# AGE AND SEX DIFFERENCES IN THE COLOR PREFERENCES OF NURSERY SCHOOL CHILDREN AND THEIR MOTHERS

by

Joyce Elaine Stronge

A Thesis Submitted to the
Graduate Faculty in Partial Fulfillment of
The Requirements for the Degree of
MASTER OF SCIENCE

Major Subject: Child Development



Iowa State University
Ames, Iowa

1970

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# INTRODUCTION

Color has long been of interest to scientists from many disciplines. Physicists have studied the physical qualities of color; chemists have studied the chemical qualities of dyes and pigments; opthalmologists and biochemists have studied the physiological aspect of color in terms of the structure of the eye, the transmission of color sensations from the eye to the brain and various forms of color blindness; psycho-physicists have studied the responses of individuals to specific kinds and amounts of color stimuli; and psychologists have studied the psychological aspects of color as people perceive and respond to colors.

Physicists have explored the physical aspects of color ever since Isaac Newton in 1666 first broke up a ray of light with a prism. The prism separated light into six colors visible to the naked eye; violet, blue, green, yellow, orange and red. These colors formed what was called the spectrum, and each color corresponded to a specific wavelength of light. The spectrum was physical in nature. However, the perception of color by humans has been considered psychological. Physically, distances exist between the colors (or wavelengths of light) of the spectrum. Psychologically, these distances have an effect on people. Shorter wavelengths of light tend to affect people as being cool; longer wavelengths of light tend to affect them as being warm. According to Cheskin (1954), lights containing violet, blue and to a lesser extent, green tend to be perceived as cool; lights containing red, orange and yellow with red predominant tend to be perceived as warm.

Color frequently has been believed to be very important to young children. Biographical reports by parents indicate that some children have a noticeable preference for one color. Shinn (1907) related an anecdote about her niece who on one occasion was fascinated by a woman's black shoes and following this incident preferred black for some time afterward. Woolley (1909) observed that his infant consistently crawled past a blue rattle to an otherwise identical pink rattle. Nursery school teachers surround children with bright colors in the selection of pictures, toys, equipment and room furnishings, apparently believing that children prefer or are stimulated by a colorful environment. Manufacturers of toys and equipment for children presumably make their products highly colorful for the same or similar reasons. Huck and Kuhn (1968, p. 118) also suggest that children prefer brightly colored illustrations in their books. Since color has been considered to be important to children, it appears to be appropriate to conduct more research to identify those aspects of color that attract or in some other way or ways affect children.

## Definition of Color

Color has been defined as that attribute of visual experience that has quantitatively specifiable dimensions of hue, value and chroma (Burnham, Hanes and Bartleson, 1963, p. 11). Colors have been classified into two categories: achromatic colors, which include black, white and the entire series of intermediate grays, and chromatic colors, such as red and green (English and English, 1958, p. 95).

This study was concerned with chromatic colors. The three dimensions of chromatic color, hue, value and chroma, have long been recognized, but the Munsell Color System was the first to quantify them systematically (Munsell, 1916, p. 18). In the Munsell Color System a notation system utilizing both numbers and letters is utilized for purposes of specifying the exact hue, value and chroma of a given color. Following is an explanation of the notation system, presented in the order given above: hue, value, chroma.

Hue is the name of the color and is that dimension of a color which distinguishes it from other colors. For example, red is distinguishable from green or yellow on the basis of hue. In the Munsell System, the hue dimension is subdivided into five major and five intermediate hues visually spaced equidistantly on a circular scale. The five major hues are red, yellow, green, blue and purple. Between each pair of major hues is one of the five intermediate hues; thus, yellow-green is the intermediate hue between yellow and green. The range of the dimension covered by each hue is subdivided into ten parts. Hue, then, is specified by utilizing a combination of a letter and a number, the letter denoting the hue, and the number indicating the distance of the hue from the hues on either side of it. For example, 5R means that the hue of the color being considered is the fifth red. If the hue were 6R, it would have a tinge of yellow in it; if the hue were 4R, it would have a tinge of purple in it. In the current study, hues used were 10P and 10GY, which indicates that the purples were close to the red-purples and

the green-yellow used was closer to green than to yellow.

Value is the "degree of lightness or darkness of a color in relation to a neutral gray scale, which extends from absolute black to absolute white" (Munsell Color Catalogue, 1968, p. 1). The Munsell System uses a number, written after the symbol for the hue, to denote the value of the color. Absolute black is denoted by 0, absolute white by 10. Middle gray is denoted by 5. All chromatic colors have a value between 1 and 9. Light hues are sometimes called tints and dark hues are sometimes called shades. Thus, pink is a tint of red and maroon is a shade of red. In Munsell notation, an example of the earlier mentioned red of middle value would be written 5R 5.

Chroma is the strength of the color. The amount of chroma in a color is frequently referred to as the saturation or intensity of the color. Chroma is the quality which distinguishes a strong color from a weak one. It indicates the "degree of departure of a given hue from a neutral gray of the same value" (Munsell Color Catalogue, 1968, p. 1). Thus, vermilion, a very bright red, is high in chroma, whereas a dull, faded red is low in chroma, and is closer to neutral gray. In the Munsell System, a number written after the symbol for value denotes the chroma of a color. Different hues have different chroma ranges, but within each hue the higher numbers indicate higher chroma. A color denoted as 10GY 5/8 has a hue of 10GY, a value of 5 and a chroma of 8.

The three dimensions of color can be represented by a color sphere. The equator of the color sphere represents hue. The vertical axis from

the south pole to the north pole represents value, with absolute black at the south pole and absolute white at the north pole. At each level of value, a chroma scale extends horizontally with low chromas near the gray value in the center of the sphere and high chromas near the surface of the sphere.

Since many persons have assumed that color is important to young children, it seems appropriate to study children's responses to color. One theoretical question asks whether response to color is innate or socially learned. It is also interesting to ask whether responses vary among ages, intelligence levels, social classes, personality types and between sexes. In so far as color responses are socially learned, the color environment of the home from which the child comes is likely to exert an influence. The colors of the physical objects in the home and the color preferences of the rest of the family are important parts of this color environment. Aldous (1946) found that kindergarten children were influenced only slightly in their color choices by the physical home environment. The influence of the color preferences of family members on a child's color preference has not been studied. Since it would be time consuming to gather and analyze data on all members of a family and since the mother frequently spends more time with a preschool child than do other family members, it seems useful to consider that her color preferences might have an important influence on her child. Thus, the purpose of this study was to determine the influence of age, sex and mother's preferences on the color preferences of nursery school children.

## Hypotheses

1. There is no pattern of preferences for the qualities of color among young children.

   a) There is no preference for one hue over another hue among young children.

   b) There is no preference for hues of lighter value over hues of darker value among young children.

   c) There is no preference for hues of higher chroma over hues of lower chroma among young children.

2. There is no difference in the pattern of preferences for the qualities of color between boys and girls.

   a) There is no difference between boys' preferences for hue and girls' preferences for hue.

   b) There is no difference between boys' preferences for value and girls' preferences for value.

   c) There is no difference between boys' preferences for chroma and girls' preferences for chroma.

3. There is no difference in the pattern of preferences for the qualities of color between three-year-old and four-year-old children.

   a) There is no difference in the preference for hue between three-year old and four-year-old children.

   b) There is no difference in the preference for value between three-year-old and four-year-old children.

   c) There is no difference in the preference for chroma between three-year-old and four-year-old children.

4. There is no pattern of preferences for the qualities of color among mothers.

   a) There is no preference for one hue over another hue among mothers.

   b) There is no preference for hues of lighter value over hues of darker value among mothers.

c) There is no preference for hues of higher chroma over hues of lower chroma among mothers.

5. There is no relationship between mothers' patterns of preference for the qualities of color and their children's patterns of preference for the qualities of color.

   a) There is no difference between mothers' preferences for hue and children's preferences for hue.

   b) There is no difference between mothers' preferences for value and children's preferences for value.

   c) There is no difference between mothers' preferences for chroma and children's preferences for chroma.

# REVIEW OF LITERATURE

In examining the literature, several factors which could influence a child's response to color stimuli were identified. These were (1) the method by which the stimuli were presented, (2) the experimental setting, (3) the ability of the child to perceive and discriminate colors, and (4) the child's color preferences.

## Methods of Presenting Color Stimuli

Color choices have been presented to subjects individually or on a group basis using verbal or object stimuli. Individual testing has usually been used at the preschool level because it was easier to "gain rapport, obtain cooperation and maintain the interest of the subject" (Anastasi, 1961, p. 34). Furthermore, on an individual basis it was easier for the experimenter and subject to communicate, and for the experimenter to control for colors other than those worn by the child.

It was found to be more appropriate to present colors to young children visually than through verbal means. One of the disadvantages of experiments requiring verbal ability was that the name of a color might mean different colors to different subjects and there was no way of determining exactly which color the subject preferred. In addition, preschool children experienced difficulty in naming colors correctly (Hildreth, 1936; Synolds and Pronko, 1949). There is an extensive literature on children's ability to name colors. Bateman (1915) summarized the early

literature and Cook (1931) agreed with his conclusion that children can discriminate between colors before they can name them. In color preference experiments requiring naming ability, children might choose the colors they find easiest to name. The literature on naming is not presented here, since the present study did not use this method.

Colors have been visually presented to young children in a variety of forms and shapes. Most stimuli used have been rectangular or square papers. Some studies have used colored objects or toys (Sulina, 1923; Tramp, 1966), colored lights (Staples and Walton, 1933; Chase, 1937), colored ribbons and cloth (Gilbert, 1894; Holden and Bosse, 1900), colored paints (Blum and Dragositz, 1947), and colored clothing (Hunt, 1959).

There is an extensive literature on the color-form preferences of young children from which it appears that children may rank colored objects on the basis of either form or color (Rivoire and Kidd, 1966). Some objects may have definite colors associated with them. The child may become preoccupied with the object stimuli and give insufficient attention to the purpose of the experiment. Staples and Conley (1949) and Corcoran (1954) presented colors in the form of paint and found that young children were more interested in exploring and manipulating the paint than in the discriminating use of color. Arlitt and Buckner (1925) presented cloth, chalk and paint to three-year-old children and reported that the choice of color was greatly influenced by the materials. The color-form literature is not further reviewed in this study. In color preference work, it is advisable to present the colors in a simple form that does not distract

the child.

The number of colors presented to the subject at one time could influence the results of a color preference experiment. Dorcus (1926) evaluated the advantages and disadvantages of three methods used to study color preference and concluded that the method of paired comparisons was probably the most adequate method. This view was supported by Woodworth and Schlosberg (1954, p. 253). The method of paired comparisons presents the subject with all possible pairs of color stimuli and requires the subject to make a choice each time.

The multiple-choice method presents all colors simultaneously to the subject and requires him to choose the color he likes best. The remaining colors are then presented simultaneously and the subject makes a second choice. This process is continued until a complete ranking of colors is obtained. This method has disadvantages in that the subject may not choose the color he likes best from all the colors, but rather may attend to only a few. When several colors are presented simultaneously to a preschool child, he may be confused. In addition, with many colors, lighting and proximity are more difficult to control.

Finally, the method of serial presentation has been used. Single colors are presented serially. Each color can be judged only in isolation, ranking it on a numerical scale. In this instance, the position of the color within the series may affect a subject's preference.

In all methods, as the subject looks from one color to another, an afterimage of a previous color may affect the appearance of the next color.

The order in which the subject views the colors should be randomized to lessen the error due to the afterimage effect. Furthermore, there is evidence that the order in which stimuli are presented may influence the results of an experiment with preschool subjects. Studying children's use of color at an easel, Corcoran in 1954 found that three-year-old children to a significant extent used color in the sequential order of presentation.

