# ENVIRONMENTAL COLOR FOR PEDIATRIC PATIENT ROOM DESIGN

A Dissertation

by

JIN GYU PARK

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

December 2007

Major Subject: Architecture

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# ABSTRACT

Environmental Color for Pediatric Patient Room Design.

(December 2007)

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Chair of Advisory Committee: Dr. Mardelle M. Shepley

Color has a large impact on our psychological and physiological responses. This study examines the value of color as a component in a healing environment for pediatric patient rooms by measuring color preferences among healthy children, pediatric patients, and design professionals. Environmental satisfaction is a significant mediator between the physical environment and children's health. Previous color preference studies have typically been done with small color chips or papers, which are very different from seeing a color applied on wall surfaces. A simulation method allowed for investigating the value of color in real contexts and controlling confounding variables. The findings of this study demonstrated that blue and green are the most preferred, and white the least preferred color, by both children and design professionals. Children's gender differences were found in that boys prefer red and purple less than girls. Pediatric patients reported lower preference scores for yellow than did healthy children. These findings lead to color application guidelines for designers to understand color more and eventually to create better environments for children and their families.

# DEDICATION

To my father, Young-il Park,

and mother, Hyun-ok Jang,

for their endless love

and lessons on the value of education.

To my wife, Hyun Rang Song,

for the lovely encouragement

and dedication she has given and continues to give.

To my lovely daughters, Ji Won Park and Jessica Park,

and my son, Hoon Chan Park,

for being the most adorable things in my life.

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# CHAPTER I

# INTRODUCTION

## 1.1 BACKGROUND

Color is taken for granted since it surrounds us from birth. People often consider our response to color as instinctive and simple, but it involves a very complex interaction between light, eyes, and the brain (Luke, 1996). Color, as one of the most important elements in our physical environment, has a great impact on our psychological and physiological responses (Manke, 1996). This presents important implications for patients in healthcare settings.

Human well-being is usually promoted when physical environments provide a moderate level of positive stimulation; in other words, if stimulation levels are too high, or too low, the cumulative effect on a patient will be stressful (Wohlwill, 1968). There is also increasing empirical evidence that poor design quality negatively affects a patient's well-being (Ulrich, 1991). An environmental stimulation that produces positive feelings holds a client's attention and interest, and may decrease stress and negative thoughts (Ulrich, 1981). If appropriate visual colors can have positive influences, it is possible that color may add to the comfort of a patient, thus allowing a quicker recovery.

Many healthcare providers and designers have questioned and searched for empirically-based color guidelines for healthcare settings, but the scientific evidence for

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This dissertation follows the style and format of *Environment and Behavior*.

making informed decisions regarding color application for patients has only been loosely tested (Tofle, Schwarz, Yoon, & Max-Royale, 2004).

## 1.2 PROBLEM STATEMENT

Positive environmental stimulations can promote patient well-being by reducing their stress or negative feelings (Ulrich, 1981). If appropriate visual colors can have positive influences, then those colors will make patients more comfortable, allowing for a quicker recovery. While many healthcare providers and designers have searched for empirical guidelines regarding color applications for patients, no source is conclusive (Tofle, Schwarz, Yoon, & Max-Royale, 2004). This may be because the methodologies used in most previous studies have lacked rigor.

Colors need to be studied in real contexts because we experience colors in environments where complex patterns interact with our perception and behavior (Tofle, Schwarz, Yoon, & Max-Royale, 2004). However, previous studies are typically done with small color chips or papers, which are fundamentally different from seeing the color applied to one or more interior surfaces. Additionally, the majority of previous studies have failed to control for confounding variables such as brightness, saturation, light sources, background colors, or cultural factors; in other words, brightness and saturation must be controlled if the hue effect is going to be investigated (Meerum Terwogt & Hoeksma, 1995).

Much of the existing research in environmental design has focused on environments for healthy adults, but those findings cannot be confidently applied to environments for children (Shepley, et al., 1998). According to Jean Piaget, a child's way of understanding does not function the same way as an adult's (Berk, 2002).

While previous studies on healthy children's color preferences are suggestive, none have focused on pediatric healthcare environments. There is a gap in the body of knowledge about how children's color preferences change in response to health status; the empirical evidence regarding color applications for pediatric patients appears to be non-existent. Therefore, a well-controlled investigation of the effects of color on pediatric patients in a real context is necessary.

**1.3 OBJECTIVES**

The purpose of this study is to investigate the value of color as a component in a healing environment for pediatric patient rooms. This is expected to provide empirically-based knowledge regarding appropriate color selections for pediatric populations. The aims of this study are:

1. To investigate pediatric patients' color preferences for patient rooms.
2. To investigate healthy children's color preferences for patient rooms.
3. To investigate design professionals' perception of the appropriate colors for pediatric patient rooms.
4. To compare the color preference data derived from the pediatric patients, healthy children, and design professionals.

## 1.4 SIGNIFICANCE OF THE STUDY

In order to address the limitations found in previous research, this study is the first to use physical model simulation in order to provide a foundation for environmental color studies in real contexts. This research advances the understanding of the value of color in a healthcare setting by studying hospitalized pediatric patients' perceptions of color. This knowledge should facilitate improvements in the design of future children's hospitals.

The practical application of knowledge generated from this study is the provision of a body of empirical evidence which informs the selection of color as a component in the healing environments of pediatric healthcare settings. This evidence will help healthcare providers and professionals select the most appropriate colors for pediatric populations.

# CHAPTER II

# LITERATURE REVIEW

## 2.1 REVIEW OF COLOR STUDIES

There are numerous studies in the field of psychology which demonstrate the relationship between human behavior and color. However, color studies in the environmental design field are almost non-existent. The following section is a review of literature regarding human physiological and psychological responses to color properties.

### 2.1.1 Preferences to Color

Numerous studies have found variations in color preferences across age, gender, and culture, and most literature suggests age differences in color preferences. Cultural and gender effects have been found, but contradictions also exist. In addition, previous color studies were mostly done with small color chips or papers which can be different from seeing a color applied on one or more wall surfaces. Therefore, further investigations are necessary for more rigorous inferences.

#### 2.1.1.1 Important Factors for Color Preferences

According to the Munsell color system, a color is characterized by three attributes: hue, saturation (chroma), and brightness (value). Color preferences can be influenced not only by those color attributes, but also light sources, background colors, culture, or psychological factors. Saturation and brightness also impact color preferences.

Preferences and emotional associations related to a color can be influenced by brightness or saturation (Guilford & Smith, 1959; Sivik, 1974); however, saturation has been found to be more important than hue in terms of affecting people's perception of which color is more calming or exciting (Mikellides, 1990). Additional variables included types of light sources or background colors (Helson & Lansford, 1970), the effect of context (Guilford & Smith, 1959), and cultural factors (Gesche, 1927; Choungourian, 1968; Wiegersma & De Klerck, 1984; Reddy & Bennett, 1985; Saito, 1996).

These confounding variables must be carefully controlled for in a successful color study. Unfortunately, the majority of color preference studies fail to control color attributes (hue, brightness, or saturation) or light sources (Child, Hansen, & Hornbeck, 1968; Meerum Terwogt & Hoeksma, 1995).

Guilford (1934) attempted to demonstrate the effects of the three dimensions of color – hue, brightness (tint), and saturation (chroma) – and affective value. He found linear relationships between affective values and both brightness and saturation when hue remained constant. With a constant hue, Guilford concluded that people preferred lighter and more saturated colors to darker and less saturated. With constant brightness and saturation, blue, green, and red were more preferred, and yellow and orange were less preferred.

Granger (1955) conducted a well-controlled color study to find a general order of color preference and gender effect with fifty subjects representing a wide range of occupations. Confounding variables such as light source and background color were controlled, and color specimens were used from the Munsell color system. The research results indicated that wavelength was the most important determinant for hue preferences, and highly saturated colors were more preferred. In other words, the short-wavelength colors such as blue and green were preferred to long-wavelength colors such as yellow and red; and the more intense the color, the more preferred. There were no gender differences among these preferences.

Guilford and Smith (1959) conducted a systematic study of the roles that hue, brightness, and saturation played in an eleven-point pleasantness scale. Guilford and Smith found that the range of green to blue was most preferred, and the range of yellow and yellow-green was least preferred when brightness and saturation were kept constant. They also found a positive curvilinear relationship between brightness and affective value.

Child, Hansen, and Hornbeck (1968) investigated children's color preferences using more than 1,100 students age 6 to 18. They also found that children's color preferences were a positive function of saturation; in other words, more saturated colors were preferred to less saturated ones. With increasing age, saturation became less important than hue as a determinant of color preference. Blue and green were preferred at all ages. No significant gender or brightness effects were found, but there was a general tendency for their subjects to prefer brighter colors. Additional studies have supported Child, Hansen, and Hornbeck's (1968) findings. Younger children preferred long-wavelength colors, such as red and yellow, to short-wavelength colors, such as blue and green (Palmer, 1973; Adams, 1987; Zentner, 2001).

Color brightness may be correlated with emotional reactions. Many researchers have indicated that bright colors elicit positive emotional associations, and dark colors elicit negative emotional associations at all ages and genders (Boyatzis & Varghese, 1994; Hemphill, 1996; Zentner, 2001).

Among many variables, saturation and brightness most strongly influence color preferences. Saturation and brightness determine color preferences within the same hue family; in other words, highly saturated and brighter colors are usually preferred. When saturation and brightness are kept constant, the short-wavelength colors such as blue and green are preferred to the long-wavelength colors such as yellow and red. Brightness has a relationship to emotional responses; therefore it can be inferred that brighter short-wavelength colors are more likely to produce positive emotional responses.

#### 2.1.1.2 Studies on Age Differences

Infants less than 5 months old showed a preference for chromatic over achromatic stimuli, but they did not show preferential responses to different chromatic stimuli before the third month (Adams, 1987). Red was highly preferred by younger children (Adams, 1987; Bornstein, 1975; Zentner, 2001), but that preference dropped in the first grade and blue tended to be preferred more with increasing age (Garth & Porter, 1934). The preference for green was found to be low for younger children, but increased with age as well (Choungourian, 1969; Dittmar, 2001; Meerum Terwogt & Hoeksma, 1995).

For adults, blue was a predominantly preferred color for Americans (Eysenck, 1941; Guilford & Smith, 1959; Simon, 1971; Valdez & Mehrabian, 1994), Swiss (Zentner, 2001), Japanese, Chinese, and Indonesians (Saito, 1996), Australians (Trueman, 1979; Hemphill, 1996), Dutch (Meerum, Terwogt, & Hoeksma, 1995), and Kenyans (Philbrick, 1976). Yellow was least preferred by American adults (Eysenck, 1941; Guilford & Smith, 1959; Valdez & Mehrabian, 1994), German adults (Dittmar, 2001), and Turkish adults (Camgöz, Yener, & Güvenç, 2001).

Dittmar (2001) investigated the effect of ageing on color preferences using 842 subjects. For younger and older adults, blue was the most preferred color and yellow was the least preferred. As age increased, the adult preference for blue decreased gradually, whereas the preference for green and red increased. The researcher concluded that adult color preferences change throughout the adult life span. The author discussed that reductions in color discrimination and visual imagery ability may influence color preferences.

2.1.1.3 Studies on Gender Differences

The majority of color preference studies have not supported a gender effect in children and adults (Child, Hansen, & Hornbeck, 1968; Dittmar, 2001; Granger, 1955; Mather et al., 1971; Tate & Allen, 1985; Wijk et al., 1999). However, Ellis and Ficek (2001), Silver and Ferrante (1995), and Silver et al. (1988) indicated that blue was preferred more by adult males than by adult females as the most preferred color; yet blue was still the most preferred color (followed by red) for both genders. It has been observed that males consider the range of cool colors most pleasant, whereas females consider the range of warm colors most pleasant (Helson & Lansford, 1970).

### 2.1.1.4 Studies on Cultural Differences

Culture seems to impact color preferences. While blue was most preferred by Caucasian children in grades 1 through 10 (Garth, 1924), red was selected most often as a favorite color by Mexican children in grades 1 through 7 (Gesche, 1927), 11 to 21-year-old full blood Native Americans (Garth, 1922), as well as 6 to 17-year-old Filipino children (Garth & Collado, 1929). However, Palmer (1973) found no differences among Caucasian and African-American children. Table 2.1 summarizes color preferences of children with different cultural backgrounds.

TABLE 2.1
Color Preferences of Children with Different Cultural Backgrounds

| Author | Subject | Color Rank Order From Most preferred | Gender Effect |
|---|---|---|---|
| Garth, 1922 | 559 full-blood Indians<br>174 mixed-blood Indians | RBVGOYW<br>BRVWGOY | No<br>No |
| Garth, 1924 | 560 Caucasians | BGRVOYW | No |
| Garth & Collado, 1929 | 1,004 Filipinos | RGBVOWY | No |
| Gesche, 1927 | 1,152 Mexicans | RGBVOWY | No |
| Meerum Terwogt & Hoeksma, 1995 | 24 of 7 year old children<br>24 of 11 year old children | BYRWGK<br>BRYWGK | No<br>No |
| Mercer (in Gesche, 1927) | 1,006 Blacks | BOGVRYW | N/A |
| Palmer, 1973 | 80 Caucasians & Blacks | RBYWK | No |
| Zentner, 2001 | 103 Swiss Caucasians | RPBYGNK | No |

NOTE: B-blue, G-green, K-black, N-brown, O-orange, P-pink, R-red, V-violet, W-white, Y-yellow

Within limited color samples (red, orange, yellow, green, blue, and purple), yellow was less preferred by school children of Caucasian (Garth, 1924), Native American (Garth, 1922), Mexican (Gesche, 1927), and Filipino backgrounds (Garth & Collado, 1929). When adding more color samples to the available choices, dark colors (such as black and brown) were the least preferred for Caucasian children (Hurlock, 1927; Zentner, 2001). It is worth noting that these studies did not look at color applied in full scale environments. Table 2.2 presents a summary of color preference studies on children.

TABLE 2.2
Color Preference Studies on Children

| Authors | Subjects | Variables | Findings |
|---|---|---|---|
| Adams, 1987 | 80 children and adults | Blue, Green, Yellow, Red, Gray | • All subjects preferred the chromatic colors over gray (achromatic)<br>• 3-month-olds preferred the long-wavelength colors (Red, Yellow) to the short-wavelength colors (Blue, Green), whereas adults showed the opposite pattern of preference<br>• Infants preferred chromatic over achromatic stimuli, but infants do not show preferential responses to different colors before the third month of age<br>• Human color preference changed with age |
| Boyatzis & Varghes, 1994 | 60 children | Blue, Red, Green, Yellow, Purple, Pink, Brown, Gray, Black | • Boys preferred: blue (26%)<br>• Girls preferred: pink (50%)<br>• All children showed more positive responses for bright colors (blue, green, red, yellow, purple, pink) than for dark colors (brown, gray, black)<br>• Children's emotional responses to bright colors tended to be positive with increasing age |

TABLE 2.2 (Continued)

| Authors | Subjects | Variables | Findings |
|---|---|---|---|
| Child, Hansen, & Hornbeck, 1968 | More than 1,100 children | Multiple color pairs | • Cool colors (blue and green) were preferred at all ages from 6-18.<br>• Preference was a positive function of saturation<br>• No significant brightness effect, but there was a general tendency to prefer higher brightness<br>• With increasing age, saturation became less important than hue as a determinant of color preference<br>• No gender effect |
| Fleming, Holmes, Barton, & Osbahr, 1993 | 89 children | 6 colors (Picture test): Blue, Yellow, Red, Green, Brown, Black<br><br>8 colors (Lüscher color test): Blue, Yellow, Red, Green, Violet, Brown, Gray, Black | • Well children most preferred blue<br>• Among ill children, 7-9 years preferred blue (32.5%) and green (35%), 10-12 years preferred blue (45.2%) dominantly (next red 9.7%)<br>• Picture test: physically disabled children preferred blue (93.7%) more than acutely ill children did (57.1%)<br>• Lüscher color test: well children most preferred green (47.1%) and blue (41.1%), whereas ill children most preferred red (31.4 %) and blue (19.6%)<br>• Unhealthy children selected red most often as the first or second favorite color in both the Lüscher color test and picture test<br>• Health status is an important factor in the color selection<br>• No gender or cultural difference |
| Garth, 1922 | 559 children | Blue, Green, Red, Yellow, Orange, Violet, White | • Full-blood Indians: red, blue, violet, green, orange, yellow, white<br>• Mixed-blood Indians: blue, red, violet, white, green, orange, yellow<br>• Caucasians: blue, green, red, violet, orange, yellow, white<br>• No gender difference among Indians |
| Garth, 1924 | 1,000 children | Blue, Green, Red, Yellow, Orange, Violet, White | • Caucasian children: blue, green, red, violet, orange, yellow, white |

TABLE 2.2 (Continued)

| Authors | Subjects | Variables | Findings |
|---|---|---|---|
| Garth & Collado, 1929 | 1,004 children | Blue, Green, Red, Yellow, Orange, Violet, White | • Filipino children: red, green, blue, violet, orange, white, yellow<br>• The girls' preference value to green was higher than the boys' |
| Garth & Porter, 1934 | 1,032 children | Blue, Green, Red, Yellow, Orange, Violet, White | • Red was highly preferred by all age-groups for children and it dropped in the first grade<br>• Blue tended to be more preferred with increasing age, and the gap between blue and yellow tended to increase with age |
| Gesche, 1927 | 1,152 children | Blue, Green, Red, Yellow, Orange, Violet, White | • Mexicans: red, green, blue, violet, orange, white, yellow<br>• No gender difference in Mexican children<br>• Group differences among Mexicans, whites, and full-blood Indians<br>-Mexicans: RGBVOWY<br>-Whites: BGRVOYW<br>-Full-blood Indians: RBVGOYW<br>-Mixed-blood Indians: BRVWGOY<br>-Southern Blacks: BOGVRYW |
| Hurlock, 1927 | 400 children<br><br>(194 Caucasians and 206 African-Americans) | Green, Red, Brown, Crimson, Pink, Blue, Violet, White, Purple, Yellow, Orange, Gray, Black | • Most preferred by both groups: blue and pink<br>• Least preferred by both groups: black, brown, gray<br>• No significant group differences |
| Katz & Breed, 1922 | 2,500 children and adults | Blue, Green, Red, Yellow, Orange, Violet | • Age 5-5: blue was most frequently preferred<br>• Age 5-22: blue (47%), green, red, violet/yellow, orange<br>• As age increased, so did the preference value to short wave length colors (green, blue, violet) and the preference value to long wave length colors decreased (red, yellow, orange)<br>• No gender difference |

TABLE 2.2 (Continued)

| Authors | Subjects | Variables | Findings |
|---|---|---|---|
| Meerum Terwogt & Hoeksma, 1995 | 72 children and adults | Blue, Red, Green, Yellow, Black, White | • 7 years old preferred: blue, yellow, red, white, green/black<br>• 11 years old preferred: blue, red, yellow, white, green/black<br>• Adults preferred: blue, red, green, white, yellow/black<br>• The preference for yellow decreased with age, whereas the preference for green increased with age |
| Palmer, 1973 | 80 children | Red, Yellow, Blue, Black, White (flesh tone) | • Preference order: red, blue, yellow, white/black<br>• No significant preference difference occurred as a function of race, age, or neighborhood of residence |
| Zentner, 2001 | 106 children for color preference<br><br>103 children for emotion to colors | Red, Yellow , Dark Blue, Bright Blue, Dark Green, Bright Green, Pink, Brown, Black | • 3 years old preferred: red, pink, dark blue, yellow, bright green, bright blue, dark green, brown, black<br>• Adults preferred: dark blue, bright blue, red, dark green, yellow, black, bright green, pink, brown<br>• No gender stereotype effect such as "pink is for girls" or "blue is for boys"<br>• Both genders preferred bright colors (red, yellow, green) to dark colors (blue, brown, black)<br>• Associations of happy with bright colors and sad with dark colors is established by 3 years of age<br>• 3 years old and adults: yellow is most often matched with happy and blue is most associated with sad |

For adults, Choungourian (1968) reported cultural differences in color preference among 160 American, Lebanese, Iranian, and Kuwaiti university students in Beirut, Lebanon. While red and blue were preferred by Americans, those colors ranked lowest for Kuwaitis. Blue-green was least preferred by Americans, but was most preferred by both Iranians and Kuwaitis. Wiegersma and De Klerck (1984) conducted a color preference study with 152 university students in the Netherlands. They used the Color Name Method which asks subjects to write down the name of a color instead of the Color Stimulus Method in isolation using color chips or papers. Unlike Americans' tendency to prefer blue, red was most preferred among the Dutch (43%), followed by blue (22%), green (9%), and so on. Wiegersma and De Klerck concluded that Americans' tendency to prefer blue is culture-dependent. Reddy and Bennett (1985) investigated cultural differences in color preferences by adults from three different nationalities. Random sets of 12 colors were presented to eighteen Americans, ten Indians, and seven Nigerians. Americans and Indians preferred blue, but Nigerians preferred red-purple to blue. They also found a significant difference regarding the preference for brightness and saturation of colors. Highly saturated colors were preferred by Americans but saturation was not very important for the other groups; bright colors were preferred by Indians and Nigerians. Saito (1996) investigated color preferences in Asian populations and found a strong preference for white for Japanese, Chinese, and Indonesians. While strong preferences for vivid blue, light green, vivid red, and white in all three groups were found, group differences were also observed. Japanese preferred metallic and pale tone colors and disliked light grayish and dull tone colors. On the other hand, Indonesians preferred achromatic tones and disliked vivid tones, pale tones, metallic and bluish colors. Chinese showed a preference for vivid tones and a dislike for achromatic and dark tones. The author concluded that color preference can be influenced by environmental variables such as cultural and geographical factors.

There have also been contradictions regarding cultural differences. With 21,060 adults of various ethnic and national backgrounds, Eysenck (1941) found that highly saturated colors were preferred in the following order: blue, red, green, violet, orange, and yellow. Eysenck concluded that there are no cultural differences in color preferences since this order does not differ in the average ranks between Caucasians and non-Caucasians.

### 2.1.2 Physiological Responses to Color

The physiological indicators commonly used for measuring arousal are Electroencephalogram (EEG), which indicates the changes in the electrical activity in the brain, Galvanic Skin Response (GSR), which shows the changes in the skin conductance or resistance, and Alpha Attenuation Response (AAR), which measures arousal through the changes in the alpha wave frequency in the human brain (Beach, Wise, & Wise, 1988).

Goldstein (1942) attempted to develop a theory based on observations and experimentation on patients with organic diseases of the central nervous system. Goldstein noticed differential effects on motor function and distortions in estimation of time, size, and weight when patients were exposed to green or red colors. He observed that green color brought the patients' behavior nearer to normality and red color increased their abnormality. He mentioned the limitation of generalizeability, because this study was conducted using special patients and these effects of colors was context-dependent. Norman and Scott (1952) pointed out that Goldstein's (1942) experiments were conducted on a small group of patients (3-5) and no statistical analyses of his observations were offered, so they questioned the extent of application to normal people.

Gerard (1958; 1959) studied the effects of colored screens projected by red, blue, and white light. Twenty-four males' blood pressure, palmary conductance, respiration rate, heart rate, eye blink frequency, and EEG were measured while they were exposed to each light for a total of ten minutes. He found statistical differences between the responses to red and blue lights for all physiological measures except heart rate.

Gerard (1958) argued that red light was more arousing than blue light on visual cortical activity and functions of the autonomic nervous system. He found that red increased blood pressure, respiration, and frequency of eye blink, whereas blue had the opposite effect. He proposed that responses to colors are predictable because they result in changes to the whole organism.

Erwin, Lerner, Wilson, and Wilson (1961) investigated arousal level by measuring suppression of alpha waves. Subjects were exposed to red, blue, green, and yellow colors for five minutes each. They found that the duration of alpha wave onset was shortest for the green, but they could not find a significant difference in arousal among others.

Wilson (1966) presented highly saturated red and green slides to twenty subjects by alternating the slides in one minute exposures for a total of 10 minutes. He found that the GSR was higher in the red condition than in the green. He concluded that the findings support for the hypothesis that red is more arousing, more stimulating, or more exciting. He speculated that colors at the ends of the visible spectrum are more arousing than those in the middle.

Nourse and Welch (1971) tested Wilson's (1966) finding that red is more arousing than green. Fourteen undergraduates were shown green and violet lights in alternating order with one minute intervals for a total of six minutes. The GSR rates were significantly higher in the violet light condition than the green light for the first trial, but they could not find this difference in the later trials. They also found an interaction between color and order because the violet-green difference in terms of arousal was much more significant for the subjects who were exposed to the green light as their first color in the session than for subjects experiencing the violet condition.

Ali (1972) investigated patterns of EEG recovery under red and blue lights. Subjects were exposed to red or blue light for either 5 or 10 minutes. He found more arousal when his subjects were exposed to red light than blue light.

Jacobs and Hustmyer (1974) found red was significantly more arousing than blue or yellow, and green more than blue. The researchers showed color slides (red, yellow, green, and blue) for one minute each with one minute white slide intervals to their subjects. Twenty-four subjects' GSR, heart rate, and respiration were measured. They observed significant differences in GSR but not in heart rate and respiration. They found that the most arousing color was red, followed by green, yellow, and blue (with the latter being the least arousing). They concluded that the significant color effect on

GSR between red and blue (with no significant color effect on heart rate) were consistent with Gerard's (1958) findings, but an absence of color effect on respiration diverged with Gerard's work. Caldwell and Jones (1985) found no significance in the effect of red, blue, or white colored light on eye-blink frequency, skin conductance, finger pulse volume, heart rate, or EEG measurements.

Fehrman and Fehrman (2004) reported on the effects of blue, red, and yellow on task performance and arousal for the effective color selection of interior spaces. The saturation and brightness of the colors were precisely controlled in order to demonstrate the effect of hue. Forty-two subjects performed mathematical exercises, reading, and motor activity tasks in colored rooms while their GSR and pulse rate were measured. The researchers found that those who experienced the colors of equal saturation and brightness had comparable arousal and task performance scores. Their findings did not support the hue effect that red is more arousing than blue.

### 2.1.3 Emotional Responses to Color

Jacob and Suess (1975) investigated the effects of the four primary colors on anxiety states. Forty subjects were asked to state their perceived anxiety levels on a self-report assessment instrument while receiving either red, yellow, green, or blue illumination. The results showed that those who were in the red and yellow rooms had significantly higher anxiety scores than those who were in the blue and green rooms.

Kwallek, Lewis, and Robbins (1988) examined the effects of a red colored office versus a blue one on subject productivity and mood. Thirty-six subjects were given typing tasks and then asked to state their mood on the Eight State Questionnaire in either a red or blue office. They found an effect on the total number of errors made on the typing task. Participants who moved into a different colored room made significantly more errors than those who entered the same colored room. On the mood questionnaire, there were no group differences. However the mean anxiety score was highest for those who were in the red room, the mean depression score was greater for those who were in the blue room than for any others, and the mean arousal score was greater for subjects who switched to a different colored office. The authors suggested that red may be related to anxiety, that blue may be related to depression, and that changes in environments may produce arousal.

Kwallek and Lewis (1990) investigated effects of environmental color on gender using a red, white, and green office. The experiment assessed worker performance in proofreading and mood under different colored office environments. Greater errors were expected from subjects in the red room because of the notion that red might have a more arousing effect which produces more tension. However, the results were opposite in that subjects in the red office performed better than those who were in the white office. Females performed significantly better on the proofreading task and reported more tension than males.

Weller and Livingston (1988) examined the effect of colored-paper on emotional responses obtained from questionnaires. Six different questionnaires were designed and compiled in this order: pink – guilty, pink – not guilty; blue – guilty, blue – not guilty; white – guilty, white – not guilty. These were distributed to 221 college students. The subjects were given three cases, each describing a murder or rape, and asked to answer a set of eight questions for each case. They found that those who responded on pink questionnaires were less emotionally upset than those who answered on either blue or white questionnaires.

Boyatzis and Varghese (1994) investigated children's color and emotion associations. Sixty children were equally divided into two groups of 5 year olds and 6.5 year olds. The children were asked their favorite color and then shown nine different colors. The children were asked to state their emotional feeling for each color. They found that children showed positive emotions to bright colors (pink, red, yellow, green, purple, or blue) and negative emotions for dark colors (brown, black, gray). Boys showed more positive emotional associations with dark colors than girls did.

Hemphill (1996) examined adults' color and emotion associations and compared them with the findings by Boyatzis and Varghese (1994). Forty subjects were asked to fill out a questionnaire about their favorite color, the major color they were wearing, their emotional feelings to colors, and the reasons for their choices. The researcher found that bright colors were associated with mainly positive emotions and dark colors were associated with negative emotions. These results were consistent with the findings for children by Boyatzis and Varghese (1994). Adult women responded more positively to bright colors than adult men, which also confirm the finding by Boyatzis and Varghese (1994) that boys were more likely to respond positively to dark colors than girls. Red was associated with excitement, which supports Boyatzis and

Varghese's (1994) finding that children associated red with excitement and happiness. Blue was the most preferred color in terms of color itself and clothing choices for adults.

### 2.1.4 Other Responses to Color

Houghton, Olson, and Suciu (1940) studied whether temperature changes occurred among subjects while they were kept in a room with a constant temperature watching screens painted white, red, and blue. They found no significant relationship between oral and skin temperatures, pulse rate, or verbal comfort indices and colors.

Clark (1975) investigated whether wall colors influence perceived temperatures. Subjects noticed cold at 75 °F with light blue color in the walls of cafeteria. After changing the wall colors to orange, subjects felt too hot at 75 °F and the room temperature was changed to 72 °F for their comfort.

Hanes (1960) attempted to demonstrate the relationship between color and spaciousness. In his experiment, subjects were surrounded by three medium gray walls and a front wall which consisted of seven replaceable differently colored partitions. The subjects sat first in front of the standard gray wall and then were able to adjust their position to the differently colored wall until the distance appeared to be the same distance as that of the standard wall. The researcher found limited statistical significance. All colors except black showed an advancing effect. Pedersen, Johnson, and West (1978) also investigated the relationship between color and spaciousness. The ratings for the size of rooms painted in cool, warm, or natural colors were investigated. The authors found no significant difference in the ratings for the room sizes.

Alexander and Shansky (1976) studied the apparent weight of colors. Twenty subjects estimated the perceived weight of colors compare to a standard white color. They concluded that the perceived weight has a positive relationship to saturation and a negative relationship to brightness.

Smets (1969) asked subjects to estimate the time spent under two different lights, red and blue. The researcher found that those who were under the red light reported shorter estimations than those who were under the blue. She also pointed out that those who with the initial exposure reported shorter time estimations regardless of the light sources.

Fanger, Breum, and Jerking (1977) measured subjects' skin and rectal temperature when they were exposed to blue or red lights. They found that the higher temperature was preferred under blue and the lower temperature was preferred under red light. However, the effects were minimal (about 0.7 °F).

Pedersen, Johnson, and West (1978) introduced subjects to identical rooms painted and decorated with warm (red, orange, and yellow), neutral (white), or cool (blue and green) colors. The subjects were asked to estimate the room temperature and dimensions. They found no evidence that room color or decoration influenced subjects' dimensional or temperature estimations.

Oyama and Nanri (1960) investigated the relationship between perceived size and colors. They found that the perceived size of an object has a positive relationship with the brightness of the object and a negative relationship with the brightness of the background. Egusa (1983) confirmed the relationship between brightness and perceived size and found that hues also have an important role in the perceived depth of objects in the space.

Nakshian (1964) asked 48 subjects to perform a series of nine tasks in three differently colored surroundings comprised of painted partitions in red, green, and gray. Matched to three Munsell color dimensions, the brightness of the colors were equal, but the red was more saturated than the green (5R 4.5/12; 7.5G 4.5/6). He found that only two of the nine tasks were significantly better when the subject was surrounded by green compared to being surrounded by red.

Goodfellow and Smith (1973) examined whether red impairs motor coordination and blue facilitates it. They found no significant relationship between color and motor coordination. Twenty-five women were asked to conduct two psychomotor tasks (pursuit rotor and dexterity) in one of five color conditions where a tabletop booth was painted red, blue, green, yellow, or gray. The brightness of the colors was fixed at medium and their saturation at high. They found no significant relationship between the performance of either the pursuit-rotor or the dexterity task and the five colors.

### 2.1.5 Conclusions

From the literature, the arousal effect of red was supported by several studies measuring physiological responses (Gerard, 1958; Wilson, 1966; Nourse & Welch, 1971; Ali, 1972; Jacobs & Hustmyer, 1974) and psychological responses (Jacobs & Suess, 1975; Kwallek, Lewis, & Robbins, 1988). However, Beach, Wise, and Wise

(1988) have pointed out that the arousal effect of color is temporary, particularly in context, so long-term effects are not necessarily warranted.

Emotional associations with colors were also suggested. Brighter colors have a positive relationship with positive emotions; in contrast, darker colors elicit negative feelings (Boyatzis & Varghese, 1994; Hemphill, 1996).

Despite subject characteristics, variables controlled for, measures used, and type of statistical analysis, a general conclusion drawn is that human color preferences change with age (Katz & Breed, 1922; Adams, 1987; Dittmar, 2001); this suggests a developmental effect. Slight gender differences were observed; females tend to prefer warm colors, whereas males tend to prefer cool colors. Cultural differences in color preferences are not widely studied, though culture does seem to impact them.

In general, younger children tended to prefer red the most when looking at small color chips or papers, while adults preferred blue the most; the least preferred color among all age groups tended to be yellow. With increasing age, the adult preference for blue decreased gradually, whereas the preference for green and red increased.

