irregularity of forms is related to matching behavior. There is a difference in using color attributes with respect to the regularity-irregularity form dimension.

It was expected that the form attribute of irregularity would be unfamiliar and, therefore, difficult to use in matching behavior. If the form attribute could not be readily used, the subject would be forced to use the only other

attribute present, color, resulting in a greater number of color matches on those trials involving irregular forms. However, there was no significant difference between the number of color and the number of form matches on the irregular stimuli. About equal proportions of each were elicited (Table 2 summarizes the response to irregular stimuli). This finding is consistent with Clapp and Eichorn's (1965) finding that the effect of redundancy, or relative uncertainty, of figure on the responsiveness of pre-school children was negligible.

Apparently many of the children did use the irregular form dimension as a basis for matching since there was no time limit on the child's response; many children examined the irregular forms before making either a color or form choice. Since there were only four irregular stimuli it is possible that the forms became very familiar in the course of 48 trials and could be used as readily as geometric shapes in matching.

Hypothesis 3.--Dimensionality affects color matches.

Three-dimensional figures would more often be matched on the basis of color than will two-dimensional figures. (Brian and Goodenough, 1929).

From Brian and Goodenough's finding that children consistently matched three-dimensional forms more frequently on the basis of color than with two-dimensional forms, it was expected that the three-dimensional stimuli used in the current study would elicit more color responses than the two-dimensional stimuli. However, no significant difference was

found between the number of color responses to two-dimensional and to three-dimensional stimuli (See Table 3). Brian and Goodenough did not perform any statistical test, but grouped their data by half-year intervals in the form of calculated percentages. Similar treatment of the data from this study is shown by Figure 2. It can be observed that the curves from the data of the present study seem to resemble the curves of the Brian and Goodenough data in general shape. However, the differences as assessed by the z test between the number of color responses to two-dimensional and number of color responses to three-dimensional stimuli were not significant. Therefore, although there may be an observable difference when the data are plotted, the difference was not statistically supported.

Hypothesis 4.--Form matches are affected by the geometric and irregular conditions.

Under the geometric condition there should be differences between the performance of boys and girls. (Sigel, 1954; Kagan and Lemkin, 1961).

The sample was divided into the two groups of 15 boys and 15 girls. When the number of color and form matches in each category were compared, several differences between girls and boys were evident. The results of chi-square tests between boys and girls on all four stimulus conditions are summarized in Table 4.

Under the two-dimensional geometric condition both boys and girls showed more color than form responses, and the differences between boys and girls in number of color matches

Figure 1.--Percentage of form responses distributed by age of subjects (grouped data).