## Experimental Setting

Color choices have been presented to subjects in a variety of experimental settings. The illumination, surrounding colors, and the behavior of the experimenter may influence the outcome of the experiment.

Two aspects of lighting conditions influence the appearance of a color: the source and the intensity of the light. A person may be delighted with a gray material viewed under artificial light, only to find it is a moderately saturated blue in daylight illumination. Helson and Jeffers (1940) reported that hues tended to lose some of their saturation under strongly chromatic illuminants. Many studies of color preference specified that hues be viewed under daylight conditions (Child, Hansen and Hornbeck, 1968; Staples, 1932). Other studies used artificial lighting, recognizing that it did change the appearance of certain colors.

Peiper (1963) discussed Purkinje's phenomenon in relation to testing color perception under light- and dark-adapted conditions. This

phenomenon follows a physiological law: the relative value of brightness of different colors changes in unequal proportion with the illumination and the corresponding condition of the observer's eye. Thus, the eye adapted to brightness looks at a spectrum and the brightest color appears to be yellow. On the other hand, to the eye adapted to darkness, the brightest spot in the spectrum is in the violet zone. Thus, the relative brightness of colors under daylight illumination is completely different from the brightness of colors viewed under twilight illumination.

Not only the illumination but also the surrounding colors in the experimental setting, particularly the color of the background on which the stimuli are mounted, could influence the results of an experiment on color preference. Color preference studies have presented stimuli on white, middle gray, and black backgrounds. Middle gray has been the most frequently used background.

Helson and Jeffers (1940) studied the effect of background on the hue, value, and chroma of colors. They built a special booth in which the background could be changed to white, gray, or black as required by the experimental design. These authors reported that the dimensions of color changed when presented against different backgrounds. On a white background, dark colors appeared most saturated, while on a black background, light colors appeared most saturated.

> ...it is seen that samples on black ground are on the average 1.14 saturation steps higher than on white ground and the average for gray is 0.73 steps higher than on white ground (Helson and Jeffers, 1940, p. 14).

Other surrounding colors include the colors of the room and the experimenter's and subject's clothing. While the influence of these variables has not been studied, color preference researchers have recognized this factor as a source of error and have attempted to minimize such variations.

The experimenter's behavior has been found to be an important variable in the experimental setting (Rosenthal, 1966). Recognizing that the experimenter's tone of voice, gestures, and facial expressions could influence the subject, an attempt should be made to be as consistent as possible from subject to subject. A pilot test can familiarize the experimenter with giving the test and, hopefully, minimize changes in the experimenter's behavior that might come with increasing experience. The experimenter's rapport with children can affect their cooperativeness. Therefore, attempts should be made to establish rapport similarly with all children.

## Color Perception and Discrimination of Young Children

Unless young children can perceive and discriminate among colors, they cannot have a color preference. Color perception has been investigated by a number of researchers. Rivoire and Kidd (1966), Peiper (1963), Cook (1931) and Staples (1931) have prepared excellent reviews of the literature in this area.

Infants

Studies on color perception have often involved infant subjects because of the interest in establishing the first appearance of color discrimination. Usually, several colors were presented and any variation in the infants' responses to the colors was taken as an indication of their ability to discriminate among them. The response was recorded either as the length of time that the infant focused on a color or as the infant's attempt to grasp a particular color stimulus object. Holden and Bosse (1900) observed that by 12 months of age infants responded to the colors of red, orange, yellow, green, blue and violet. Baldwin (1906) reported on the study of his nine month old daughter. Colored papers were placed in front of the child at different distances and the child's reaching for the color was used as an index of color perception. The child reached for blue, red, white, green and brown, in that order.

Shinn (1907) studied the color perception of her niece for three years, reporting no discrimination at birth. Beginning at about the fourth week, the infant appeared to notice and respond to colored objects. By the time the child was four years old, she was able to discriminate all colors presented.

These early studies did not carefully control for the hue, value and chroma levels of the stimuli; thus, it was not clear whether the infant could discriminate among all three dimensions of color. Shinn (1907) observed that all colored objects of interest to the infant were illuminated with bright light. She hypothesized that the infant's

interest was due not to color but to the reflection of light. McDougall (1906) and Woolley (1909) concluded from their studies that infants were more often attracted by hue than by value differences. Myers (1908) reported that his subject was able to discriminate value differences at an early age, perhaps before six months. Staples (1932) studied infant discrimination of colors and carefully controlled for value. She reported that infants looked at color consistently more than gray. Furthermore, she reported consistent differences in responses to four colors; red, yellow, blue and green were responded to in that order. In a second experiment the infants were shown a colored disc and a gray disc slightly lighter in value than the colored disc. The infants responded more to the hue than to the lighter value. Thus, it appeared that it was hue and not the value that was preferred by infants.

Chase (1937) controlled for the value of colors. He projected two colors of equal light intensity opposite the infant and manipulated one of the colors within the other. His results suggest that infants were able to differentiate between several hues; a colorless dark spot inside a lighter spot was not followed with the eyes.

Peiper (1963) reported from his experiments that infants did distinguish between different degrees of value and that color perception if not present at birth develops in the first weeks of life. He experimented by alternating colored and gray stripes on a rotating drum in front of the infant's eyes. He reported the following results:

> In the first two weeks no color differentiation occurred; the reaction was absent if gray and color were equal in brightness. The first color that caused reactions in the third and fourth week was blue when paired with gray of equal brightness; red and yellow followed in the fourth to eighth week; green, which was last to be differentiated (in the seventh to eleventh week), completed the trichromatic vision (Peiper, 1963, p. 74).

Thus, it appears from the literature on infants that sensitivity to hue increases with increasing age. There is also some evidence that infants can discriminate between values.

Preschool children

A number of studies have investigated the ability of preschool children to discriminate among colors. In 1931, Cook studied 110 children, aged 17 months to six years, on color matching. Using Munsell colors of varying hues (red, green, yellow, blue), values, and chromas, she asked the children to match the colors. She concluded that accuracy in color matching increased with chronological age and that no color was consistently matched more accurately than any other color by older children. In addition, she found a slight tendency to match colors more accurately when chroma was constant and value was varied than when value was constant and chroma was varied. She also reported that children discriminated more accurately between differences in hue than between differences in value or chroma. At age three, children matched the colors with 71 percent accuracy; at age four and a half, they matched with 82 percent accuracy.

Several tests in color matching were given by Monroe (1907) to

more than five hundred children between the ages of two and six. Subjects matched colors successfully in the following order: red, blue, yellow, green, orange, violet. Baldwin and Stecher (1924) reported a study where two-to-six-year-old children were asked to sort tints and shades of red, green, blue and yellow into their respective boxes. The young children worked unsystematically at this task, frequently making up their own games. Their spontaneous remarks indicated that many of the children considered the tints and shades to be entities separate from the saturated colors. The saturated colors were found to be the easiest to sort, the pastel tints to be most difficult. Smith (1943) examined the matching ability of five-year-old children using five hues, five values, and five chromas from the Munsell system. Girls were found to be significantly better than boys at matching on the basis of hue and chroma, but not on the basis of value.

Peiper (1963) reported a study he did in 1927 to test the color discrimination of preschool children. Using two boxes, identical in appearance except that one had a color on the front and the other had a shade of gray, the child's task was to compare the colors red, yellow, green or blue on one box with a shade of gray on the second box. The shades of gray were successively changed, so that if a child was color-blind, one of the shades of gray would appear identical to the comparison color. Peiper reported that the children were able to match with great accuracy at the beginning of the third year of life and thus were perceiving and discriminating colors by that time.

Nagel (1906) and Tucker (1911) noted some confusion in the child's color matching, especially with the blues and greens. Nagel reported that a two-year-old child learned to match red with red and green with green rather quickly, but that blue with blue and gray with gray were more difficult. Studying school children, Tucker reported that blues, violets, and greens were confused whereas reds and yellows were matched most successfully.

Thus, matching literature indicates that three- and four-year-old children can discriminate colors with a high degree of accuracy and that this ability improves with chronological age.

## Color Blindness in Children

To be able to discriminate colors, children must not be colorblind. Colorblindness is usually congenital, but may be acquired (DeValois and Abramov 1966, p. 355). There are three major types of abnormal color-vision: monochromatism, dichromatism, and anamalous trichromatism. Monochromatism or total color blindness is very rare. Dichromatism is the type of color blindness where the individual is capable of making just two kinds of color discrimination, light-dark and either yellow-blue or red-green. Anomalous trichromatism is the type of color blindness in which the individual perceives color but his matches do not fall within the normal range. There are three types, red-weak, green-weak and blue-weak.

As reported in Burnham, Hanes, and Bartleson (1963, p. 101), the incidence of color defects among school children is about eight percent for boys and less than one-half of one percent for girls. About 1.1

percent of girls are protanomalous trichromats or red-weak, requiring more than a normal amount of red to match a given yellow. About 4.9 percent of boys and .38 percent of girls are deuteranomolous trichromats or green weak. About 1.0 percent of boys and .02 percent of girls are protanopes. They confuse red and bluish green with neutral and with each other. All wavelengths of light are seen as blue and yellow. About 1.1 percent of boys and .01 percent of girls are deuteranopes and confuse bluish red and green with neutral and with each other. They see all light as some saturation of blue or yellow. About .0001 percent of boys and no girls are tritanopes, who confuse purplish blue and greenish yellow with neutral and with each other. They see only two hues, red and green. Congenital monochromatism or total color blindness occurs in about .003 percent of boys and .002 percent of girls. Brown (1951), studying English school children, confirmed that color vision defects were about eight percent for boys, but about four percent for girls.

Several color vision tests are used to screen for the different types of color blindness. The Committee on Colorimetry of the Optical Society of America (1953) adequately describes these tests. Burnham, Hanes, and Bartleson (1963) also summarize some of these tests.

From the preceding literature on perception and discrimination of color by infants and young children, the following conclusions can be drawn. Children, by the time they reach preschool age, can apparently perceive hue, value, and chroma. They tend to respond more to hue than to the other two attributes of color.

## Color Preferences of Preschool Children

Many studies have examined the color preferences of preschool children. Table 1 summarizes the results of research relevant to the current study. These studies do not include naming and matching literature. Some studies, such as Alschuler and Hattwick (1951), produced some data on color preferences. However, these data were only incidental to their study so they are not reviewed in the present study.

As can be seen from Table 1, six of the ten Munsell hues have been studied. The numbers under each of these hues represent the order in which children chose them. The four Munsell hues of yellow-green, blue-green, purple-blue and red-purple have not been studied. This study used the hues yellow-green and purple, the yellow-green used being very close to green in hue. Although in the literature studies have not been found in which subjects were asked to compare yellow-green with purple, it appears that it would be useful to examine the relationships found between green and purple. In only three of the six studies have comparisons between green and purple been reported. In two studies, green was found to be preferred to purple.

### Hue preference

Holden and Bosse (1900), Garth and Porter (1934), and Hunt (1959) are the only studies of preschool children which have examined preferences for green and purple.