Preferences and emotional associations related to a color can be influenced by brightness or saturation (Guilford & Smith, 1959; Sivik, 1974; Boyatzis & Varghese, 1994; Hemphill, 1996), light sources or background colors (Helson & Lansford, 1970), context (Guilford & Smith, 1959), and cultural factor (Gesche, 1927; Choungourian, 1968; Wiegersma & De Klerck, 1984; Reddy & Bennett, 1985; Saito, 1996). These confounding variables must be carefully controlled when conducting any color study.

Based on previous studies, the consistent trend is that blue is one of the most preferred colors and that brightness and saturation have a relationship to emotional responses. However, the majority of color preference studies failed to control the confounding variables such as color attributes (hue, brightness, or saturation) and light sources (Child, Hansen, & Hornbeck, 1968; Meerum Terwogt & Hoeksma, 1995). A well controlled color preference study of 7 to 11 year old children appears to be non-existent.

For example, Fleming, Holmes, Barton, and Osbahr (1993) found that most 7 to 12 year old unhealthy children preferred red as compared to healthy children's preferences for blue and green. They concluded that health status is an important factor in color selection. However, the light sources were not controlled and they used the color stimulus in isolation. Therefore, the effects of color on pediatric patients are still inconclusive and a well-controlled investigation in a real context is necessary.

## 2.2 REVIEW OF RESEARCH METHODOLOGY

Scientific research means reviewing a concept through observation in order to test a theory or hypothesis in order explain a phenomenon. The presupposed theory and hypotheses are tested by systematic observations to make a general explanation for the natural phenomena. Experiments are useful to explore the phenomena because they involve testing hypotheses and investigating cause-and-effect relationships (Sommer & Sommer, 1997; Zeisel, 1981).

Experiments are characterized by the manipulation of independent variables and identifying possible cause-and-effect relationships between an independent variable and a dependent variable (Sommer & Sommer, 1997). Types of experiments are categorized by the degree of random assignment of subjects to the various conditions; they are true experiments, quasi-experiments, and single-subject experiments (Sommer & Sommer, 1997). True experiments require unbiased random assignment of subjects to treatment groups and the researcher's ability to manipulate independent variables directly. Quasi-experiments lack the random assignments of subjects because of external circumstances often encountered in the field. Single-subject experiments conduct all treatment using only one subject.

Rigorous experiments are typically done in a laboratory where it is possible to control variables. The major advantage of these experiments is their ability to establish causal relationships; quasi-experiments do not establish causal relationships to the same degree as true experiments since experiments in the field routinely encounter uncontrollable factors (Sommer & Sommer, 1997). The advantage of quasi-experiments is their higher generalizeability because of their naturalness when compared to the artificiality of true experiments (Sommer & Sommer, 1997).

### 2.2.1 Methodology in Color Studies

Reviews of research methodology focus on the topics of color effects and are helpful in enabling the researcher to find appropriate methods for research design. Table 2.3 summarizes the types of research methodologies in the literature related to color studies. According to the table, typical research methods in color studies are experiments with questionnaires or physical measures.

TABLE 2.3
Research Methodology Reviews in Color Study 1922-2004

| Methodologies | Literature Examples in Color Studies |
|---|---|
| Experiment with questionnaire (34) | Adams, 1987 |
| | Bornstein, 1975 |
| | Boyatzis, & Varghese, 1994 |
| | Camgöz, Yener, & Güvenç, 2001 |
| | Child, Hansen, & Hornbeck, 1968 |
| | Choungourian, 1969 |
| | Dittmar, 2001 |
| | Ellis & Ficek, 2001 |
| | Eysenck, 1941 |
| | Garth, 1922, 1924 |
| | Garth & Collado, 1929 |
| | Garth & Porter, 1934 |
| | Gesche, 1927 |
| | Granger, 1955 |
| | Guilford, 1934 |
| | Guilford & Smith, 1959 |
| | Helson & Lansford, 1970 |
| | Hemphill, 1996 |
| | Hurlock, 1927 |
| | Jacobs & Suess, 1975 |
| | Kwallek & Lewis, 1990 |
| | Kwallek, Lewis, & Robbins, 1988 |
| | Meerum, Terwogt, & Hoeksma, 1995 |
| | Palmer, 1973 |
| | Philbrick, 1976 |
| | Reddy & Bennett, 1985 |
| | Saito, 1996 |
| | Silver & Ferrante, 1995 |
| | Simon, 1971 |
| | Trueman, 1979 |
| | Valdez & Mehrabian, 1994 |
| | Weller &Livingston, 1988 |
| | Zentner, 2001 |

TABLE 2.3 (Continued)

| Methodologies | Literature Examples in Color Studies |
|---|---|
| Experiment with physical measures (9) | Ali, 1972<br>Caldwell & Jones, 1985<br>Erwin, Lerner, Wilson, & Wilson, 1961<br>Fehrman & Fehrman, 2004<br>Gerard, 1958, 1959<br>Jacobs &Hustmyer, 1974<br>Nourse & Welch, 1971<br>Wilson, 1966 |
| Lüscher Color Test (2) | Fleming, Holmes, Barton, & Osbahr, 1993<br>Garvey & Luxenberg, 1987 |
| Color Name Method (1) | Wiegersma & De Klerck, 1984 |
| Interview (1) | Karp & Karp, 1987 |

The self-administered questionnaire is a frequently-used tool in survey research and it is efficient in terms of time, cost, and effort. Questionnaires refine researcher's thoughts and provide useful data when problems are well defined by the researcher (Zeisel, 1981). Questionnaires are better suited for identifying opinions rather than behavior (Sommer & Sommer, 1997). The advantage of questionnaires is to guarantee the consistency of measurement since all subjects are asked the same questions in the same manner (Sommer & Sommer, 1997). The disadvantage of questionnaires is that they are not appropriate for those who are very young, old, or busy with other activities; and they are also limited to investigating profound motivation on intricate issues (Sommer & Sommer, 1997).

In the assessment of children's color preferences, the Pediatric Quality of Life Inventory (PedsQL) can be used. The PedsQL is a self-administered research instrument for measuring pediatric patients' and parents' evaluations of health-related value (Varni, Seid, & Rode, 1999; Varni, Seid, & Kurtin, 2001). Varni, Seid, and Rode (1999) tested both the reliability and validity of this instrument and the results support the PedsQL as a reliable and valid measure of health-related value. The PedsQL can be used in various types of applied and clinical research for pediatric patients and children aged two to eighteen (Varni, Seid, & Rode, 1999). An adaptation of the PedsQL was utilized in order to measure participants' preferences to colors. The modified PedsQL employed an analogue scale which consists of a happy face and a sad face at the end of a 10 centimeter horizontal line. This happy and sad face appearance helps children express their color preferences easily without long written or verbal instruction. Color preferences can be measured on a 10 cm horizontal line and the marked preferences can be converted to 0 to 100 points with 1 mm equivalent to 1 point.

An experimental design was employed for this study in order to investigate the value of color on children. With a randomly assigned study population, colors as independent variables were manipulated by the researcher.

### 2.2.2 Environmental Simulation

Colors need to be studied in real contexts because they are experienced in environments where complex patterns interact with perception and behavior (Tofle, Schwarz, Yoon, & Max-Royale, 2004). As stated above, color preferences are subject to influence from an array of factors but the majority of them fail to control confounding variables properly (Child, Hansen, & Hornbeck, 1968; Meerum Terwogt & Hoeksma, 1995). Therefore, experiments must be carefully controlled in order to maintain validity.

To investigate the value of color in real contexts and to control for the confounding variables, simulations were considered due to their inherent feasibility and reliability. For example, simulations can support environmental effect assessments as data and a controlled stimulus (Sheppard, 1989); they can also deal with environments where preferences or responses are sought to different styles of environments or views (Sanoff, 1991). The major advantage of simulations is that they can be designed to control variables and environmental change without actual construction for purposes of academic research and statistical analysis (Sanoff, 1991).

The reliability of data obtained from a simulation compared to those from real settings has been debated because simulations vary in their levels of detail and this can make it difficult to generalize results. The more accurate the simulation is representing a context, the more reliable the results will be to those obtained them in a real context (Sanoff, 1991). Examples of demonstrating the reliability of simulations are as follows.

De Long (1976) conducted a study to demonstrate whether data collected in scale-model simulations are a reliable representation of those obtained under real settings. The author replicated a study about the distance for a comfortable conversation by Sommer (1969) through the use of 1:12 scale model settings. With two sofas in a large lounge, the most comfortable distance for conversation and a sudden shift from models sitting across from one another to sitting side-by-side were measured. With descriptive analysis, the data obtained from the scale-model environment were reliable to those of Sommer's study. De Long concluded that the perception of spatial features in the scale-model environments was faithful to the sense of spatial features in the real world.

Baird, Cassidy, and Kurr (1978) conducted an experiment on room preference with different ceiling heights where participants were asked to imagine presumed user activities (talking, listening, reading, dancing, dining, and no activity). One group was tested for their preferences on 1:12 scale-model rooms and the other group participated in a real room with an adjustable ceiling. The analysis demonstrated a fit between data obtained from the small scale model rooms and those from the realistic setting. They concluded that the general characteristics of preference functions are reliable when the stimulus is a model room on the scale of one inch to one foot (i.e. 1:12 scale).

TABLE 2.4
Age-Appropriate Research Methods in Environmental Design Research

| | Appropriate Age Categories | | | |
|---|---|---|---|---|
| Survey Instruments | Infants | Preschool Children | School Children | Adolescents |
| Open-ended Questions | | | | O |
| Directed Questions | | | | O |
| Likert Scale | | | | O |
| Semantic Differential | | | | O |
| Cognitive Mapping | | | O | O |
| Photographic Simulation | | O | O | O |
| Games | | O | O | O |
| Scale Model Simulation | | O | O | O |

Source: Adapted from Lozar, 1974.

Table 2.4 presents a summary of age-appropriate research methods for use in environmental design research offered by Lozar (1974). Scale model simulation for this study was considered an appropriate method for preschool children up to adolescents.

Sheppard (1988) suggested five principles in order to create good and valid simulations: representativeness, accuracy, visual clarity, interest, and legitimacy. Important views should be employed to represent conditions in reality that would be experienced by a significant number of people. The appearance of simulations should be clear and realistic in detail, parts, and overall design when compared to a similar real context and participants' attention should be captured in order to elicit their responses.

# CHAPTER III

# THEORETICAL FOUNDATION OF RESEARCH

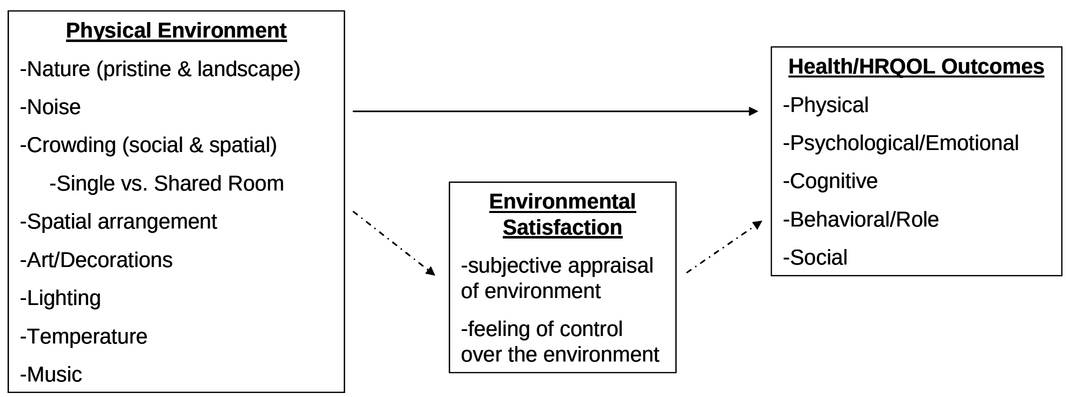
## 3.1 THEORETICAL FRAMEWORK OF THE STUDY

### 3.1.1 Conceptual Model of the Study

Humans rely strongly on vision for every aspect of life. Seeing is impossible without light, and so is perceiving color. Color is often taken for granted since it surrounds us from birth; people consider color to be simple, but it has a profound impact on human psychological and physiological responses (Manke, 1996). Color serves as an important signaling function and helps people perceive objects. Humans react emotionally to colors and give special meanings to them.

Color is closely linked to electromagnetic wavelengths (another form of light that can be measured by frequency) because they activate the visual receptors on the retina known as rods and cones; the receptors then transform the wavelengths into neural energy which initiates neural processing in the central visual system. Since such wavelengths can be measured on any object, it is possible to generate a systematic structure of color application based on natural order; color can then be used as an architectural quality in a systematic way to create a harmonious feeling which promotes the occupants' well-being (Marberry & Zagon, 1995). Physical environmental qualities such as color, noise, temperature, or odor can cause discomfort if they do not meet individual needs (Cassidy, 1997). This is more serious for the well-being of vulnerable people such as children, the elderly, or health care patients.

Sherman, Shepley, and Varni (2005) propose a conceptual model which indicates that physical environments can influence children's health-related outcomes in many ways. They propose that, "this relationship between the physical environment and health/HRQOL outcomes is at least partially mediated by environmental satisfaction and its components" (Sherman, Shepley, & Varni, 2005, p. 214). Figure 3.1 shows the conceptual model of the effects of physical environments on children's well-being.




NOTE: Dotted arrows indicate role of Environmental Satisfaction as mediator; Solid arrow indicates direct effects of the Physical Environment on Health/HRQOL Outcomes.

Figure 3.1: Conceptual Model of the Effects of Physical Environments on Children's Health-Related Outcomes
Source: Adapted from Sherman, Shepley, & Varni, 2005.

The role of environmental satisfaction as a mediator between the physical environment and children's health is considered a significant indicator and this conceptualization is well supported by Thurber and Malinowski (1999), Whitehouse et al (2001), and Boman and Enmarker (2004). The Thurber and Malinowski (1999) study showed that, “self-reported negative emotions were associated with low overall environmental satisfaction” (p. 487). Whitehouse et al. (2001) indicated that environmental satisfaction was associated with positive mood changes. Boman and Enmarker (2004) also indicated that general sensitivity to noise was a strong mediator between stress symptoms and noise levels.

Color was not included in their model since environmental color studies are few, but color is an important component of the physical environment. As such, color preferences can be measured in order to investigate their effects on subjects and their environmental satisfaction. Drawing on the model presented by Sherman, Shepley, and Varni (2005), the influence of color on health-related outcomes can be explained as seen in Figure 3.2. Figure 3.2 describes that color preference can mediate children’s health-related outcomes through their satisfaction with colors as components of the physical environment.

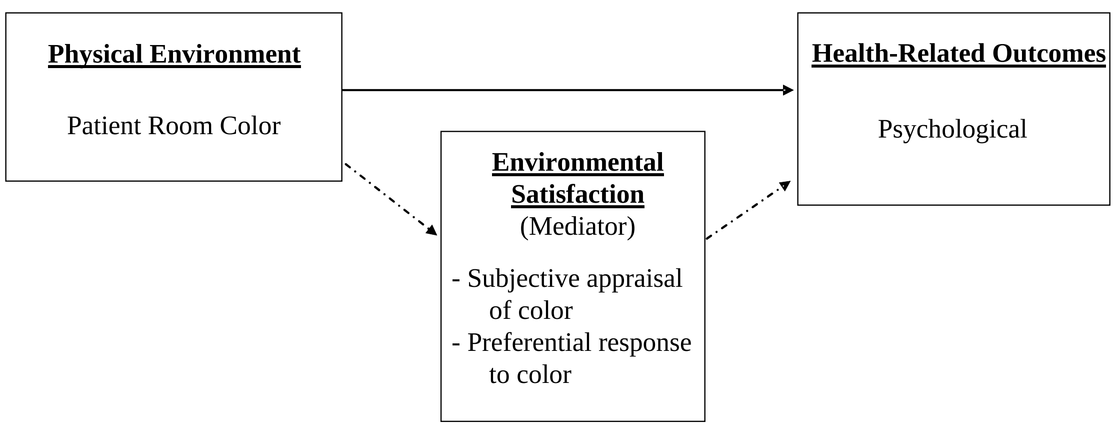



Figure 3.2: Conceptual Model of the Effects of Color on Children’s Health-Related Outcomes

### 3.1.2 Supportive Healthcare Design Theory

The physical environment affects our sense of well-being. Since ancient times, human connections with nature, fresh air, and sunlight have been identified as influences on well-being. Health outcomes are promoted when physical environments provide a moderate level of positive stimulation; in other words, if stimulation levels are extreme (i.e. too high or too low), the cumulative effect on the patient will be negative on wellness (Wohlwill, 1968). There is also increasing empirical evidence that poorly-designed built environment negatively affects patient well-being (Ulrich, 1991).

Healthcare designers and providers have engaged in practices to promote patients' health, which focuses on reducing stress and increasing pleasantness. Although the contribution of the healthcare environment related to human well-being has not been fully quantified, many researchers have investigated the relationships between the built environment and human health using psychological and physiological indicators of wellness such as measures of stress, mood, productivity, or cognitive performance.

Design professionals should provide psychologically supportive environments because they deal with built environments which can influence a user's well-being. If designers are to be socially responsible, knowledge-based design is critical (Shepley, Fournier, & McDougal, 1998). They should thoroughly understand humans' needs, particularly vulnerable population such as children, healthcare patients, and the elderly. Many healthcare designers and providers have questioned the impact of built environments on health outcomes, but direct empirical evidence has been limited (Ulrich, 1991). However, general concepts can be generated from a large body of indirect scientific research fields such as clinical psychology, environmental psychology, behavioral medicine, and other health-related research (Ulrich, 1991, 2001).

To outline the fundamental concepts of healthcare facilities design guidelines, a supportive healthcare design theory was proposed (Ulrich, 1991). The supportive healthcare design theory "is intended to help increase understanding of the needs of patients, visitors, and staff in relation to physical environments" (Ulrich, 1991, p. 98). It not only helps designers make informed decisions, it also provides researchers a guideline for discussing research findings (Ulrich, 1991).

The key concept of the theory relies on reducing stress. Hans Selye first defined stress as stimulus, but he subsequently distinguished stress from stressor by using stressor to refer to a stimulus and stress to refer to a response to the stimulus (Brannon & Feist, 2000). Lazarus and Folkman later defined stress as, "a particular relationship between the person and the environment that is appraised by the person as taxing or exceeding his or her resources and endangering his or her well-being" (1984, p. 19). They view stress as an interaction between the person and the environment and this interaction view provides the basis for the ability or inability to deal with a stressful event. "Stress is a well-established concept in health related fields, and well over 100 studies have shown that stress is linked with psychological, physiological, and behavioral dimensions of wellness" (Ulrich, 1991, p. 99).

Users of healthcare facilities such as patients, visitors, physicians, and staff experience substantial stress. Typical sources of stress for patients are their diseases (impaired physical ability or painful medical treatments) and physical-social environments (noise, lack of privacy, or disconnection with families) (Ulrich, 1991). Stress decreases the functionality of the immune system and works against the patient's healing process (Kennedy, Glaser, & Kiecolt-Glaser, 1990). Stress is also a problem for visitors, physicians, and staff. Considerable stress for healthcare personnel is linked with low job satisfaction and high turnover rates (Shumaker & Pequegnat, 1989). Therefore, the supportive healthcare design theory focuses on healthcare environments which help people cope with stress and consequently promote wellness. Table 3.1 shows strategies for reducing stressors in healthcare facilities design and the following sections describe major concepts in the theory (according to Ulrich, 1991, 2001):

TABLE 3.1
Strategies of Supportive Healthcare Facilities Design
(per Ulrich, 1991, 2001)

| Concepts | Strategies to Reduce Stressors |
|---|---|
| Self-control | • Control over lighting, temperature, and television<br>• Accessible gardens for patients<br>• Display personal belongings<br>• Break areas for personnel<br>• Personnel workstations designed to avoid interruptions by visitors |
| Social Support | • Overnight accommodations for family members<br>• Comfortable waiting areas for visitors<br>• Social gathering spaces for patients and visitors |
| Access to Nature and Positive Distractions | • Window view to nature<br>• Access to gardens or nature elements (water, plants, trees)<br>• Friendly or caring faces<br>• Animals |

To design healthcare environments which promote wellness, physical and psychological stressors must be avoided; physical features or social conditions that elicit positive influences must be employed; and patients, visitors, and healthcare personnel must be considered as target users. In this regard, three key concepts are introduced in order for designing healthcare environments which minimize stressors: self-control, social support, and access to nature.

A sense of self-control has significant influence on stress levels and health-related outcomes (Steptoe & Appels, 1989). A large body of research has indicated that those who posses a sense of self-control cope with stress better than those who do not (Evans & Cohen, 1987). Lack of self-control is a major obstacle for patients to cope with stress and it is associated with negative effects such as depression, elevated blood pressure, or impaired immune system. Elements reducing patients' sense of self-control include noise, difficult wayfinding (Carpman & Grant, 1993), lack of privacy, and inaccessibility to controls over lighting and temperature (Winkel & Holahan, 1986). In addition to patients, self-control is also important for healthcare personnel because their tasks are typically highly demanding so they need break areas to use for escape from stressors.

Patients can have benefits from interaction with others such as family members, friends, or caregivers who are supportive and caring. Individuals with high social support typically experience less stress and have better health than those who are more socially isolated (Cohen & Syme, 1985; Sarason & Sarason, 1985). There are also links between low social support and both higher susceptibility of disease and lower recovery

(Berkman & Syme, 1979). Although social interaction and support is desirable, designers should consider the fact that social interaction which is too intense may result in an invasion of privacy.

Physical environments which provide a moderate level of positive stimulation promote people's well-being (Wohlwill, 1968). If a positive environmental stimulation holds a patient's attention and interest without overstressing them, it may decrease the patient's general stress level and negative thoughts (Ulrich, 1981). Many researchers have agreed that significant positive stimulations are typically elements that have been important and critical for survival throughout their evolutionary and cultural development such as trees, water, animals, and friendly faces (Kaplan & Kaplan, 1989; Katcher, Segal, & Beck, 1984; Ohman, 1986; Orians, 1986; Ulrich, 1983; Wilson, 1993).

Wilson (1984) proposed the Biophilia Hypothesis which essentially states that humans' innate preference to nature has evolved from an evolutionary survival process. The term biophilia, literally "love of life", refers to the manifest attraction to nature which is associated with vital biological needs; the developmental process of biophilia came about through human evolution being intertwined with the benefits of the natural environment (Wilson, 1993). As a result, humans instinctively prefer natural setting or environments with natural elements because of their genetic inheritance. In this regard, the Biophilia Hypothesis suggests that natural elements have a restorative impact and this restoration concept has been well received in environmental design field.

Natural elements or window views to nature can be effective as positive stimulations that provide positive feelings in healthcare environments. Exposure to positive nature scenes provides benefits of emotional improvement and physiological changes such as reducing heart rate and lowering blood pressure (Ulrich et al., 1991). Surgery patients who had window views to nature took less pain medication and had more favorable recoveries than patients who had window views to buildings or brick walls (Ulrich, 1984). In addition to research on patients, windowless rooms are also stressful for healthy workers (Heerwagen & Orians, 1986; Collins, 1975).

An important role of designers is to be aware of conflicting needs among target users: patients, visitors, staff, etc. It should be kept in mind that these different types of users have contradictory needs or perspectives regarding self-control, social support, and access to nature. Designers should evaluate and assess pros and cons for each group versus the others in making an informed decision for supportive healthcare facilities design.

## 3.2 DEVELOPMENTAL THEORIES

Age group is important because this study compares children's preferences to adults', meaning that the two groups must have a similar capability for interaction with the research tool. According to Piaget's cognitive-developmental theory and the theory of dual representation, children below a certain age lack the ability to reference symbols, or in this case, physical models. Therefore, the children's age group of seven to eleven years is used because they are in the concrete-operational stage according to Piaget's cognitive-developmental theory. Their thinking has become logical (Brainerd, 1978) and they are fully developed in representing both the symbol itself and its relation to its referent, i.e. dual representation (DeLoache, Peralta de Mendoza, & Anderson, 1999). They are also able to discriminate colors with normal vision. This level of development ensures that they can reference the models akin to an adult capacity as well as being able to discriminate colors normally.

### 3.2.1 Cognitive-Developmental Theory

According to Swiss cognitive theorist Jean Piaget's cognitive-developmental theory, children actively construct knowledge by interacting with their surrounding environments (Berk, 2002). Piaget posited that children go through four developmental stages in understanding the world, each of which is age-related and distinguished by different ways of thinking (Brainerd, 1978). Piaget's four stages of cognitive development are as follows (according to Brainerd, 1978; Berk, 2002):

In the sensorimotor stage, which lasts from birth to about two years of age, infants explore and understand the world by coordinating senses with physical movements. Newborns cannot distinguish themselves from the world, but they keep developing a sense existence of themselves and objects during this stage; this is the development of objectivity. Their sensory system becomes developed and organized, but their understanding of the world is limited because they lack internal thought processes. The simple connections of sensation and motor actions develops into symbolic, but non-logical, thinking in the preoperational stage which lasts from approximately two to seven years of age. Pre-operational children are able to represent language and recognize that objects continue to exist even when they are hidden from view. Although they acquire the recognition of hidden objects, they still lack the ability to perform operations. The concept of operation plays an important role in Piaget's theory of intelligence. Operations are the mental power that adolescents and adults possess, but younger children do not. Pre-operational children need concrete physical conditions to understand the world and are not yet able to conceptualize abstract thoughts. Their thinking is egocentric-dominated and irreversible, meaning that they understand the world only from their own perspectives.

TABLE 3.2
Piaget's Stages of Cognitive Development
(per Brainerd, 1978)

| Stage | Period of Development | Characteristics |
|---|---|---|
| Sensorimotor | Birth-2 years | • Intelligence is developed by coordinating sensory experiences and physical (motor) actions<br>• Reflexive |
| Pre-operational | 2-7 years | • Intelligence is developed by using primitive symbols<br>• Non-logical and non-reversible thinking<br>• Language development<br>• Recognition of hidden objects<br>• Self-oriented |
| Concrete operational | 7-11 years | • Intelligence is developed through systematic manipulation of symbols related to concrete objects<br>• Logical and reversible thinking but short of adult<br>• Less self-oriented |
| Formal operational | 11 years and older | • Intelligence is developed through logical use of symbols related to abstract concepts<br>• Hypothetical and systematic thinking |

In the concrete operational stage, which lasts from about seven to eleven years of age, cognition is transformed into more structured thought, but their logical thinking is not yet as fixed as adults. Concrete operational children can perform operations. Their thinking has become less egocentric and reversible; that is, they are able to take in more than one perspective simultaneously. However, their cognition is still not adult-like. Finally, in the formal operational stage, their thought becomes like the more logical system of adolescents and adults. Children who attain the formal operational stage are capable of theoretical and hypothetical thinking. The person in this stage no longer requires physical conditions in order to make rational judgment. Table 3.2 summarizes Piaget's stages of cognitive development.

### 3.2.2 Dual Representation Theory

A participant's ability to understand and represent symbols is critical in order to validate this study since the research tools are physical models of pediatric patient rooms. Participants should recognize the relationship between the symbol (in this study, a physical model of patient room) and what it represents (a patient room in reality). This is particularly important for the groups of children.

A symbol has dual entities; one is a physical property and the other is an abstract property (Potter, 1979). In order to use a symbol such as a model, map, or picture successfully, one must recognize both aspects of the dual entity; to do so is to understand dual representation (DeLoache, 2000). Dual representation is quite difficult and a key achievement for younger children in their ability to understand and use symbols (DeLoache, 1991). Its acquisition is critical for them to communicate since a variety of symbols are used in every human culture.

Children's acquisition of dual representation depends on the accuracy between symbol and referent, the degree of description of the symbol-referent relationship, and the amount of previous exposure to symbols (DeLoache, 2000). The more a symbol physically resembles what it represents, the easier it is to detect relationships between the symbol and its referent. However, even if the physical similarity is high, two-and-a-half year old children typically failed to understand the use of symbols (DeLoache, Kolstad, & Anderson, 1991). With a higher level of physical accuracy, three-year-old children were usually successful in relating the symbol to its referent, but they understood the relationship poorly and with a lower level of accuracy (DeLoache, Kolstad, & Anderson, 1991). As children received more information or instruction, they more easily understood the relationship between a symbol and what it represents. A group of three-year-olds that was well versed in the relationship between a symbol and its referent showed better performance on finding a larger toy hidden in real room after seeing a small-scaled toy hidden in the model room (DeLoache, Kolstad, & Anderson, 1991); but a group of three-year-old children who were less informed failed to relate the symbol to its referent and so it was determined that the acquisition of dual representation occurs around 34 to 36 months of age (DeLoache, 1989). DeLoache, Peralta de Mendoza, and Anderson (1999) confirmed that three-year-olds understood how the symbol was to be represented when they received explanations, but they failed to understand if they were not fully informed. The researchers further tested five- to seven- year-olds and those children understood the relationship between the symbol and its referent without any instruction whatsoever. Children's specific experiences can also enhance their development of dual representation. Children who previously participated in a higher similarity model task were more successful in a lower similarity model task in comparison with non-experienced children (Marzolf & DeLoache, 1994).

In summary, children's acquisition of dual representation ability occurs around three years of age, and five to seven year old children can understand the relationship between symbols and their referents without any instruction. Therefore, children with ages ranging from seven to eleven years are fully developed in understanding the relationship between the symbol itself and its referent. This level of development ensures that they can reference the models akin to an adult capacity.

### 3.2.3 Development of Color Perception

Human color perception involves a complex interaction between light, eyes, and the brain (Luke, 1996), which is not yet completely understood. According to the perceptual process introduced by Goldstein (2002), sensing color involves a sequence of steps starting with light entering into the eyes, light (as electromagnetic wavelengths) on the retina, transforming the wavelengths into neural energy (i.e. transduction), neural processing through the central visual system, perceiving color in the brain, and action with regard to the color. Any change among those steps can influence color perception.

More importantly, transforming wavelengths into neural energy is not the same as color perception; perceiving color involves not only determining the wavelengths of a stimulus, but also further processing this information through the central visual system in order to generate the experience of color (Goldstein, 2002).

A newborn baby's color vision is poor because the structures in their eyes, particularly visual receptors in the fovea, are not yet fully formed (Banks & Shannon, 1993), and their central visual system continues to develop for several years (Hickey & Peduzzi, 1987). Most eye growth occurs during the first year, but subtle morphological changes keep continuing until at least four years of age (Yuodelis & Hendrickson, 1986). Newborns see objects clearly at a distance of 20 feet as adults do at 600 feet (20/600), their visual acuity reaches about 20/100 by six months, and an adult-like level at eleven months (Courage & Adams, 1990).

Infants in the second month of life can discriminate lights that differ in wavelength only (Teller & Bornstein, 1987). By four to six months, infants are capable of discriminating hue differences (Fagan III, 1974). Infants less than five-months-old showed a preference for chromatic over achromatic stimuli, but they did not show preferential responses to different chromatic stimuli before the third month (Adams, 1987). Most three-month-old infants have some chromatic discrimination (Adams, Courage, & Mercer, 1994; Brown, 1990; Teller, 1998), but stimulus thresholds for the infants are higher than those of the adults (Teller, 1998). By four months, infants perceive and categorize color, at least to some degree, akin to adults' perceptual color categories (Franklin & Davies, 2004; Teller & Bornstein, 1987).

Through an adult life span, two major age-related changes in vision are usually experienced. One is changes in the structures of the eye and the other is changes in the retina (Kline & Schieber, 1985). Structural changes occur around age 40 and cause decreases in the eye’s ability to focus and adjust (Cavanaugh, 1997). Retinal changes start around age 50 and cause difficulties in seeing details (Cavanaugh, 1997). Human’s color perception peaks during the twenty’s and thirty’s then it steadily begins to decline with age (Lakowski, 1958).

### 3.3 CONCLUSIONS

Although contradictions exist in the literature, the consistent trend is that blue is one of the most preferred colors across age and gender. The arousal effect of red is suggested by studies measuring physiological and psychological responses. Emotional association with color is also found; brighter colors are associated with positive feelings such as happy, cheerful, or hopeful. In contrast, darker colors evoke negative feelings such as boring, sad, or non-inviting.

Built environments can affect human’s well-being, as does color as one of the components of the physical environment. Color should be carefully applied to architectural spaces since colors have a great impact on human psychological and physiological responses.

While previous studies are suggestive, there are no empirical color studies involving patients. The previous studies were typically done with small color papers using healthy people and a lack of control of confounding variables was pervasive. Color preferences can be influenced by brightness, saturation, background colors, light sources, and cultural factors.

A well controlled color preference study of pediatric patients appears to be non-existent. Therefore, this study addressed the effects of color on pediatric patients using a well-controlled investigation in a real context.

# CHAPTER IV

# INTRODUCTION TO EXPERIMENTS

This dissertation study uses a simulation design to investigate color preference in a real context. Colors need to be studied in real contexts because they are experienced in environments where complex patterns interact with human perception and behavior (Tofle, Schwarz, Yoon, & Max-Royale, 2004). To investigate values of color in real contexts, simulations were considered due to their inherent feasibility and reliability. For example, simulations can support environmental effect assessments as data and a controlled stimulus (Sheppard, 1989); they can also deal with environments where preferences or responses are sought regarding different styles of environments or views (Sanoff, 1991). Data obtained from small scale models compares reliably to those gathered from real settings (Baird, Cassidy, and Kurr, 1978; De Long, 1976).

Ten 1:12 scale-models of patient rooms, each with a single interchangeable side wall, were built by the researcher and utilized for this study (see Appendix N for details). The models were built based on the evolution of patient room design (Vance, 2002) and the Guidelines for Design and Construction of Hospital and Health Care Facilities published in 2001 by the American Institute of Architects Academy of Architecture for Health.