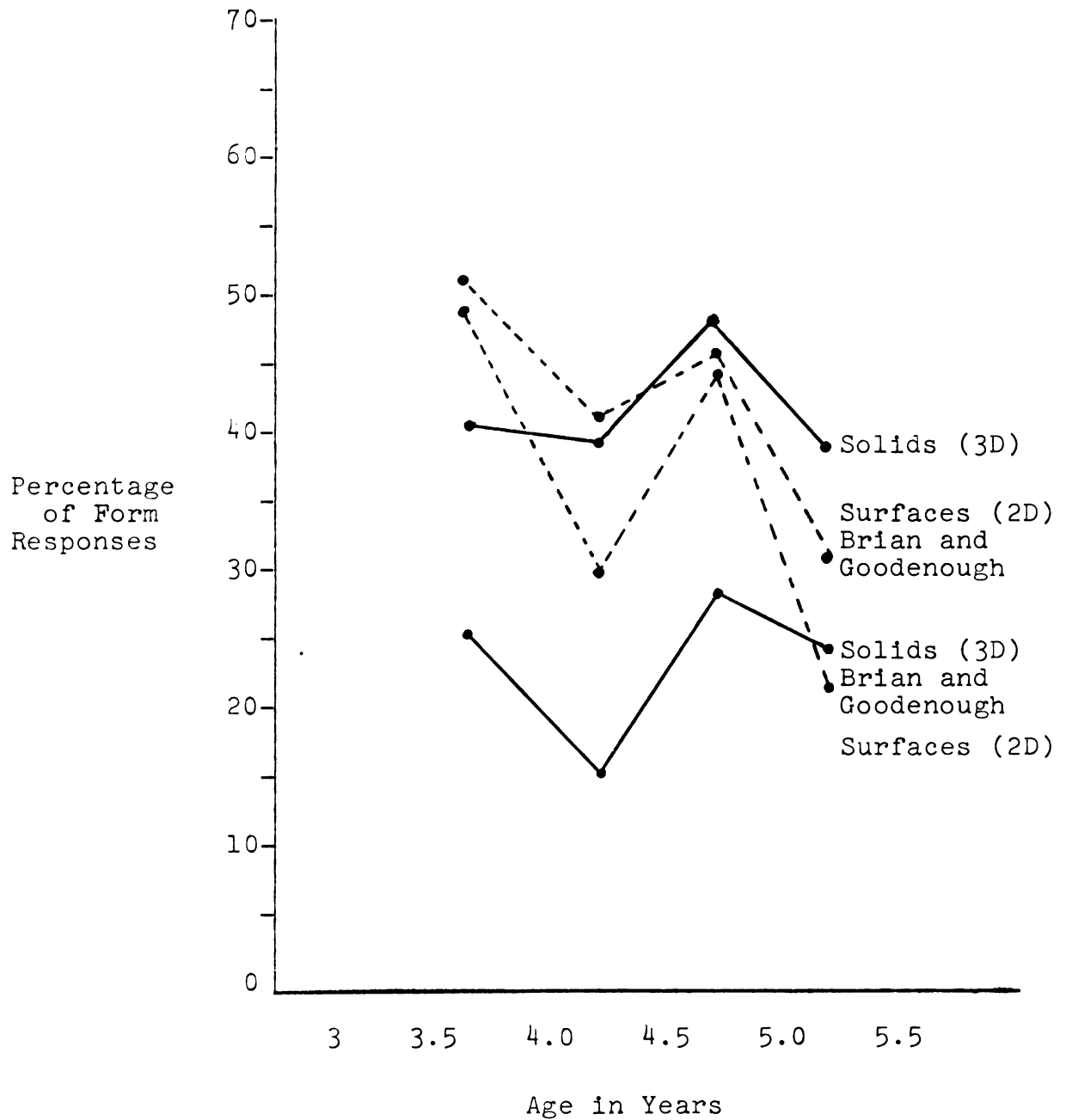


Table 10.--Percentages of form and color matches distributed by age of subjects.

	<u>Age Groups</u>			
	3-6 to 3-11	4-0 to 4-5	4-6 to 4-11	5-0 to 5-11
<u>Data from</u> <u>Present Study</u>				
Two-Dimensional Condition				
Form	.47	.30	.46	.20
Color	.53	.70	.54	.80
Three-Dimensional Condition				
Form	.42	.39	.48	.42
Color	.58	.61	.52	.58
- - - - -				
<u>Brian and</u> <u>Goodenough Data</u>				
Two-Dimensional Condition				
Form	.34	.25	.36	.29
Color	.66	.75	.64	.71
Three-Dimensional Condition				
Form	.24	.17	.29	.22
Color	.76	.83	.71	.78

and number of form matches was not significant. However, on all of the other three conditions--two-dimensional irregular, three-dimensional geometric, and three-dimensional irregular--girls made a significantly larger proportion of color responses than the boys (Table 4). It also should be noted that the ratio of color to form responses holds through all four conditions for the girls. However, the boys showed more color than form responses on the two-dimensional geometric stimuli only, and for all other conditions showed a ratio of more form than color responses.