In 1900, Holden and Bosse were among the first to study color preferences of preschool children experimentally. Their procedure was

Table 1. Summary of investigations into color preferences of preschool children

| Investigator | No. of children | Ages of children | Color preference ranking of young children | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | R[a] | YR | Y | G | B | P |
| Aars (1899) | 8 | 3-7 | 2 | - | 4 | 3 | 1 | - |
| Holden and Bosse (1900) | 9 | 3 and 4 | 6 | 5 | 4 | 2.5 | 2.5 | 1 |
| Staples (1932) | 50 | 2/6-4/10[b] | 1 | - | 4 | 2 | 3 | - |
| Staples and Walton (1933) | 13 | 3/1-4/10 | 1 | - | 2 | 3 | 4 | - |
| Garth and Porter (1934) | 439 | 3/0-4/11 | 1 | 4 | 6 | 3 | 2 | 5 |
| Hunt (1959) | 32 | 3 and 4 | 1 | 5 | 2 | 3 | 4 | 6 |

[a]Letters refer to: R = red; YR = yellow-red, or orange; Y = yellow; G = green; B = blue; P = purple.

[b]The notation 2/6 reads two years/six months.

to present six satin ribbons on a medium gray cardboard, using the multiple-choice method. The 1" x 1' ribbons were placed one inch apart to allow distinct viewing of each ribbon and to prevent the subjects picking up more than one ribbon at a time. The placement of the ribbons alternated warm and cool colors. The cardboard was brought within the reaching distance of the subject for each color choice. After each selection, the ribbon was taken from the child and the other ribbons were rearranged on the cardboard before the next presentation. The authors studied four three-year-old children and five four-year-old children.

Children's responses were classified into three categories: positive, negative, and atypical. Those who gave positive responses indicated a choice by looking over all the ribbons before choosing one. Those who gave negative responses paid little attention to the ribbons and watched the experimenter for suggestions or randomly picked up any color. Those who gave atypical responses made positive responses on one or two choices and randomly picked the rest. Holden and Bosse reported an equal number of positive and atypical responses among three-year-old children. They did not report the number of negative responses. The results in Table 1 are those of the subjects who gave positive responses. For the total group, purple was preferred to green. However, three-year-old children did place green higher than purple.

In their study the sample was very small, no mention was made of the exact age range of the subjects or the sex distribution of the nine preschool subjects. Furthermore, the full results were not reported on

the subjects who gave negative responses. The value and chroma levels of the stimuli were not controlled and hues were mentioned only as corresponding to the six spectral hues. Finally, the details of the experimental setting were not mentioned.

Using the largest preschool sample of any study on color preference, Garth and Porter (1934) studied 439 young children in Arizona and Colorado. One hundred twenty-five three-year-old children and one hundred twenty-eight four-year old children were tested. Six saturated Milton Bradley colors and one white stimulus were presented to the children. The stimuli were colored discs, one-half inch in diameter, mounted on small white cards. The multiple-choice method was used. Very young children were given the test three times to insure that their real order of preference was obtained. The details of the experimental setting were not mentioned. Since the preschool children were found in homes, Sunday schools and playgrounds, experimental settings may not have been controlled. The hues used were controlled, the chromas were high but the values were not mentioned. Yellow was ranked lowest by the children; this may in part be explained by the fact that the hues were presented on a white background.

The children's color choices were ranked on an affective scale with white set as the arbitrary zero value. Green was preferred to purple by both ages. The spread between the most- and least-preferred colors was greater for the four-year-old children than for the three-year-old children. Hunt (1959) found a similar result when she compared the preferences of preschool children with those of kindergarten and first

grade children.

Studying children's clothing preferences, Hunt (1959) also examined color preferences. She studied hue, value, and chroma preferences, varying one or two of these dimensions at a time. Six hues high in chroma were used: red, orange, yellow, green, blue and violet. Three value levels were selected: a middle value, a lighter value halfway between middle value and white, and a darker value halfway between middle value and black. Two chroma levels were used: one high chroma and one lower chroma halfway between the high chroma and the gray of equal value.

The multiple-choice method was used to present the stimuli, the child being instructed to put his finger on the one he liked best. The colors were presented against a middle gray background and the slope of the board was controlled to reflect light equally from all stimuli. The stimuli were presented under daylight conditions.

She concluded that the results of the three- and four-year-old children appeared to be unreliable.

> Many of the three- and four-year-olds ranked the colors in sequential order; others, after making a first choice, ranked the remaining five colors in sequential order first on one side, then on the other side of their first choices (Hunt, 1959, p. 19).

She also reported that the difference between the most- and least-preferred colors was smaller for this age group than for older children. For her total group of subjects, red, yellow, green and blue were about equally preferred, whereas orange and purple were considerably less preferred. An analysis of the results obtained with three- and four-year-old children was not reported.

The studies of Staples (1932) and Staples and Walton (1933) did not compare green to purple, but they did study preferences for other hues. Staples (1932) controlled for many variables that are important in color preference research. Using the method of paired comparisons, she presented four Munsell Colors, R 5/10, Y 5/7, G 5/7 and B 5/6 in a circular form mounted on a middle-gray cardboard background. Her procedure was to bring the subject into a small, well-lighted room and seat him at a table in front of a large window. The child faced away from the window and the experimenter stood in front of him presenting the charts one at a time, holding them 15 inches from the child and at an even angle so that the colors were equally distant from him. The instructions to the subjects were to "find the prettiest ball." The first color reached for was considered a response in favor of that color. Six pairs of colors were presented, the order of presentation being rotated with successive subjects. The positions of left and right were also alternated to avoid a particularly favorable position for any one color. Staples did not mention controlling for the room coloring and the experimenter's behavior.

The purpose of Staples and Walton's study (1933) was quite different from that of the present study. They were interested in the effect of a pleasurable experience upon the color preferences of nursery school children. A preliminary test of color preference using colored lights was first given to the children and then the child's least-preferred color was assigned to him for a conditioning experience. When the assigned color came on, the child found a toy or piece of candy in a small

box that was in the experimental setting. Following this procedure, it was found that there was a "decided increase in the strength of preference for the assigned color after the pleasurable experience as compared with the original presentation of lights" (Staples and Walton 1933, p. 221). In this study the method of paired comparisons was used, the lighting in the experimental setting was controlled and by using lights, the brightness of the different hues was controlled. However, factors like the room coloring and the experimenter's behavior were not mentioned.

Value preference

The value dimension of stimuli was examined by Hunt (1959). The preference for value was found to be highly significant. Among all children in her study, light colors were most preferred, standard colors less so and dark colors were much less preferred. The colors red, orange, yellow and green were preferred first at the standard level, with the lighter level being less preferred and the darker level least preferred. For blue and purple, the lighter values were overwhelmingly preferred.

Aldous (1946) studied kindergarten children and reported preference for tints to be highly significant. She found no indication of a preference for pure colors over shades or vice versa. Boys chose shades more than pure colors, but this preference was not statistically significant.

Among older children, Child, Hansen, and Hornbeck (1968) found that hues light in value were most preferred. Katz and Breed (1922) found the same preference to be true of older girls. However, Dorcus (1926), who asked school children to rank two series of Munsell colors, found

little difference in the rankings of the two series, and concluded that value had little effect on preference.

Chroma preference

Chroma has been studied by Aars (1899) and Hunt (1959). Aars studied the color preferences of eight three- to seven-year-old children. He reported that chromatic colors were preferred to grays of equal value and that saturated colors were preferred to unsaturated ones.

Hunt (1959) reported that most subjects preferred saturated colors to unsaturated colors. However, she observed a tendency among the children to prefer the saturated levels in their best-liked colors and the unsaturated levels in their least-liked colors.

Holden and Bosse (1900), Staples (1932), Staples and Walton (1933) and Garth and Porter (1934) presented only highly saturated colors to their subjects.

Studies by Katz and Breed (1922) and Child, Hansen, and Hornbeck (1968) found a preference for hues of higher chroma among older children.

Age differences

Studies of age differences in color preference in which children of ages three and four were compared have been conducted only by Holden and Bosse (1900) and by Garth and Porter (1934). Holden and Bosse (1900) found three-year-olds preferred green to purple, whereas four-year-olds preferred purple to green. Garth and Porter (1934) found no real difference in the order of preference between the two ages, but rather found

that older children showed greater differentiation between most- and least-liked colors.

Hunt (1959) did not test for differences between three- and four-year-old children, but for differences between this group and five- and six-year-old children. Since the evidence on age differences between three- and four-year-olds is inconclusive, and since the number of studies of this age group is limited, it seems useful to report the literature on kindergarten children.

Hunt (1959) found that among kindergarten children green was preferred to purple. Garth and Porter (1934) also obtained this result. Holden and Bosse (1900) found that purple was preferred to green. Four studies examined the color preferences of kindergarten children but did not look at the preferences of preschool children. These studied are evenly divided in their rating of purple and green. Aldous (1946) found green preferred, while Tramp (1966) found purple preferred. Dashiell (1917) and Katz and Breed (1922) found girls preferred purple and boys preferred green.

Sex differences

Besides Dashiell (1917) and Katz and Breed (1922), studies by Garth and Porter (1934), Staples (1932), Hunt (1959), Aldous (1946) and Tramp (1966) have examined sex differences in color preferences. Hunt (1959) reported that the sex-value interaction was highly significant. Girls preferred the lighter levels of value more than boys, while boys preferred the darker levels of value more than girls. The standard (intermediate)

Table 2. Summary of investigations into color preferences of kindergarten children

| Investigator | No. of children | Ages of children | Color preference rankings of kindergarten children | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | R[a] | YR | Y | G | B | P |
| Holden and Bosse (1900) | 8 | 5 - 6 | 5 | 6 | 4 | 3 | 2 | 1 |
| Dashiell (1917) | 107(girls) | 5 - 6 | 5 | 6 | 4 | 3 | 1 | 2 |
| | 105(boys) | 5 - 6 | 2 | 3 | 4 | 5 | 1 | 6 |
| Katz and Breed (1922) | 63(girls) | 5 - 6 | 5 | 3.5 | 1 | 6 | 2 | 3.5 |
| | 79(boys) | 5 - 6 | 3.5 | 5 | 2 | 3.5 | 1 | 6 |
| Garth and Porter (1934) | 102 | 5/0-5/11[b] | 2 | 1 | 6 | 3 | 5 | 4 |
| | 102 | 6/0-6/11 | 1 | 4 | 6 | 3 | 2 | 5 |
| Aldous (1946) | 86 | 5 - 6 | 1 | 5 | 4 | 2 | 3 | 6 |
| Hunt (1959) | 32 | 5 - 6 | 1 | 5 | 2 | 3 | 4 | 6 |
| Tramp (1966) | 25 | 6/0-6/9 | 3 | 6 | 5 | 4 | 2 | 1 |

[a]Letters refer to: R = red; YR = yellow-red, or orange; Y = yellow; G = green; B = blue; and P = purple.

[b]The notation 5/0-5/11 reads 5 years to 5 years 11 months.

colors were found to be equally often preferred by both sexes.

Garth and Porter (1934) gave the ranking by sex of the preferences of their three- to six-year-old subjects. The order of preference for the 495 boys was: red, blue, green, orange, purple and yellow. The order of preference for the 537 girls was: blue, red and orange, green, purple, and yellow. Green was preferred to purple by both sexes.

Staples (1932) looked for sex differences in her data and reported only that boys ranked green higher than did girls. However, she did not use purple in her experiment.

Dashiell (1917) studied 212 kindergarten children in kindergartens in the Minneapolis area. He presented six standard Milton Bradley colors mounted on a neutral gray background to the children using the method of multiple choice. He reported a sex difference, with purple preferred by girls and green by boys.

Katz and Breed (1922) also studied kindergarten-age children. In their study, they presented six rectangular Milton Bradley colors mounted on white cardboard in two rows. Above each color was written a number. The tests were administered in groups by the kindergarten teachers. The multiple-choice method was used, the children being instructed to write down the numbers of the colors in order of their preference. Again, girls preferred purple and boys preferred green. Aldous (1946) and Tramp (1966) reported no significant sex differences in the color preferences of their kindergarten-age subjects.