Vance (2002) analyzed the private patient room design trend and created the evolution of patient room types (see Figure 4.1). Inboard toilet types (the bathroom being located along the corridor side) were typical in the 1990's as this arrangement allows more daylight and spaces for family members (Vance, 2002). As a new trend for future model, outboard toilet types (the toilet being located along the exterior wall) were proposed. The outboard toilet type provides better visibility for medical staff but limits daylight, window views, and patient privacy.

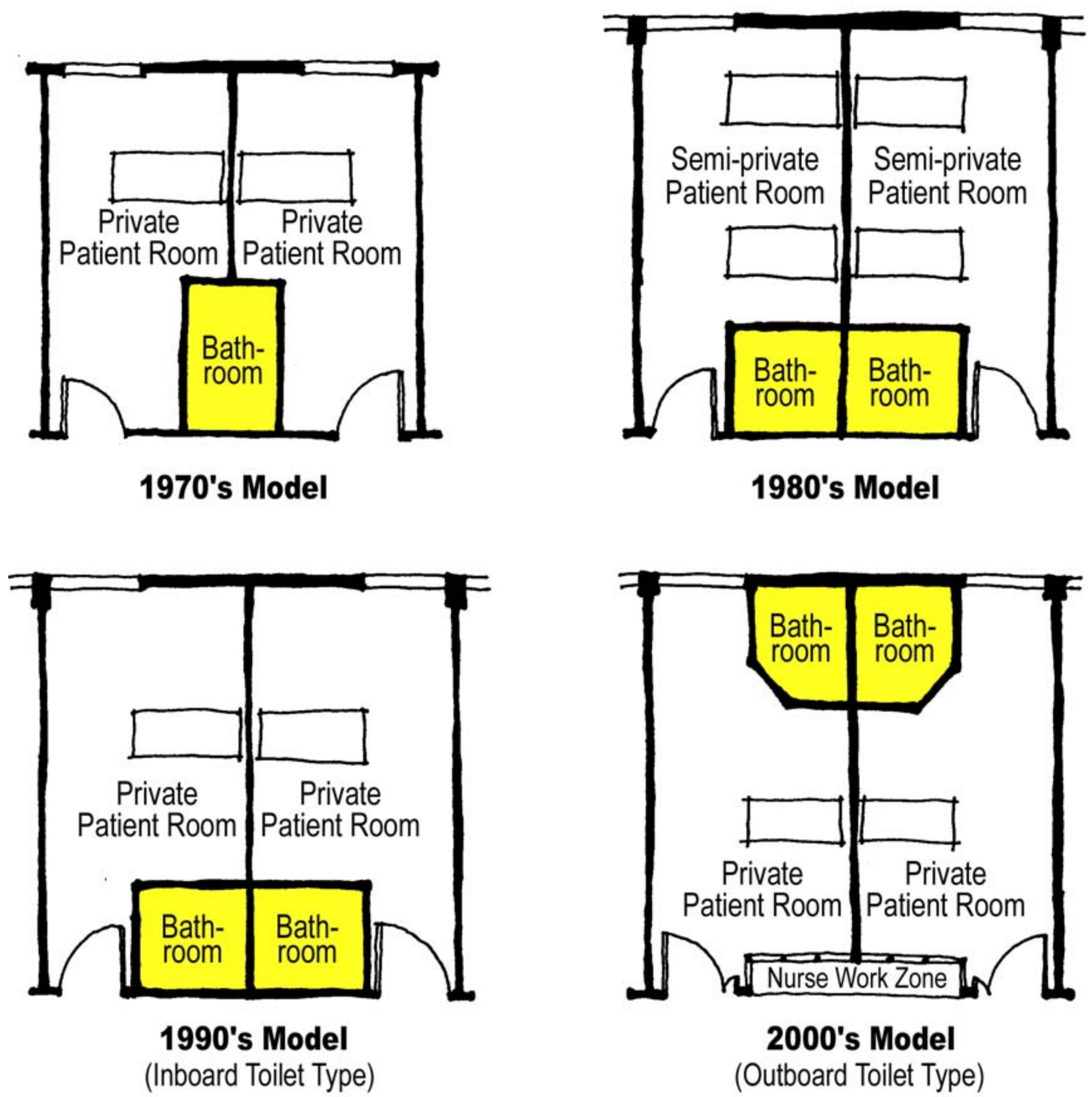



Figure 4.1: Evolution of Patient Room Design
Source: Adapted from Vance, 2002.

An inboard toilet type patient room was developed by the researcher for the scale-model since the inboard toilet types were more pervasive at the time of the study. The patient room for the scale-model satisfied the standards of the Guidelines for Design and Construction of Hospital and Health Care Facilities. Three standards applied for the patient room design were as follows: 1) Patient rooms shall be constructed with a minimum of 120 square feet of clear floor area in a single-bed room. 2) The dimensions of the rooms shall be a minimum of three feet between the sides and foot of the bed and any wall or any other fixed obstruction. 3) Each patient room shall have a window. The developed patient room plan for scale-models is shown in Figure 4.2.

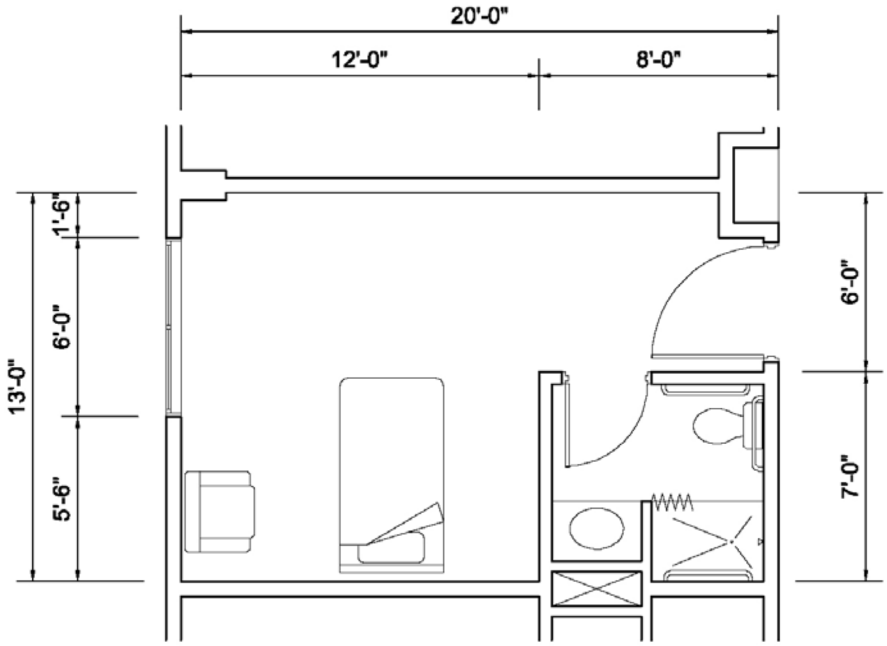



Figure 4.2: Patient Room Plan for Scale-Models

For visual clarity, a 1:12 scale detailed patient bed and two chairs were located inside the room. The layout and environment of all models (room size, window size and view, light source, furniture, interior materials, etc.) was identical, excluding the single interchangeable side wall's color. As a patient lies on a bed, the wall facing their feet is where they are most likely to direct their gaze; therefore, the wall at the foot of the bed was selected as the interchangeable one and different colors were displayed on it only.

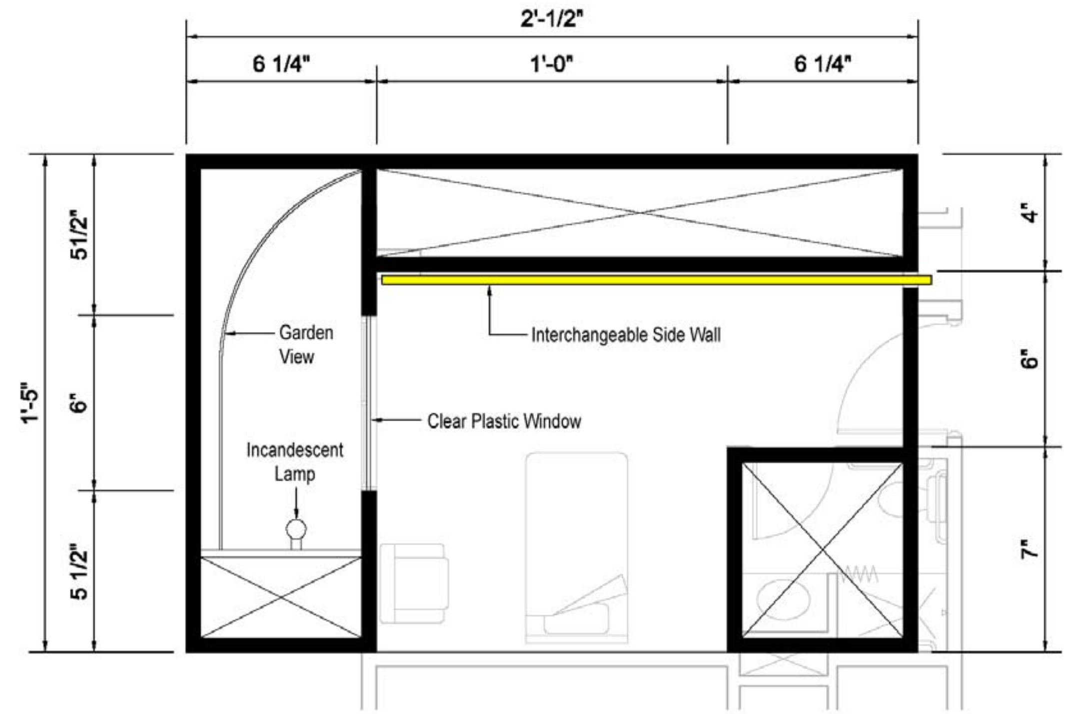



Figure 4.3: Floor Plan of Scale-Model

Two different light sources were installed in order to control illuminance levels inside the scale-models. One was a cool white fluorescent light used to act as an interior light source and the other was an incandescent light used to represent an exterior light source. The illuminance level of the fluorescent light was controlled using translucent materials. The illuminance level of the incandescent light was controlled by a dimmer. For controlling the illuminance levels inside the scale-model rooms, data on the illuminance levels of pediatric patient rooms at St. Joseph Regional Health Center in Bryan, Texas, measured by Choi (2005) were used. According to Choi's (2005) research, the range of overall illuminance levels of the patient rooms (which have southern facing windows in addition to both electric and natural lights) at St. Joseph Regional Health Center was from 500 to 540 lux during 12:00 pm to 2:00 pm in October, November, December, January, and February. The average illuminance levels of pediatric patient rooms using the electric lights only (with curtain closed) was 240 lux. Therefore, the illuminance level inside the scale-models was set to 520 lux for overall illuminance level – both incandescent and fluorescent lights – and 240 lux for the fluorescent light only. The illuminance levels inside the scale-models were measured and maintained by the researcher prior to the subjects' participation. A garden picture was also installed inside the models to complete the patient room window view. Figure 4.3 presents the floor plan of scale-model (see Figure 4.4 for images of the scale-models).

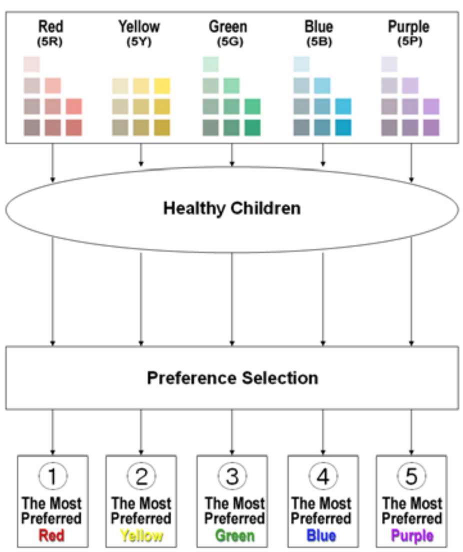
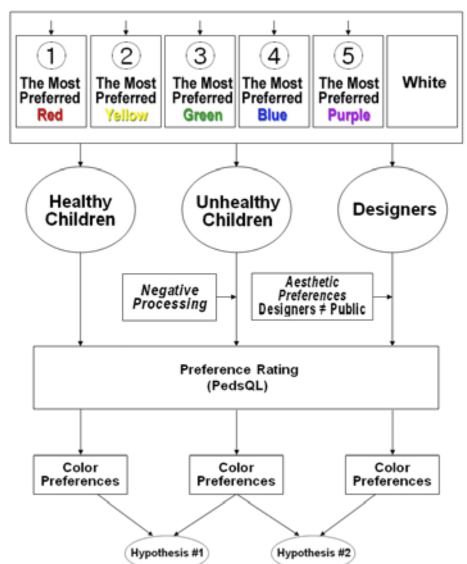
Figure 4.4: Image of Scale-Model

This dissertation research consisted of two phases. The first was a pilot study (Experiment I) and the other was the main study (Experiment II).

In the pilot study, healthy children's most preferred colors from each of five hue families defined by the Munsell color system were investigated. Specification of scale-models and colors used in the pilot study were covered in the next chapter. There are numerous color preference studies, but they are typically done with a small color chips or papers. In addition, lack of control in color attributes was pervasive. This study aimed to investigate the effect of environmental colors applied on wall surfaces. Since there are too many color samples to investigate color effects in a limited experiment, narrowing down color samples in meaningful way was a necessity. Therefore, the researcher considered to investigate what was the most preferred color among various samples in its own hue family. For example, there were numerous red samples but what the most preferred red color among those samples was not clear. This issue was parallel with other hue families as well. The pilot study addressed this issue and investigated children's the most preferred colors (red, yellow, green, blue, and purple) of their respective hue families. The most preferred colors configured by the pilot study were used in the main study as independent variables.

The purpose of this main study is to investigate the value of color as a component in a healing environment for pediatric patient rooms. Three different groups' color preferences were investigated and compared in order to generate design recommendations. Pediatric patients' color preferences (i.e. users of patient rooms) were investigated and compared to healthy children's color preferences (i.e. normal children) and design professionals' color appreciation on pediatric patient room design (i.e. decision-makers for pediatric patient room design). Table 4.1 summarizes the two experiments.

TABLE 4.1
Summary of Experiments

| Experiment | I: Pilot Study | II: Main Study |
|---|---|---|
| Purpose | To investigate children's color preferences about each of five major hue families within the Munsell color system | To investigate the value of color as a component in a healing environment for pediatric patient rooms |
| Methods | Simulation design using 1:12 scale-models of patient rooms  | Simulation design using a 1:12 scale-model of six differently colored accent walls  |
| Independent Variables | Multiple colors from five major hue families in the Munsell color system  | Six color samples: Five most preferred colors configured by the pilot study + white  |
| Subject Groups | | |
| Dependent Variables | | |
| Data | | |

# CHAPTER V

# METHODOLOGY FOR EXPERIMENT I (PILOT STUDY): CHILDREN'S COLOR PREFERENCES AMONG THE FIVE MAJOR HUE FAMILIES

## 5.1 PURPOSE

The purpose of the pilot study was to investigate children's most preferred colors among each of the five major hue families in the Munsell color system using scale-models. Those five major hue families were red, yellow, green, blue, and purple.

## 5.2 PARTICIPANTS

### 5.2.1 Demographic Information of Participants

Sixty-three children were recruited from four schools in Brazos County, Texas. The schools used as research sites were Cypress Intermediate School in College Station and Jones Elementary School, Kemp Elementary School, and St. Michael's Academy in Bryan. Students in after-school programs were recruited in order to avoid the interruption of regular school activities. Thirty boys and thirty-three girls (seven to eleven year-old) were recruited and the average age of the sample was 10.04 year-old.

Twenty-eight children were Caucasian. Seventeen were Hispanic and ten were African-American. Four Asian and four bi-racial children participated. Demographic information about the participants is summarized in Tables 5.1 and 5.2.

TABLE 5.1
Number of Subjects by Age and Gender

| Age (Years) | Gender | | Total | Reference |
|---|---|---|---|---|
| | Boys | Girls | | |
| 7 | 5 | 5 | 10 | |
| 8 | 4 | 3 | 7 | |
| 9 | 3 | 5 | 8 | |
| 10 | 7 | 6 | 13 | |
| 11 | 11 | 14 | 25 | |
| Total | 30 | 33 | 63 | |

TABLE 5.2
Number of Subjects by Ethnicity

| Ethnicity | Gender | | Total | % | Average Age (Years) |
|---|---|---|---|---|---|
| | Boys | Girls | | | |
| Caucasian | 16 | 12 | 28 | 44.5 | 10.57 |
| Hispanic | 6 | 11 | 17 | 27.0 | 10.11 |
| African-American | 4 | 6 | 10 | 15.9 | 8.63 |
| Asian | 2 | 2 | 4 | 6.3 | 9.81 |
| Other | 2 | 2 | 4 | 6.3 | 9.83 |
| Total | 30 | 33 | 63 | 100 | 10.04 |

### 5.2.2 Recruitment of Participants

Parental permission forms and child assent forms were sent to the parents and children to be signed and returned prior to participation. Data collection of the pilot study was mainly conducted from February to May, 2006.

This study was approved by the Texas A&M University Institutional Review Board – Human Subjects in Research, the College Station Independent School District (CSISD) Research Review Committee, and the Bryan Independent School District Research Committee.

The Research Review Committee from CSISD required a third person as an observer for liability purposes since the experiments were originally to be conducted only between the subject and the researcher. As a result, an independent observer accompanied the researcher during the experiment. This issue was discussed with the researcher's Ph.D. committee members and Dr. Holley Mohr, Director of the 21st Century Project Grant in Bryan Independent School District. Through this discussion Dr. Mohr referred the researcher to Dr. Clifton Watts, a professor in the Department of Recreation, Parks, and Tourism Sciences at Texas A&M University, for finding an observer; this was because Dr. Watts had previously been involved in many research projects related to youth programs. Dr. Watts introduced the researcher to a well-qualified observer who was aware of their responsibilities for the welfare of the children participating in the experiment. The observer fulfilled this role for the pilot study and main study as well.

The risk associated with this study was minimal. There was a possibility that participants would feel uncomfortable from being in a novel research situation. To manage this, the researcher introduced himself and the characteristics of the research to participants in order to become familiar prior to the experiment. There was no compensation for participation.

### 5.2.3 Selection of Child Population

Age group was important because the final study would go on to compare children's preference to adults'. This necessitated that the two groups have a similar capability for interaction with the research tool. According to Piaget's cognitive-developmental theory and the theory of dual representation, children below a certain age lack the ability to reference symbols, or in this case, scale models. Therefore, the children's age group of seven to eleven years was used because they are in the concrete-operational stage according to Piaget's cognitive-developmental theory. The concrete operational stage lasts from about seven to eleven years of age and during this time cognition is transformed into more organized thought, though logical thinking is not yet at an adult level (Brainerd, 1978). Children in this age range are fully developed in understanding the representation of a symbol to its referent, a process known as dual representation (DeLoache, Peralta de Mendoza, & Anderson, 1999). By using this age group the experiment ensured that the child subjects could reference the models akin to the adult subject's capacity.

## 5.3 APPARATUS

Ten 1:12 scale-models of patient rooms, each with a single interchangeable side wall, were built by the researcher and utilized for this study (see Appendix B for more detail). The layout and environment of all models was identical except the single interchangeable side wall's color.

Figure 5.1: Illuminance Measurement Method inside Scale-Models

The illuminance level inside the scale-models was set to 520 lux for the overall illuminance level – both incandescent and fluorescent lights – and 240 lux for the fluorescent light only. The illuminance level was measured by a photometer (see Appendix O). Figure 5.1 shows illuminance measurement method inside scale-models.

**5.4 VARIABLES**

1. Independent variables: different types of colors

2. Dependent variables: children's color preferences

The Munsell color system was the most often used color system among those found in the literature (Beach, Wise, & Wise, 1988) because of it's feasibility and international acceptance (Indow, 1988). The Munsell color system is a method of accurately specifying surface colors using three interrelated dimensions: hue, brightness (value), and saturation (chroma) (Luke, 1996) (see Appendix A).

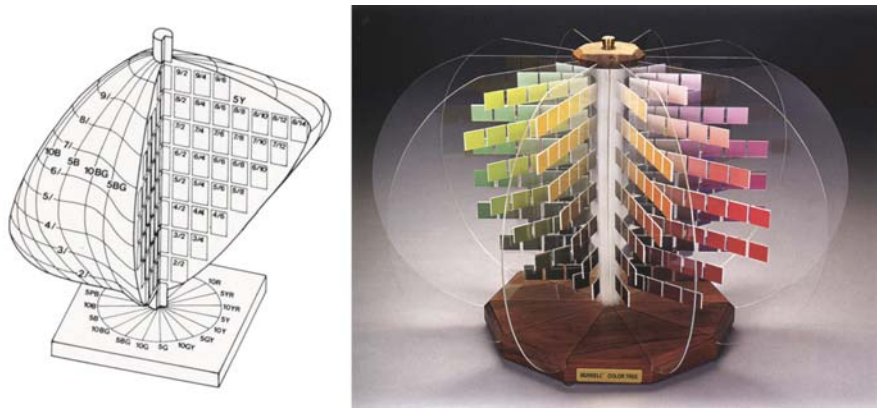


Figure 5.2: Munsell Color Solid
Source: Adapted from Luke, 1996.

Hue refers to the attribute of color which distinguishes red from yellow, green from blue, and so on. The Munsell system visually divided the hue wheel into 100 uniform steps. The red hue family is identified by points 0 to 10. The middle of the red hue family is called five red, and is written 5R. Each 10 steps consists of a hue family so there are ten hue families in total; red, yellow-red, yellow, green-yellow, green, blue-green, blue, purple-blue, purple, and red-purple. Red, yellow, green, blue, and purple are categorized as the five major hue families and the others are categorized as the five minor hue families. The minor hue families can be made by mixing paints of adjacent pairs of hues, for example, combinations of red and yellow create orange (yellow-red). However, the inverse does not hold true. In other words, combinations of yellow-red and green-yellow does not create yellow. In each major hue family, nine different brightness and saturation combinations and a neutral color (white) were selected and used for the single interchangeable side wall color. Munsell Color Solid and Hue Wheel are shown in Figures 5.2 and 5.3.

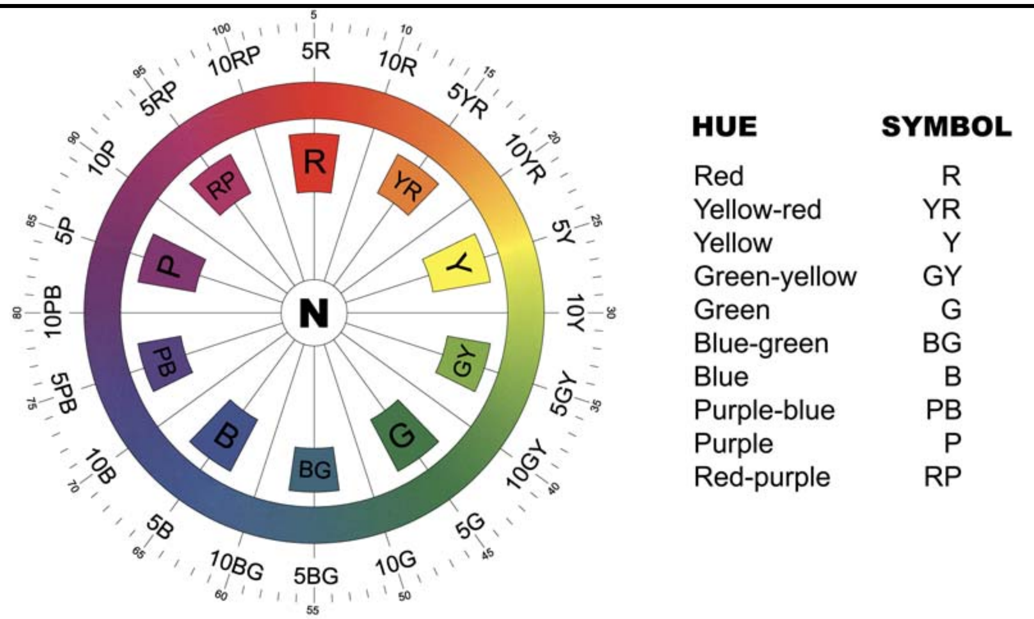



Figure 5.3: Munsell Hue Wheel
Source: Adapted from Luke, 1996.

Brightness refers to the lightness of a color. The point of brightness ranges from 0 for black and 10 for white. In-between colors from black to white are grays or neutral colors. These colors are also called achromatic colors since they do not possess hues. Colors that have hues are defined as chromatic colors. A chromatic color is specified by a notation of hue brightness/saturation (H B/S) and a neutral color is written by neutral brightness (N B/) in the Munsell color system

Saturation refers to the degree of departure of a color from the neutral color of the same lightness. Saturation often indicates the strength of a color: colors of low saturation are said to be weak colors while those of high saturation are called strong.

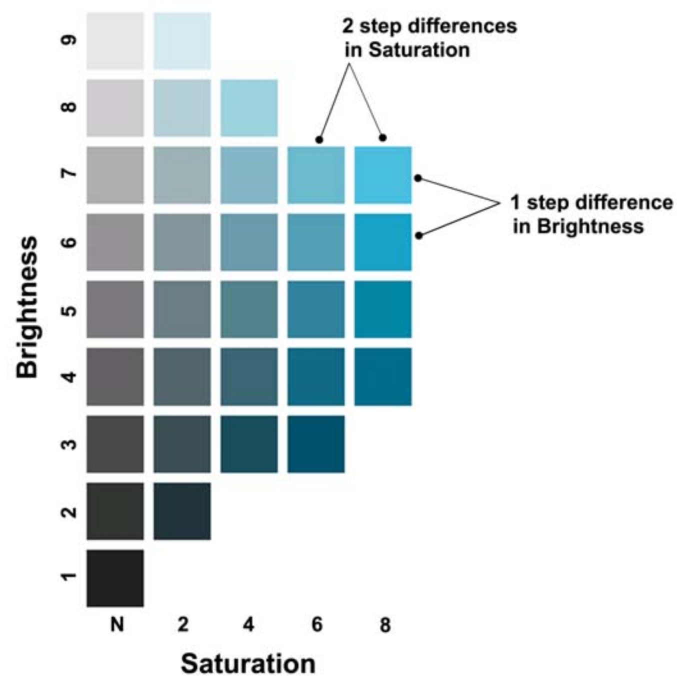



Figure 5.4: Ratio of Perceptual Difference in Munsell Color System

For color selection, the magnitude of perceptual difference between colors in the Munsell system was considered. The Munsell color system was constructed using the ratio method in order to provide a visually uniform step for two adjacent color chips (Indow, 1988). The perceptually equal steps of the units of three attributes (hue, brightness, and saturation) are important for meaningful interpolation and universal application (Indow, 1988). The ratio of the perceptual difference for brightness and saturation in the Munsell system is designed to be 1:2 (see Figure 5.4). In other words, a one step difference in brightness is considered an equal perceptual difference to a two step differences in saturation.

Several studies have been conducted regarding the perceptual uniformity in order to investigate human color perception captured on the Munsell color system. These studies generated various ratios of the units for brightness and saturation in order to achieve perceptual uniformity (see Indow, 1980). Table 5.3 summarizes different ratio of units for brightness and saturation in the Munsell color system.

TABLE 5.3
Ratio of Units for Brightness and Saturation in the Munsell Color Solid

| Study | Ratio of Units for Brightness and Saturation |
|---|---|
| Nickerson and Stultz (1944) | 1:2.3 |
| Godlove (1951) | 1:4.0 |
| Torgerson (1952) | 1:2.3 |
| Messick (1954) | 1:2.5 |
| Indow and Shiose (1956) | 1:2.3-3.1 |
| Indow and Kanazawa (1960) | 1:1.8 |
| Indow and Ohsumi (1972) | 1:2.8 |
| Indow and Aoki (1983) | 1:2.4 |
| Indow and Watanabe (1980) | 1:1.7-2.5 |
| Farmer, Taylor, and Belyavin (1980) | 1:3.76 |

For equal size in the perceptual color differences, 1:3 was used as the ratio of units for brightness and saturation (see Figure 5.5). This was because the perceptually equal step of saturation to brightness defined by the previous studies was mostly in-between two to four steps. In other words, a one step difference in brightness is perceptually equivalent to three steps in saturation.

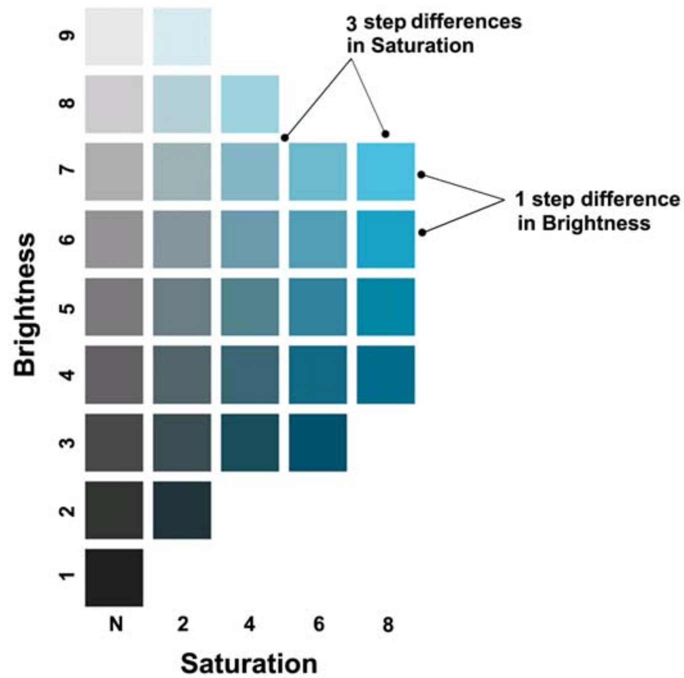



Figure 5.5: Ratio of Units for Brightness and Saturation Using in Study

In interior spaces, bright and less saturated colors such as pastel tones have been commonly considered for wall colors. In contrast, children prefer highly saturated colors to less saturated ones when color stimuli were used in isolation (Child, Hansen, & Hornbeck, 1968). Therefore, as many colors as possible from high saturation to low saturation were selected as independent variables for this study.

Color was specified by a notation of hue brightness/saturation (H B/S) in the Munsell color system. The notation of brightness 7 and saturation 8 was the most saturated and the brightest spot among existing color chips for all five major hue families. Nine samples for each hue family were selected from this coordinate (brightness 7 and saturation 8) with three step differences in saturation or one step in brightness. As a result, a total of forty-five color samples were produced by the Munsell Conversion software program provided by the Munsell Company. Figure 5.6 presents the selected color samples for pilot study.

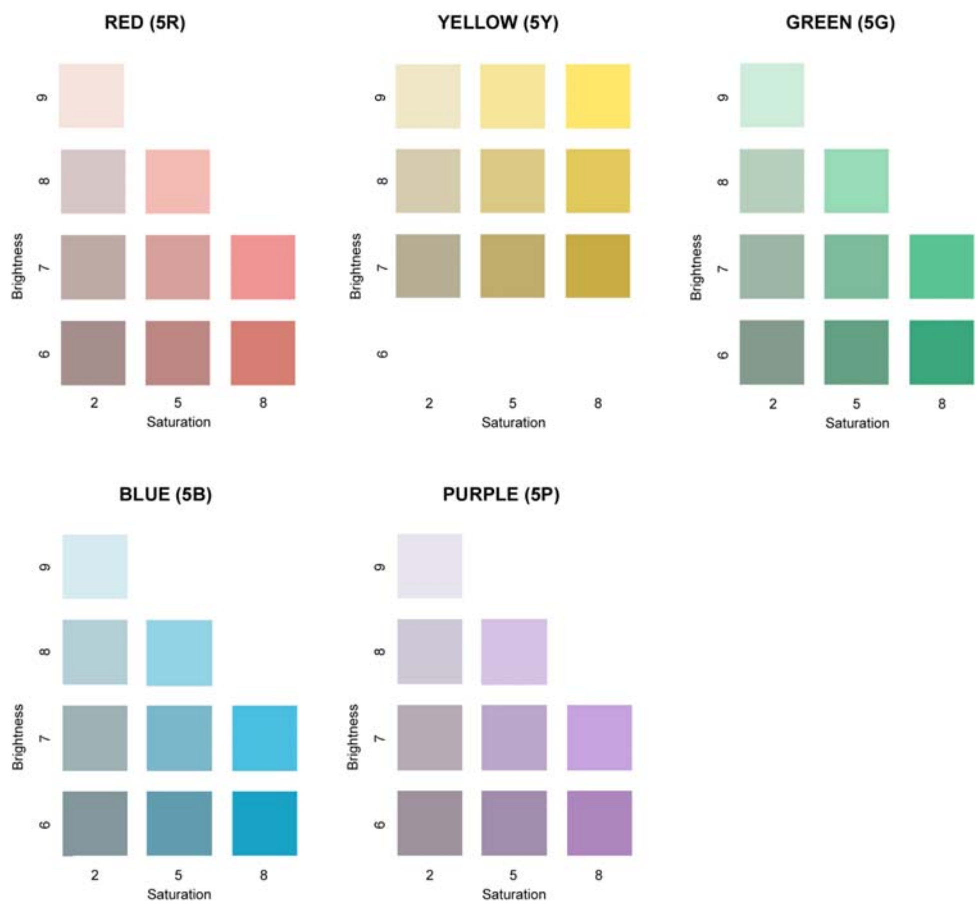



Figure 5.6: Selected Color Samples for Pilot Study

Since the colors were printed on matt paper, the quality of a color on the paper was not the same as that in the software program. For consistency and replication of the study, the quality of the selected color samples were measured and recorded by the researcher. Chromatic values of the colors on matt paper in isolation were measured (see Appendix P) and the visual qualities of the colors inside the scale-models were also measured (see Appendix Q).