As the color attributes were constant over all four stimulus conditions, the form attributes of dimensionality and regularity-irregularity were the only attributes of the stimuli which were varied. Previous research has generally used only two-dimensional geometric stimuli. There has been, with the exception of the Kagan and Lemkin study (1961), a predominance of color over form matches. The findings of the present study with respect to the two-dimensional geometric stimulus condition are consistent with those of the previous studies. However, in the conditions in which there was a modification of the form attributes of either dimensionality or regularity, the boys reacted to the change by showing more form responses. The girls apparently did not react to the change in the form dimension, since they consistently showed a preponderance of color rather than form responses over all four stimulus conditions.

Hypothesis 5.--Presence of verbal labels affects form matching.

On the basis of Sigel's (1954) finding that semantic meaning dominates other bases of conceptualization and on the basis of Kagan and Lemkin's (1961) speculation that implicit verbal labelling could account for differences in performance on a matching task, it was expected that ability to give verbal labels for the stimuli used would affect matching performance. If verbal labels do carry relevant semantic meaning for the pre-school child, and if the color-form matching task is an example of conceptualization (Heidbreder, 1946), then the number of verbal tags present for colors and forms should be directly related to the number of matches made using the colors and forms for which the tags exist. Pre-school children probably would have verbal tags for the four colors and four geometric forms; however, they would not be expected to have verbal tags for the irregular forms.

The data were analyzed for differences in frequency of color and form matches under each condition:

color matches-geometric compared with form matches-geometric

color matches-irregular compared with form matches-irregular

form matches-geometric compared with form matches-irregular

The last comparison was made to determine the difference in the number of form matches attributable to the irregularity form component of the stimuli. The above analyses were done for both two- and three-dimensional stimuli.

The only significant difference in number of color and form matches was under the two-dimensional, geometric condition. There were significantly more color matches than form matches (Table 5).

In the analysis for difference between mean number of verbal tags present for forms and colors, none of the differences are significant under the two-dimensional conditions (Table 6). However, under the three-dimensional conditions the difference between mean number of color verbal tags and form verbal tags under the irregular condition is significant. Under three-dimensional condition the difference between mean number of form tags for geometric forms and form tags for irregular forms is also significant. More verbal tags were expected for both colors and geometric forms than for the irregular forms. However, this was supported by the results from the tests on the three-dimensional stimuli but not by the test on the two-dimensional stimuli. Apparently, children assign labels differently to colors, geometric forms, and irregular forms only when three-dimensional objects are used. When the stimuli were familiar to the children they may have regarded the two-dimensional irregular forms as cut-outs or designs in a general class of two-dimensional pieces of paper. However, the three-dimensional objects were not easily classifiable into a larger class of three-dimensional objects. Thus the two-dimensional objects could be assigned verbal tags in a similar way to their geometrical class members. The three-dimensional irregular stimuli, however, were

quite unfamiliar and the children lacked pre-established modes of assigning verbal labels to them. It was observed that the children either named the three-dimensional geometric stimuli accurately or did not name them at all; whereas they gave the three-dimensional irregular stimuli a greater variety of names.

The implicit verbal labelling described by Kagan and Lemkin (1961) appears to be present and in some instances explicit. The effect of verbal labelling appears to be more complex than originally was thought by Kagan and Lemkin and its importance changes with variations in the dimension (two-dimensional or three-dimensional) of the stimuli. The data lend some support for Chen and Wong's (1965) findings that children form more specific verbal tags to colors than to forms (Table 5). However, colors appear to have more verbal tags only when compared with irregular three-dimensional forms and not when compared with geometric forms. Therefore, the data do not support the expectation that children who form more concrete verbal tags to colors than to forms will also show more color than form matches.