Other factors

Although a child's mental ability may influence his color preferences, the relationship between mental ability and color preference apparently has not been considered to be very important by most researchers in the field. Winch (1909) studied school children and reported that children of higher mental ability tended to prefer green more than did children of lower mental ability. Staples and Walton (1933) and Hildreth (1936), in studies reported earlier under hue and chroma preference and naming literature, respectively, reported the mean intelligence quotients for their groups as being above average in mental ability.

The social class background in relation to color preference was examined by Winch (1909), Katz and Breed (1922), and Staples (1932). Winch (1909) and Katz and Breed (1922) studied school age children and found that children from "poorer" neighborhoods reported red, whereas children from "better" neighborhoods reported green to be their favorite color. Staples (1932) found no difference in the preference of subjects from different social classes.

No studies have been published on the influence of the mother's preferences on the child's preferences. Hunt (1959) studied mother-child agreement on preferences under circumstances in which the mother was instructed to choose the color she thought her child would prefer, and the child was instructed to indicate his color preference. No significant differences were reported on hue choices. For value, the differences between the sexes in agreement with mothers' indication was highly significant. Girls agreed more with their mothers and preferred the lighter

colors more than did the boys. For chroma, mothers accurately indicated the preferences of their children, choosing high levels of chroma for red, yellow, green and blue and lower levels of chroma for orange and purple. A study could now well be done to determine the effect of the mother's preference on her child's preference.

## Color Preferences of Adult Women

Eysenck (1941) summarized the data from 21,060 observers in 26 investigations on preference for single colors. The weighted-average order of preferences from most preferred to least preferred was found to be: blue, red, green, purple, orange and yellow. In light of foregoing data, it is interesting to note that among adult women green was preferred to purple. The preference for value was not studied nor was preference for chroma, but many colors used in the investigations were highly saturated.

Granger (1955) and Guilford and Smith (1959) supported Eysenck's conclusion that green was preferred to purple by adults. Furthermore, they found that preferences for value and chroma were curvilinear, that is, lighter values and higher chromas were preferred up to a point, after which they diminished in affective value. According to Granger (1955), the value of the background mounting of the color greatly affected the most preferred value for hues. Unfortunately, neither Granger (1955) nor Guilford and Smith (1959) used black as a background. In terms of the affective value of chroma, Guilford and Smith (1959) found that a chroma of 8 had the highest affective value.

These last two studies carefully controlled many important variables. Both Granger (1955) and Guilford and Smith (1959) used a large number of color stimuli from all parts of the color sphere. Granger (1955) used Munsell colors and Guilford and Smith (1959) carefully matched all of their stimuli to the Munsell System. In both experiments, the background against which the colors were presented was a gray with the Munsell value of 5. The lighting was carefully controlled within special viewing enclosures which also controlled for the influence of surrounding colors. Using the multiple-choice method, Granger (1955) presented 60 sets of colors, each containing an average of seven stimuli. These sets were presented in a prearranged random order and within sets the colors were randomized. Guilford and Smith (1959) presented single stimuli serially in sets of 25 colors. Subjects judged each color on a 10-point pleasantness-unpleasantness scale. The order of presentation of the stimuli was partly planned and partly random as a means of avoiding both extreme and minimal changes in hue, value and chroma. In both studies careful instructions were given to the subjects and all subjects were screened for color blindness.

# METHODOLOGY

## Subjects

Subjects in this investigation were 48 children and their mothers. All children were enrolled in a laboratory nursery school. An equal number of boys and girls served as subjects (See Table 3).

Table 3. Description of subjects

| Sex | Age | | Total |
|---|---|---|---|
| | Three-year olds | Four-year-olds | |
| Male | 12 | 12 | 24 |
| Female | 12 | 12 | 24 |
| Total | 24 | 24 | |

From a total of 83 children in four nursery school groups, 48 subjects were selected on the following criteria: (1) aged between 3/0 and 5/0, (2) understands English, (3) not suspected of mental retardation, emotional disturbance or perceptual difficulties, (4) middle class background, (5) mother present in the home, (6) not tested previously on color preference, (7) not suspected of color blindness. Information on the subjects regarding the above criteria was obtained from the head teachers in the nursery school groups. Of the 35 children who were excluded, eight were too young, and three were too old; one had suspected perceptual difficulties; seven did not have a middle class background;

two did not have a mother in the home; nine had been tested previously on color preference; four would not cooperate with the experimenter; and one was suspected of color-blindness.

The ages of the 48 subjects ranged from three years to four years eleven months. However, the ages were not evenly distributed within each subgroup of subjects, as can be seen from Table 4.

Table 4. Age level of subjects by sex

| Age | | Sex: Male | Sex: Female |
|---|---|---|---|
| Three-year-olds | Mean | 3/5[a] | 3/6 |
| | Median | 3/3 | 3/6 |
| Four-year-olds | Mean | 4/6 | 4/7 |
| | Median | 4/7 | 4/6 |

[a]The notation 3/5 reads three years five months.

All subjects attended nursery school either from 9:00 A.M. to 11.30 A.M. or from 2:00 P.M. to 4:30 P.M. Monday through Friday except for nine of the young three-year-olds, who attended every other day. All subjects except one had attended nursery school the quarter previously and some had attended more than one year.

Most of the subjects came from upper middle class professional families in which both parents had completed bachelor's degrees or beyond. All subjects were assumed to be of a normal or above intellectual level, although no intelligence scores were available.

## Instruments

Two separate instruments were administered to each of the 48 subjects and to the mother of each subject. They were a color preference test and the Farnsworth Dichotomous Test for Color Blindness. A modified version of the Ishihara Tests for Color Blindness was administered to seven subjects.

The color preference test consisted of eight 5½" x 8" color samples purchased from the Munsell Color Company. The color samples were selected along the Purple-Green-yellow axis of the Munsell Color System. These hues were selected because they were neither cool nor warm hues and because they were available. Two levels of value and two levels of chroma were selected along the hue axis. Table 5 lists the color samples that were used.

Table 5. Munsell color samples used for testing preference

| | |
|---|---|
| $H_1V_1C_1$[a] | 10 P 5/4 |
| $H_1V_1C_2$ | 10 P 5/8 |
| $H_1V_2C_1$ | 10 P 7/4 |
| $H_1V_2C_2$ | 10 P 7/8 |
| $H_2V_1C_1$ | 10GY 5/4 |
| $H_2V_1C_2$ | 10GY 5/8 |
| $H_2V_2C_1$ | 10GY 7/4 |
| $H_2V_2C_2$ | 10GY 7/8 |

[a] H = Hue, V = Value, C = Chroma, 1,2 = level of hue, value, chroma.

All possible paired combinations of these color samples were presented in a different random ordering to each subject and to the mother of each subject. About 12 minutes of testing time was used to present the total of 28 pairs of color samples to each subject.

These color samples were mounted and centered on 9" x 12" posterboard covered with black felt on both sides. They were displayed vertically, in pairs, at eye-level for the subjects on a black felt-covered easel. Two white placards with the words "left" and "right" printed in black were attached to the easel over the display spaces.

To indicate a preference for one of the color samples, the preschool subjects pointed to the color they liked best and the experimenter recorded that preference. The mothers recorded their preferences by checking either left or right on an answer sheet.

Following the color preference test, all subjects were given the Farnsworth Dichotomous Test for Color Blindness. The procedure was modified for preschool subjects. This test was designed to screen subjects with substantial degrees of color blindness. All mothers passed the test. Those nursery school subjects who failed the Farnsworth Test after two trials were given a modified version of the Ishihara Tests for Color Blindness. Seven subjects took the Ishihara test, six boys and one girl. All but one boy passed the Ishihara test. The boy who failed the test was dropped from the study. The descriptions of these two color blindness tests are presented in Appendices A and B.

## Experimental Setting

The nursery school children and their mothers were tested individually. The testing room was bland in color (a very pale yellow) and all extraneous color material was removed. A one-way glass was located along one wall. The lighting was fluorescent ceiling lights. There was one small window and a louvered door panel which were covered to prevent other light from entering the room. Lighting was similar for testing in the morning and afternoon sessions. The lighting level in the room was tested with a spot brightness meter and the easel was set so that the left and right color samples received equal amounts of light.

The testing materials were presented at eye-level about three feet from the subjects on a black felt-covered easel. A small, black felt-covered table was placed between the subjects and the easel. The subjects were seated in a child-sized chair at the table. It was desired that they be close enough to the color samples to indicate a preference by pointing, but far enough away so they could not touch the colors. To the right of the subjects, the testing materials were placed face down on a black felt-covered table. To give the initial instructions the experimenter squatted to the eye-level of the subjects between the two tables. Then she stood in order to present the pairs of color samples.

The setting for testing the mothers was the same research room. Mothers were seated in the child-sized chair at the black felt-covered table in front of the easel. The easel shelf on which the color samples

were displayed was raised to the eye-level of the mothers.

The author administered all tests. To avoid biasing the subject's choices during the testing, the experimenter wore a gray dress that was judged by three individuals to match closely to a value of 4 in the Munsell System.

## Procedure

After gaining rapport with the subjects in the nursery school, the experimenter said that she was trying to find out what children like and that she had something downstairs to show the subject. The experimenter then told the subject that it was his turn to come downstairs. A teacher was allowed to accompany the subject if he refused to come alone with the experimenter. Three of the young three-year-old male subjects were accompanied by their head teacher.

In the testing room, the experimenter seated the subject and proceeded with the following task instructions (Holt, 1969, p. 1):

> Do you see this board? (indicating easel) I'm going to put two colors up here... one here (indicate left space) and one here (indicate right space). You look at both of them, carefully, and then decide which one you like the best. After you look at both of the colors, point to the one you like. Even if you don't like either one much, show me which one you like better. Are you ready to try it? OK, here are the first colors.

The experimenter then placed one stimulus pair on the easel and instructed the subject, "Show me the one you like best." When necessary, the experimenter confirmed the subject's choice by pointing to the color sample and asking, "This one?" After each presentation, the experimenter recorded the subject's choice. After the completion of the task, the

experimenter praised the child for doing a good job.

Then the experimenter said:

> I have one other thing I would like you to see. Do you see this little black box? (indicate Farnsworth Test) I'm going to open it and show you what is inside.

The Farnsworth Dichotomous Test for Color Blindness was administered to each subject. The instructions for this test, somewhat modified for the preschool child, appear in Appendix A.

Following this test, the experimenter praised the subject for doing a good job and returned him to nursery school. Subjects who failed the Farnsworth test were retested within one week, using the same procedure. If the subject had a questionable score on the second test, he was then given a modified version of the Ishihara Tests for Color Blindness. The procedure for this test can be found in Appendix B.

The mothers of subjects were contacted first by letter and later by telephone for appointments. The experimenter explained that she was trying to find out something about the preferences of preschool children and their mothers. All mothers, except two who were working, were tested during nursery school hours. Baby sitting was arranged if necessary.

The mothers of the subjects took the color preference test and the Farnsworth Dichotomous Test for Color Blindness in that order. The instructions to the mothers for the color preference test were as follows (Arnold, 1969, p. 2):

> I am going to put two colors on this easel (indicate), one color under "left" and one color under "right". You have to decide which color you like best. After you have decided, make a check

> mark under left if you like that one best. If you like the right one best, make a check mark under right on your answer sheet. You can only choose one of each pair of colors. Even if you don't like either of the colors very much or you like both of the colors, choose the one you like best. Before each pair of colors, I will tell you the pair number. Do you have any questions before we begin?

Following this test, the mother was given the Farnsworth Dichotomous Test for Color Blindness. Total testing time for each subject was about 15 minutes.