In order to measure a color quality on matt paper in isolation, a special tool was used. Figure 5.7 shows the measurement of color quality printed on matt paper in isolation. A full spectrum light bulb was installed as a light source. The color was lit only by the light source and the chromatic values of the color were measured by a photometer.

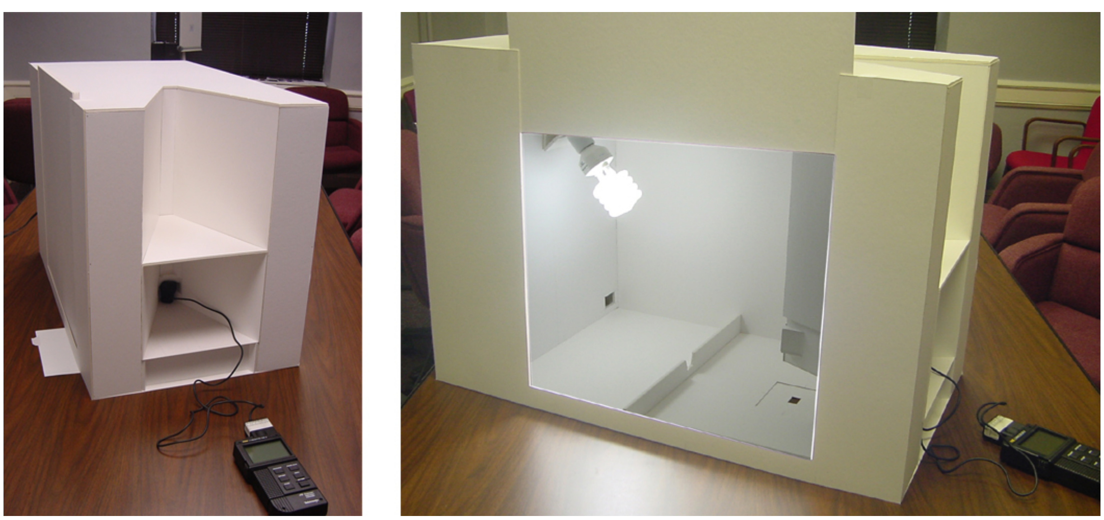


Figure 5.7: Measurement of Color Quality Printed on Matt Paper in Isolation

Color quality in the model was also important because it was the actual property of the color that participants observed. The displayed color was lit by two light sources. One was a cool fluorescent lamp and the other was an incandescent light lamp. Light from the two different light sources created an uneven spectral distribution on the displayed colors. Therefore, the chromatic values of the colors were measured based on six designated spots. This measurement was conducted without any light source except what was inside the models. Figure 5.8 displays the measurement method of the visual quality of the colors.

Figure 5.8: Measurement of Visual Quality of Color in Scale-Model

**5.5 PROCEDURE**

A classroom location was chosen based on convenience and desks in the classroom were rearranged in front of a chair. The desks were covered with a white cloth and the models were displayed on the desks. The luminance levels on the tops of the desks were measured by photometer and maintained throughout the experiment. The luminance levels inside the scale-models were measured in the classroom and matched among all the models used by the researcher.

Students performed the experiment in the classroom individually at their own pace based on a first-available first-participate principle. Subjects participated according to an assigned time schedule to avoid waiting. There were five sessions in the experiment and those were performed in random order. Table 5.4 shows the organization of the pilot study and the selected color samples.

TABLE 5.4
Organization of the Pilot Study

| Session | Preference Experiment for | Selected Color Samples | | Neutral (White) |
|---|---|---|---|---|
| | | Hue | Brightness/Saturation | |
| A | Red hue family | 5R | 6/2, 6/5, 6/8, 7/2, 7/5, 7/8, 8/2, 8/5, 9/2 | N 9.5/ |
| B | Yellow hue family | 5Y | 7/2, 7/5, 7/8, 8/2, 8/5, 8/8, 9/2, 9/5, 9/8 | N 9.5/ |
| C | Green hue family | 5G | 6/2, 6/5, 6/8, 7/2, 7/5, 7/8, 8/2, 8/5, 9/2 | N 9.5/ |
| D | Blue hue family | 5B | 6/2, 6/5, 6/8, 7/2, 7/5, 7/8, 8/2, 8/5, 9/2 | N 9.5/ |
| E | Purple hue family | 5P | 6/2, 6/5, 6/8, 7/2, 7/5, 7/8, 8/2, 8/5, 9/2 | N 9.5/ |

Before the subject entered the room, ten 1:12 scale-models of patient rooms were displayed on the desks throughout the experiment. Each of the ten color samples were presented on the single interchangeable side wall in each of the ten scale-models in random order using Latin Square Design method. For example, each of the nine chromatic colors (5B 6/2, 5B 6/5, 5B 6/8, 5B 7/2, 5B 7/5, 5B 7/8, 5B 8/2, 5B 8/5, 5B

9/2) within the blue hue family and a white (N 9.5) as neutral color were shown to the subject in session D using the interchangeable side wall.

In the session, subjects were asked to select their favorite colored rooms three times in order and then their least preferred ones three times in order. Sufficient time was given to the subjects for exploring the environment of the models and deciding on each evaluation.

The subjects received a verbal introduction about the researcher and the experiment. “My name is Jin Gyu Park. I need your help because I want to know about children’s favorite colors. There are no right or wrong answers because this is not a test. It will take about thirty minutes to finish. You can ask questions or stop at anytime.”

All participants were tested for color deficiency prior to participation using an Ishihara plate. All participants were shown the Ishihara plate and asked to indicate what they saw in the plate by the researcher, “What do you see in this picture?” It was planned that anyone who failed this test would be excluded from the study; however, all participants passed the test.

To control the illuminance levels inside the models, the classroom lights were turned off and the windows were blocked by blinds. This was explained to the participants verbally by the researcher. “To help the models look clear, I am going to make this room dark. Please let me know if you are uncomfortable, then I will turn the lights back on. Now, I will turn off the lights and blind the windows. Before we start, take your time and look around these rooms as much as you want. Then, let me know when you are ready.” Anyone who did not want the lights off or windows blinded was excluded from the study. No participant requested the lights remain on or the window stay un-blinded. Figure 5.9 shows display method of scale-models.

The subjects were asked to select their favorite colored room among the ten rooms. To do so, the subjects were asked by the researcher, “Now, we have ten rooms. Each room has a different color on the wall. When I ask a question, please take your time and point with your finger to show your choice. Which room do you like best?”

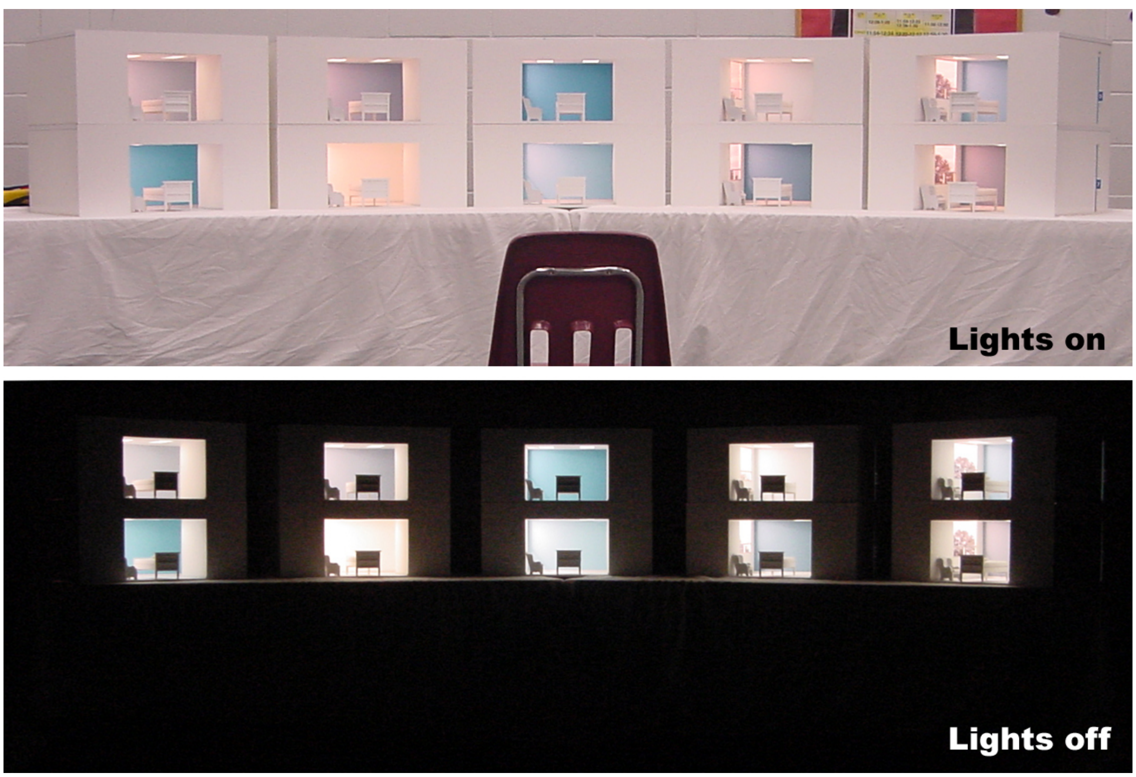



Figure 5.9: Display of Scale-Models

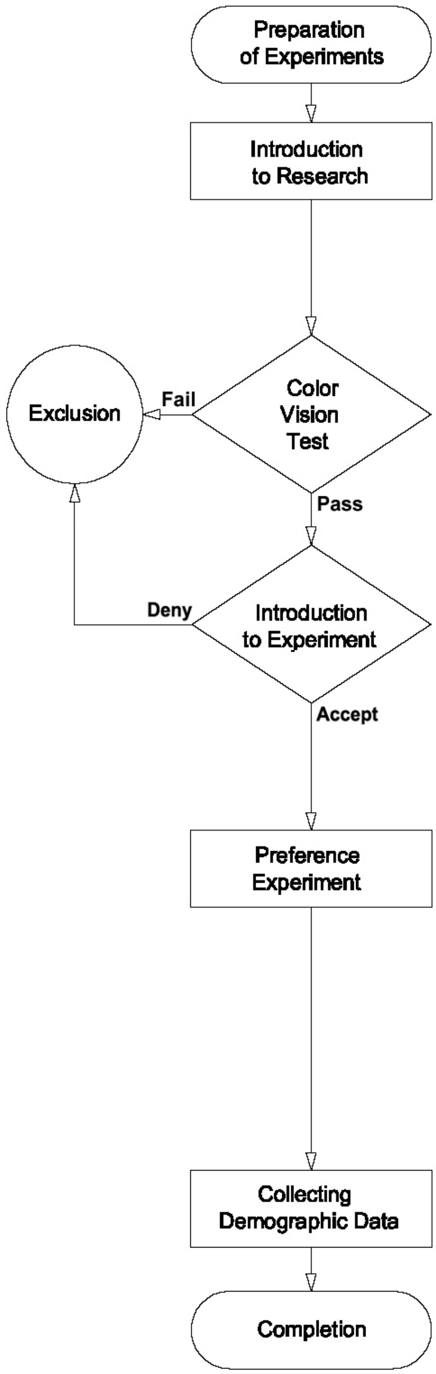
After the selection, the selected model was covered with a white board by the researcher. For the second selection, the subjects were asked to pick their favorite colored room among the remaining nine models. “Which room do you like best?” The selected model was then covered with a white board by the researcher. This process was repeated for the third selection of the most preferred room.

After the selection of three most preferred rooms, the subjects were asked to select their least preferred colored room from the remaining seven models. To do so, the subjects were asked by the researcher, “Now, I am going to ask which room you do not like. Which room do you like least?”

The selected model was then covered with a white board by the researcher. For the second selection, the subjects were asked to pick their choice among the remaining six models. “Which room do you like least?” This process was repeated for the third selection of least preferred room in the same manner.

After completing one session, another randomly selected session from the different hue families began. The interchangeable walls were replaced with another set of colors within a hue family by the researcher. The process was identical excluding the hue family of the previously displayed colors. This process continued until all five sessions had been completed.

As soon as the test was completed, the instructor recorded the student’s age, gender, ethnicity, and preference order. No identifier or name was recorded. Each experiment took approximately thirty minutes per child to complete. Figure 5.10 summarizes the procedure of this study.




| Flow Diagram | Verbal Description | Instrument |
|---|---|---|
| | My name is Jin Gyu Park. I need your help because I want to know about children's favorite colors. There are no right or wrong answers because this is not a test. It will take about twenty minutes to finish. You can ask questions or stop at anytime. | |
| | What do you see in this picture? | Ishihara plate |
| | To help the models look clear, I am going to make the room dark. You can ask me to turn on the lights and open the blinds anytime if you want. (Turn off the lights and blind the windows). Before we start, take your time and look around these rooms as much as you want. Then, let me know when you are ready. | |
| | Now, we have ten rooms. Each room has a different color on the wall. When I ask a question, please take your time and point with your finger to show your choice.<br>Which room do you like best? (3 times)<br>Now, I am going to ask which room you do not like.<br>Which room do you like least? (3 times) | Ten models |
| | I have one more question. What is your birthday? | |
| | You are finished. Thank you very much. | |

Figure 5.10: A Flow Diagram of the Procedure for the Pilot Study

Data obtained from the experiment were analyzed for determining the most preferred color of each of the five major hue families in children's color preferences. Based on these results, the most preferred colors configured by the pilot study were applied to the researcher's final study as independent variables.

## 5.6 RELIABILITY

In order to generate scientific results, data obtained from research must be valid and reliable. The concept of reliability ensures that measurements or findings are consistent when a study is replicated under the same conditions in different locations or times (Sommer & Sommer, 1997).

This study measured children's preferences among various colored rooms using scale-models. Children's color preferences (dependent variables) were expected to be reliable since only colors (independent variables) were manipulated; that is, all conditions except the colors were identical regardless of locations and time.

In addition to reliability, validity is another important issue. While reliability is critical for good science, it is insufficient without validity (Leedy & Ormrod, 2001).

## 5.7 VALIDITY

The pilot study was categorized as an experimental design since the independent variables were controlled by the researcher in order to observe their effects on the dependent variables. Validity is the credibility of a conclusion, and there are four types of validity: statistical conclusion validity, internal validity, construct validity, and external validity (Shadish, Cook, & Campbell, 2002). Shadish, Cook, and Campbell (2002) also enumerated factors jeopardizing the validity of experimental designs. Unless a research design is strong in the types of validity, it might be confounded with plausible alternative explanations. As such, this study was evaluated in terms of the four types of validity one by one.

### 5.7.1 Statistical Conclusion Validity

"Statistical conclusion validity concerns two related statistical inferences that affect the covariation component of causal inferences: (1) whether the presumed cause and effect covary and (2) how strongly they covary" (Shadish, Cook, & Campbell, 2002, p. 42). If the statistical power is too low, it is difficult to detect an effect. Several steps can be taken for increasing the power and this includes increasing sample sizes, raising the alpha level, or avoiding extreme responses (Shadish, Cook, & Campbell, 2002). When increasing the alpha value, the chances of making a Type I Error (i.e. indicating there is covariation when there is none) are higher, but statistical power is higher, too. That is, increasing the alpha value decreases the chances of making a Type II Error (i.e. indicating there is no relationship when there is). Children's preferential responses to colors were measured using an ordinal scale. The ordinal scale was transferred to designated numeric values and Ranked Multiple Response Analysis was used to determine the most preferred colors.

When the range of outcome values is too narrow, the outcome is subject to extreme responses (Shadish, Cook, & Campbell, 2002). To identify the most preferred color among various color samples, the participant's selection process was repeated until the three most preferred and three least preferred colors were selected. The preferential orders provided sufficient data in order to identify the most preferred colors accordingly.

Statistical conclusions can be influenced if treatment is conducted inconsistently from person to person within sites (Lipsey, 1990); it commonly results in effect size reduction (Shadish, Cook, & Campbell, 2002). To avoid these threats, this study needed consistency in procedures and instruments. All procedures and instruments used in this study were identical so the inconsistency threat was minimal.

To reduce extraneous variance in the experimental setting, participants need to focus on the experiments (Shadish, Cook, & Campbell, 2002). As the experiments were conducted in a secure place under lights off conditions, distractions were minimized.

### 5.7.2 Internal Validity

Internal validity refers to, "inferences about whether observed covariation between A and B reflects a causal relationship from A to B in the form in which the variables were manipulated or measured" (Shadish, Cook, & Campbell, 2002, p. 53). Presumed causes must occur prior to their effects (Shadish, Cook, & Campbell, 2002). Different colors in the scale-model rooms were presented and then the preferential responses were expressed by participants. That is, colors were independent variables and the participants' preferential responses were dependent variables; in this case, the causes (colors) and outcomes (preference orders) are not reciprocal.

Selection is pervasive and selection bias can influence the effects because of population differences; selection bias can be reduced by random assignment because randomly assigned groups are different only by chance (Shadish, Cook, & Campbell, 2002). The participants (children ages 7 – 11 years) participated in this study by means of first-available first-participate principle since the pool of subjects was not large enough to select who could or could not participate. All children who had parental and child assent forms participated. Instead of randomizing subjects to experiments, color samples used in this study were displayed according to the Latin Square Design in order to reduce the order effect. The Latin Square Design is a square matrix such that no same item is repeated twice in any row or column; in other words, each item appears in all rows and columns but only one time in systematic order. This process enhances randomness and eliminates selection bias.

The history threat can be reduced by isolating participants from outside stimuli or by selecting dependent variables that could seldom be influenced by outside environments (Shadish, Cook, & Campbell, 2002). This threat was minimal because the experiments were conducted in a secure place with the lights off.

Maturation addresses participants' changes during the experiments, such as them becoming older or wiser as time goes by (Shadish, Cook, & Campbell, 2002). The range of child groups in this study was the same and the duration of the experiment was less than 30 minutes per subject, so they were in the same maturational condition and the threat of maturation was minimal.

Practice and familiarity can influence treatment effects (Shadish, Cook, & Campbell, 2002). All subjects of the pilot study had only one opportunity to participate so the familiarity threat was minimal. When children who previously went through the pilot study participated in the main study again, they may have been familiar with the scale-model simulation experiments. However, the threat was also minimal because the independent variables and measurement instruments of the main study were different from those of the pilot study.

### 5.7.3 Construct Validity

"Construct validity involves making inferences from the sampling particulars of a study to the higher-order constructs they represent" (Shadish, Cook, & Campbell, 2002, p. 65). This refers to the degree of generalization between the operational stage and theoretical level. This study sought children's most preferred wall colors among the five major hue families according to the Munsell color system. The best way of doing this would have been manipulating wall colors in real rooms, but it also would have been ineffective and cost-consuming. Therefore, scale-model simulation was employed because it was a cost-effective, time-efficient, and reliable method regarding the investigation of environmental effects. Participants' preferential orders were a significant indicator of the participant's satisfaction with the environmental colors. This concept matches with the conceptual model proposed by Sherman, Shepley, and Varni (2005).

Monomethod bias can occur when a complex piece of research is measured by just one method (Shadish, Cook, & Campbell, 2002). If the results of different measurements agree, the results are more trustworthy (Brewer & Hunter, 1989). The pilot study simply sought children's color preference orders using scale-models. Participants' preferential orders were sufficient for determining children's most preferred colors. Second and third preferred colors also helped identify the most preferred colors as they provided more information about the preferential relations among brightness and saturation.

If participants can guess what the researcher wants to know, the participants may start guessing answers in that direction (Rosenzweig, 1933). The researcher's expectations can also affect outcomes (Rosenthal, 1956). To avoid these threats, the research hypotheses were not introduced to participants and the researcher was not in contact with the participants prior to the experiments. Less threatening settings, anonymity, and confidentiality all reduce these threats (Shadish, Cook, & Campbell, 2002); this study followed all of those practices. To manage the possibility that participants' might have felt uncomfortable being in a novel research situation, the researcher and the characteristics of the research were introduced to participants. Participants were clearly told that there were no right or wrong answers and their responses could be accessed only by the researcher.

### 5.7.4 External Validity

"External validity concerns inferences about the extent to which a causal relationship holds over variations in persons, settings, treatments, and outcomes both that were in the experiment and that were not in the experiment" (Shadish, Cook, & Campbell, 2002, p. 83). External validity refers to the degree of generalization of findings from experiments to real settings.

"Random sampling eliminates possible interactions between the causal relationship and the class of persons who are studied versus the class of persons who are not studied within the same population" (Shadish, Cook, & Campbell, 2002, p. 91). Random sampling secures external validity but it is very difficult to achieve random sampling in experiments (Shadish, Cook, & Campbell, 2002). This study recruited normal children ages 7 – 11 years in after school program from schools in Brazos County, Texas; this was categorized as convenience sampling, which is nonrandom. This nonrandom sampling could be a factor which decreases external validity. To draw a large sample size is effective to reduce sampling error; and sample bias can be reduced by careful sampling methods (Sommer & Sommer, 1997). The participants were recruited from one private and three public schools and the sample size was sufficient to draw study conclusions. The majority of students in the private school were Caucasians in high socioeconomic status. Other students in after-school programs differed because the programs were basically for low-income families and they were more diversified in terms of ethnicity. This combination of public and private school children improved external validity since the ethnic and socioeconomic status distribution of the sample was more representative to that of the general population in the United States.

Manski and Garfinkel (1992) speculated that the results of data obtained from a small-scale simulation might not be the same with those from a real situation. This study employed a simulation design due to its inherent feasibility and reliability. There has been evidence that data gathered from small-scale environments were reliably comparable to those from full-scale environments (Baird, Cassidy, & Kurr, 1978; De Long, 1976). Simulations can support environmental effect assessments as data and a controlled stimulus (Sheppard, 1989); they can also deal with environments where preferences or responses are sought to different styles of environments or views (Sanoff, 1991).

A mediator considered significant in one context may not function in another context (Shadish, Cook, & Campbell, 2002). The context of this pilot study was specific. Multiple 1:12 typical patient rooms were used and the environments of the rooms were identical, except for the accent wall where different colors (independent variable) were displayed. The illuminance levels inside the models were matched with the typical pediatric patient room in St. Joseph Regional Health Center in Bryan. To simulate a daylight source, incandescent lights were installed inside the models and adjusted to the illumination level from 12 pm to 2 pm during the fall season (October to February) in Bryan. These specific contexts decreased the external validity; thus this study was limited in generalizing its findings as applied to the specific context.

### 5.7.5 Conclusion

As an experimental design, this pilot study had high internal validity since the independent variables and dependent variables were carefully manipulated by the researcher. However, it had potentially low external validity because of the nonrandom sampling and context-dependency; that is, the generalizability of the study results were limited to the specific contexts in which it was conducted. However, research that provides limited generalization may be just as important as those which provide broad generalization (Shadish, Cook, & Campbell, 2002).

# CHAPTER VI

# RESULTS AND DISCUSSION OF EXPERIMENT I (PILOT STUDY)

## 6.1 RESULTS

### 6.1.1 Overall Children's Color Preferences

All subjects selected their three most preferred colored rooms and three least preferred ones among the ten different colored rooms. In order to quantify the data, the participant's preference orders were converted. Table 6.1 is conversion table of preference orders.

TABLE 6.1
Conversion Table of Preference Orders

| Preference Order | Converted Score | Reference |
|---|---|---|
| Most Preferred | 7 | |
| Second Preferred | 6 | |
| Third Preferred | 5 | |
| Not Selected | 4 | |
| Third Least Preferred | 3 | |
| Second Least Preferred | 2 | |
| Least Preferred | 1 | |

Means were used for determining healthy children's five most preferred colors among each of the five hue families based on the Munsell color system. Table 6.2 shows the means and standard deviations of the children's color preferences. In the red hue family, 5R 7/8 was most preferred followed by 5R 6/8. Other most preferred colors were 5Y 9/8 (yellow), 5G 7/8 (green), 5B 6/8 (blue), and 5P 7/8 (purple).

TABLE 6.2
Means and Standard Deviation on Children's Color Preferences

| Hue | Munsell Color Notation | Number of Subjects | Mean | Standard Deviation | Reference |
|---|---|---|---|---|---|
| Red | 5R 7/8 | 63 | 5.08 | 1.76 | Most Preferred |
| | 5R 6/8 | 63 | 5.03 | 1.48 | |
| | 5R 8/5 | 63 | 4.56 | 1.48 | |
| | 5R 7/5 | 63 | 3.90 | 1.51 | |
| | 5R 6/5 | 63 | 3.86 | 1.40 | |
| | 5R 8/2 | 63 | 3.78 | 1.16 | |
| | 5R 9/2 | 63 | 3.76 | 1.48 | |
| | N 9.5 | 63 | 3.73 | 1.74 | |
| | 5R 7/2 | 63 | 3.38 | 1.34 | |
| | 5R 6/2 | 63 | 2.92 | 2.00 | Least Preferred |
| Yellow | 5Y 9/8 | 63 | 4.81 | 1.78 | Most Preferred |
| | 5Y 9/5 | 63 | 4.46 | 1.45 | |
| | 5Y 8/8 | 63 | 4.19 | 1.47 | |
| | 5Y 9/2 | 63 | 4.14 | 1.40 | |
| | N 9.5 | 63 | 4.05 | 1.98 | |
| | 5Y 8/2 | 63 | 3.87 | 1.59 | |
| | 5Y 8/5 | 63 | 3.65 | 0.97 | |
| | 5Y 7/8 | 63 | 3.63 | 2.06 | |
| | 5Y 7/2 | 63 | 3.60 | 1.85 | |
| | 5Y 7/5 | 63 | 3.59 | 1.57 | Least Preferred |
| Green | 5G 7/8 | 63 | 5.08 | 1.77 | Most Preferred |
| | 5G 6/8 | 63 | 4.76 | 2.01 | |
| | 5G 8/5 | 63 | 4.62 | 1.21 | |
| | 5G 6/5 | 63 | 4.03 | 1.31 | |
| | 5G 7/5 | 63 | 4.02 | 0.68 | |
| | 5G 9/2 | 63 | 3.79 | 1.38 | |
| | 5G 8/2 | 63 | 3.76 | 1.32 | |
| | N 9.5 | 63 | 3.60 | 2.04 | |
| | 5G 7/2 | 63 | 3.48 | 1.37 | |
| | 5G 6/2 | 63 | 2.86 | 1.98 | Least Preferred |

TABLE 6.2 (Continued)

| Hue | Munsell Color Notation | Number of Subjects | Mean | Standard Deviation | Reference |
|---|---|---|---|---|---|
| Blue | 5B 6/8 | 63 | 5.79 | 1.63 | Most Preferred |
| | 5B 7/8 | 63 | 5.21 | 1.31 | |
| | 5B 8/5 | 63 | 4.60 | 1.30 | |
| | 5B 6/5 | 63 | 4.27 | 1.15 | |
| | 5B 7/5 | 63 | 4.24 | 0.91 | |
| | 5B 9/2 | 63 | 3.70 | 1.30 | |
| | 5B 8/2 | 63 | 3.57 | 1.24 | |
| | N 9.5 | 63 | 3.19 | 1.86 | |
| | 5B 7/2 | 63 | 2.90 | 1.17 | |
| | 5B 6/2 | 63 | 2.52 | 1.60 | Least Preferred |
| Purple | 5P 7/8 | 63 | 5.19 | 1.93 | Most Preferred |
| | 5P 6/8 | 63 | 5.08 | 1.83 | |
| | 5P 7/5 | 63 | 4.63 | 1.02 | |
| | 5P 8/5 | 63 | 4.37 | 1.21 | |
| | 5P 6/5 | 63 | 4.05 | 0.99 | |
| | 5P 9/2 | 63 | 3.75 | 1.30 | |
| | N 9.5 | 63 | 3.68 | 1.64 | |
| | 5P 8/2 | 63 | 3.30 | 1.24 | |
| | 5P 7/2 | 63 | 3.02 | 1.61 | |
| | 5P 6/2 | 63 | 2.94 | 1.85 | Least Preferred |

The following graphs show the mean scores and confidence intervals of the children's color preferences in each of the five major hue families. Dots represent the variables' means and the protruding lines from the dots represent 95% confidence intervals. Figure 6.1 displays children's color preferences in red hue family, Figure 6.2 in yellow, Figure 6.3 in green, Figure 6.4 in blue, and Figure 6.5 in purple hue family.