There may be an explanation for the lack of influence of presence of verbal tags on matching behavior in the work of Suchman (1966) with children in Zaria, Nigeria, West Africa. Koranic education in Zaria requires that form differences be discriminated in terms of producing spoken sounds and written symbols, but comprehension is not required. These children (range 3.0-15.6) in Nigeria did not show the

classic color-to-form shift found in Euro-American cultures, but were clearly color dominant well into adolescence. Suchman raises the question, "Is it possible that perceptual discrimination skill is a component of some concept or organizer meaningful to the individual?" Thus in the present study it was possible for children to possess verbal tags for the color and form stimuli which may or may not have had much meaning for the individual. If a verbal tag, e.g., "ball," had meaning for the individual child he may have used that concept for his matching behavior. However, if a tag, e.g., "rectangle," had very little meaning for the individual he may have used a more salient tag, probably one of color, which would have more references in his conceptual organization. This would also happen with the irregular stimuli; e.g., "duck," "hat" or "holey" may have had more meaning for a child than color, thereby producing a form match under the irregular condition rather than a color match. The difficulty with this explanation lies in delineating "meaningfulness" of verbal labels for the individual.

Hypothesis 6.--Boys and girls exhibit differences in verbal tags for forms and colors. (Chen and Wong, 1965).

The t-tests performed between mean number of verbal tags for boys and mean number of verbal tags for girls showed no significant differences under any of the four conditions (Table 7). These results are not in accordance with Kagan and Lemkin's speculation that girls label forms implicitly more often than boys. However, the subjects in the present

study were asked to state labels for the stimuli. It is possible that implicit labels which cannot be stated by children influence matching behavior but there was no way for implicit labelling to be recorded in this present study except by the child's verbal response to a direct question.

Hypothesis 7.--Order of presentation (two-dimensional then three-dimensional or three-dimensional then two-dimensional) does not affect matching behavior.

There was no significant difference in the frequencies of color and form matches for subjects who received the two different orders of presentation. The two different orders of stimuli were introduced to control for inducing a "set to respond." However, the initial type of stimuli (two-dimensional or three-dimensional) presented did not affect matching behavior.

Hypothesis 8.--There is an interaction between sex-age and stimulus in determining number of color and form matches.

An analysis of variance was performed to explore the relationship of age-sex stimulus interaction. No significant F-ratios were found (Table 9). In this sample, although there are isolated sex and age differences in performance, there is no consistent performance relationship between sex-age group and stimulus condition.

CHAPTER V

SUMMARY AND CONCLUSIONS

Thirty pre-school children, separated into two groups of 15 each--older group (4-8 to 5-5) and younger group (3-5 to 4-7)--were each given 48 trials on a color-form matching task. Four kinds of stimuli were used: two-dimensional geometric, two-dimensional irregular, three-dimensional geometric, and three-dimensional irregular. Each child received 12 trials under each of the four stimulus conditions. The stimuli were constructed in four colors (red, yellow, blue, green), four geometric shapes (circle, square, triangle, rectangle), and four irregular shapes.

Contrary to Brian and Goodenough's finding that younger children would make more color responses and older children would make more form responses, the older group made significantly more color responses than the younger group. This result may be indicative of a later peaking period for the color response tendency in this sample, seemingly attributable to cultural influences.

The form attribute of irregularity was expected to be unfamiliar to the children and therefore difficult to use in matching. However, examination of the responses to irregular stimuli indicated no significant difference between color or

form responses to irregular stimuli. This finding is consistent with Clapp and Eichorn (1965) that the effect of redundancy of figure was negligible. It was inferred that children could have become sufficiently familiar with the irregular forms to use them as well as geometric forms in matching behavior.

Brian and Goodenough's finding (1929) that children consistently matched three-dimensional forms more frequently on the basis of color than they matched two-dimensional on the basis of color was not replicated by the present study.