## Analysis of Data

The data obtained from this investigation were studied by means of analyses of variance. The experimental design used was the split plot design with a factorial arrangement of treatments. The analysis of variance was used to test null hypotheses and to see if there were differences between the means of two or more groups receiving different treatments (Winer, 1962). Experimental units were exposed to certain treatments and the technique was used to test whether the treatments had a significant effect on the performance of the experimental units. In this investigation there were five treatments--age, sex, hue, value and chroma--and two levels of each treatment, as shown in Table 6.

It is often desirable to get more information on some treatments than on others. To test the significance of these treatments and their interaction with the other treatments may be the purpose of the experiment. The split plot design is appropriate for such situations. In this investigation, attention was focused on the three subtreatments, hue, value

Table 6. Treatment levels in split-plot design

| Treatment | Level 1 | Level 2 |
|---|---|---|
| Age | three-year-olds | four-year-olds |
| Sex | male | female |
| Hue | 10P | 10GY |
| Value | 5 | 7 |
| Chroma | 4 | 8 |

and chroma and on their interaction with the main treatments, age and sex. Thus, the split plot design was used in this study (Snedecor and Cochran, 1967, p. 369). Data for each child corresponded to a plot and were split among the eight factorial combinations of the three subtreatments of hue, value and chroma. Random orderings of all eight stimuli were randomly presented to each child. Thus, the subtreatments were applied to the subjects randomly. The main treatments were fixed.

The method by which the eight color stimuli were presented to the subjects was Thurstone's method of paired comparisons (Edwards, 1957, p. 20). The stimuli were paired so that each one appeared with every other one. The subject was asked to indicate a preference for one of the colors in each pair and frequency-of-choice scores were computed. The choice scores are presented in Appendix C. These frequencies were converted into scale value or z scores (Woodworth and Schlosberg, 1954, p. 253). These scores were then subjected to analyses of variance to assess the interactions between the main treatments, among the main treatments and

the subtreatments, and among the subtreatments. An analysis of covariance was used to determine the relationship of the mother's pattern of preferences for the three factors of hue, value and chroma to her child's pattern of preferences for hue, value and chroma (Winer, 1962).

# FINDINGS

## Color Preferences among Children

The analysis of variance is presented in Tables 7 through 11, and 14. The sources of variation in each table correspond to treatments except for the last row, which corresponds to the experimental error. Each F-statistic tested the null hypothesis that the treatment had no significant effect.

Table 7 presents the results of the analysis of variance for the main treatments, sex and age. Sex, age and sex by age interactions were

Table 7. Sex and age differences among children's color preferences

| Source of variation | Degrees of freedom | Mean square | F-value[a] |
|---|---|---|---|
| Sex | 1 | .0006 | .1840 |
| Age | 1 | .0025 | .8361 |
| Sex x Age | 1 | .0026 | .8696 |
| Error | 44 | .0030 | |

[a] $F_{.05} = 4.06$; $F_{.01} = 7.24$.

not significant in this study. Therefore, there is no basis for rejection of the hypotheses of no difference in the pattern of preferences for the qualities of color between boys and girls, or between three-year-olds and four-year-olds.

The analysis of variance for the subtreatment of hue preferences for purples and greens and their interactions with sex and age are presented in Table 8. The hypothesis of no difference in the preference for hue between three-year-olds and four-year-olds cannot be rejected. The F-statistic for the hue by sex interaction, 3.29, approaches significance ($F_{.10} = 2.84$), indicating the possibility of a sex difference in hue

Table 8. Hue differences among children's color preferences

| Source of variation | Degrees of freedom | Mean square | F-value[a] |
|---|---|---|---|
| Hue | 1 | .0726 | .1178 |
| Hue x Sex | 1 | 2.0329 | 3.2979 |
| Hue x Age | 1 | .8048 | 1.3057 |
| Hue x Sex x Age | 1 | .3337 | .5414 |
| Error | 44 | .6164 | |

[a] $F_{.05} = 4.06$; $F_{.01} = 7.24$.

preferences. Table 9 shows the mean preferences for boys and girls for the two hues studied. Boys showed a tendency to prefer greens while girls preferred purples.

Table 10 presents the analysis of variance for the sub-treatment of value and its interaction with age and sex. This table indicates that none of the treatments was significant in this study and that therefore

Table 9. Means of hue preferences for boys and girls

| | Boys | Girls |
|---|---|---|
| $H_1$ (purple) | -0.0556 | .0875 |
| $H_2$ (green-yellow) | .0624 | -.0855 |

Table 10. Value differences among children's color preferences

| Source of variation | Degrees of freedom | Mean square | F-value[a] |
|---|---|---|---|
| Value | 1 | .0610 | .2070 |
| Value x Sex | 1 | .0438 | .1485 |
| Value x Age | 1 | .0041 | .0140 |
| Value x Sex x Age | 1 | .0794 | .2692 |
| Error | 44 | .2948 | |

[a] $F_{.05} = 4.06$; $F_{.01} = 7.24$.

there is no basis for the rejection of the hypotheses of no preference for hues of lighter value over hues of darker value, or of no difference between boys' and girls' preferences or between three-year-olds' and four-year-olds' preferences on this dimension.

In Table 11, the analysis of variance for the subtreatment of chroma and its interaction with age and sex is recorded. Chroma and its interaction with sex were significant in this investigation. Thus, the null

Table 11. Chroma differences among children's color preferences

| Source of variation | Degrees of freedom | Mean square | F-value[a] |
|---|---|---|---|
| Chroma | 1 | 11.0568 | 11.0568** |
| Chroma x Sex | 1 | 1.5226 | 4.4656* |
| Chroma x Age | 1 | .1226 | .3594 |
| Chroma x Sex x Age | 1 | .3528 | 1.0348 |
| Error | 44 | .3410 | |

[a] $F_{.05} = 4.06$; $F_{.01} = 7.24$.

**$p < .01$.

*$p < .05$.

hypotheses of no preference for hues of higher chroma over hues of lower chroma, and of no difference between boys' and girls' preferences for chroma can be rejected. However, there is no basis for rejecting the hypothesis of no difference in the preference for chroma between three- and four-year-olds. The mean preferences for the levels of chroma are given in Table 12. This table indicates that the direction of preference is for hues of higher chroma (or brighter colors) among children in this study.

The chroma-sex interaction was also significant. Table 13 gives the means for the interaction of sex with each level of chroma. A difference in the magnitude of preference for chroma was found between boys and girls.

Table 12. Mean preferences for levels of chroma

| | |
|---|---|
| $C_1$ (lower) | -0.1675 |
| $C_2$ (higher) | .1719 |

Table 13. Means for the chroma-sex interaction

| | Boys | Girls |
|---|---|---|
| $C_1$ (lower) | -0.1033 | -0.2317 |
| $C_2$ (higher) | .1101 | .2337 |

Both boys and girls preferred the hues of higher chroma. However, girls preferred brighter colors more than did boys. They also preferred duller colors less than did boys.

The analysis of variance for the interactions between the subtreatments and the interactions between the subtreatments and the main treatments of age and sex are presented in Table 14, in which F-statistics for three two-way interaction terms, seven three-way interaction terms, five four-way interaction terms and one five-way interaction term are reported. Since none of these was significant, a detailed interpretation will not be given.

## Color Preferences among Mothers

This study also investigated the color preferences of the mothers. The preference for a color was measured by the number of times it was

Table 14. Interaction differences among children's color preferences

| Source of variation | Degrees of freedom | Mean square | F-value[a] |
|---|---|---|---|
| Hue x Value | 1 | .6305 | 1.8840 |
| Hue x Value x Sex | 1 | .0341 | .1020 |
| Hue x Value x Age | 1 | .1625 | .4857 |
| Hue x Value x Sex x Age | 1 | .2970 | .8876 |
| Error | 44 | .3347 | |
| Hue x Chroma | 1 | .2522 | .9993 |
| Hue x Chroma x Sex | 1 | .0000 | .0000 |
| Hue x Chroma x Age | 1 | .0005 | .0018 |
| Hue x Chroma x Sex x Age | 1 | .3876 | 1.5346 |
| Error | 44 | .2526 | |
| Value x Chroma | 1 | .0235 | .9973 |
| Value x Chroma x Sex | 1 | .0014 | .0070 |
| Value x Chroma x Age | 1 | .4361 | 2.1369 |
| Value x Chroma x Sex x Age | 1 | .1067 | .5227 |
| Error | 44 | .2041 | |
| Hue x Value x Chroma | 1 | .2542 | 1.0003 |
| Hue x Value x Chroma x Sex | 1 | .0138 | .0542 |
| Hue x Value x Chroma x Age | 1 | .4718 | 1.8565 |
| Hue x Value x Chroma x Sex x Age | 1 | .0737 | .2900 |
| Error | 44 | .2541 | |

[a] $F_{.05} = 4.06$; $F_{.01} = 7.24$.

chosen when paired with each other color. An analysis of variance was conducted for the mothers' preferences. Table 15 presents the results for the main treatments and subtreatments and for the interactions between the main and subtreatments. It indicates that hue, value, hue-value interactions and hue-chroma interactions were highly significant. Chroma was also significant for the mothers' preferences. Therefore, the hypotheses of no preference among mothers for one hue over another, of no preference for lighter value over darker value and of no preference for higher chroma over lower chroma can be rejected.

Tables 16, 17, and 18 present the means for the two levels of hue, value and chroma, respectively. Table 16 indicates that mothers preferred the greens over the purples. Table 17 shows the direction of preference for hues of lighter value over darker hues for the mothers. Table 18 indicates the direction of preference for chroma, the mothers preferring hues of higher chroma (that is, brighter colors).

The means for the hue-value interaction are reported in Table 19. These means indicate the direction and magnitude of mothers' preferences for the combinations of hue and value. The lighter purple was preferred to the darker purple and the lighter green was chosen more frequently than was the darker green. Of the darker hues, greens were preferred to purples. This was also the case with lighter-value hues. The overall order of preference among these hues and values was light green, dark green, light purple, dark purple.

The hue-chroma interaction for the mothers is presented in Table 20. The means in this table show differences in the mothers' preferences for

Table 15. Differences among mother's color preferences

| Source of variation | Degrees of freedom | Mean square | F-value[a] |
|---|---|---|---|
| Sex | 1 | .0000 | .0052 |
| Age | 1 | .0100 | 1.9841 |
| Sex x Age | 1 | .0016 | .3135 |
| Error | 44 | .0050 | |
| Hue | 1 | 27.7779 | 35.5676** |
| Hue x Sex | 1 | 1.4925 | 1.9110 |
| Hue x Age | 1 | .0900 | .1153 |
| Hue x Sex x Age | 1 | .0004 | .0005 |
| Error | 44 | .7810 | |
| Value | 1 | 24.4924 | 29.5616** |
| Value x Sex | 1 | .2035 | .2456 |
| Value x Age | 1 | .3163 | .3817 |
| Value x Sex x Age | 1 | .2204 | .2660 |
| Error | 44 | .8285 | |
| Chroma | 1 | 6.7204 | 4.4213* |
| Chroma x Sex | 1 | .7159 | .4710 |
| Chroma x Age | 1 | .7812 | .5139 |
| Chroma x Sex x Age | 1 | .0710 | .0467 |
| Error | 44 | 1.5201 | |

[a] $F_{.05} = 4.06$; $F_{.01} = 7.24$.

**$P < .01$.

*$P < .05$.