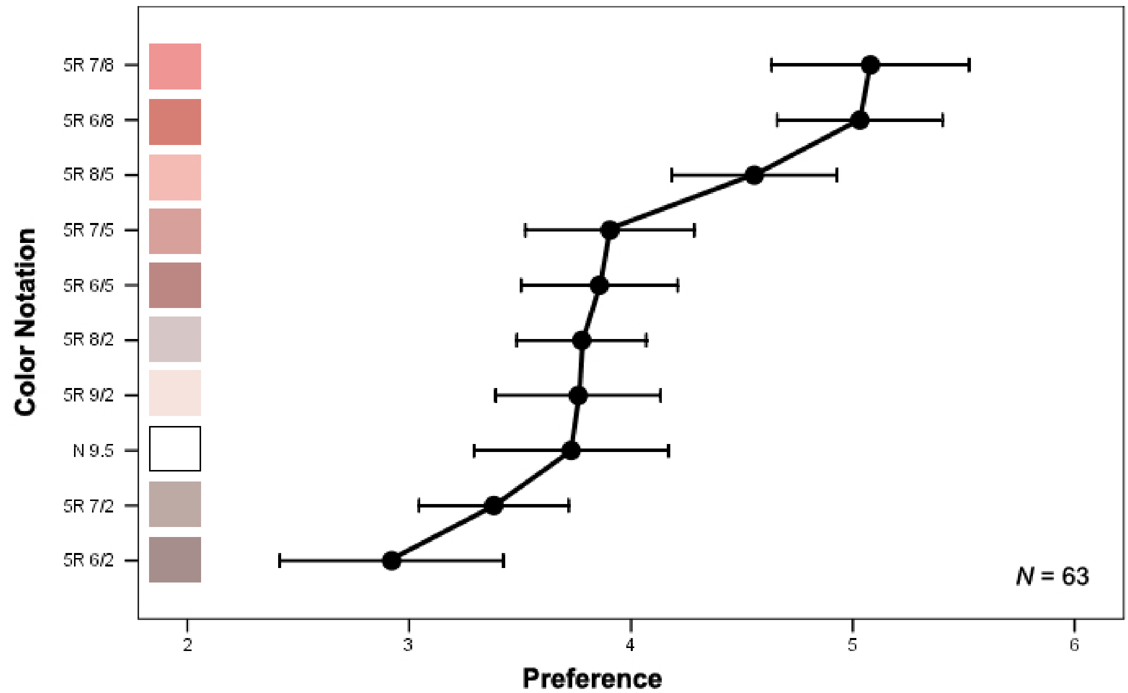



Figure 6.1: Children's Color Preferences in Red Hue Family

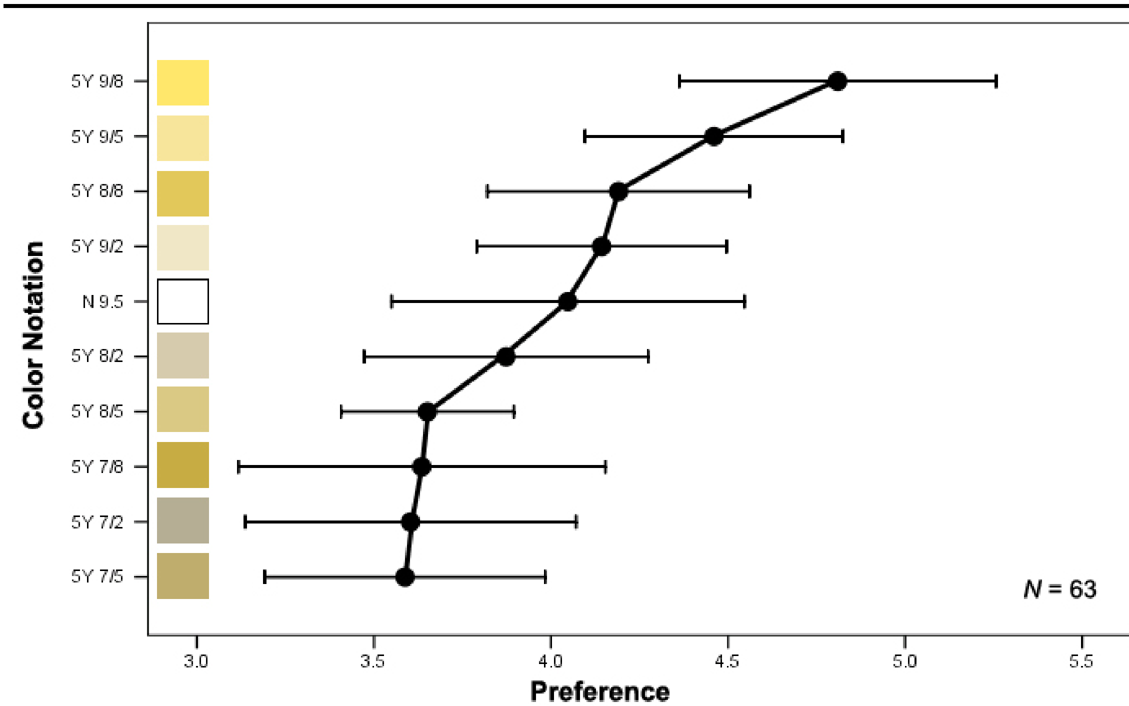



Figure 6.2: Children's Color Preferences in Yellow Hue Family

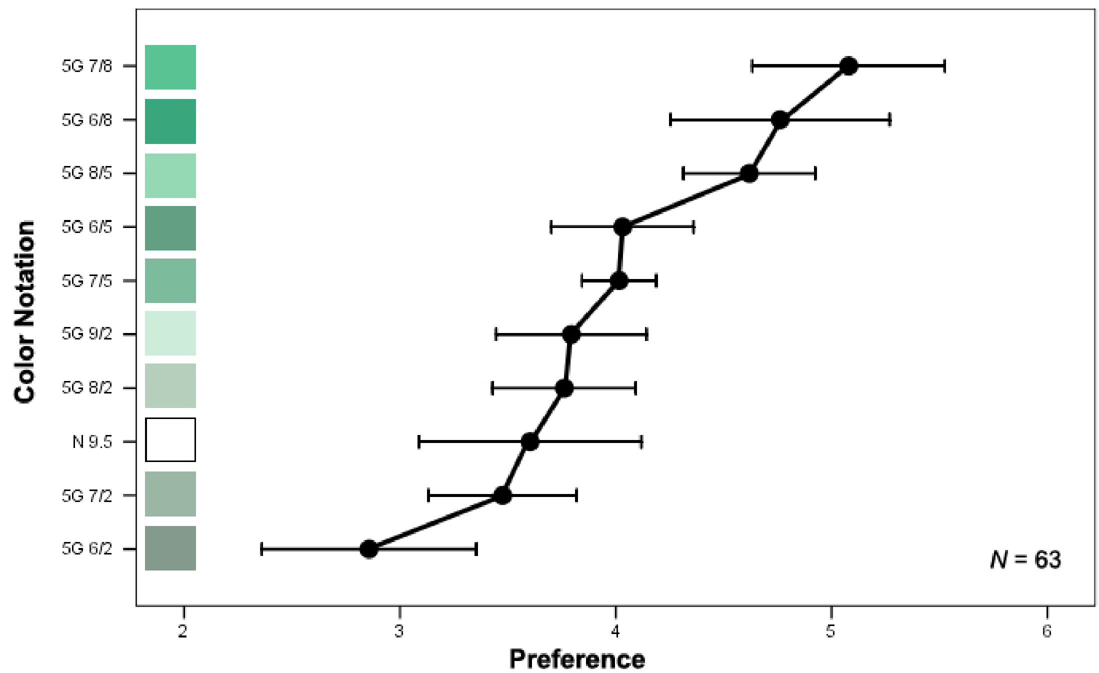



Figure 6.3: Children’s Color Preferences in Green Hue Family

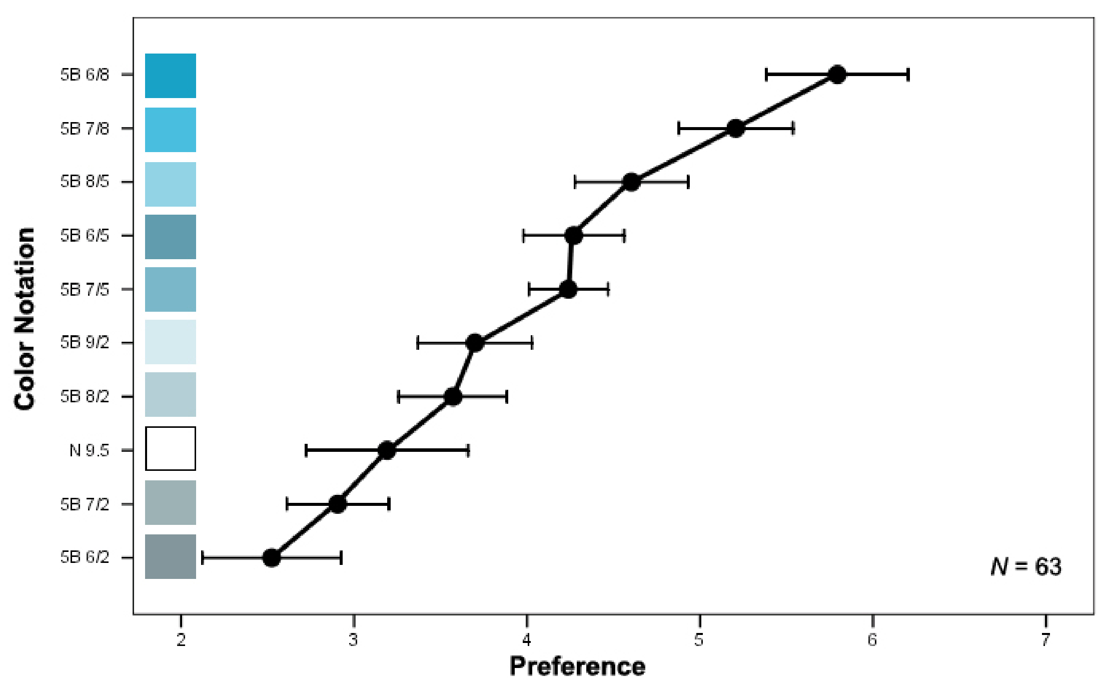



Figure 6.4: Children’s Color Preferences in Blue Hue Family

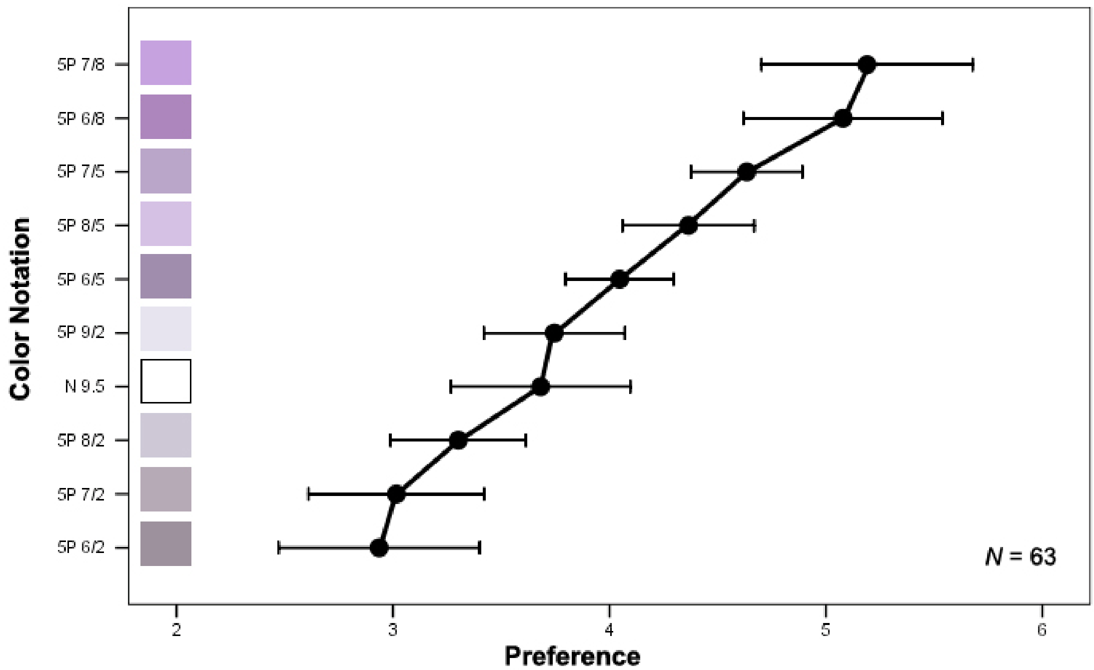



Figure 6.5: Children's Color Preferences in Purple Hue Family

### 6.1.2 Comparison of Caucasian versus Non-Caucasian Groups

Caucasian (*N*=28) versus non-Caucasian children's (*N*=35) preferences were compared for each of the five major hue families. The following graphs show the variable's means and 95% confidence intervals. The two groups were agreed in terms of the most preferred colors in all of the five hue families. In the red hue family, 5R 7/8 was most preferred, 5Y 9/8 for yellow, 5G 7/8 for green, 5B 6/8 for blue, and 5P 7/8 for purple. This result is in agreement with the results from all subjects. In the yellow and green hue families, the non-Caucasian group showed a tendency to prefer white more than the Caucasian group, but this is not statistically significant. Therefore, no significant difference between Caucasian and non-Caucasian groups was found.

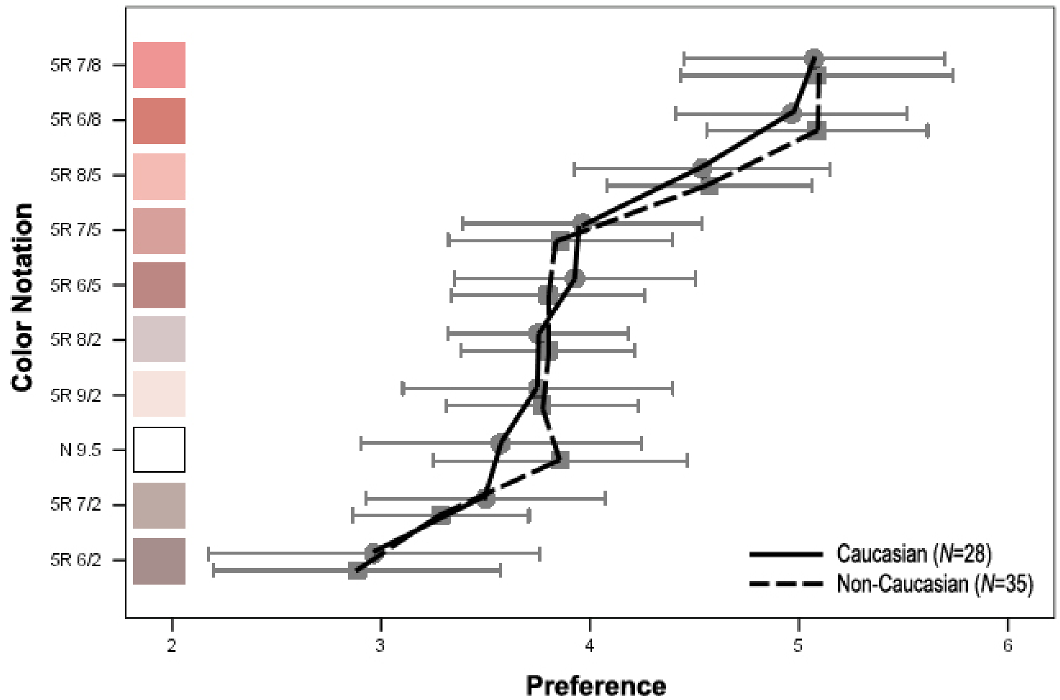



Figure 6.6: Red Color Preferences from Caucasian vs. Non-Caucasian Groups

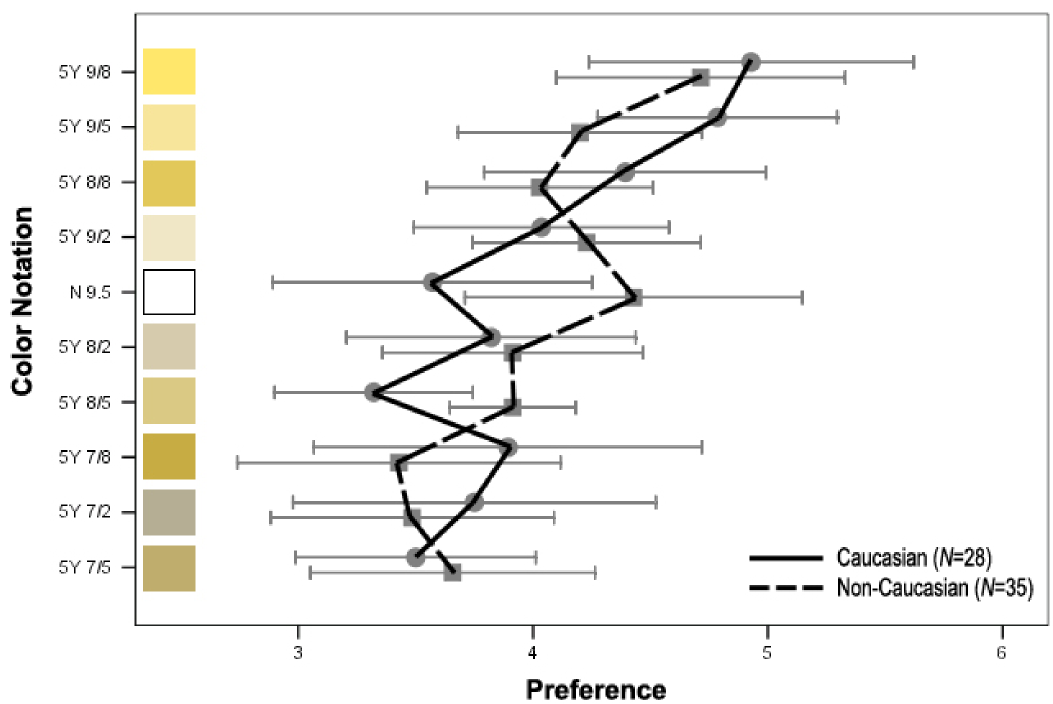



Figure 6.7: Yellow Color Preferences from Caucasian vs. Non-Caucasian Groups

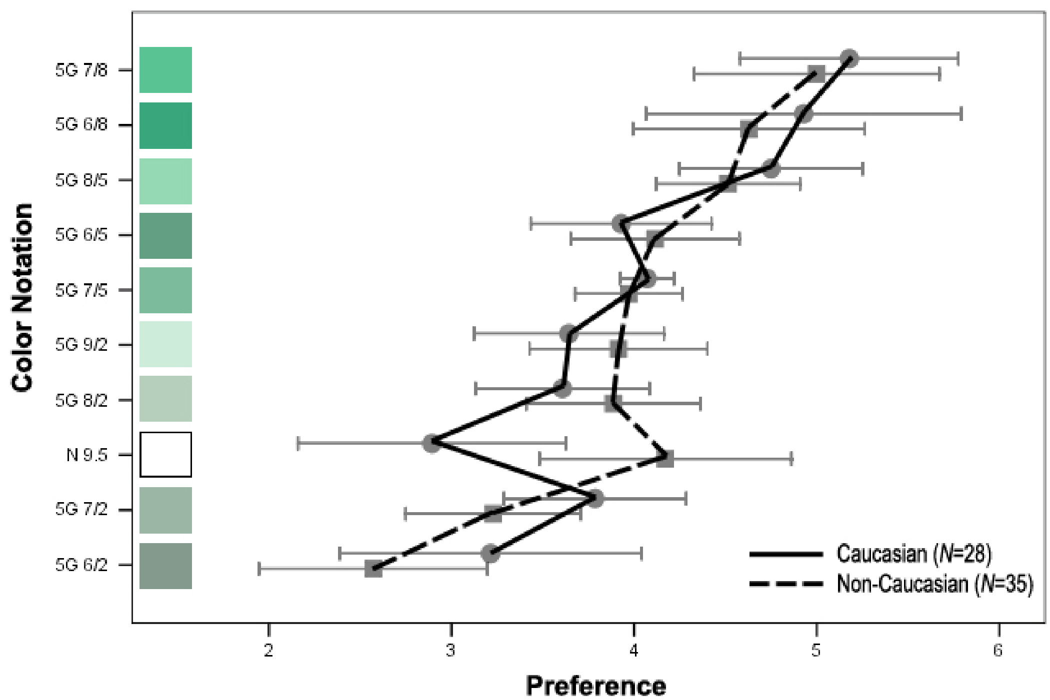



Figure 6.8: Green Color Preferences from Caucasian vs. Non-Caucasian Groups

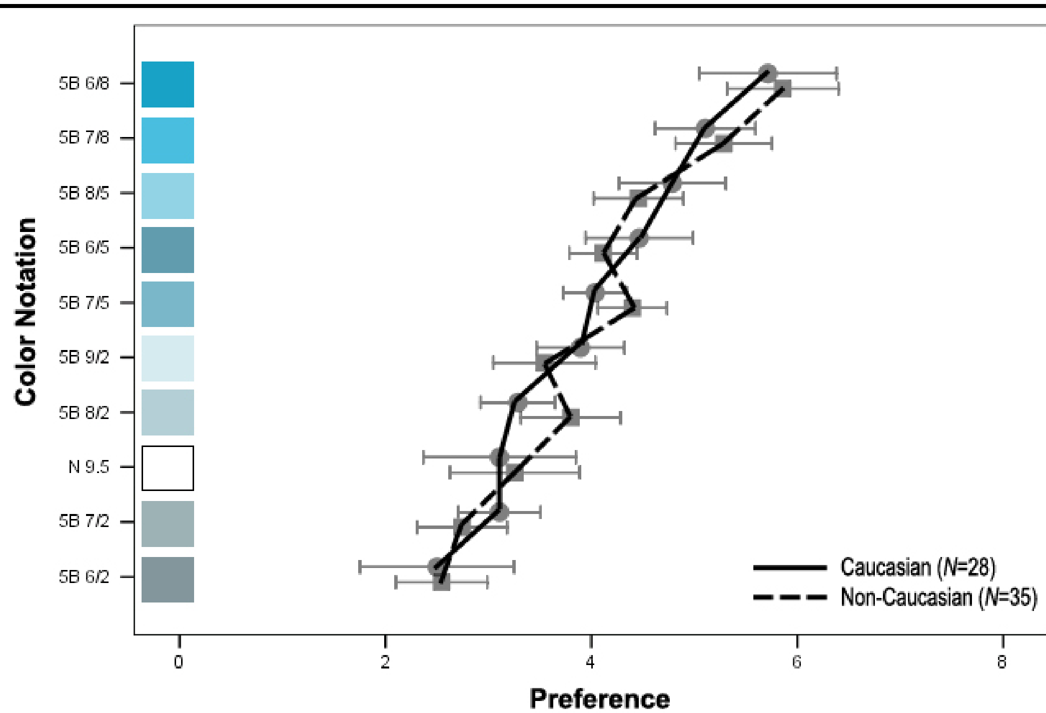



Figure 6.9: Blue Color Preferences from Caucasian vs. Non-Caucasian Groups

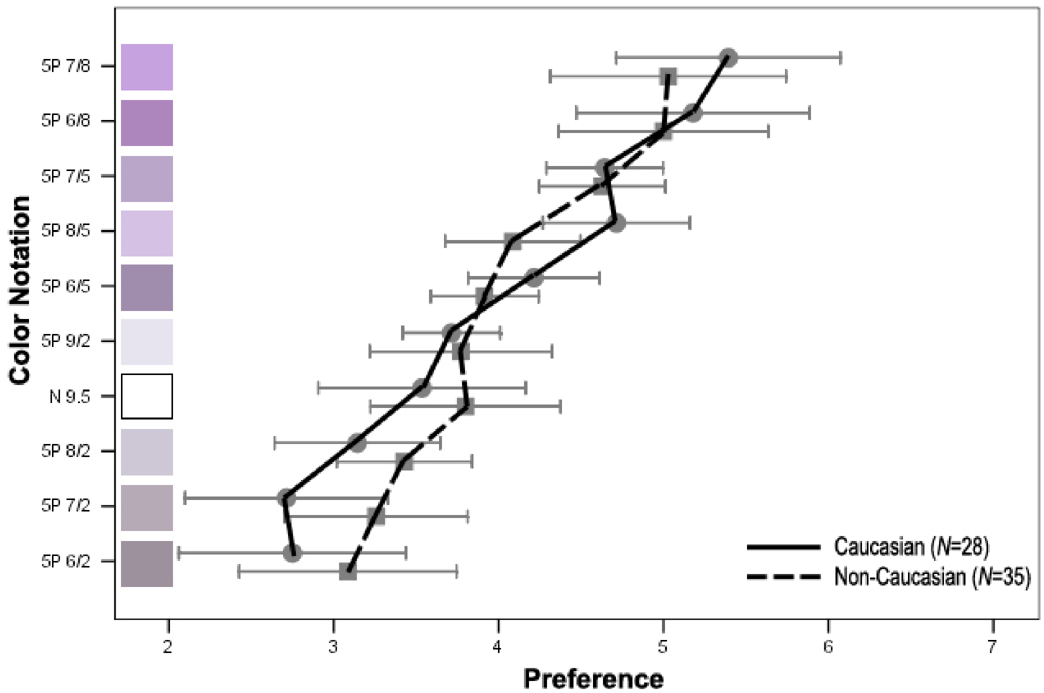



Figure 6.10: Purple Color Preferences from Caucasian vs. Non-Caucasian Groups

Figures 6.6, 6.7, 6.8, 6.9, and 6.10 present Caucasian versus non-Caucasian comparisons in red, yellow, green, blue, and purple hue families respectively.

### 6.1.3 Gender Differences in Children's Color Preferences

Multivariate analysis of variance (MANOVA) was used to investigate gender differences in the children's color preferences. The results showed gender differences in only the red and purple hue families. There was no statistically significant gender difference in the yellow, green, and blue hue families in terms of children's color preferences.

Ten dependent variables were used in MANOVA for the red family; specifically, the preferences on the ten different samples in that family. The independent variable was gender. Preliminary assumption testing was conducted to check for normality, linearity, univariate and multivariate outliers, and multicollinearity, all with no serious violations noted. There was a statistically significant difference between boys and girls' color preferences in the red hue family: *F* (9, 53) = 5.15, *p* < .05; Wilks' Lambda = .53; partial eta squared = .47. Table 6.3 shows results from multivariate tests for gender difference in red hue family.

TABLE 6.3
Multivariate Tests (b) for Gender Difference in Red Hue Family

| Effect | | Value | F | Hypothesis df | Error df | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|---|
| Intercept | Pillai's Trace | .998 | 3771.084(a) | 9.00 | 53.00 | .000 | .998 |
| | Wilks' Lambda | .002 | 3771.084(a) | 9.00 | 53.00 | .000 | .998 |
| | Hotelling's Trace | 640.373 | 3771.084(a) | 9.00 | 53.00 | .000 | .998 |
| | Roy's Largest Root | 640.373 | 3771.084(a) | 9.00 | 53.00 | .000 | .998 |
| Gender | Pillai's Trace | .466 | 5.146(a) | 9.00 | 53.00 | .000 | .466 |
| | Wilks' Lambda | .534 | 5.146(a) | 9.00 | 53.00 | .000 | .466 |
| | Hotelling's Trace | .874 | 5.146(a) | 9.00 | 53.00 | .000 | .466 |
| | Roy's Largest Root | .874 | 5.146(a) | 9.00 | 53.00 | .000 | .466 |

(a) Exact statistic
(b) Design: Intercept + Gender

The following graphs show the mean scores and confidence intervals of the boys' and girls' color preferences in each of the five major hue families. Figures 6.11, 6.12, 6.13, 6.14, and 6.15 display gender differences in red, yellow, green, blue, and purple hue families respectively.

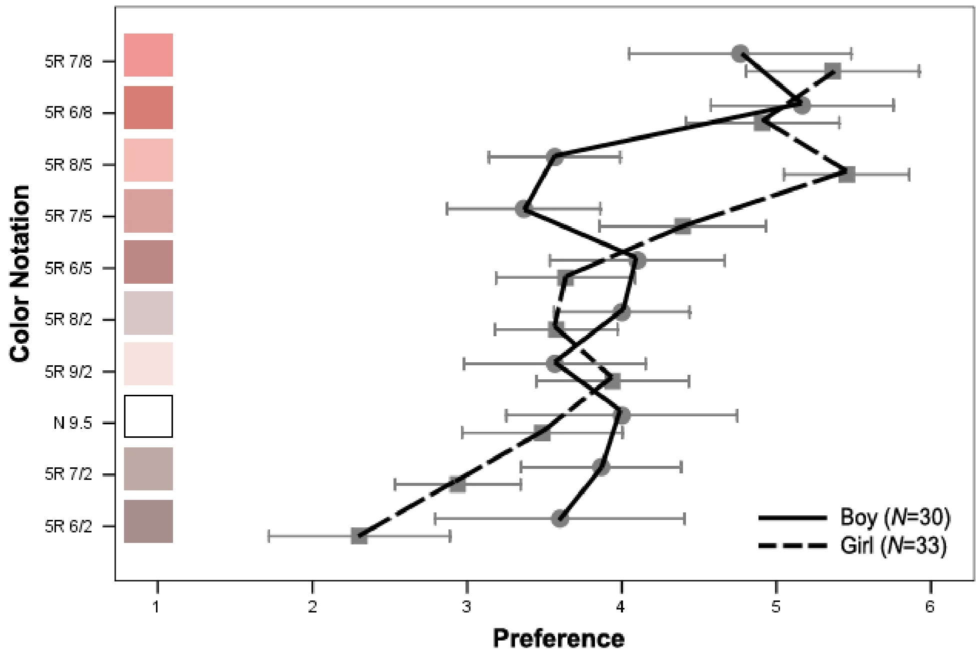



Figure 6.11: Red Color Preferences for Boys and Girls

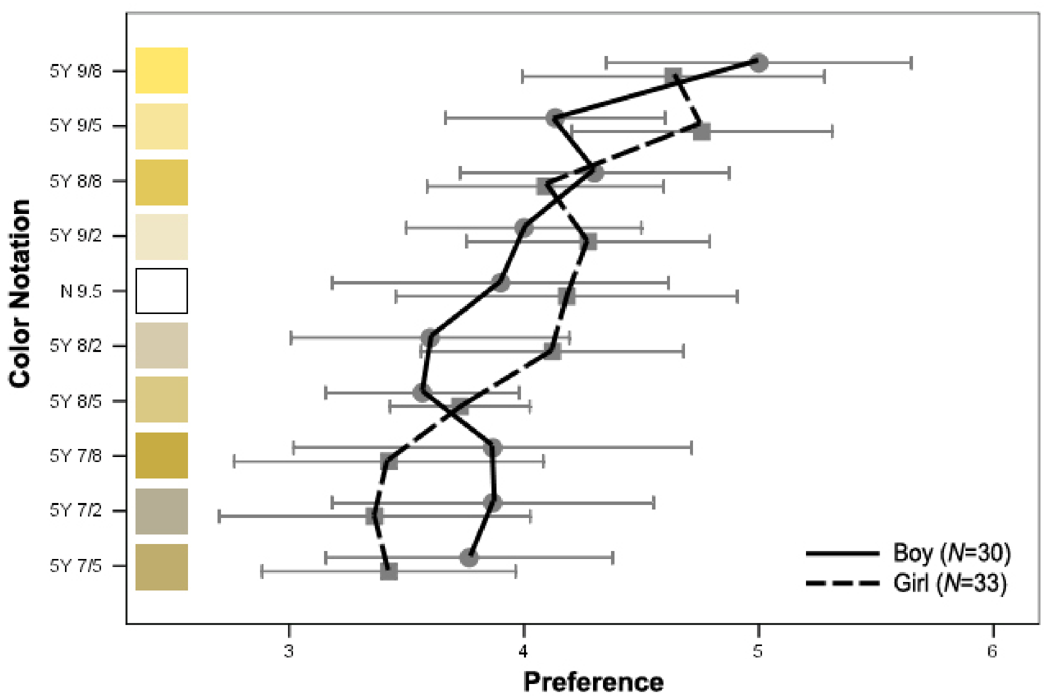



Figure 6.12: Yellow Color Preferences for Boys and Girls

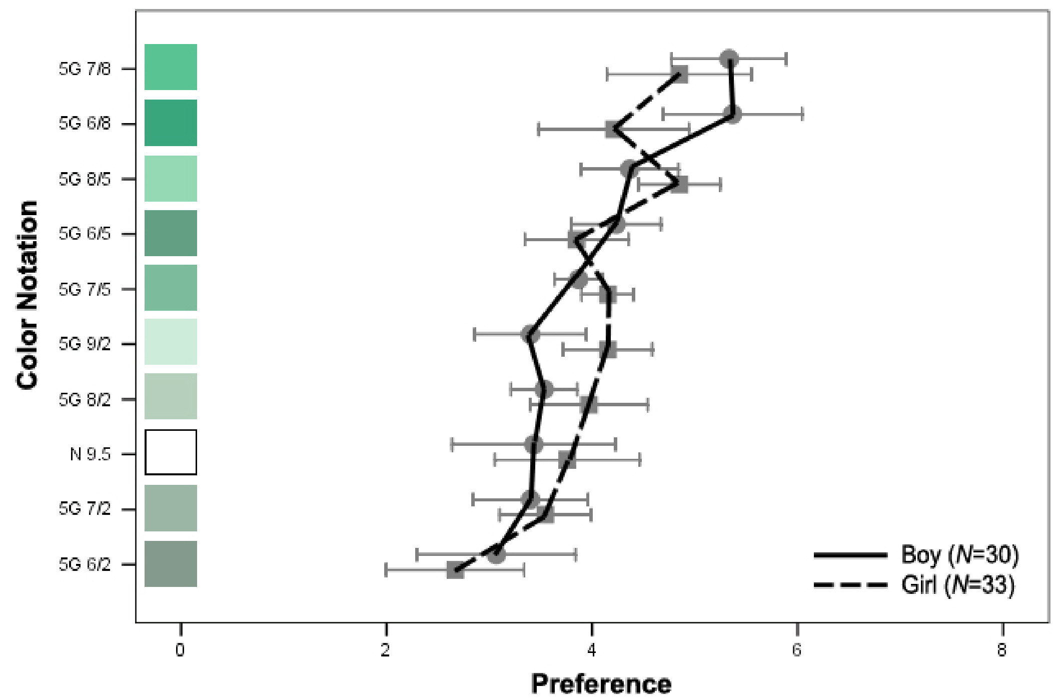



Figure 6.13: Green Color Preferences for Boys and Girls

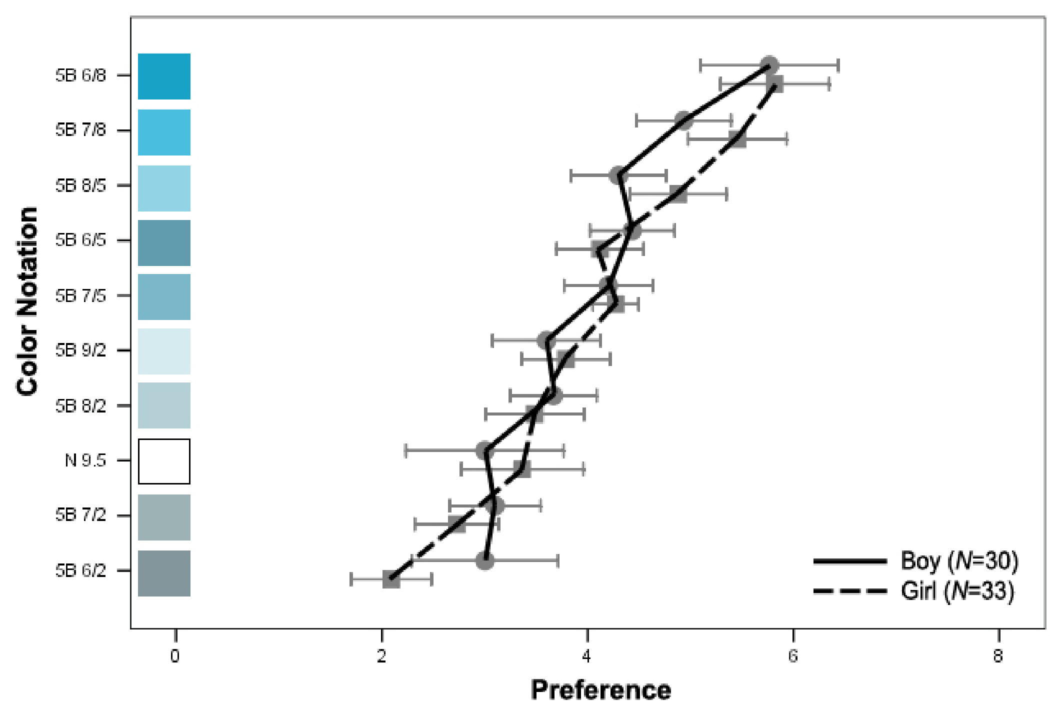



Figure 6.14: Blue Color Preferences for Boys and Girls

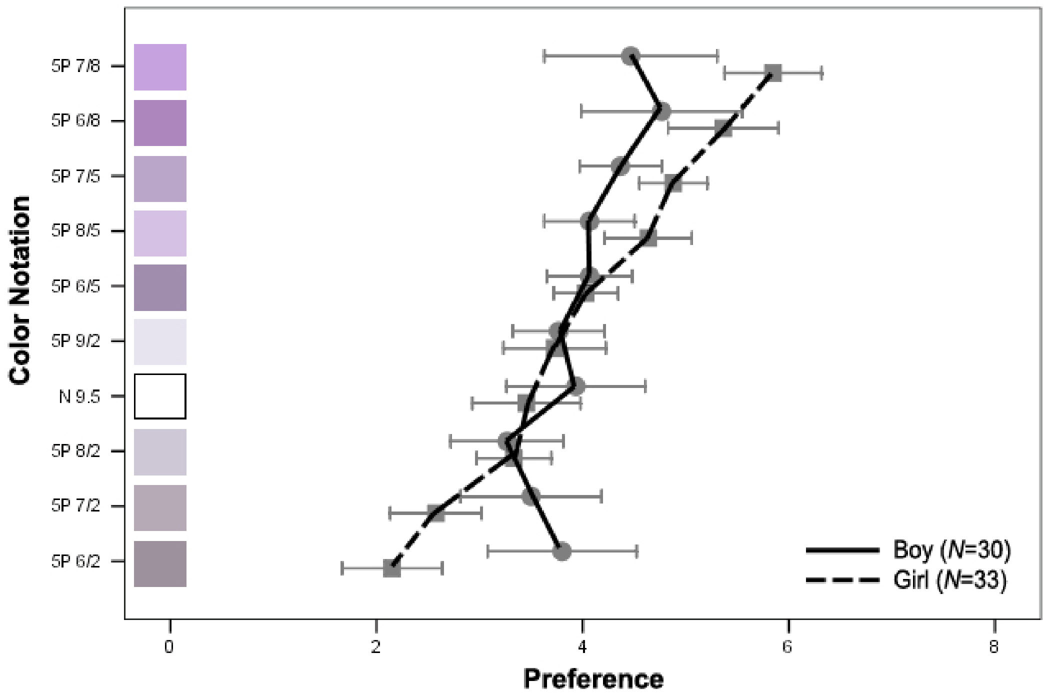



Figure 6.15: Purple Color Preferences for Boys and Girls

The mean differences were significant in 5R 6/2 ($p$ = .009), 5R 7/2 ($p$ = .005), 5R 7/5 ($p$ = .006), and 5R 8/5 ($p$ = .000) at the .05 alpha level. However, a higher alpha level is recommended in order to reduce the probability of a Type I error since a number of separate analyses were conducted. The most common way to do this is with a Bonferroni adjustment: simply divide the original alpha level of .05 by the number of conducted analyses (Pallant, 2005). In this study ten dependent variables were used to investigate, so divide .05 by 10, having a new alpha level of .005. Using the new alpha level of .005, there were statistically significant gender differences in only 5R 7/2 and 5R 8/5. In the case of 5R 7/2, boys reported a higher preference ($M$ = 3.87, $SD$ = 1.38) than girls ($M$ = 2.94, $SD$ = 1.14). In 5R 8/5, girls reported a higher preference ($M$ = 5.46, $SD$ = 1.15) than boys ($M$ = 3.57, $SD$ = 1.14).