It was expected that children would possess more verbal labels for both colors and geometric forms than for irregular forms. However, there were differences in assigning labels to colors, geometric forms, and irregular forms only with three-dimensional stimuli. A possible explanation was conceptual grouping with respect to the familiarity component of the stimuli. None of the differences observed in verbal tags present was reflected by a corresponding difference in number of color-form matches in corresponding conditions. In the present study verbal tags had no significant effect on matching behavior. There were no significant differences in mean numbers of verbal tags for boys and girls. This finding did not support the speculation of Kagan and Lemkin (1961) that girls do more implicit verbal labelling than boys and this labelling affects their matching behavior. However, there is possible support for Suchman's (1966) inference that perceptual discrimination skills are used only when the skill

is a component of some concept or organizer meaningful to the individual. In order for the child to make use of a verbal label in matching behavior that verbal label must have meaning for him in his own conceptual organization.

Among the four form conditions the only significant difference between number of color and form responses was on two-dimensional geometric stimuli. This finding was congruent with the results of previous investigations which used only two-dimensional geometric stimuli.

The children in the present study exhibited more verbal tags for colors than for irregular forms but not significantly more verbal tags for colors than for geometric forms.

When the sample was divided into two groups of 15 boys and 15 girls several differences in number of color and form matches were evident. Girls showed a significantly greater number of color than form responses throughout all four stimulus conditions. However, boys showed a significantly greater number of color than form responses on only the two-dimensional geometric condition. On the remaining three stimulus conditions the boys showed a significantly greater number of form than color responses. Therefore, when there was a change in the form attribute from geometric to irregular or two-dimensional to three-dimensional, girls did not show any observable change in matching behavior; however, boys reacted by exhibiting a significantly greater number of form responses. The sex differences were evaluated with respect to the verbal tag hypothesis of Kagan and Lemkin (1961); however, differences

in matching behavior could not be explained by corresponding differences in stated verbal tags.

Order of presentation of stimuli (two-dimensional then three-dimensional or three-dimensional then two-dimensional) did not produce a significant difference in frequency of color and form matches. Therefore, the order of presentation did not set the subjects to respond on either the color or form dimension. There was no consistent color and form matching behavior shown by sex-age group of subjects or under any stimulus condition. There was no significant interaction between sex-age group and stimulus condition.

The present study lends support for Suchman's (1966) conclusion that the shift from color to form dominance in American children is culturally induced rather than the result of a developmental process. No significant shift was evident in the sample of children (3-5 to 5-5) who had not been forced to attend to form difference in formal reading and arithmetic instruction. Apparently, with pre-school children change in dimensionality and regularity of the form of the stimulus do not produce corresponding changes in matching behavior. The findings of the present study are not consistent with respect to dimensionality with those of Brian and Goodenough's (1929) findings concerning dimensionality but are consistent with Clapp and Eichorn's (1965) findings concerning irregularity of form.

The sex difference between the reactions of boys and girls in ratio of color to form matches under the four form

conditions was expected from the data of Kagan and Lemkin (1961). Boys reacted to a change in stimulus form by showing more form matches; girls did not change their ratio of color to form matches. However, Kagan and Lemkin's explanation of verbal labelling by girls was not supported by the data collected on verbal tags.

In the absence of direct relationship between presence of verbal labels and matching there is some support for the findings of both Sigel (1954) and Suchman (1966) that in conceptual processes meaning is the most salient dimension over color, form, size, or ability to label verbally.

No clear sex-age stimulus interaction was evident. It appears the color dominance is a complex mode of responding which is characteristic of pre-school children (3-6 to 5-5). Although there are differences in responding they cannot be categorized consistently by any age group, sex, or stimulus condition difference. The differences are not attributable to the ability to state labels verbally for the stimuli.

In subsequent research, measurement of meaningfulness of the verbal labels for the stimuli might be incorporated into the color-form matching task, and the role of meaningfulness could be clarified. Important aspects of form which cause a child to shift from one index of classification (color or form) might be explored with individual children rather than sex or age groups.

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APPENDIX

Figure II.--Order of presentation to subjects--geometric stimuli.