Table 15. (Continued)

| Source of variation | Degrees of freedom | Mean square | F-value[a] |
|---|---|---|---|
| Hue x Value | 1 | 4.6684 | 15.0925 ** |
| Hue x Value x Sex | 1 | .0693 | .2242 |
| Hue x Value x Age | 1 | .0000 | .0000 |
| Hue x Value x Sex x Age | 1 | .1291 | .4173 |
| Error | 44 | .3093 | |
| Hue x Chroma | 1 | 6.0000 | 12.9648** |
| Hue x Chroma x Sex | 1 | .0677 | .1464 |
| Hue x Chroma x Age | 1 | .0273 | .0591 |
| Hue x Chroma x Sex x Age | 1 | .0491 | .1060 |
| Error | 44 | .4628 | |
| Value x Chroma | 1 | .6650 | 2.5981 |
| Value x Chroma x Sex | 1 | .4134 | 1.6153 |
| Value x Chroma x Age | 1 | .0312 | .1218 |
| Value x Chroma x Sex x Age | 1 | .4988 | 1.9489 |
| Error | 44 | .2560 | |
| Hue x Value x Chroma | 1 | .0546 | .2445 |
| Hue x Value x Chroma x Sex | 1 | .2752 | 1.2320 |
| Hue x Value x Chroma x Age | 1 | .0039 | .0174 |
| Hue x Value x Chroma x Sex x Age | 1 | .2234 | 1.0040 |
| Error | 44 | .2234 | |

Table 16. Mean preferences for hue of mothers

| | |
|---|---|
| $H_1$ (purple) | -0.2681 |
| $H_2$ (green-yellow) | .2698 |

Table 17. Mean preferences for value of mothers

| | |
|---|---|
| $V_1$ (darker) | -0.2517 |
| $V_2$ (lighter) | .2534 |

Table 18. Mean preferences for chroma of mothers

| | |
|---|---|
| $C_1$ (lower) | -0.1315 |
| $C_2$ (higher) | .1331 |

Table 19. Means for the hue-value interaction

| | $H_1$ (purple) | $H_2$ (green-yellow) |
|---|---|---|
| $V_1$ (darker) | -0.6309 | .1275 |
| $V_2$ (lighter) | .0947 | .4121 |

Table 20. Means of hue-chroma interaction

| | $H_1$ (purple) | $H_2$ (green-yellow) |
|---|---|---|
| $C_1$ (lower) | -0.5254 | .2625 |
| $C_2$ (higher) | -0.0108 | .2771 |

the combinations of hue and chroma. Brighter purple was preferred to duller purple. The green of higher chroma was slightly preferred to the lower chroma green. Considering only lower chroma hues, the greens were preferred to the purples. Of the higher chroma hues, greens were chosen over purples. Among these four combinations of hue and chroma, the lower chroma purple was least preferred and the higher chroma green was most preferred.

## Mothers' Influence on Children's Color Preferences

In this study, an analysis of covariance was made of the children's preferences using the mothers' preferences as a covariant. The results are presented in Table 21. When the children's preferences were adjusted for the mothers' preferences, chroma was highly significant and the chroma-sex interaction was significant. In the original analysis of variance of children's preferences, chroma was significant at the .01 level, while the chroma-sex interaction was significant at the .05 level. There was no change in significance of treatments after the children's

Table 21. Hue, value and chroma preferences among mothers

| Source of variation | Degrees of freedom | Mean square | F-value[a] |
|---|---|---|---|
| Sex | 1 | .0005 | .1717 |
| Age | 1 | .0013 | .4377 |
| Sex x Age | 1 | .0032 | 1.0741 |
| Error | 44 | .0030 | |
| Hue | 1 | .0558 | .0886 |
| Hue x Sex | 1 | 2.2070 | 3.5680 |
| Hue x Age | 1 | .7256 | 1.1731 |
| Hue x Sex x Age | 1 | .3306 | .5345 |
| Error | 44 | .6186 | |
| Value | 1 | .0545 | .1852 |
| Value x Sex | 1 | .0212 | .0719 |
| Value x Age | 1 | .0002 | .0006 |
| Value x Sex x Age | 1 | .0460 | .1564 |
| Error | 44 | .2943 | |
| Chroma | 1 | 8.0557 | 23.3553** |
| Chroma x Sex | 1 | 1.7005 | 4.9302* |
| Chroma x Age | 1 | .2064 | .5985 |
| Chroma x Sex x Age | 1 | .3083 | .8938 |
| Error | 44 | .3449 | |

[a] $F_{.05} = 4.07$; $F_{.01} = 7.26$.

**$P < .01$.

*$P < .05$.

Table 21. (Continued)

| Source of variation | Degrees of freedom | Mean square | F-value[a] |
|---|---|---|---|
| Hue x Value | 1 | .8088 | 2.4135 |
| Hue x Value x Sex | 1 | .0485 | .1448 |
| Hue x Value x Age | 1 | .1622 | .4840 |
| Hue x Value x Sex x Age | 1 | .2423 | .7229 |
| Error | 44 | .3351 | |
| Hue x Chroma | 1 | .0167 | .0653 |
| Hue x Chroma x Sex | 1 | .0015 | .0059 |
| Hue x Chroma x Age | 1 | .0020 | .0076 |
| Hue x Chroma x Sex x Age | 1 | .4245 | 1.6575 |
| Error | 44 | .2561 | |
| Value x Chroma | 1 | .2976 | 1.4620 |
| Value x Chroma x Sex | 1 | .0025 | .0122 |
| Value x Chroma x Age | 1 | .4673 | 2.2962 |
| Value x Chroma x Sex x Age | 1 | .1712 | .8409 |
| Error | 44 | .2035 | |
| Hue x Value x Chroma | 1 | .2862 | 1.1193 |
| Hue x Value x Chroma x Sex | 1 | .0020 | .0077 |
| Hue x Value x Chroma x Age | 1 | .4599 | 1.7987 |
| Hue x Value x Chroma x Sex x Age | 1 | .1109 | .4339 |
| Error | 43 | .2557 | |

preferences were adjusted for the influence of the mothers.

Thus, it can be interpreted that the mothers' preferences for the qualities of color had no influence on children's preferences for the qualities of color.

# DISCUSSION

## Conclusions

For the children as a group, no significant difference was found in preferences for green and purple hues or for lighter or darker values. Colors of higher chroma, however, were preferred to those of lower chroma. The pattern of three-year-olds was not found to be significantly different from that of four-year-olds. Boys and girls appeared to have the same preferences for value. Although both boys and girls preferred hues of higher chroma, this preference was more pronounced for girls. At the .10 level of significance, there was a difference in the preferences of boys and girls for green and purple. Girls preferred purples and boys preferred greens.

The mothers were found to have a pattern of preference for the dimensions of color. Green was preferred to purple, lighter value and higher chroma hues were preferred. Light green, dark green, light purple and dark purple were preferred in that order. The order of preference for chroma was bright green, duller green, bright purple and duller purple. No relationship was found between the mothers' pattern of preferences for the qualities of color and the children's pattern of preferences.

## Limitations of the Study

The findings of this study are limited by several factors. The sample size was very small and the subjects were not selected at random,

so the generalizations from this study cannot be applied to a wider population. In addition, the subjects were chosen from children attending a university nursery school, already a select group.

The choice of color stimuli was very limited. Only two out of a possible 40 equally-spaced hues on a scale from zero to one-hundred, were presented. For each of the hues, nine values and several chromas were possible. Only two value and two chroma levels were used. The particular hues selected and the small number of hues utilized in the study prevent the testing of frequently-stated hypotheses such as:

> Children's color preferences develop and shift with age, showing a tendency to move from warm to cool colors with increasing years.
> (Burnham, Hanes, and Bartleson, 1963, p. 212)

The small number of values and chroma levels is also a limitation in so far as preferences for these dimensions may be curvilinear, that is, increasing up to a point and decreasing thereafter. In addition, the value levels used in this study were five and seven, only two steps apart. This very small difference in value levels could account for the fact that no significant difference in preference for value was found. Certainly there is the possibility that when values are far apart from each other, a more definite response to one or the other might occur.

A third limitation of this study was the lack of a test for validity of the experimental procedure. Some limitations of the procedure and experimental setting should be mentioned.

The mothers' instructions were not complete. They were told to choose the color they liked better. Frequently they commented that their

choice depended so much on what it was to be used for. In this study, the experimenter just repeated the instructions for the mother to choose the one she liked better. Guilford and Smith (1959) instructed their adult subjects to

> judge the pleasantness of the color presented, being careful to judge it as a color. Do not think of it in connection with any object in particular, but rather take it just as a sensation (Guilford and Smith 1959, p. 489).

These instructions would have clarified the task for the mothers.

The tests for color blindness also had limitations for use with young children. On the Farnsworth Dichotomous Test for Color Blindness, the nursery school children made many minor errors by mixing up adjacent color buttons or by starting part of the series in reverse. Unless the pattern was parallel to one of the reference axes or laced across the circular pattern two or more times, the subject was passed. This meant that more minor errors were accepted as passing than might be accepted from an adult taking the same test. With the Ishihara Tests for Color Blindness, it was difficult to determine precisely the children's responses. Their instructions were to trace their fingers around the designs. They often did this quickly and it was difficult to determine exactly what they were tracing. Furthermore, they were not interested in repeating the tracing but rather wanted to see the next card. The cards that were examined for passing children were the ones on which the subjects with normal vision would see nothing, but the colorblind subjects would see something. Subjects who shrugged their shoulders were

assumed to see nothing and thereby have normal color vision. The one child who was dropped from the study because of suspected color blindness not only was very confident in his choice of Farnsworth buttons but also confidently traced the designs in which the subject with normal vision could see nothing.

Probably developmental differences on the part of individuals could account for their scores on the colorblindness tests. Only one girl who was nearly five years old passed the Farnsworth test with no errors. Six of the seven children who failed the test were boys, most of whom were three-year-olds. Their motor coordination and ability to discriminate would be expected to be less advanced than would be the case for older children.

The stimuli were presented rather rapidly to the nursery school subjects. Many had a tendency to be restless,as a result of which the experimenter found it necessary to present the colors as rapidly as possible in order to maintain the attention of the subjects. Because of this, the experimenter was not able to record many of the spontaneous comments of the subjects. The comments that were recorded indicated that the children were trying to label the color stimuli. One girl volunteered that she liked dark things best; a three-year-old boy said that he liked light green. Another boy said that green was his favorite color. Several children called the light value of purple as pink, and one three-year-old girl wanted to see only the pink ones because she liked them best. One child when presented with the pair 10GY 5/4 and

10P 5/4 commented, "I think they look the same!" Apparently he was responding to the darkness the colors had in common. When the subjects named colors, the experimenter always asked them to point to the color they liked best in order to confirm the child's choice.

The use of fluorescent lighting might be a limitation of this study in that the colors probably appeared less saturated than they would have under daylight conditions.

> Small departures from color constancy of illuminated objects are quite common with these lamps and they have frequently been criticized on account of the color distortions which they cause even though their own color may be perfectly acceptable (Wright 1969, p. 269).

A discussion of the problem of using different light sources with Munsell colors is presented by Evans (Evans 1948, Chapter 16). However, the light falling on each stimulus was controlled, as were the surrounding colors in the experimental setting. The colors were also presented simultaneously to prevent subjects from fixating on them in any particular order.

## Relation to the Literature

The findings of this study should be related to the findings of others who have examined the color preferences of preschool children. Hue has been the most studied dimension of color, but prior to this study the hues of green and purple had been studied in only three experiments on preschool children. With a sample of nine children, Holden and Bosse (1900) found that purple was preferred to green. However, Garth and Porter (1934), with 439 subjects, and Hunt (1959), with 32 subjects,

reported that green was preferred. The results of this study fail to confirm any of these studies. Perhaps these results could be due to lack of equivalent color stimuli from study to study. Furthermore, Holden and Bosse (1900) and Garth and Porter (1934) failed to control adequately for value and chroma. Holden and Bosse (1900) did not run a statistical analysis but only reported the ranking. Since this ranking included only positive responses, less confidence can be placed in the obtained results. Hunt (1959) presented stimuli in the form of clothing, a procedure which may have influenced preferences.