For the purple family, ten dependent variables were used in similar fashion to the red family (i.e. purple color preferences). Again, the independent variable was gender. Preliminary assumption testing was conducted to check for normality, linearity, univariate and multivariate outliers, and multicollinearity - again, no serious violations were noted. There was a statistically significant gender difference in the purple hue family: $F$ (9, 53) = 2.8, $p < .05$; Wilks' Lambda = .68; partial eta squared = .32.

The mean differences were significant in 5P 6/2 ($p$ = .000), 5P 7/2 ($p$ = .022), 5P 7/5 ($p$ = .046), and 5P 7/8 ($p$ = .004) at the .05 alpha level. Using a Bonferroni adjustment, a new alpha level of .005 was used. There were statistically significant gender differences in only 5P 6/2 and 5P 7/8. Boys reported a higher preference ($M$ = 3.80, $SD$ = 1.94) than girls ($M$ = 2.15, $SD$ = 1.37) in 5P 6/2. In the case of 5P 7/8, girls reported a higher preference ($M$ = 5.85, $SD$ = 1.33) than boys ($M$ = 4.47, $SD$ = 2.24). Table 6.4 shows results from multivariate tests for gender difference in purple hue family.

TABLE 6.4
Multivariate Tests (b) for Gender Difference in Purple Hue Family

| Effect | | Value | F | Hypothesis df | Error df | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|---|
| Intercept | Pillai's Trace | .999 | 4302.124(a) | 9.00 | 53.00 | .000 | .999 |
| | Wilks' Lambda | .001 | 4302.124(a) | 9.00 | 53.00 | .000 | .999 |
| | Hotelling's Trace | 730.549 | 4302.124(a) | 9.00 | 53.00 | .000 | .999 |
| | Roy's Largest Root | 730.549 | 4302.124(a) | 9.00 | 53.00 | .000 | .999 |
| Gender | Pillai's Trace | .322 | 2.796(a) | 9.00 | 53.00 | .009 | .322 |
| | Wilks' Lambda | .678 | 2.796(a) | 9.00 | 53.00 | .009 | .322 |
| | Hotelling's Trace | .475 | 2.796(a) | 9.00 | 53.00 | .009 | .322 |
| | Roy's Largest Root | .475 | 2.796(a) | 9.00 | 53.00 | .009 | .322 |

(a) Exact statistic
(b) Design: Intercept + Gender

**6.2 CONCLUSION**

The pilot study generated healthy children's five most preferred colors among each of the five hue families based on the Munsell color system. The five colors were red (5R 7/8), yellow (5Y 9/8), green (5G 7/8), blue (5B 6/8), and purple (5P 7/8).

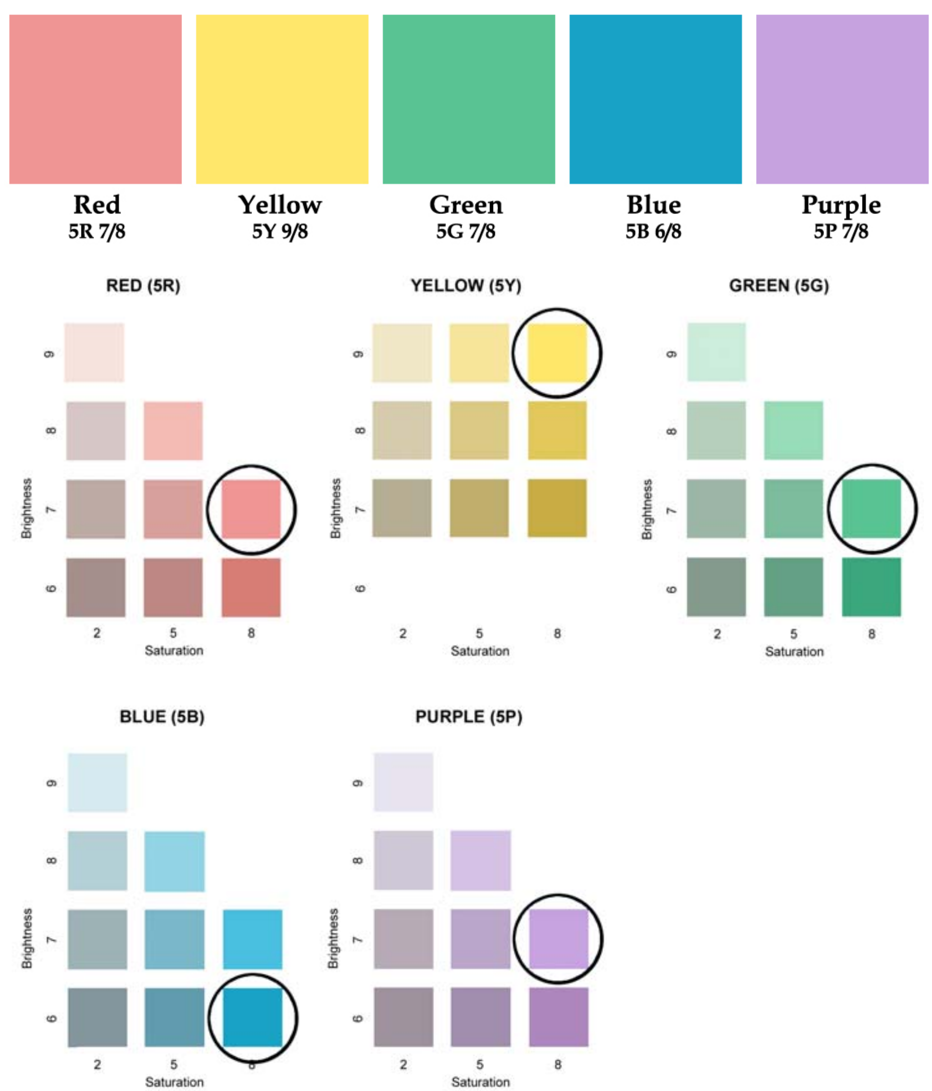



Figure 6.16: The Most Preferred Colors among Five Major Hue Families

Figure 6.16 shows the most preferred five colors and these colors were used as independent variables for the main study. An additional neutral color (white) was included because of its pervasiveness in healthcare facilities.

Within the limited color samples, children tend to prefer highly saturated and brighter colors. Caucasian and non-Caucasian children groups were compared and no significant differences were found. In terms of gender differences, slight gender differences were found in two samples from each of the red and purple hue families. Boys reported higher preferences for darker and less saturated colors than did girls; specifically 5R 7/2 and 5P 6/2. In contrast, girls showed a higher preferences for brighter and more saturated colors; that is, 5R 8/5 and 5P 7/8. Other than these four colors, there were no statistically significant gender effects.

# CHAPTER VII

# METHODOLOGY FOR EXPERIMENT II (MAIN STUDY): COLOR PREFERENCES FOR PEDIATRIC PATIENT ROOMS

## 7.1 PURPOSE

The purpose of this main study was to investigate the value of color as a component in a healing environment for pediatric patient rooms. Three different groups' color preferences were investigated and compared. From comparing these data, design implications regarding color applications for pediatric populations were provided. These results can help healthcare providers and professionals to select appropriate colors for pediatric populations.

Pediatric patients' color preferences (i.e. users of patient rooms) were investigated and compared to healthy children's color preferences and design professionals' color appreciation on pediatric patient room design (i.e. decision-makers for pediatric patient room design).

This study has provided a foundation for environmental color studies in real contexts. It advanced the understanding of the pediatric patients' perception of patient wall colors. This knowledge will facilitate improvements in the design of future children hospitals.

## 7.2 HYPOTHESES

When children are sick, they may not perceive their surroundings in the same way as healthy children. More specifically, patients in negative emotional states tend to process their feelings and emotions in negative ways (Carpman & Grant, 1993). From this, it can be hypothesized that health status may play a role in how people perceive their environments. Therefore, the first hypothesis was that children's color preferences change with health status. To test this hypothesis, healthy children and pediatric patients groups were served.

Design professionals should provide psychologically supportive environments for patients in order to promote their wellness. To do so, designers should thoroughly understand patient's needs in terms of healthcare facility design. As designers occupy a socially responsible role, knowledge-based design is critical in order to allow them to create healing environments (Shepley, Fournier, & McDougal, 1998). However, since there is no empirical evidence regarding color applications for pediatric patients, designers may follow their own aesthetic preferences which can be different from those of the public. Architect and non-architect groups show strong differences in preferences for model colors (Hogg, Goodman, Porter, Mikellides, & Preddy, 1979). Most artists and experienced art viewers also reject the public's belief that art should make them feel happy or relaxed (Winston & Cupchik, 1992). This leads to the second hypothesis, which was that design professionals' appreciation of color on pediatric patient room design is different from pediatric patients' perception of color on patient rooms. To test this hypothesis, design professionals and pediatric patients groups were served.

Actual users' color preferences in patient rooms (pediatric patients) were investigated and compared to healthy children's color preferences (i.e. normal children) and design professionals' color appreciation in pediatric patient room design (i.e. decision-makers for pediatric patient room design). Figure 7.1 displays conceptual diagram of main study.

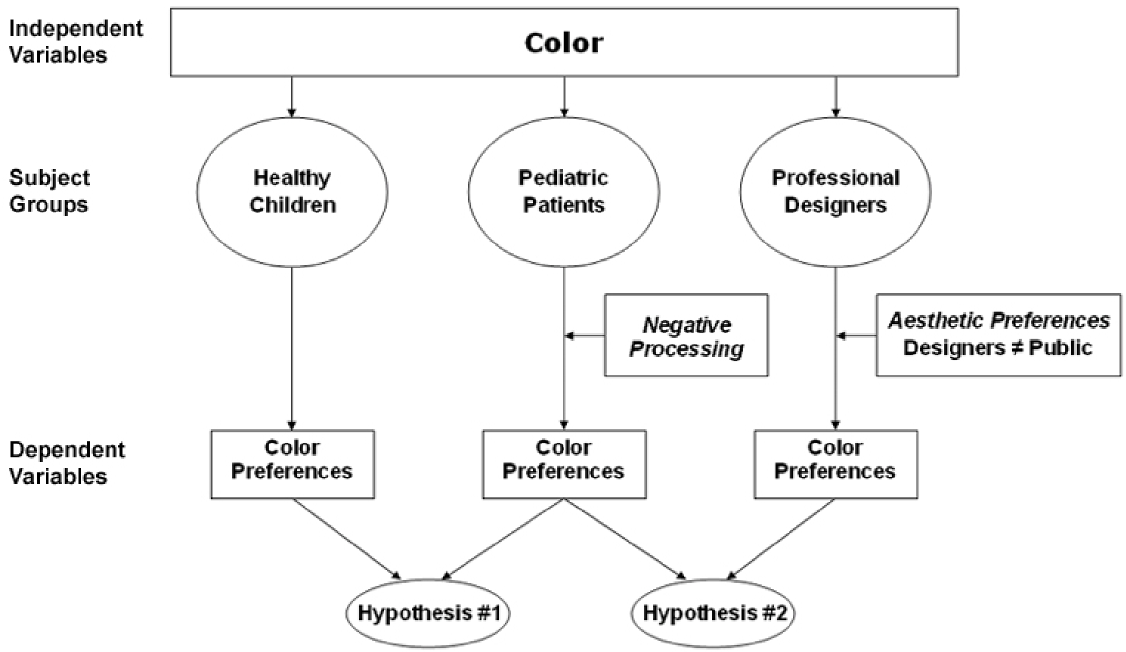



Figure 7.1: Conceptual Diagram of Main Study

Hypothesis 1: Healthy children's color preferences are different from pediatric patients' color preferences.

Hypothesis 2: Design professionals' appreciation of color on pediatric patient room design is different from pediatric patients' perception of color on patient rooms.

## 7.3 PARTICIPANTS

### 7.3.1 Demographic Information of Participants

A total of 213 subjects participated in this study. Sixty healthy children (29 boys and 31 girls, mean age = 9.08 years) were recruited from schools in Brazos County, Texas. Sixty pediatric outpatients (22 boys and 38 girls, mean age = 9.17 years) were recruited from the Pediatric Clinic Center at Scott & White Memorial Hospital in Temple, Texas. Thirty-three pediatric inpatients (21 boys and 12 girls, mean age = 9.5 years) were recruited from the Scott and White Hospital in Temple and St. Joseph Regional Health Center in Bryan, Texas. A total of 60 design professionals (31 males and 29 females, mean age = 40.83 years) from FKP in Houston, HKS in Dallas, RTKL in Dallas, and WHR in Houston participated in this study. Demographic information of the participants is summarized in Tables 7.1 and 7.2.

TABLE 7.1
Age Distribution of Subjects

| Group | Age (year) | | | | | | Total |
|---|---|---|---|---|---|---|---|
| | 7 | 8 | 9 | 10 | 11 | 23 - 62 | |
| Pediatric Inpatients | 10 | 2 | 6 | 6 | 9 | - | 33 |
| Pediatric Outpatients | 12 | 17 | 14 | 9 | 8 | - | 60 |
| Healthy Children | 11 | 17 | 17 | 10 | 5 | - | 60 |
| Design Professionals | - | - | - | - | - | 60 | 60 |
| Total | 33 | 36 | 37 | 25 | 22 | 60 | 213 |

TABLE 7.2
Ethnicity Distribution of Subjects

| Group | Ethnicity | | | | | Total |
|---|---|---|---|---|---|---|
| | White | African-American | Hispanic | Asian | Other | |
| Pediatric Inpatients | 16 | 9 | 3 | 0 | 5 | 33 |
| Pediatric Outpatients | 26 | 8 | 14 | 1 | 11 | 60 |
| Healthy Children | 39 | 2 | 15 | 2 | 2 | 60 |
| Design Professionals | 49 | 0 | 2 | 8 | 1 | 60 |
| Total | 130 | 19 | 34 | 11 | 19 | 213 |

**7.3.2 Recruitment of Participants**

This study has been approved by the Institutional Review Board – Human Subjects in Research, Texas A&M University, Institutional Review Board of St. Joseph Health System, Scott & White Institutional Review Board, the Research Review Committee from College Station Independent School District (CSISD), and the Bryan Independent School District Research Committee.

The risk associated with this study was minimal. It might be possible that subjects feel uncomfortable from being in a novel research situation. To manage this, the researcher introduced himself and the characteristics of the research to participants in order to become familiar with them prior to the experiment. There was no compensation for participation.

7.3.2.1 Pediatric Inpatients Group

Pediatric inpatients were recruited from the Scott and White Memorial Hospital in Temple, and the St. Joseph Regional Health Center in Bryan, Texas. The researcher contacted charge nurses at both hospitals and all experiments were processed through these persons. At no point during the selection and recruitment process did the researcher have access to personally identifying or sensitive medical records; the selection and recruitment process was handled by the nurses and they did not provide any patient information to the researcher except in the case of demographic information obtained from completed consent forms.

Potential participants were selected from the hospitals' population based on the discretion of the nurses. Patients who were color blind, mentally ill, or unable to participate based on the judgment of the nurses or physicians were excluded.

The charge nurse initially contacted the potential participants and their parents; the nurse gave the patients and their parents consent forms to sign and return prior to participation. Before receiving the completed consent forms, the researcher had no direct contact with or personally identifying information about the subject population; that is, patients who were ineligible or who chose not to participate in the experiment remained completely anonymous to the researcher. Upon receiving the completed consent forms, the nurse and the researcher set up schedules of participation. Based on the schedule, the researcher contacted the participants. The participants conducted the experiments in their patient rooms based on a first-available first-participate principle.

Unfortunately, data collection from pediatric inpatients was extremely slow because the majority of pediatric patients were either too young or too old (less than 7 years or greater than 11 years). Outpatient data collection was suggested by Dr. Tasha Burwinkle, Resident Educator/Research Program Manager at the Children's Hospital at Scott and White, because the hospital usually has more outpatients than inpatients. In discussion with the researcher’s Ph.D. committee members about this issue, the recruitment of both pediatric outpatients and inpatients was decided. Data from pediatric outpatient and inpatient groups were gathered and compared.

7.3.2.2 Pediatric Outpatients Group

All pediatric outpatients were recruited from the Pediatric Clinic Center at Scott and White Hospital in Temple, Texas. An examination room was used for the experiments. The model was set up on an examination bed.

The researcher had no access to personally identifying or sensitive medical records; the selection and recruitment process was handled by the medical assistants. Potential participants were selected from the outpatients based on the discretion of the medical assistants. Outpatients who were color blind, mentally ill, or unable to participate based on the judgment of the medical staff were excluded.

The medical assistants initially contacted the potential participants and their parents; the medical assistants gave the outpatients and their parents consent forms to sign and return prior to participation. Before receiving the completed consent forms, the researcher had no direct contact with the patients or personally identifying information about them; that is, patients who were ineligible or who chose not to participate in the experiment remained completely anonymous to the researcher. Upon receiving the completed consent forms, the medical assistants guided and brought the consentient patients and their parents to the examination room where the experiment was set up. A first-available first-participate principle was employed for recruitment of pediatric outpatients.

During the outpatient data collection period as many inpatients as possible were recruited simultaneously. Figure 7.2 is display method for pediatric outpatients.

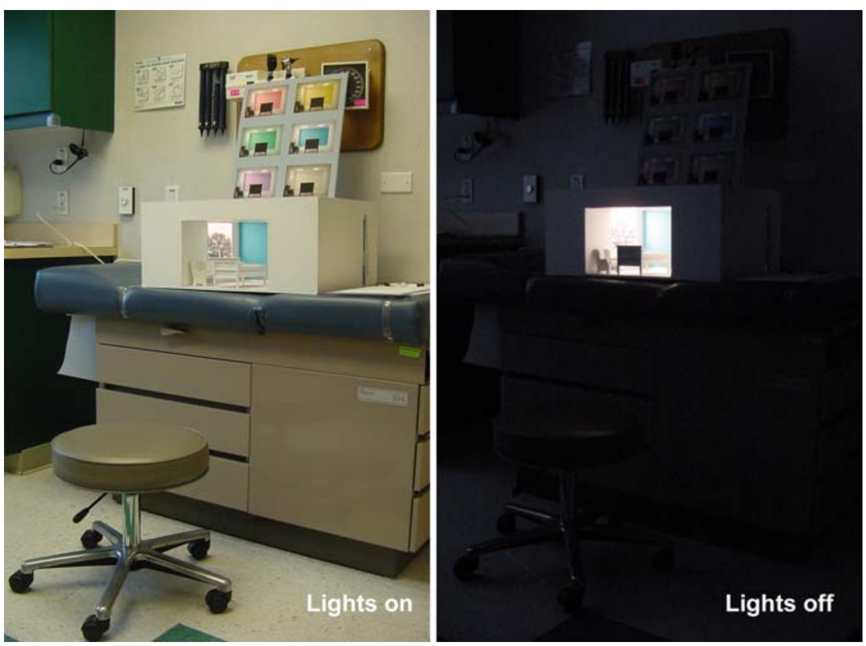



Figure 7.2: Display Method for Pediatric Outpatients

7.3.2.3 Healthy Children Group

The experiment for healthy children's perception of color was conducted at elementary and intermediate schools in Brazos County, Texas. Parental permission forms and child assent forms were sent to the parents and the children to sign and return prior to participation. The researcher and a supervisor of the after school program set up a schedule for participation among consentient subjects. Participants performed the experiments based on a first-available first-participate rule. A third person fulfilled an observer's role for healthy children group according to the request from the Research Review Committee from College Station Independent School District.

Age group was important because this study compares children's preference to adults', meaning that the two groups must have a similar capability for interaction with the research tool. The children's age group of 7 – 11 years was used because they are fully developed in dual representation (DeLoache, Peralta de Mendoza, & Anderson, 1999). Though their cognition has been transformed into more organized thoughts, it is not yet as fixed as adults' (Brainerd, 1978).

7.3.2.4 Design Professionals Group

Design professionals conducted the experiments in their offices. Healthcare designers, architects, and interior designers were the major target populations for this study as they are the decision-makers for pediatric patient room designs. FKP in Houston, HKS in Dallas, RTKL in Dallas, and WHR in Houston were proposed and used as research sites throughout the discussion with the researcher's Ph.D. committee members since they were sponsors of the Health Industry Advisory Council. Consent forms were obtained prior to participation.

**7.4 APPARATUS**

The scale-model being used in the previous pilot study was employed for all subject groups in this main study. The layout and environment of the scale-model was identical with the previous pilot study circumstances except for the single interchangeable side wall's color.


Figure 7.3 Display Method of Six Scale-Models for Design Professionals

In terms of data collection from design professionals, six scale-models were utilized. Colors were randomly displayed based on prearranged order using Latin Square

Design. The Latin Square Design is a square matrix such that no two if the same items are repeated twice in any row or column; in other words, each item appears in all rows and columns but only one time in and in a systematic order. This enhances randomness and eliminates selection bias. Participants experienced six different colors simultaneously and indicated their preferences on questionnaires. Figure 7.3 shows display method for design professionals.

For the pediatric patients and healthy children groups, an alternative method of one model with six colored cards, instead of using six colored models, was applied. When the researcher recruited the first pediatric patient at St. Joseph Regional Health Center in Bryan, six models were presented to the patient and the patient experienced them altogether prior to the preference rating. Then the patient indicated his/her preference to one model at a time. That procedure seemed to work sufficiently well. However, bringing six models into the small patient room was inefficient because of crowding with the patient, the researcher, the charge nurse, and the participant's parents.

To avoid crowding the patient room, a new display method was used which employed one model with six colored cards all together in the interchangeable wall's slot. Prearranged colored cards based on the Latin Square Design were inserted in the slot of the model and the participants indicated their preferences to one color at a time. After each color preference rating, the very first colored card was removed from the slot and consequently the next colored card was presented. The participants saw one model, but experienced the different colors sequentially. Figure 7.4 presents display method of one scale-model with six color cards for children.

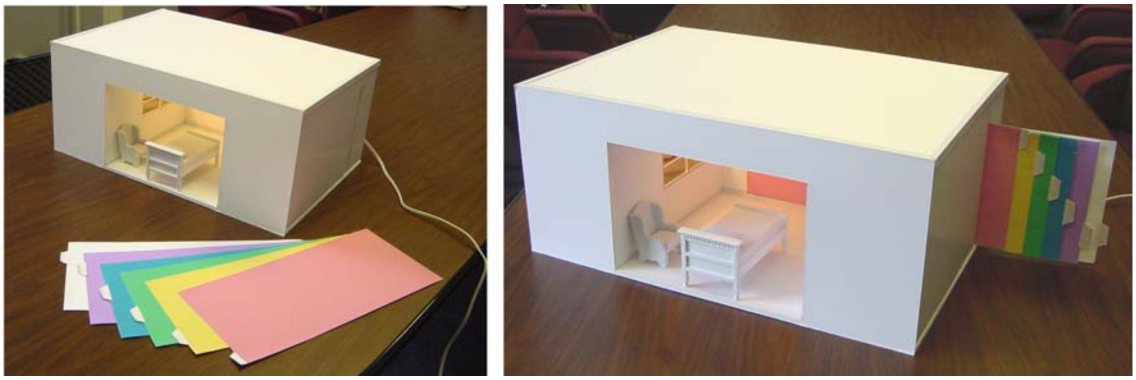


Figure 7.4 Display Method of One Scale-Model with Six Color Cards

For the simultaneous comparison of all six colors, a picture of all six different colored scale-models was made and presented to the participants prior to the preference rating task (see Figure 7.5). This method was applied to both pediatric patients and healthy children for consistency.

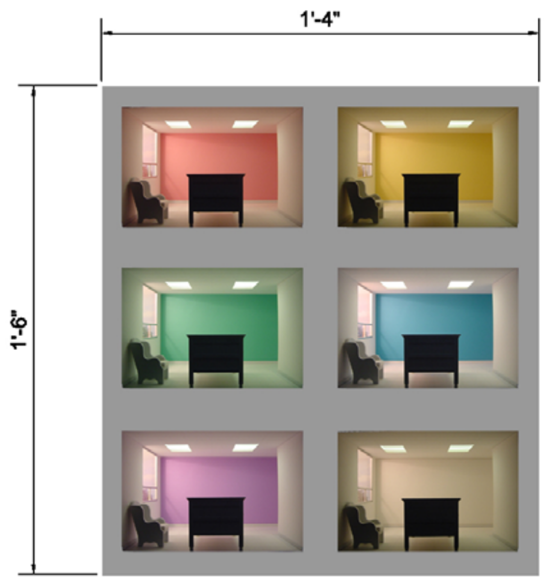



Figure 7.5 Picture of Six Colored Scale-Models of Patient Room

An Ishihara plate was used to eliminate participants with color perception deficiencies. The Ishihara plates were used to make a quick and precise assessment of color vision problems. The plate used in this study was a No. 4 plate; the normal children read the plate as 29, but those who had red-green deficiencies read it as 70. Those who had serious color vision problems would not have been able to read any numbers on it. Original plates were used for an accurate assessment of color deficiency because reproduced or poor quality plates could have caused misleading results.

Since emotions are associated with colors (Boyatzis & Varghese, 1994; Hemphill, 1996; Zentner, 2001), a quick mood test was performed prior to the color preference rating tasks for all participants. The Self-Assessment Manikin (SAM) was used for measuring participants’ mood (see Appendix L). The SAM is a picture-oriented instrument for emotional responses and it has been used for decades in experimental psychology with children (Greenbaum, Turner, Cook, & Melanmed, 1990), patients (Cook, Melamed, Cuthbert, McNeil, & Lang, 1988; Patrick, Bradley, & Lang, 1993), and adults (Bradley & Lang, 1994).

The Pediatric Quality of Life Inventory (PedsQL) is a research instrument for assessing health-related quality of life in children ages 2 – 18 years (Varni, Seid, & Rode, 1999). In order to measure color preferences, a modified PedsQL (see Appendix M) was used for all subject groups. Color preferences can be marked on a 10 cm horizontal line that as an analogue scale. The marked preferences can be converted to 0 to 100 points with 1 mm equivalent to 1 point. In addition to the modified PedsQL, additional questions such as age, gender, ethnicity, field of work, model preference order, and reasons for the model order selections were added on questionnaires for design professionals (see Appendix K).

## 7.5 VARIABLES

The previous pilot study generated healthy children's five most preferred colors among each of the five hue families based on the Munsell color system. The five colors were used as independent variables for this main study. In addition to the five colors, a neutral color (white) was included because it is a pervasive color in healthcare facilities.

The colors used as independent variables were red (5R 7/8), yellow (5Y 9/8), green (5G 7/8), blue (5B 6/8), purple (5P 7/8), and white (N 9.5) as shown in Figure 7.6.

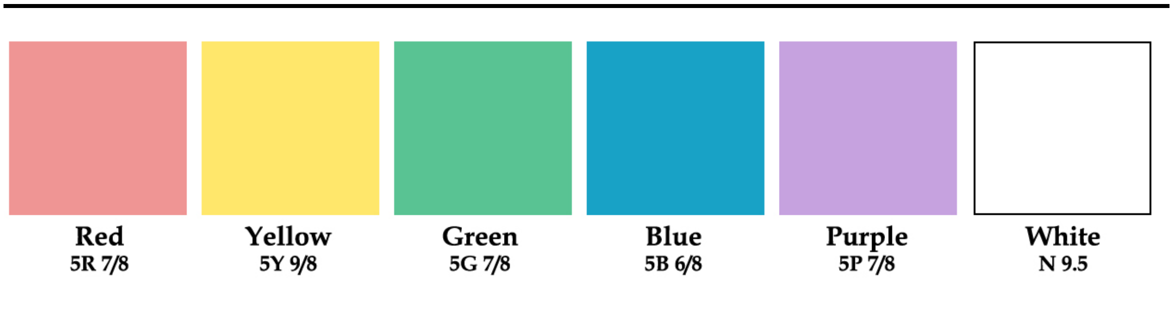



Figure 7.6 Colors as Independent Variables

Color preferences (both healthy and pediatric patient groups) and selections of the appropriate color for pediatric patient room design and their reasons (design professional group) were measured as dependent variables.

## 7.6 PROCEDURE

All subjects participated based on first-available first-participate principle and performed experiments individually. Pediatric inpatients were tested in their patient rooms, pediatric outpatients were tested in an examination room, healthy children were tested in a secure place such as a classroom or lecture room, and design professionals were tested in their offices. Table 7.3 shows the organization of the main study.

TABLE 7.3
Organization of the Main Study

| Session | Subject Group | Research Site | Experiment |
|---|---|---|---|
| A | Pediatric Inpatients | Hospitals in Texas<br>- Scott and White Memorial Hospital<br>- St. Joseph Regional Health Center | Color Preferences |
| B | Pediatric Outpatients | Pediatric Clinic Center at Scott and White Memorial Hospital | Color Preferences |
| C | Healthy Children | Schools in Brazos County, Texas | Color Preferences |
| D | Design Professionals | Design Firms in Texas | Color Selections for Pediatric Patient Rooms |

### 7.6.1. Procedure for Pediatric Patients Group

Experimental procedures were identical for all children groups (pediatric inpatients, pediatric outpatients, and healthy children). The only difference was the locations where the experiments were conducted. Distractions from the outside environment were minimal because the room lights were off while conducting the experiments. For pediatric inpatients, the experiments were conducted in their patient rooms. A bedside table was used to carry and display a 1:12 scale-model. For pediatric outpatients, an examination room at the Pediatric Clinic Center was used and the model was displayed on an examination bed in the same room.

The introduction and color vision screening were identical to that of the pilot study. All participants passed the test.

A quick mood test was performed prior to the color preference rating tasks by using the SAM. The subjects were shown the SAM and it was explained by the researcher. “This is about how you’re feeling now. It has nothing to do with this model [handing out the SAM]. [Indicating the 1st row in the SAM] These figures are about how happy you are. If you are very happy, you check this box. If you are very sad, you check this box. [Indicating the 2nd row in the SAM] These figures are about how excited you are. If you are very excited, you check this box. If you are very calm, you check this box. [Indicating the 3rd row in the SAM] These figures are about how confident you are. If you feel very confident, you check here. If you feel very shy, you check here.” Consequently the subjects were asked to indicate their emotional state on the SAM. “Go ahead and check how you feel now.”

The subjects were shown the PedsQL and the researcher explained how to answer. “This is a form that will tell me how much you like these colors. If you like this color a lot, please draw a line near the happy face like this. If you think the color is just “so-so”, put a line near the middle. If you do not like this color at all, put a line by the sad face. You can practice with the form if you like. Or, we can just begin. Would you like to practice first, or start now?”

In the event that the subjects wanted to practice or did not understand how to use the PedsQL, a practice run was provided. Six different pictures were displayed on the desk. The subjects were asked to select both the most preferred and least preferred pictures. A template PedsQL and a pencil were given to the subjects. Either of two pictures selected by the subjects was displayed and then the subjects were asked to perform their preference rating. After the completion, the evaluated picture and the template PedsQL were removed and the remaining picture was given to the subjects for an additional preference rating practice. The researcher checked whether the subjects were able to read the directions and to mark their preference on the template PedsQL correctly. This practice run was repeated a maximum of three times until the subject performed all responses correctly. Anyone who failed the practice run was excluded from the study. All pediatric patients understood how to mark their preferences on the PedsQL.

After completing the practice runs for the PedsQL, a picture of six differently colored patient rooms was presented to the subjects for simultaneous comparison. Sufficient time was given to the subjects for exploring the environment of the rooms and deciding on each evaluation.

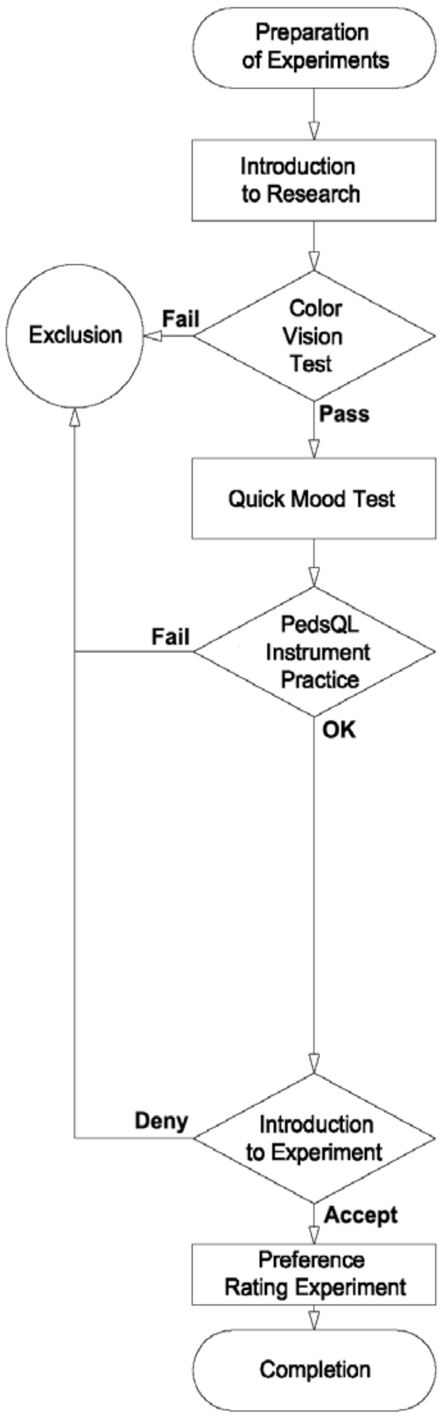
The subjects were introduced to the next experiment verbally, “Now we are ready to look at the model. You are going to see six different wall colors [showing the picture of the six colored models]. What you need to do is to mark how much you like each color on the form. Before we start, take your time and look around the picture of the rooms as much as you want. Then, let me know when you are ready.”