	Circle r y b g	Triangle r y b g	Square r y b g	Rectangle r y b g
Order				
1.		L	S R	
2.		R S		L
3.			L S	R
4.	L S			R
5.			R	S L
6.	L	R S		
7.	S R	L		
8.		R		L S
9.	R			S L
10.		S L		R
11.	R S	L		
12.	L		S R	

Key:

S = stimulus
 L = left comparison
 R = right comparison

r = red
 y = yellow
 b = blue
 g = green

Figure III.--Order of presentation to subjects--irregular stimuli.

	Curvi-linear Few-Sided				Straight Few-Sided				Curvi-linear Many-Sided				Straight Many-Sided			
	r	y	b	g	r	y	b	g	r	y	b	g	r	y	b	g
Order																
13.	L								R S							
14.	S R				L											
15.					L S								R			
16.	R												L		S	
17.					R								S		L	
18.	R S				L											
19.	L				S R											
20.									R				L		S	
21.	S		L										R			
22.									S L				R			
23.					S		R		L							
24.	L								R		S					

Key:

S = stimulus
 L = left comparison
 R = right comparison

r = red
 y = yellow
 b = blue
 g = green

Table 11.--Color matches for four form stimuli distributed by sex-age group.

Sex-Age Group	Stimulus Condition				Total
	2DG	2DI	3DG	3DI	
Older Girls	2	8	8	12	
	4	5	4	15	
	12	1	0	0	
	12	12	2	1	
	12	12	12	12	
	7	9	10	4	
	11	12	11	12	
	Sum	60	59	47	56
Mean	8.6	8.4	6.7	8.0	7.9
Older Boys	9	12	12	12	
	12	12	12	12	
	12	12	12	9	
	11	6	1	1	
	1	0	0	0	
	0	0	4	3	
	12	12	6	11	
	10	4	0	0	
Sum	67	58	47	48	220
Mean	8.4	7.2	5.9	6.0	6.9
Younger Girls	5	4	0	6	
	7	11	12	12	
	12	12	9	1	
	12	12	12	12	
	2	4	6	7	
	12	12	11	12	
	0	0	10	12	
	0	0	1	1	
Sum	50	55	61	63	229
Mean	6.2	6.9	7.6	7.9	7.2
Younger Boys	1	0	0	1	
	5	4	2	8	
	6	0	0	0	
	1	0	4	1	
	0	0	2	0	
	7	9	4	7	
	12	12	12	12	
	Sum	32	25	24	29
Mean	4.6	3.6	3.4	4.1	3.9
Sums for Stimuli	209	197	179	196	781
Means for Stimuli	7.0	6.5	5.9	6.5	6.5

Table 12.--Color and form matches distributed by subjects--older group.

Subject Number	Sex	Age	Two-Dimensional			Three-Dimensional			Total		
			Geometric	Irregular	Color	Geometric	Irregular	Color	Geometric	Irregular	Color
1.	F	5-4	10	2	8	4	8	4	12	0	38
2.	M	4-10	9	3	12	0	12	0	12	0	45
3.	F	5-2	4	8	5	7	4	8	5	7	18
4.	M	5-0	12	0	12	0	12	0	12	0	48
5.	M	4-9	12	0	12	0	12	0	9	3	45
6.	F	5-5	12	0	1	11	0	12	0	12	13
7.	F	4-11	12	0	12	0	2	10	1	11	27
8.	M	4-9	11	1	6	6	1	11	1	11	19
9.	M	4-8	1	11	0	12	0	12	0	12	1
10.	M	5-2	0	12	0	12	4	8	3	9	7
11.	M	5-3	12	0	12	0	6	6	11	1	41
12.	F	5-5	12	0	12	0	12	0	12	0	48
13.	F	5-2	7	5	9	3	10	2	4	8	30
14.	F	5-2	11	1	12	0	11	1	12	0	46
15.	M	5-5	10	2	4	8	0	12	0	12	14
Total			135	45	117	63	94	86	94	86	440
											280

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