Although no significant difference was found in value preferences in the current study, other investigators have reported positive findings. Hunt (1959) reported that lighter value hues, middle value hues and lower value hues were preferred in that order. For kindergarten children, Aldous (1946) found that lighter values were preferred. She did not find that middle or lower value hues were preferred to each other. The small difference in the value levels of the stimuli used in this study may account for the failure to confirm the conclusions of Hunt (1959) and of Aldous (1946).

The finding of this study that higher chroma was preferred confirmed the results of Aars (1899) and Hunt (1959). Hunt noted some tendency for the children to prefer unsaturated hues in their least liked colors. The small sample of hues used in this study prevented an examination of this result.

Looking for age differences, Holden and Bosse (1900) found that

their three-year-old subjects preferred green over purple whereas their four-year-old subjects preferred purple over green. However, this result is subject to the limitations discussed above. In 1934, Garth and Porter reported that the order of preferences was nearly the same for the two age groups, but that the distance between the most- and least-preferred colors was greater for four-year-old children, apparently indicating a greater differentiation in preference for hue on their part. This study found no significant age differences.

The current study found that boys had a slight tendency to prefer green and girls to prefer purple, a result previously reported by Dashiell (1917) and Katz and Breed (1922) for kindergarten children. Only one other study has examined sex differences in preschool children's preference for green and purple. Garth and Porter (1934) found that green was preferred to purple by both sexes.

The preferences of the mothers for green over purple, for lighter values and for higher chromas were in agreement with the literature on color preferences of adult women (Eysenck, 1941; Granger, 1955; Guilford and Smith, 1959). This result provides some support for the experimental procedure used in the present study.

No other study has examined the effect of mothers' preferences on the preferences of their preschool children. Aldous (1946) found no significant effect on the color preferences of kindergarten children due to the colors of the home environment. In so far as the colors of home

environments reflect the mothers' preferences, Aldous' result confirms the result of a portion of this study.

## Implications for Further Study

In reviewing the literature, it appeared that the color preferences of young children are complex and cannot easily be resolved by statements to the effect that preferences shift from warm to cool colors with increasing age or that boys and girls differ in a particular way in their preferences for color. A summary of the literature on the color preferences of infants (Rivoire and Kidd 1966) indicated that red may rank high in the preferences of infants. However, when the results of preschool studies are examined, a preference for a certain ordering of hues is not clear. This can be seen for the preferences reported for green and purple. Furthermore, in looking at studies on older children's preferences, it is not clear that they always prefer cool colors. Gale (1933) found that warm colors were preferred by school children and adolescents. A tendency for cool colors within specific pairs, to decline in preference with older children was observed by Child, Hansen, and Hornbeck (1968). The results of analyses of sex and age differences also indicate that their relationship with the dimensions of color are not a foregone conclusion.

Solutions to the questions on children's color preferences cannot be found without looking at large numbers of subjects, using a large sample of colors varying along the three dimensions, and carefully

controlled experimental settings. Then comparisons can be made between experiments to get a clearer idea of preferences. At this time, the research and its interpretations are subjected to many limitations. With more carefully controlled research, statements can be eventually made about the color preferences of subjects with some degree of accuracy. Variation in the results at this time can be partially explained by the different color stimuli used, varying age and maturity levels of subjects, different experimental settings, and different degrees of experience that subjects have had with color.

In terms of future research, it seems that longitudinal studies could perhaps answer some questions about shifts in preferences from one age to another. Only Shinn (1907) has done longitudinal research in this area, reporting on one child over a three year period. Finally, further research needs to be done on color blindness tests for young children. Although previous studies on the color preferences of preschool children have not controlled for color blindness, it would seem that controlling this factor would increase the validity of such studies.

# SUMMARY

The purpose of this research was to investigate: (a) patterns of preference among nursery school children for the qualities of color, (b) differences in the patterns of preference between three- and four-year-old children, (c) differences in the patterns of preference between boys and girls, and (d) effects of mothers' patterns of preference on a, b, and c above.

Forty-eight nursery school children and their mothers served as subjects. An equal number of three- and four-year-old children and an equal number of boys and girls were selected. The children were selected from a university laboratory nursery school, were of middle class background, had no suspected mental retardation, emotional instability, perceptual impairments or color blindness, and had not been tested previously on color preference.

All subjects responded on a color preference test and the Farnsworth Dichotomous Test for Color Blindness; seven preschool subjects performed on a modified version of the Ishihara Tests for Color Blindness. Using the method of paired comparisons for the color preference test, subjects were asked to choose between colors in all possible pairs of a sample of Munsell colors. Eight standard Munsell colors were selected from the two hues, Purple and Green-Yellow. Two levels of value and two levels of chroma were selected for each hue. All tests were administered individually in a controlled experimental setting.

In the color preference test, the subject's choice for one color over the other with which it was paired was computed. These frequency of choice scores were then converted into scale value or z scores, and subjected to analyses of variance. The effect of the mothers' preferences was ascertained by using analysis of covariance.

For the children as a group, no significant difference was found in patterns of preference for hue, and value. Higher chroma was preferred by both boys and girls, although girls showed a greater preference for higher chroma colors than did boys. No significant difference was found in the preferences of three- and four-year-old children for the dimensions of color. At the .10 level of significance, there was a difference in the preferences of boys and girls for green and purple, with girls liking purple and boys liking green. The mothers were found to prefer green to purple, lighter hues to darker hues, and higher chroma over lower chroma. No relationship was found between mothers' pattern of preferences for the qualities of color and children's pattern of preferences.

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ACKNOWLEDGMENTS

I wish to express my sincere appreciation to Dr. Bess-Gene Holt, major professor, for her continued interest, guidance, and encouragement throughout this investigation. Appreciation is expressed to other members of my committee, Dr. Roger Coulson for his invaluable assistance in writing the thesis, Dr. Terry Dickinson for his advice in analyzing and interpreting the data, and Dr. Carole Arnold for her support.

Gratitude is also extended to Miss Mary Meixner for her help in specifying the colors of the experimental setting, and to Mr. Charles Deutsch for his help in reading the spot brightness meter to determine the optimal lighting position for the color stimuli.

Special thanks are also expressed to Dr. Phyllis Lueck and her staff of the Iowa State University Child Development Laboratories for their help and cooperation in this study.

# APPENDIX A. DESCRIPTION AND INSTRUCTIONS OF THE FARNSWORTH DICHOTOMOUS TEST FOR COLOR BLINDNESS

## Description

Test material consisted of a small black box containing 16 different color caps or buttons. One of the buttons was used as a reference point or standard. The subject was required to arrange the other 15 randomly arranged, simultaneously presented caps in serial order according to color, beginning with the reference cap. Each cap was numbered on the reverse side to facilitate scoring and from a table of random numbers, an ordering was determined for presenting them. It was: 1, 7, 14, 6, 2, 10, 11, 4, 9, 8, 5, 3, 15, 13, 12.

During pilot testing with the Farnsworth, it appeared that preschool children were confused when all 16 colors were visible at once. Therefore, a black felt-covered piece of posterboard was used to cover all of placed color buttons except the one most recently selected. The child had a continuously changing reference button, but the posterboard was removed if and when the subject asked to see all the buttons.

The Farnsworth test is a screening device designed to distinguish color blind subjects from moderately color defective and normal subjects (Linksz 1966). It is qualitatively diagnostic for protanopes, deutanopes and tritanopes. The test manual indicates that it cannot be used to distinguish degrees of color blindness in normal subjects (Farnsworth 1947, p. 2).

Passing or failure on the Farnsworth is determined by the particular types of errors made. The subject's ordering of the color buttons is diagrammed for scoring on a circular pattern. Lines crossing the circle parallel and close to one of the axes may indicate the presence of color blindness and the Farnsworth manual recommends retesting the subject. In interpreting the test, the manual states that more weight should be given to crossovers closest to the index lines (Farnsworth 1947, p. 3). Although the manual states that this test is suitable for children, no special instructions were given for the administration and scoring of tests of young subjects. The experimenter in the present study determined that to pass there should not be more than one crossover line near or parallel to a reference axis. Subjects with more than one crossover line failed and were retested within one week.

## Instructions

The written instructions in the Farnsworth manual were given to the mothers:

> The object of the test is to arrange the buttons in order according to color. Take the button from this panel (indicate) which looks most like this button and place it here (indicate space next to the fixed reference cap). Take the button which looks most like that, and place it here; and the button most like that, and place it here; and the button most like that and place it here. Continue doing this until all the buttons are arranged in order (Manual, 1947, p. 3).

The instructions to the preschool subjects varied from the standard instructions. The experimenter pointed to the reference cap and said to the child:

> Do you see the color inside this little black button? The object of this game is to look at all the colors inside the little black buttons on this panel (indicate) and find the color which looks almost like this color (point to the reference cap). When you find the color that looks almost like this one, pick up the button with your fingers and put it here next to this button (point).

After the subject selected one button and placed it by the reference button, the experimenter then said:

> Now which color on this panel looks almost like this one? (pointing to the button the subject just selected. Find the button with the color in it that looks almost like this one and put it here (beside the last button).

These instructions were continued until the child had placed all the buttons in order. The experimenter recorded the subject's score using the procedure specified in the manual.

# APPENDIX B. DESCRIPTION AND INSTRUCTIONS OF THE ISHIHARA TESTS FOR COLOR BLINDNESS USED WITH PRESCHOOL CHILDREN

## Description

The Ishihara Tests for Color Blindness consist of numerous plates which have a form or number made up of small dots embedded in a continuous background of other similar dots. Normal and color blind adults are distinguished by the way they read the Ishihara tests. According to Pickford (1949), the Ishihara Tests are satisfactory for screening major red-green defectives.

Woelfel (1930) developed an adaptation of the Ishihara Tests for use with preschool children. She presented the subject with an Ishihara plate and four cards, one of which had the number painted on it that the normal subject could see, one that had the number the color blind subject could see, and two other numeral cards. The subject was to match the number he saw on the Ishihara plate to one of the four cards. A preliminary test using black instead of colored numbers was given to test the children's ability to match numbers. Woelfel reported that children could not perform on this test until they had a mental age of three years, eleven months.

Woelfel's procedure for the Ishihara Tests was not used in this research. Instead subjects were asked to trace their index finger around the forms in eight Ishihara plates. These particular plates were selected because it was thought that their numbers were different enough to enable the experimenter to determine exactly what the subjects were seeing.

Table 22 lists forms normal and red-green color blind subjects see.

Table 22. Numbers subjects could see in Ishihara plates

| Card | Normal could see: | R-G colorblind could see: |
|---|---|---|
| 11 | "12" | "12" |
| 2 | "8" | "3" |
| 3 | "5" | "2" |
| 4 | "8" | Nothing |
| 5 | Nothing | "5" |
| 6 | Nothing | "2" |
| 7 | Twisted line | Nothing |
| 8 | Nothing | Twisted line |

## Instructions

The experimenter first introduced some black-on-gray designs to the subjects to make sure that they understood the instructions. The experimenter said to the subject:

> I'm going to show you some designs in this book. I want you to trace your finger around the design that is inside the circle of each picture. In some pictures you will see a design and in some pictures you will only see a big circle.