When ready, the preference rating task began. To control the illuminance levels inside the models, the patient room lights were turned off and the windows were blocked by blinds. This was explained to the participants verbally by the researcher. “To help the model look clear, I am going to make the room dark. You can ask me to turn on the lights and open the blinds anytime if you want. Now, I will turn off the lights and blind the windows. [Turning off the lights and closing the window blinds.]” Anyone who did not want the lights off or windows blinded was excluded from the study. No subjects refused the lights-off and window blinding conditions.

To display six different colors sequentially, a 1:12 scale-model with six differently colored cards in the slot of the model was used. Prearranged colored cards based on the Latin Square Design were inserted in the slot of the model and the participants indicated their preferences to one color at a time. After each color preference rating, the very first colored card was removed from the slot and consequently the next colored card was presented. The participants saw one model but experience six different colors.

The subjects were asked to rate their preference for each color on the PedsQL. A pen and the PedsQL forms were provided to the subjects. One colored room at a time, in random order, was presented to the subjects. Then, the subjects marked their preferences about the room on the PedsQL. After each evaluation, the PedsQL was removed and another colored room, in random order, was presented to the subjects. The subjects’ evaluation continued until all the rooms had been evaluated.

Flow Diagram




| Verbal Description | Instrument |
|---|---|
| My name is Jin Gyu Park. I need your help because I want to know about children's favorite colors. There are no right or wrong answers because this is not a test. It will take about twenty minutes to finish. You can ask questions or stop at anytime. | |
| What do you see in this picture? | Ishihara plate |
| This is about how you're feeling now. It has nothing to do with this model.<br>(Explanation about the SAM)<br>Go ahead and check how you feel now? | SAM,<br>Pen |
| This is a form that will tell me how much you like these colors. If you like this color a lot, please draw a line near the happy face like this. If you think the color is just "so-so", put a line near the middle. If you do not like this color at all, put a line by the sad face.<br>You can practice with the form if you like. Or, we can just begin. Would you like to practice first, or start now? | Pictures,<br>PedsQL,<br>Pen |
| Now we are ready to look at the model. You are going to see six different wall colors. What you need to do is to mark how much you like each color on the form.<br>Before we start, take your time and look around these rooms as much as you want. Then, let me know when you are ready. | Picture of the six colored rooms,<br>Model |
| To help the model look clear, I am going to make the room dark. I am going to close the blinds and turn off the lights. If you feel uncomfortable, tell me and I will turn the lights back on. | Model,<br>PedsQL,<br>Pen |
| Alright, you are finished. Thank you very much. I appreciated your help (and I hope you feel better soon). | |

Figure 7.7: Flow Chart of the Procedure for Children Groups

As soon as the test was completed, the researcher announced that the experiment was finished. “Alright, you are finished. Thank you very much. I appreciate your help and I hope you feel better soon.” This experiment took approximately twenty minutes per child to complete.

The patient’s name, date of birth, and gender were gathered from the parental permission form. The patients’ mood and their responses to the colors were gathered using the SAM and PedsQL. Any identifiable health information was not gathered because of the concern of wrongful disclosure according to the Health Insurance Portability and Accountability Act.

Figure 7.7 shows a flow chart of the procedure for all children groups (pediatric inpatients, pediatric outpatients, and healthy children).

### 7.6.2. Procedure for Healthy Children Group

For the healthy children group, a secure place such as classroom or lecture hall in their school was chosen based on convenience (size, availability, etc.). Desks in the room were arranged in front of a chair. The desks were covered with white cloth on top. The model was displayed on the desks. All procedures for the healthy children group were identical to that for the pediatric patients groups. No participants showed a problem with the color deficiency test, practice run of the PedsQL, the lights-off, or window blinding. This experiment took approximately twenty minutes per child to complete.

### 7.6.3. Procedure for Design Professionals Group

To get design professionals' color appreciations about pediatric patient room design, the six models were displayed and presented with different colors on their accent walls in an assigned room at their offices.

Design professionals participated voluntarily. Consents were obtained prior to participation. All participants took color deficiency tests by using the Ishihara plate. After color deficiency test, the participants were given a questionnaire with a pen and asked to complete the questionnaire heart their own pace. The necessity of the room lights being off was explained to the participant verbally by the researcher. Anyone who did not want the lights off or windows blinded was excluded from the study. All design professionals were satisfied the color deficiency test, usage of the PedsQL, and the lights off, and window blinding. This experiment took approximately twenty minutes per participant to complete. Figure 7.8 displays experimental setting for design professionals.


Figure 7.8: Experimental Setting for Design Professionals

## 7.7 RELIABILITY

In order to generate scientific results, data obtained from research must be valid and reliable. The concept of reliability refers to consistency of results under different time or location. Reliability also concerns the degree of replication. The experimental tools and procedures of this study were replicable and applicable for other settings. This study measured three different subject groups' preferential responses to various colored rooms using scale-models. Color preferences were expected to be reliable since only colors were manipulated; that is, all conditions except the colors were identical regardless of locations and time.

## 7.8 VALIDITY

This main study was categorized as an experimental design since the independent variables were controlled by the researcher in order to observe their effects on the dependent variables. Unless a research design is strong in validity, the research might be confounded with plausible alternative explanations. As such, this study was evaluated in terms of four types of validity one by one. For a more detailed discussion of the four types of validity, refer to section 5.7. For the final study, validity concerns were addressed as follows.

### 7.8.1 Statistical Conclusion Validity

Statistical conclusion validity concerns statistical inferences regarding whether variables are related to one another or not. If the variables are related, then further investigation about causal relationship is worth to be conducted which is the concern of internal validity. This study focuses on four different subject groups: pediatric inpatients, pediatric outpatients, healthy children, and design professionals. Each of the groups had a sample size of 60 subjects, excluding the pediatric inpatient group which included 33. A mixed between-within subjects ANOVA was used for investigating correlations between and within subject effects. An alpha value of 0.5 was used and the mixed between-within ANOVA revealed that the main effect for group was significant in term of mean differences. Therefore, a post hoc test was conducted in order to investigate group differences. The Games-Howell Test was selected since it is useful when variances are unequal. The Games-Howell Test revealed group differences in terms of the mean score comparison.

When the range of outcome values is too narrow, the outcome is subject to extreme responses (Shadish, Cook, & Campbell, 2002). To identify color preferences, a 10 cm long analogue PedsQL was employed. It allowed for an easy conversion of the participant's color preferences into 0 to 100 points. The SAM provided nine steps of happiness, excitement, and confidence for the participant to check his/her emotion. These instruments provided a sufficient range of the selection regarding the participants' emotion and color preferences.

Statistical conclusions can be influenced if treatment is conducted inconsistently from person to person within sites (Lipsey, 1990); it commonly results in effect size reduction (Shadish, Cook, & Campbell, 2002). The instruments and procedures used in this study were identical for all subject groups so the inconsistency threat was minimal. All participants' color preferences were measured by the PedsQL by using the same scale-model simulation in secure places under lights off conditions.

To reduce extraneous variance in the experimental setting, participants need to focus on the experiments (Shadish, Cook, & Campbell, 2002). Again, the lights-off condition in secure places addressed the potential for distraction from the outside environment.

### 7.8.2 Internal Validity

Internal validity refers to whether dependent variables result from independent variables. Different colors in the scale-model rooms were only manipulated and then the preferential responses were expressed by participants. That is, colors were independent variables and the participants' preferential responses were dependent variables; in this case, the causes (colors) and outcomes (preference orders) are not reciprocal.

Selection bias can influence the effects because of population differences; this bias can be reduced by random assignment because randomly assigned groups are different only by chance (Shadish, Cook, & Campbell, 2002). All consentient participants performed the experiments by means of first-available first-participate principle, or nonrandom convenience sampling. Instead of randomizing subjects to experiments, the color samples used in this study were displayed randomly using the Latin Square Design in order to reduce the order effect.

The history threat can be reduced by isolating participants from outside stimuli or by selecting dependent variables that could seldom be influenced by outside environments (Shadish, Cook, & Campbell, 2002). Maturation addresses participants' changes during the experiments, such as older or wiser as time goes by (Shadish, Cook, & Campbell, 2002). The history threat was minimal as participants were isolated.

Practice and familiarity can influence treatment effects (Shadish, Cook, & Campbell, 2002). All subjects had only one opportunity to participate so familiarity threat was minimal. Children who previously went through the pilot study were allowed to participate in the main study again, so they may have been familiar with the scale-model simulation experiments. However, the threat was minimized because the independent variables and measurement instruments of the main study were different from those of the pilot study.

### 7.8.3 Construct Validity

Construct validity refers to the degree of generalization between experimental level and theoretical level. While the most precise solution to exploring color effects would be to paint a real health care environment, it was an impractical option. Scale models were used due to its feasibility and reliability. Participants' preferential orders are considered as a significant indicator of the participant's satisfaction with the wall colors of patient rooms based on the Conceptual Model of the Effects of Physical Environments on Children's Health-Related Outcomes proposed by Sherman, Shepley, and Varni (2005). Figure 7.9 shows conceptual diagram of construct validity in this study.

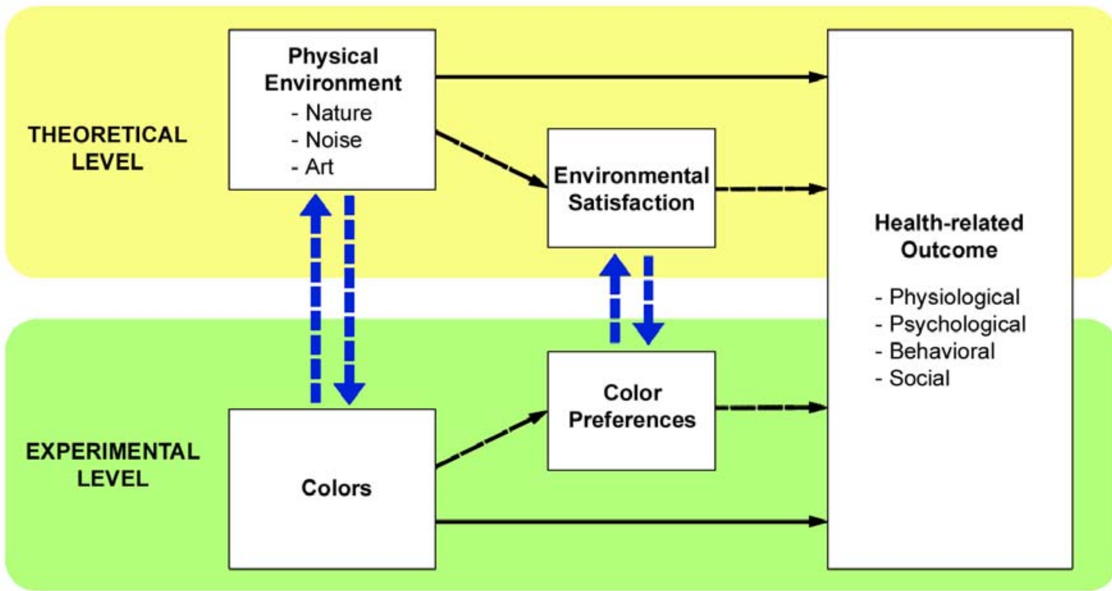



Figure 7.9: Concept Diagram of Construct Validity in the Study

Monomethod bias can occur when a complex piece of research is measured by just one method (Shadish, Cook, & Campbell, 2002). If the results of different measurements agree, the results are more trustworthy (Brewer & Hunter, 1989). In addition to the color preference measure, the participant's mood was checked since color preference can be influenced by emotion. It not only facilitated the analysis of the relationship between emotion and color preferences, it also reduced the possibility of an alternative explanation of causal relations.

### 7.8.4 External Validity

External validity refers to the degree of generalization of findings from experiments to real settings. Random sampling secures external validity but achieving random sampling in experiments is very difficult (Shadish, Cook, & Campbell, 2002).

All participants were recruited based on a first-available first-participate principle. This approach is categorized as convenience sampling which is nonrandom. This nonrandom sampling may be a factor to decrease external validity. To draw a large sample size is effective to reduce sampling error; and sample bias can be reduced by careful sampling methods (Sommer & Sommer, 1997). Sample size of this study is relatively small so it may decrease external validity.

A mediator considered as significant in one context may not function in another context (Shadish, Cook, & Campbell, 2002). This main study is context-dependent. The environments of the scale-model rooms were adjusted to the illumination level from 12 pm to 2 pm during the fall season (October to February) in Bryan, Texas. Environmental color effects were investigated using one color at a time applying on the accent wall so effect of interactions between adjacent two or multiple colors were not applied. These specific contexts can decrease the external validity; this study is limited to generalize findings applying for the specific contexts.

### 7.8.5 Conclusion

As an experimental design, this main study had high internal validity since the independent and dependent variables were carefully controlled by the researcher. However, it had relatively low external validity because of the nonrandom sampling and context dependency; that is, the generalizations of the study would be limited within the specific contexts in which it was conducted.

# CHAPTER VIII

# RESULTS AND DISCUSSION OF EXPERIMENT II (MAIN STUDY)

## 8.1 RESULTS

This study addresses two hypotheses. The first is that healthy children's color preferences are different from pediatric patients' color preferences. To test this hypothesis, healthy children and pediatric patient groups were served and compared. The second hypothesis is that design professionals' appreciation of color on pediatric patient room design is different from pediatric patients' perception of color on patient rooms. To test the hypothesis, design professionals and pediatric patients groups were served.

Color preferences were measured using a modified Pediatric Quality of Life Inventory (PedsQL) for all participants. The PedsQL is a research instrument for assessing health-related quality of life in children ages 2 to18 years (Varni, Seid, & Rode, 1999). Color preferences were marked on a 10 cm horizontal line. The marked preferences were converted to 0 to 100 points with 1 mm equivalent to 1 point. In addition to the modified PedsQL, additional questions such as age, gender, ethnicity, field of work, colored model preference order, and reasons for the model order selections were added on questionnaires for design professionals.

Since emotions are associated with colors (Boyatzis & Varghese, 1994; Hemphill, 1996; Zentner, 2001), a quick mood test was performed prior to the color preference rating tasks for all participants. The Self-Assessment Manikin (SAM) was used for measuring participants' mood. The SAM is a picture-oriented instrument for emotional responses and it has been used for decades in experimental psychology with children (Greenbaum, Turner, Cook, & Melanmed, 1990), patients (Cook, Melamed, Cuthbert, McNeil, & Lang, 1988; Patrick, Bradley, & Lang, 1993), and adults (Bradley & Lang, 1994). The SAM was designed based the theory that emotion can be explained by combinations of pleasure, excitement, and dominance. The SAM consists of these three components in the forms of a picture scale so children are able to indicate their emotional states without verbal instruction. Each of the components has nine boxes to check. Therefore, the subject's mark on emotional states can be converted from 1 to 9 points. Using the quantified data, correlations between emotional states and color preferences were investigated using analysis of covariance.

First of all, the design professionals' color preference scores and their reasons for the selections were analyzed. The results from design professionals were compared with those of other groups using mixed between-within subjects analysis of variance in order to investigate group, gender, and ethnic differences.

### 8.1.1 Design Professionals' Color Selections

A total of sixty design professionals participated in this study. Their fields of experience were mostly healthcare design, architectural design, or interior design. The design professionals were asked to indicate the most and least appropriate colors for pediatric patient rooms on the modified PedsQL. They were also asked to explain their reasons for the color selections on a questionnaire.

8.1.1.1 Design Professionals' Color Preference Scores

Design professionals' color preference scores were analyzed and the means and standard deviations are presented in Table 8.1. Design professionals scored blue as the most appropriate color for pediatric patient room design, followed by green, purple, yellow, red, and white (from most appropriate to least, see Figure 8.1).

TABLE 8.1
Means and Standard Deviations of Design Professionals' Color Preferences

| | N | Mean | Std. Deviation |
|---|---|---|---|
| Preference (Blue) | 60 | 70.050 | 25.2797 |
| Preference (Green) | 60 | 65.508 | 28.4958 |
| Preference (Purple) | 60 | 60.833 | 24.8345 |
| Preference (Yellow) | 60 | 49.667 | 32.3706 |
| Preference (Red) | 60 | 49.325 | 25.2905 |
| Preference (White) | 60 | 14.933 | 22.9324 |

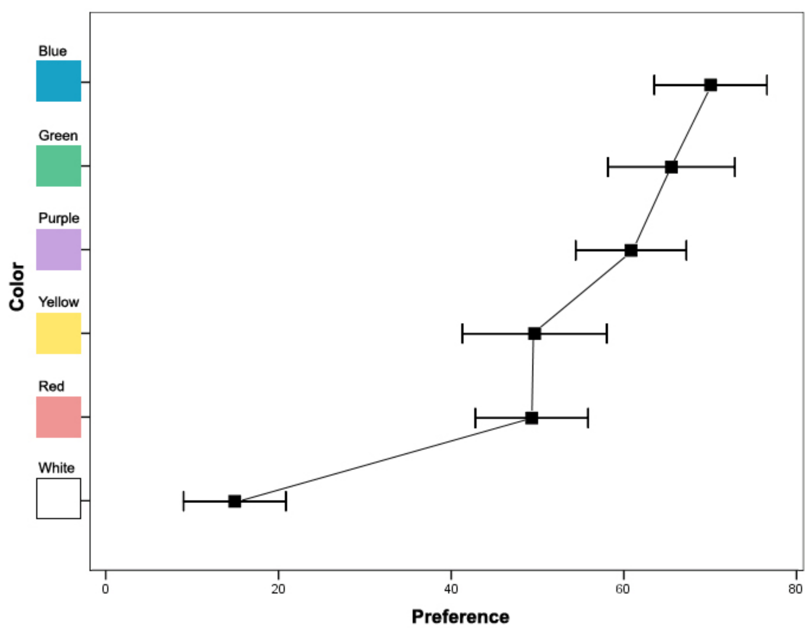



Figure 8.1: Designers' Preferences of Color on Pediatric Patient Room Design

8.1.1.2 Design Professionals' Reasons for Color Selections

Design professionals' reasons for the color selections were gathered from the questionnaire. Their descriptive reasons were categorized as follows: Positive emotions (happy, cheerful, hopeful, energizing, lively, fun, uplifting, or inviting), negative emotions (depressive, non-inviting, agitating, or unnatural), restoration (calming, soothing, restful, relaxing, or soft-ease tension), reference to nature (recalls natural environment), discomfort (high anxiety, hyperactive, too stimulating, or vomitory response), positive skin color reflection (patient looks healthier), negative skin color reflection (hard to diagnose, looks jaundice, or liver inflection), neutral color (no gender specification), institutional look (too stark or sterile, inhumane, no life, or too clinical), and other (by intuition, or no selection).

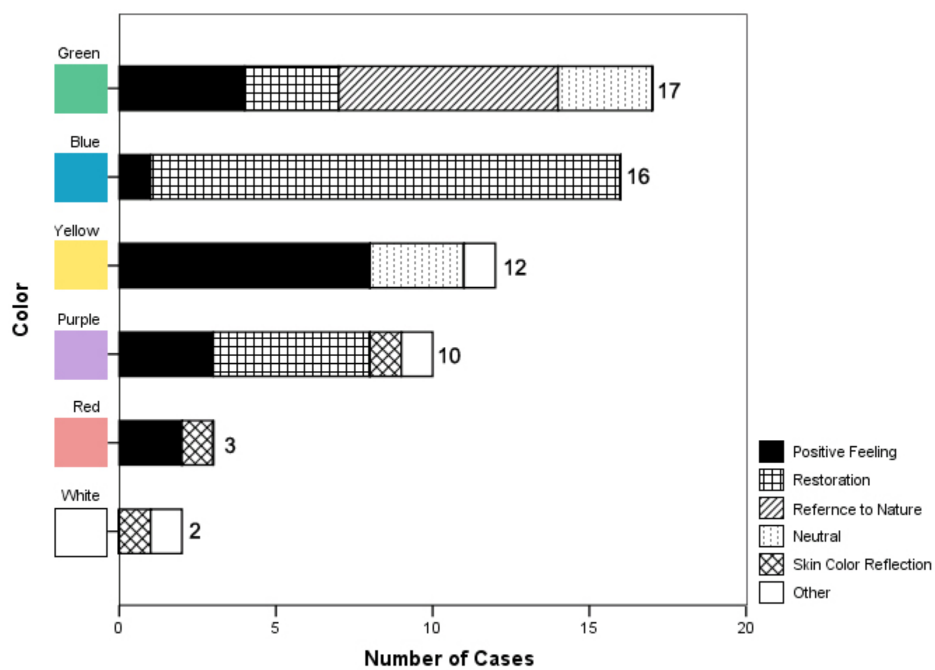



Figure 8.2: Designers' Most Appropriate Colors for Pediatric Patient Room Design

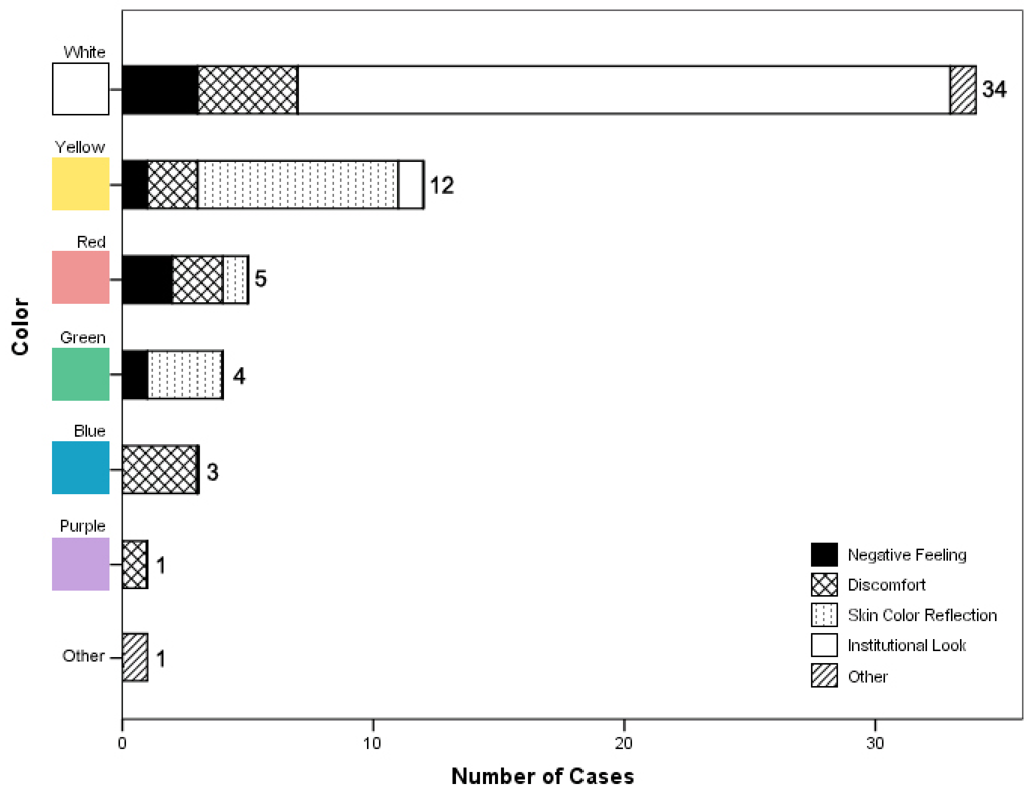



Figure 8.3: Designers' Least Appropriate Colors for Pediatric Patient Room Design

Figures 8.2 and 8.3 show design professionals' most and least appropriate colors for pediatric patient room design respectively.

Design professionals preferred green and blue as the most appropriate colors for pediatric patient rooms. The designers indicated that green evokes references to nature and positive feelings such as being happy, cheerful, and hopeful. They interpreted blue as calming and restful. According to designers, yellow was the third most appropriate because it elicits positive feelings and is neutral for both boys and girls. Few designers selected purple and white because the purple and white were considered to be the least affective colors compared to the others in terms of their effects on patient skin color. The designer professionals were also concerned that if a wall color is too saturated it might limit the physician's ability to diagnose a patient by examining their skin color.

Regarding the least appropriate colors for pediatric patient rooms, white was predominantly selected because it was considered to be too stark or institutional, and suggesting of negative feelings such as being cold or depressed. Yellow was the second least appropriate color because they felt it might make a patient look sick or jaundice which could cause misdiagnoses. One designer specifically indicated that yellow color may produce vomiting for some patients based on the information he received from pediatric oncologist.

### 8.1.2 Group Differences in Color Preference

A mixed between-within subjects ANOVA was conducted to investigate group differences in color preferences. Subjects were divided into four groups and served as independent variables: healthy children (7–11 years, $N$ = 60), pediatric outpatients (7–11 years, $N$ = 60), pediatric inpatients (7–11 years, $N$ = 33), and design professionals (18+ years, $N$ = 60). Six dependent variables were used: preference scores for red, yellow, green, blue, purple, and white. The means and standard deviations of the color preferences according to group are presented in Table 8.2.

TABLE 8.2
Means and Standard Deviations by Group

| | Group | Mean | Std. Deviation | N |
|---|---|---|---|---|
| Preference (Red) | Healthy Children | 57.833 | 31.5869 | 60 |
| | Pediatric Outpatients | 66.450 | 35.4087 | 60 |
| | Pediatric Inpatients | 57.758 | 36.6598 | 33 |
| | Design Professionals | 49.325 | 25.2905 | 60 |
| | Total | 57.852 | 32.3877 | 213 |
| Preference (Yellow) | Healthy Children | 62.467 | 31.2667 | 60 |
| | Pediatric Outpatients | 53.517 | 36.0421 | 60 |
| | Pediatric Inpatients | 50.061 | 34.6211 | 33 |
| | Design Professionals | 49.667 | 32.3706 | 60 |
| | Total | 54.418 | 33.6756 | 213 |
| Preference (Green) | Healthy Children | 73.950 | 26.7559 | 60 |
| | Pediatric Outpatients | 69.517 | 33.0657 | 60 |
| | Pediatric Inpatients | 70.818 | 28.4950 | 33 |
| | Design Professionals | 65.508 | 28.4958 | 60 |
| | Total | 69.838 | 29.3654 | 213 |
| Preference (Blue) | Healthy Children | 86.083 | 20.9530 | 60 |
| | Pediatric Outpatients | 81.950 | 23.6704 | 60 |
| | Pediatric Inpatients | 77.030 | 26.3848 | 33 |
| | Design Professionals | 70.050 | 25.2797 | 60 |
| | Total | 79.000 | 24.5149 | 213 |
| Preference (Purple) | Healthy Children | 61.250 | 27.3506 | 60 |
| | Pediatric Outpatients | 58.650 | 36.7109 | 60 |
| | Pediatric Inpatients | 53.515 | 35.7597 | 33 |
| | Design Professionals | 60.833 | 24.8345 | 60 |
| | Total | 59.202 | 30.9026 | 213 |
| Preference (White) | Healthy Children | 33.583 | 32.8186 | 60 |
| | Pediatric Outpatients | 40.167 | 37.8906 | 60 |
| | Pediatric Inpatients | 26.394 | 36.1999 | 33 |
| | Design Professionals | 14.933 | 22.9324 | 60 |
| | Total | 29.070 | 33.7899 | 213 |

Mauchly's test pf sphericity indicated that the assumption of sphericity had been violated ($\chi^2$ (14) = 54.73, $p < .05$); therefore degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\varepsilon = .91$). Table 8.3 presents tests of interactions between color and group. The results showed that the interaction between group and color preference was not significant, $F$ (13.68, 952.84) = 1.54, $p > .05$, partial eta squared = .02 which indicates a small effect size.

TABLE 8.3
Color and Group Interactions

Measure: MEASURE_1

| Source | | Type III Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|---|
| prefer | Sphericity Assumed | 288080.181 | 5 | 57616.036 | 65.460 | .000 | .239 |
| | Greenhouse-Geisser | 288080.181 | 4.559 | 63188.916 | 65.460 | .000 | .239 |
| | Huynh-Feldt | 288080.181 | 4.740 | 60774.951 | 65.460 | .000 | .239 |
| | Lower-bound | 288080.181 | 1.000 | 288080.181 | 65.460 | .000 | .239 |
| prefer * Group | Sphericity Assumed | 20380.703 | 15 | 1358.714 | 1.544 | .083 | .022 |
| | Greenhouse-Geisser | 20380.703 | 13.677 | 1490.134 | 1.544 | .091 | .022 |
| | Huynh-Feldt | 20380.703 | 14.220 | 1433.208 | 1.544 | .088 | .022 |
| | Lower-bound | 20380.703 | 3.000 | 6793.568 | 1.544 | .204 | .022 |
| Error(prefer) | Sphericity Assumed | 919776.677 | 1045 | 880.169 | | | |
| | Greenhouse-Geisser | 919776.677 | 952.837 | 965.303 | | | |
| | Huynh-Feldt | 919776.677 | 990.684 | 928.426 | | | |
| | Lower-bound | 919776.677 | 209.000 | 4400.845 | | | |

TABLE 8.4
Group Differences

Measure: MEASURE_1
Transformed Variable: Average

| Source | Type III Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|
| Intercept | 4017575.632 | 1 | 4017575.632 | 3357.950 | .000 | .941 |
| Group | 27312.595 | 3 | 9104.198 | 7.609 | .000 | .098 |
| Error | 250055.355 | 209 | 1196.437 | | | |

A 4 (Group) x 6 (Color preference) mixed-model ANOVA revealed that the main effect of the between-subjects variable (Group) was significant, $F$ (3, 209) = 7.61, $p < .05$, partial eta squared = .098 which indicates a moderate effect size (see Table 8.4). Therefore, a post hoc test was conducted in order to investigate the group difference (see Table 8.5). The Games-Howell Test was selected since it is useful when variances are unequal. In terms of the mean differences among the groups, the Games-Howell Test revealed that the group of design professionals showed significant differences when compared to healthy children and pediatric outpatients. However, there were no significant differences among the children groups: healthy, pediatric outpatients, and pediatric inpatients.

TABLE 8.5
Post Hoc Test of Group Differences

Measure: MEASURE_1
Games-Howell

| (I) Group | (J) Group | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval Lower Bound | Upper Bound |
|---|---|---|---|---|---|---|
| Healthy Children | Healthy Children | | | | | |
| | Pediatric Outpatients | .819 | 2.8899 | .992 | -6.714 | 8.353 |
| | Pediatric Inpatients | 6.598 | 3.2783 | .194 | -2.053 | 15.250 |
| | Design Professionals | 10.808* | 2.1910 | .000 | 5.080 | 16.536 |
| Pediatric Outpatients | Healthy Children | -.819 | 2.8899 | .992 | -8.353 | 6.714 |
| | Pediatric Outpatients | | | | | |
| | Pediatric Inpatients | 5.779 | 3.4692 | .349 | -3.346 | 14.904 |
| | Design Professionals | 9.989* | 2.4676 | .001 | 3.527 | 16.451 |
| Pediatric Inpatients | Healthy Children | -6.598 | 3.2783 | .194 | -15.250 | 2.053 |
| | Pediatric Outpatients | -5.779 | 3.4692 | .349 | -14.904 | 3.346 |
| | Pediatric Inpatients | | | | | |
| | Design Professionals | 4.210 | 2.9129 | .479 | -3.571 | 11.991 |
| Design Professionals | Healthy Children | -10.808* | 2.1910 | .000 | -16.536 | -5.080 |
| | Pediatric Outpatients | -9.989* | 2.4676 | .001 | -16.451 | -3.527 |
| | Pediatric Inpatients | -4.210 | 2.9129 | .479 | -11.991 | 3.571 |
| | Design Professionals | | | | | |

Based on observed means.

*. The mean difference is significant at the .05 level.

Figure 8.4 shows the means for each group's color preferences. Healthy children reported higher preferences for the colors when compared to the other groups. Design professionals had lower preference ratings for colors overall. Even though there were group differences in terms of means, the differences were relatively small and all the groups showed similar color preference patterns except for red and yellow; interestingly, pediatric patients, both outpatients and inpatients, less preferred than the healthy children group for yellow.