The experimenter then opened the book with the Ishihara plates and pointed to a black triangle pasted inside the gray circle. The experimenter said, "Trace your finger around the black triangle." If the subject appeared not to understand the task, the experimenter took his hand and helped him to trace. When the subject could do this by himself,

the experimenter turned the page to a black curved design pasted on a gray circle and said, "Trace your finger around the design in this picture." After the subject did this, he was shown eight Ishihara plates, one at a time. For each plate, the experimenter repeated the instructions, "Trace your finger around the design in this picture." The subject's response was recorded by the experimenter.

# APPENDIX C. COLOR CHOICE SCORES OF NURSERY SCHOOL CHILDREN AND THEIR MOTHERS

Table 23. Color choice scores of three-year-old boys and their mothers

| Subject Age | 1[a] 3/10[c] | M[b] | 2 3/3 | M | 3 3/3 | M | 4 3/11 | M | 5 3/2 | M | 6 3/5 | M | 7 3/9 | M | 8 3/5 | M | 9 3/0 | M | 10 3/2 | M | 11 3/2 | M | 12 3/2 | M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 P 5/4 | 3[d] | 0 | 2 | 0 | 1 | 4 | 5 | 0 | 3 | 6 | 4 | 0 | 2 | 0 | 3 | 3 | 4 | 1 | 2 | 0 | 4 | 1 | 3 | 2 |
| 10 P 5/8 | 5 | 1 | 4 | 3 | 5 | 3 | 2 | 2 | 3 | 4 | 2 | 2 | 4 | 1 | 3 | 0 | 5 | 4 | 2 | 1 | 4 | 4 | 4 | 0 |
| 10 P 7/4 | 3 | 3 | 4 | 1 | 2 | 4 | 3 | 1 | 6 | 5 | 2 | 3 | 4 | 2 | 3 | 6 | 3 | 1 | 4 | 3 | 3 | 3 | 4 | 6 |
| 10 P 7/8 | 2 | 5 | 3 | 7 | 2 | 4 | 2 | 3 | 4 | 2 | 5 | 3 | 5 | 4 | 5 | 4 | 4 | 2 | 5 | 3 | 3 | 6 | 4 | 3 |
| 10GY 5/4 | 2 | 2 | 1 | 3 | 4 | 7 | 2 | 4 | 4 | 6 | 4 | 6 | 4 | 6 | 1 | 6 | 2 | 3 | 7 | 4 | 2 | 0 | 6 | 5 |
| 10GY 5/8 | 5 | 6 | 5 | 4 | 7 | 1 | 6 | 6 | 2 | 1 | 4 | 2 | 2 | 7 | 5 | 2 | 4 | 7 | 3 | 4 | 3 | 5 | 4 | 3 |
| 10GY 7/4 | 4 | 6 | 2 | 4 | 1 | 4 | 5 | 5 | 3 | 4 | 4 | 5 | 3 | 5 | 4 | 6 | 2 | 5 | 2 | 7 | 6 | 2 | 0 | 7 |
| 10GY 7/8 | 4 | 5 | 7 | 6 | 6 | 1 | 3 | 7 | 3 | 0 | 3 | 7 | 4 | 3 | 4 | 1 | 4 | 5 | 4 | 6 | 3 | 7 | 3 | 2 |

[a]Indicates subject 1.

[b]M = mother of subject 1.

[c]The notation 3/10 is read three years, ten months.

[d]Indicates that subject 1 chose 10 P 5/4 three times out of a possible seven times that it was paired with the other color stimuli.

Table 24. Color choice scores of four-year-old boys and their mothers

| Subject Age | 1[a] 4/8[c] | M[b] | 2 4/4 | M | 3 4/5 | M | 4 4/8 | M | 5 4/6 | M | 6 4/1 | M | 7 4/11 | M | 8 4/10 | M | 9 4/1 | M | 10 4/8 | M | 11 4/1 | M | 12 4/11 | M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 P 5/4 | 3[d] | 1 | 2 | 0 | 4 | 0 | 1 | 1 | 5 | 1 | 3 | 2 | 4 | 0 | 3 | 0 | 3 | 4 | 3 | 3 | 3 | 1 | 3 | 0 |
| 10 P 5/8 | 4 | 0 | 6 | 3 | 6 | 1 | 0 | 2 | 6 | 4 | 3 | 1 | 3 | 2 | 6 | 1 | 3 | 6 | 0 | 1 | 1 | 3 | 5 | 1 |
| 10 P 7/4 | 2 | 4 | 2 | 1 | 3 | 6 | 3 | 1 | 5 | 2 | 6 | 4 | 3 | 1 | 3 | 3 | 3 | 1 | 2 | 3 | 2 | 3 | 1 | 4 |
| 10 P 7/8 | 6 | 3 | 5 | 5 | 4 | 4 | 2 | 5 | 6 | 7 | 2 | 5 | 2 | 3 | 0 | 7 | 5 | 2 | 2 | 1 | 6 | 7 | 5 | 7 |
| 10GY 5/4 | 3 | 7 | 3 | 3 | 2 | 5 | 5 | 2 | 0 | 2 | 6 | 3 | 3 | 4 | 3 | 2 | 4 | 6 | 5 | 6 | 4 | 0 | 4 | 4 |
| 10GY 5/8 | 4 | 3 | 4 | 5 | 5 | 2 | 7 | 7 | 3 | 5 | 3 | 1 | 4 | 5 | 4 | 4 | 4 | 1 | 7 | 5 | 6 | 5 | 2 | 3 |
| 10GY 7/4 | 3 | 5 | 2 | 4 | 2 | 5 | 4 | 5 | 1 | 5 | 2 | 6 | 5 | 6 | 6 | 5 | 4 | 5 | 4 | 7 | 5 | 3 | 4 | 6 |
| 10GY 7/8 | 3 | 5 | 4 | 7 | 2 | 5 | 6 | 5 | 2 | 2 | 3 | 6 | 4 | 7 | 3 | 6 | 2 | 3 | 6 | 2 | 1 | 6 | 4 | 3 |

[a]Indicates subject 1.

[b]M = mother of subject 1.

[c]The notation 4/8 is read four years, 8 months.

[d]Indicates that subject 1 chose 10 P 5/4 three times out of a possible seven times that it was paired with the other color stimuli.

Table 25. Color choice scores of three-year-old girls and their mothers

| Subject Age | 1[a] 3/11[c] | M[b] | 2 3/5 | M | 3 3/4 | M | 4 3/1 | M | 5 3/9 | M | 6 3/1 | M | 7 3/6 | M | 8 3/11 | M | 9 3/9 | M | 10 3/2 | M | 11 3/8 | M | 12 3/3 | M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 P 5/4 | 3[d] | 1 | 4 | 1 | 4 | 1 | 3 | 0 | 2 | 2 | 3 | 1 | 4 | 4 | 3 | 1 | 3 | 0 | 5 | 3 | 3 | 0 | 3 | 3 |
| 10 P 5/8 | 4 | 2 | 4 | 1 | 7 | 6 | 1 | 2 | 4 | 1 | 4 | 4 | 5 | 1 | 2 | 6 | 5 | 2 | 6 | 0 | 4 | 4 | 4 | 5 |
| 10 P 7/4 | 3 | 4 | 2 | 6 | 4 | 0 | 2 | 5 | 5 | 6 | 3 | 2 | 2 | 5 | 4 | 3 | 3 | 2 | 4 | 4 | 5 | 1 | 5 | 0 |
| 10 P 7/8 | 5 | 3 | 4 | 7 | 6 | 4 | 6 | 4 | 4 | 3 | 4 | 5 | 4 | 4 | 5 | 6 | 4 | 6 | 6 | 4 | 6 | 4 | 4 | 2 |
| 10GY 5/4 | 4 | 0 | 4 | 1 | 0 | 2 | 4 | 1 | 2 | 6 | 3 | 7 | 4 | 4 | 5 | 2 | 2 | 5 | 3 | 6 | 3 | 4 | 1 | 4 |
| 10GY 5/8 | 2 | 5 | 4 | 3 | 2 | 7 | 6 | 6 | 4 | 2 | 4 | 2 | 3 | 0 | 4 | 5 | 7 | 5 | 2 | 1 | 3 | 3 | 3 | 7 |
| 10GY 7/4 | 3 | 7 | 1 | 4 | 3 | 3 | 2 | 4 | 4 | 6 | 4 | 6 | 2 | 7 | 3 | 1 | 0 | 2 | 0 | 6 | 3 | 6 | 2 | 1 |
| 10GY 7/8 | 4 | 6 | 5 | 5 | 2 | 5 | 4 | 6 | 3 | 2 | 3 | 1 | 4 | 3 | 2 | 4 | 4 | 6 | 2 | 4 | 1 | 3 | 6 | 6 |

[a]Indicates subject 1.

[b]M = mother of subject 1.

[c]The notation 3/11 is read three years, eleven months.

[d]Indicates that subject 1 chose 10 P 5/4 three times out of a possible seven times that it was paired with the other color stimuli.

Table 26. Color choices scores of four-year-old girls and their mothers

| Subject Age | 1[a] 4/7[c] | M[b] | 2 4/2 | M | 3 4/6 | M | 4 4/4 | M | 5 4/6 | M | 6 4/2 | M | 7 4/4 | M | 8 4/11 | M | 9 4/10 | M | 10 4/5 | M | 11 4/11 | M | 12 4/11 | M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 P 5/4 | 4[d] | 1 | 3 | 1 | 3 | 0 | 5 | 1 | 3 | 0 | 3 | 0 | 3 | 2 | 2 | 0 | 2 | 1 | 1 | 3 | 2 | 1 | 3 | 1 |
| 10 P 5/8 | 2 | 2 | 5 | 3 | 6 | 3 | 6 | 5 | 4 | 3 | 6 | 6 | 5 | 5 | 4 | 2 | 5 | 4 | 3 | 2 | 3 | 4 | 2 | 1 |
| 10 P 7/4 | 4 | 3 | 4 | 3 | 0 | 1 | 3 | 6 | 2 | 2 | 1 | 2 | 4 | 0 | 3 | 6 | 3 | 3 | 2 | 6 | 5 | 3 | 5 | 7 |
| 10 P 7/8 | 6 | 1 | 3 | 7 | 3 | 2 | 3 | 7 | 3 | 2 | 5 | 2 | 3 | 3 | 4 | 5 | 6 | 6 | 3 | 6 | 6 | 6 | 5 | 4 |
| 10GY 5/4 | 1 | 7 | 2 | 1 | 5 | 7 | 1 | 3 | 4 | 3 | 1 | 2 | 1 | 7 | 3 | 1 | 0 | 1 | 4 | 4 | 3 | 0 | 1 | 1 |
| 10GY 5/8 | 4 | 5 | 5 | 2 | 6 | 4 | 3 | 2 | 5 | 7 | 5 | 7 | 6 | 4 | 4 | 6 | 4 | 4 | 7 | 0 | 5 | 5 | 2 | 4 |
| 10GY 7/4 | 4 | 6 | 3 | 6 | 2 | 6 | 2 | 3 | 4 | 5 | 3 | 4 | 2 | 6 | 4 | 3 | 1 | 3 | 3 | 4 | 2 | 2 | 5 | 4 |
| 10GY 7/8 | 3 | 3 | 3 | 5 | 3 | 5 | 5 | 1 | 3 | 6 | 4 | 5 | 4 | 1 | 4 | 5 | 7 | 6 | 6 | 3 | 2 | 7 | 5 | 6 |

[a]Indicates subject 1.

[b]M = mother of subject 1.

[c]The notation 4/7 is read four years, seven months.

[d]Indicates that subject 1 chose 10 P 5/4 4 times out of a possible seven times that it was paired with the other color stimuli.