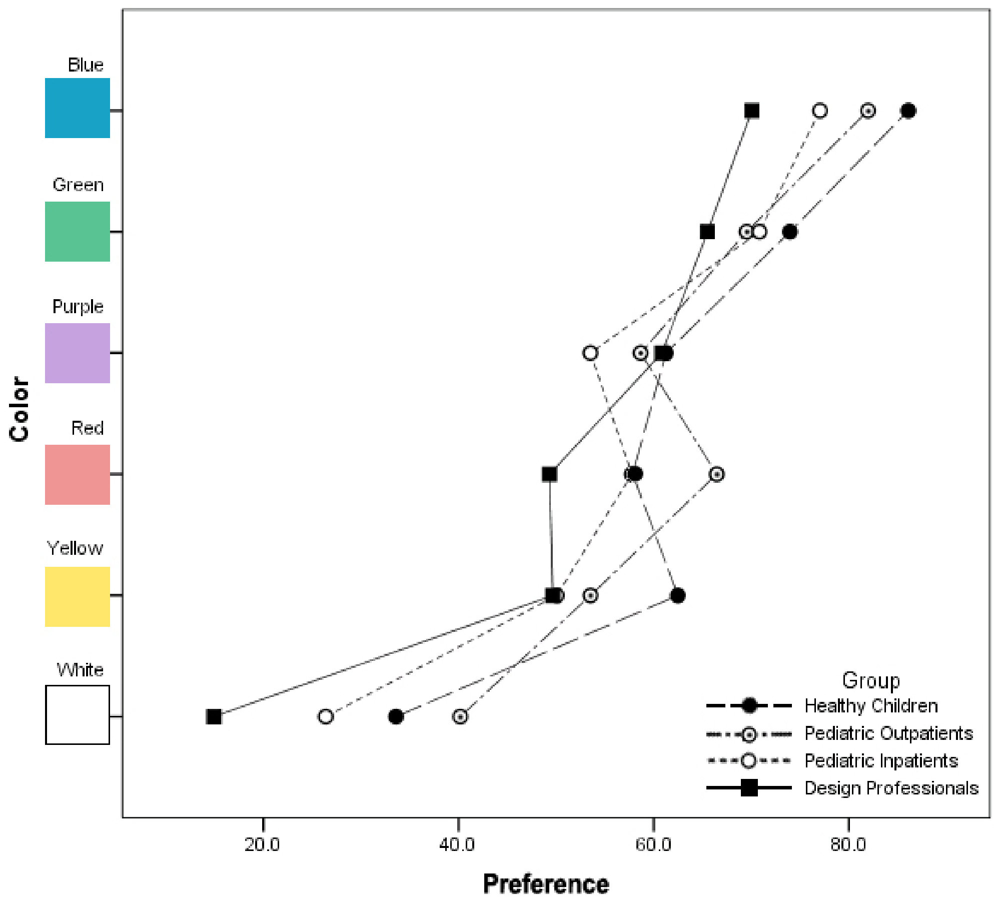



Figure 8.4: Means of Color Preferences by Four Different Groups

To summarize, there was no statistically significant difference between healthy children and pediatric patient groups in terms of color preferences. The mean of design professionals was significantly different from pediatric outpatients but not from pediatric inpatients. Although the mean difference was significant, the overall color preference patterns of all four groups were almost similar excluding slight differences in red, yellow, and purple. Blue and green were the most preferred colors and white was the least preferred color for all groups. The color preferences of pediatric patients were slightly different from the others; they reported higher preferences towards red than the others. The overall color preference orders according to the groups are shown in Table 8.6

TABLE 8.6
Overall Color Preference Orders

| Preference Order | 1 (Most) | 2 | 3 | 4 | 5 | 6 (Least) |
|---|---|---|---|---|---|---|
| Healthy Children | Blue | Green | Yellow | Purple | Red | White |
| Pediatric Outpatients | Blue | Green | Red | Purple | Yellow | White |
| Pediatric Inpatients | Blue | Green | Red | Purple | Yellow | White |
| Design Professionals | Blue | Green | Purple | Yellow | Red | White |

**8.1.3 Gender Differences in Color Preference**

8.1.3.1 Overall Gender Differences

A mixed between-within subjects ANOVA was conducted to investigate gender differences. Subjects were divided into males ($N$ =103) and females ($N$ = 110) regardless of their age and used as independent variables. Six dependent variables were used: the preference scores for red, yellow, green, blue, purple, and white. The means and standard deviations by gender are presented in Table 8.7.

TABLE 8.7
Means and Standard Deviations by Gender

| | Gender | Mean | Std. Deviation | N |
|---|---|---|---|---|
| Preference (Red) | Female | 65.609 | 30.3445 | 110 |
| | Male | 49.568 | 32.5888 | 103 |
| | Total | 57.852 | 32.3877 | 213 |
| Preference (Yellow) | Female | 53.945 | 34.3756 | 110 |
| | Male | 54.922 | 33.0720 | 103 |
| | Total | 54.418 | 33.6756 | 213 |
| Preference (Green) | Female | 66.909 | 30.5925 | 110 |
| | Male | 72.966 | 27.8033 | 103 |
| | Total | 69.838 | 29.3654 | 213 |
| Preference (Blue) | Female | 80.727 | 23.7282 | 110 |
| | Male | 77.155 | 25.3136 | 103 |
| | Total | 79.000 | 24.5149 | 213 |
| Preference (Purple) | Female | 70.736 | 28.3270 | 110 |
| | Male | 46.883 | 28.8211 | 103 |
| | Total | 59.202 | 30.9026 | 213 |
| Preference (White) | Female | 24.427 | 32.3798 | 110 |
| | Male | 34.029 | 34.7070 | 103 |
| | Total | 29.070 | 33.7899 | 213 |

Mauchly's test of sphericity indicated that the assumption of sphericity had been violated ($\chi^2$ (14) = 45.64, $p$ < .05); therefore degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity (ε = .93). The results showed that interaction between gender and color preference was significant, $F$ (4.63, 976.24) = 10.65, $p$ < .05, partial eta squared = .05 which indicates a small effect size. Table 8.8 shows results of color and gender interactions. Contrasts of the interactions are presented in Table 8.9.

TABLE 8.8
Color and Gender Interactions

Measure: MEASURE_1

| Source | | Type III Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|---|
| prefer | Sphericity Assumed | 302613.210 | 5 | 60522.642 | 71.342 | .000 | .253 |
| | Greenhouse-Geisser | 302613.210 | 4.627 | 65405.508 | 71.342 | .000 | .253 |
| | Huynh-Feldt | 302613.210 | 4.766 | 63499.521 | 71.342 | .000 | .253 |
| | Lower-bound | 302613.210 | 1.000 | 302613.210 | 71.342 | .000 | .253 |
| prefer * Gender | Sphericity Assumed | 45154.831 | 5 | 9030.966 | 10.645 | .000 | .048 |
| | Greenhouse-Geisser | 45154.831 | 4.627 | 9759.569 | 10.645 | .000 | .048 |
| | Huynh-Feldt | 45154.831 | 4.766 | 9475.165 | 10.645 | .000 | .048 |
| | Lower-bound | 45154.831 | 1.000 | 45154.831 | 10.645 | .001 | .048 |
| Error(prefer) | Sphericity Assumed | 895002.548 | 1055 | 848.344 | | | |
| | Greenhouse-Geisser | 895002.548 | 976.239 | 916.787 | | | |
| | Huynh-Feldt | 895002.548 | 1005.541 | 890.070 | | | |
| | Lower-bound | 895002.548 | 211.000 | 4241.718 | | | |

TABLE 8.9
Contrasts of Color and Gender Interactions

Measure: MEASURE_1

| Source | prefer | Type III Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|---|
| prefer | Level 1 vs. Level 6 | 171132.602 | 1 | 171132.602 | 94.870 | .000 | .310 |
| | Level 2 vs. Level 6 | 135178.486 | 1 | 135178.486 | 61.634 | .000 | .226 |
| | Level 3 vs. Level 6 | 352613.354 | 1 | 352613.354 | 169.424 | .000 | .445 |
| | Level 4 vs. Level 6 | 525838.170 | 1 | 525838.170 | 345.799 | .000 | .621 |
| | Level 5 vs. Level 6 | 186190.464 | 1 | 186190.464 | 99.892 | .000 | .321 |
| prefer * Gender | Level 1 vs. Level 6 | 34977.390 | 1 | 34977.390 | 19.390 | .000 | .084 |
| | Level 2 vs. Level 6 | 3957.002 | 1 | 3957.002 | 1.804 | .181 | .008 |
| | Level 3 vs. Level 6 | 668.443 | 1 | 668.443 | .321 | .572 | .002 |
| | Level 4 vs. Level 6 | 9231.484 | 1 | 9231.484 | 6.071 | .015 | .028 |
| | Level 5 vs. Level 6 | 59534.013 | 1 | 59534.013 | 31.940 | .000 | .131 |
| Error(prefer) | Level 1 vs. Level 6 | 380615.708 | 211 | 1803.866 | | | |
| | Level 2 vs. Level 6 | 462777.289 | 211 | 2193.257 | | | |
| | Level 3 vs. Level 6 | 439143.303 | 211 | 2081.248 | | | |
| | Level 4 vs. Level 6 | 320856.459 | 211 | 1520.647 | | | |
| | Level 5 vs. Level 6 | 393286.306 | 211 | 1863.916 | | | |

To break down this interaction, contrasts were performed comparing color preference across males and females. The results revealed that the increased preference found for females was significantly higher than for males when comparing red to white, *F* (1, 211) = 19.39, *p* < .05, partial eta squared = .08; blue to white, *F* (1, 211) = 6.07, *p* < .05, partial eta squared = .03; and purple to white, *F* (1, 211) = 31.94, *p* < .05, partial eta squared = .13. Figure 8.5 shows male and female mean of color preferences. Males reported lower preferences for red and purple than did females.

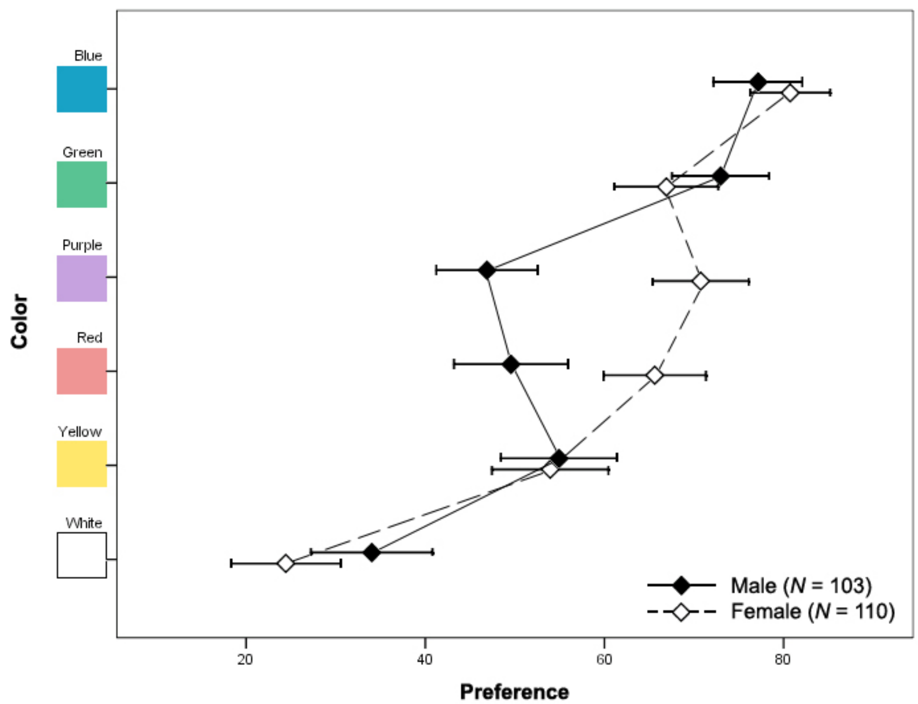



Figure 8.5: Overall Gender Effect

There were gender effects when combining all children and adults subjects together. To break down gender differences in detail, the subjects were divided into two different groups: children (healthy children, pediatric outpatients, and pediatric inpatients) and adults (design professionals). Gender effects on children and adult groups were investigated.

8.1.3.2 Gender Differences in Adults Group

A mixed between-within subjects ANOVA was conducted to investigate any gender differences in color preferences for the adult group (design professionals). The independent variables were males (*N* =31) and females (*N* = 29) among design professionals. Six dependent variables were used: the preference scores for red, yellow, green, blue, purple, and white. The means and standard deviations are presented in Table 8.10.

TABLE 8.10
Means and Standard Deviations of Adults Group

| | Gender | Mean | Std. Deviation | N |
|---|---|---|---|---|
| Preference (Red) | Female | 57.069 | 23.1593 | 29 |
| | Male | 42.081 | 25.3989 | 31 |
| | Total | 49.325 | 25.2905 | 60 |
| Preference (Yellow) | Female | 50.414 | 34.9658 | 29 |
| | Male | 48.968 | 30.3089 | 31 |
| | Total | 49.667 | 32.3706 | 60 |
| Preference (Green) | Female | 72.655 | 25.7672 | 29 |
| | Male | 58.823 | 29.6936 | 31 |
| | Total | 65.508 | 28.4958 | 60 |
| Preference (Blue) | Female | 73.793 | 24.5319 | 29 |
| | Male | 66.548 | 25.8635 | 31 |
| | Total | 70.050 | 25.2797 | 60 |
| Preference (Purple) | Female | 61.862 | 25.4681 | 29 |
| | Male | 59.871 | 24.6086 | 31 |
| | Total | 60.833 | 24.8345 | 60 |
| Preference (White) | Female | 9.690 | 18.4199 | 29 |
| | Male | 19.839 | 25.8097 | 31 |
| | Total | 14.933 | 22.9324 | 60 |

Mauchly's test of sphericity indicated that the assumption of sphericity had been met ($\chi^2$ (14) = 20.37, $p$ = .119 > .05). Table 8.11 presents tests of interaction effects and the results showed that there was no significant interaction between gender and color preference, $F$ (5, 290) = 1.72, $p$ = .13 > .05, partial eta squared = .03 which is a small effect size. Figure 8.6 shows the design professionals' mean color preferences. Although females tended to prefer colors slightly more than males across all groups, excluding white, this was not statistically significant.

TABLE 8.11
Color and Gender Interactions in Adults Group

Measure: MEASURE_1

| Source | | Type III Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|---|
| prefer | Sphericity Assumed | 119568.825 | 5 | 23913.765 | 31.647 | .000 | .353 |
| | Greenhouse-Geisser | 119568.825 | 4.360 | 27423.893 | 31.647 | .000 | .353 |
| | Huynh-Feldt | 119568.825 | 4.840 | 24705.831 | 31.647 | .000 | .353 |
| | Lower-bound | 119568.825 | 1.000 | 119568.825 | 31.647 | .000 | .353 |
| prefer * Gender | Sphericity Assumed | 6501.691 | 5 | 1300.338 | 1.721 | .130 | .029 |
| | Greenhouse-Geisser | 6501.691 | 4.360 | 1491.206 | 1.721 | .140 | .029 |
| | Huynh-Feldt | 6501.691 | 4.840 | 1343.408 | 1.721 | .132 | .029 |
| | Lower-bound | 6501.691 | 1.000 | 6501.691 | 1.721 | .195 | .029 |
| Error(prefer) | Sphericity Assumed | 219133.470 | 290 | 755.633 | | | |
| | Greenhouse-Geisser | 219133.470 | 252.881 | 866.546 | | | |
| | Huynh-Feldt | 219133.470 | 280.703 | 780.661 | | | |
| | Lower-bound | 219133.470 | 58.000 | 3778.163 | | | |

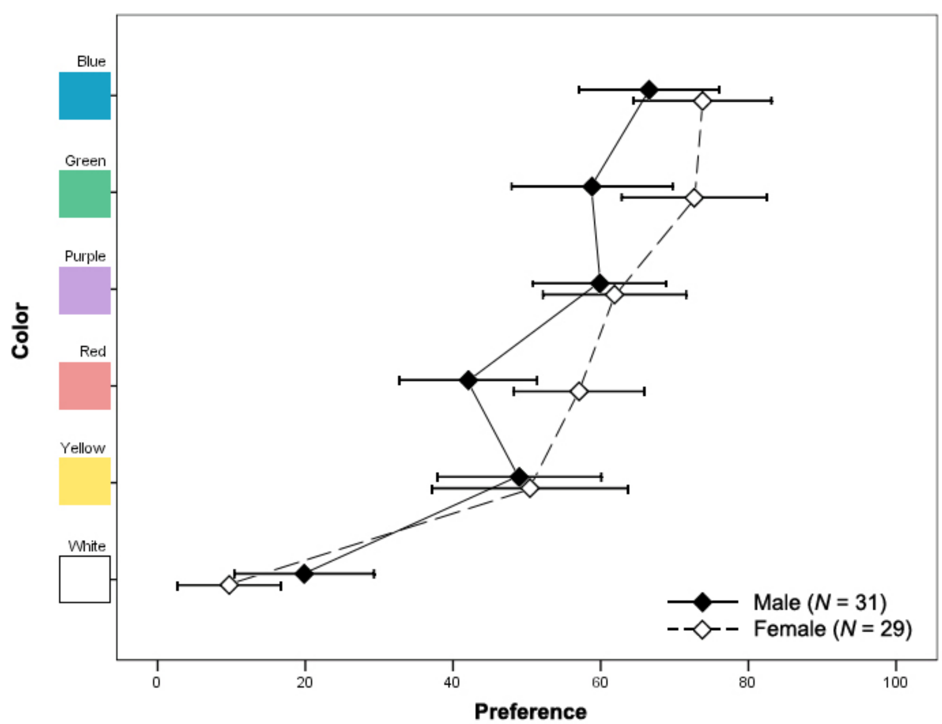



Figure 8.6: Gender Effect in Design Professionals Group

<u>8.1.3.3 Gender Differences in Children Group</u>

A mixed between-within subjects ANOVA was conducted to investigate gender differences in the color preferences of the children group. All three groups (healthy children, pediatric outpatients, and pediatric inpatients) were combined together and a new group was created. The children group was divided into males ($N$ =72) and females ($N$ = 81) as independent variables. Six dependent variables were used: the preference scores for red, yellow, green, blue, purple, and white. The means and standard deviations are presented in Table 8.12.

TABLE 8.12
Means and Standard Deviations of Children Group

| | Gender | Mean | Std. Deviation | N |
|---|---|---|---|---|
| Preference (Red) | Female | 68.667 | 32.1084 | 81 |
| | Male | 52.792 | 34.9018 | 72 |
| | Total | 61.196 | 34.2754 | 153 |
| Preference (Yellow) | Female | 55.210 | 34.2928 | 81 |
| | Male | 57.486 | 34.0737 | 72 |
| | Total | 56.281 | 34.0963 | 153 |
| Preference (Green) | Female | 64.852 | 32.0395 | 81 |
| | Male | 79.056 | 24.7596 | 72 |
| | Total | 71.536 | 29.6180 | 153 |
| Preference (Blue) | Female | 83.210 | 23.0828 | 81 |
| | Male | 81.722 | 23.8252 | 72 |
| | Total | 82.510 | 23.3695 | 153 |
| Preference (Purple) | Female | 73.914 | 28.7664 | 81 |
| | Male | 41.292 | 28.8461 | 72 |
| | Total | 58.562 | 33.0315 | 153 |
| Preference (White) | Female | 29.704 | 34.6819 | 81 |
| | Male | 40.139 | 36.3769 | 72 |
| | Total | 34.614 | 35.7560 | 153 |

Mauchly's test of sphericity indicated that the assumption of sphericity had been violated ($\chi^2$ (14) = 43.04, $p$ < .05); therefore degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity (ε = .90). The results showed that the interaction between gender and color preference was significant, $F$ (4.51, 680.20) = 13.82, $p < .05$, partial eta squared = .08 which indicates a moderate effect size.

TABLE 8.13
Color and Gender Interactions in Children Group

Measure: MEASURE_1

| Source | | Type III Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|---|
| prefer | Sphericity Assumed | 197217.278 | 5 | 39443.456 | 46.262 | .000 | .235 |
| | Greenhouse-Geisser | 197217.278 | 4.505 | 43780.898 | 46.262 | .000 | .235 |
| | Huynh-Feldt | 197217.278 | 4.691 | 42041.597 | 46.262 | .000 | .235 |
| | Lower-bound | 197217.278 | 1.000 | 197217.278 | 46.262 | .000 | .235 |
| prefer * Gender | Sphericity Assumed | 58912.258 | 5 | 11782.452 | 13.819 | .000 | .084 |
| | Greenhouse-Geisser | 58912.258 | 4.505 | 13078.122 | 13.819 | .000 | .084 |
| | Huynh-Feldt | 58912.258 | 4.691 | 12558.562 | 13.819 | .000 | .084 |
| | Lower-bound | 58912.258 | 1.000 | 58912.258 | 13.819 | .000 | .084 |
| Error(prefer) | Sphericity Assumed | 643721.609 | 755 | 852.611 | | | |
| | Greenhouse-Geisser | 643721.609 | 680.201 | 946.370 | | | |
| | Huynh-Feldt | 643721.609 | 708.342 | 908.773 | | | |
| | Lower-bound | 643721.609 | 151.000 | 4263.057 | | | |

TABLE 8.14
Contrasts of Color and Gender Interactions in Children Group

Measure: MEASURE_1

| Source | prefer | Type III Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|---|
| prefer | Level 1 vs. Level 6 | 101552.452 | 1 | 101552.452 | 50.277 | .000 | .250 |
| | Level 2 vs. Level 6 | 69999.760 | 1 | 69999.760 | 29.452 | .000 | .163 |
| | Level 3 vs. Level 6 | 209098.042 | 1 | 209098.042 | 97.712 | .000 | .393 |
| | Level 4 vs. Level 6 | 344660.305 | 1 | 344660.305 | 226.419 | .000 | .600 |
| | Level 5 vs. Level 6 | 78437.366 | 1 | 78437.366 | 40.935 | .000 | .213 |
| prefer * Gender | Level 1 vs. Level 6 | 26386.020 | 1 | 26386.020 | 13.063 | .000 | .080 |
| | Level 2 vs. Level 6 | 2537.434 | 1 | 2537.434 | 1.068 | .303 | .007 |
| | Level 3 vs. Level 6 | 541.337 | 1 | 541.337 | .253 | .616 | .002 |
| | Level 4 vs. Level 6 | 5418.580 | 1 | 5418.580 | 3.560 | .061 | .023 |
| | Level 5 vs. Level 6 | 70666.830 | 1 | 70666.830 | 36.880 | .000 | .196 |
| Error(prefer) | Level 1 vs. Level 6 | 304999.208 | 151 | 2019.862 | | | |
| | Level 2 vs. Level 6 | 358882.566 | 151 | 2376.706 | | | |
| | Level 3 vs. Level 6 | 323131.722 | 151 | 2139.945 | | | |
| | Level 4 vs. Level 6 | 229855.747 | 151 | 1522.223 | | | |
| | Level 5 vs. Level 6 | 289338.752 | 151 | 1916.151 | | | |

Table 8.13 shows color and gender interactions. Contrasts of the interactions are presented in Table 8.14. To break down this interaction, contrasts were performed comparing color preferences across males and females. The results revealed that the increased preference found among females was significantly higher than for males when comparing red to white, $F$ (1, 151) = 13.06, $p < .05$, partial eta squared = .08 (a moderate effect size); and purple to white, $F$ (1, 151) = 36.88, $p < .05$, partial eta squared = .20 (a very large effect size).

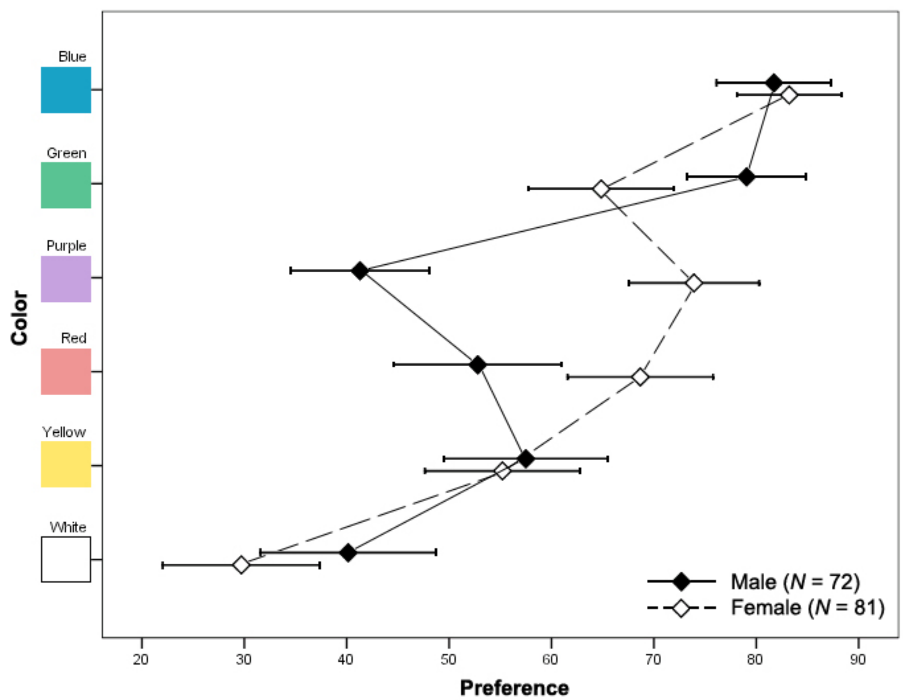



Figure 8.7: Gender Effect in Children Group

An inspection of means and confidence intervals indicated that males reported lower preference scores on red and purple than did females. In contrast, females showed a lower preference for green than did males. Therefore, gender effects in red, green, and purple were significant in the children's groups. Figure 8.7 presents gender differences in children group.

Since gender differences were detected among the children groups, additional analyses were conducted to investigate gender differences in each of the healthy children, pediatric outpatients, and pediatric inpatients groups separately.

8.1.3.4 Gender Differences in Healthy Children Group

A mixed between-within subjects ANOVA was conducted to investigate gender differences in the healthy children group. Males (*N* =29) and females (*N* = 31) were used as independent variables. The same six dependent variables from previous analyses were used. The means and standard deviations are presented in Table 8.15.

TABLE 8.15
Means and Standard Deviations of Healthy Children Group

| | Gender | Mean | Std. Deviation | N |
|---|---|---|---|---|
| Preference (Red) | Female | 62.032 | 33.1657 | 31 |
| | Male | 53.345 | 29.7229 | 29 |
| | Total | 57.833 | 31.5869 | 60 |
| Preference (Yellow) | Female | 56.806 | 32.2091 | 31 |
| | Male | 68.517 | 29.5811 | 29 |
| | Total | 62.467 | 31.2667 | 60 |
| Preference (Green) | Female | 65.516 | 30.0676 | 31 |
| | Male | 82.966 | 19.4137 | 29 |
| | Total | 73.950 | 26.7559 | 60 |
| Preference (Blue) | Female | 89.419 | 14.4217 | 31 |
| | Male | 82.517 | 26.0146 | 29 |
| | Total | 86.083 | 20.9530 | 60 |
| Preference (Purple) | Female | 73.226 | 24.2895 | 31 |
| | Male | 48.448 | 24.8116 | 29 |
| | Total | 61.250 | 27.3506 | 60 |
| Preference (White) | Female | 28.258 | 32.0177 | 31 |
| | Male | 39.276 | 33.2597 | 29 |
| | Total | 33.583 | 32.8186 | 60 |

Mauchly's test of sphericity indicated that the assumption of sphericity had been violated ($\chi^2$ (14) = 29.29, $p$ < .05); therefore degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity (ε = .84). Table 8.16 shows color and gender interactions and the results showed that interaction between gender and color preference was significant, $F$ (4.21, 243.96) = 5.71, $p$ < .05, partial eta squared = .09 which indicates a moderate effect size.

TABLE 8.16
Color and Gender Interactions in Healthy Children Group

Measure: MEASURE_1

| Source | | Type III Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|---|
| prefer | Sphericity Assumed | 92305.282 | 5 | 18461.056 | 27.056 | .000 | .318 |
| | Greenhouse-Geisser | 92305.282 | 4.206 | 21945.038 | 27.056 | .000 | .318 |
| | Huynh-Feldt | 92305.282 | 4.654 | 19832.282 | 27.056 | .000 | .318 |
| | Lower-bound | 92305.282 | 1.000 | 92305.282 | 27.056 | .000 | .318 |
| prefer * Gender | Sphericity Assumed | 19479.027 | 5 | 3895.805 | 5.710 | .000 | .090 |
| | Greenhouse-Geisser | 19479.027 | 4.206 | 4631.024 | 5.710 | .000 | .090 |
| | Huynh-Feldt | 19479.027 | 4.654 | 4185.173 | 5.710 | .000 | .090 |
| | Lower-bound | 19479.027 | 1.000 | 19479.027 | 5.710 | .020 | .090 |
| Error(prefer) | Sphericity Assumed | 197877.784 | 290 | 682.337 | | | |
| | Greenhouse-Geisser | 197877.784 | 243.960 | 811.108 | | | |
| | Huynh-Feldt | 197877.784 | 269.949 | 733.019 | | | |
| | Lower-bound | 197877.784 | 58.000 | 3411.686 | | | |

TABLE 8.17
Contrasts of Color and Gender Interactions in Healthy Children Group

Measure: MEASURE_1

| Source | prefer | Type III Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|---|
| prefer | Level 1 vs. Level 6 | 34296.369 | 1 | 34296.369 | 20.178 | .000 | .258 |
| | Level 2 vs. Level 6 | 50039.196 | 1 | 50039.196 | 22.614 | .000 | .281 |
| | Level 3 vs. Level 6 | 98178.791 | 1 | 98178.791 | 56.575 | .000 | .494 |
| | Level 4 vs. Level 6 | 163317.096 | 1 | 163317.096 | 132.928 | .000 | .696 |
| | Level 5 vs. Level 6 | 43918.494 | 1 | 43918.494 | 29.331 | .000 | .336 |
| prefer * Gender | Level 1 vs. Level 6 | 5817.969 | 1 | 5817.969 | 3.423 | .069 | .056 |
| | Level 2 vs. Level 6 | 7.196 | 1 | 7.196 | .003 | .955 | .000 |
| | Level 3 vs. Level 6 | 619.791 | 1 | 619.791 | .357 | .552 | .006 |
| | Level 4 vs. Level 6 | 4811.496 | 1 | 4811.496 | 3.916 | .053 | .063 |
| | Level 5 vs. Level 6 | 19198.228 | 1 | 19198.228 | 12.822 | .001 | .181 |
| Error(prefer) | Level 1 vs. Level 6 | 98583.281 | 58 | 1699.712 | | | |
| | Level 2 vs. Level 6 | 128336.988 | 58 | 2212.707 | | | |
| | Level 3 vs. Level 6 | 100652.142 | 58 | 1735.382 | | | |
| | Level 4 vs. Level 6 | 71259.504 | 58 | 1228.612 | | | |
| | Level 5 vs. Level 6 | 86845.106 | 58 | 1497.329 | | | |

To break down this interaction, contrasts were performed comparing color preferences across males and females. Table 8.17 presents contrasts of the interactions and the results revealed that the increased preference found among females was significantly higher than for males when comparing purple to white, $F(1, 58) = 12.82$, $p < .05$, partial eta squared = .18 (a very large effect size). An inspection of means and confidence intervals indicated that males reported significantly lower preference scores on purple. Females showed lower interest in green than did males. Figure 8.8 displays gender differences in healthy children group.

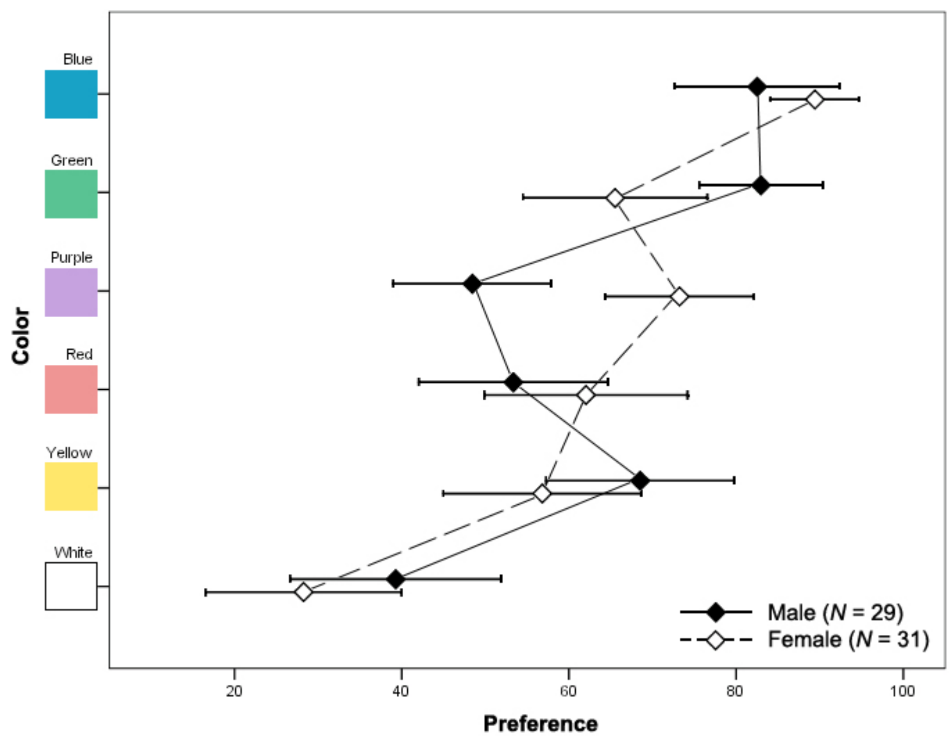



Figure 8.8: Gender Effect in Healthy Children Group

8.1.3.5 Gender Differences in Pediatric Outpatients Group

A mixed between-within subjects ANOVA was conducted to investigate gender differences in the pediatric outpatient group. Subjects were divided into males (*N* =22) and females (*N* = 38). Again, the same six dependent variables were used. The means and standard deviations are presented in Table 8.18.

TABLE 8.18
Means and Standard Deviations of Pediatric Outpatients Group

| | Gender | Mean | Std. Deviation | N |
|---|---|---|---|---|
| Preference (Red) | Female | 74.053 | 32.1314 | 38 |
| | Male | 53.318 | 37.6594 | 22 |
| | Total | 66.450 | 35.4087 | 60 |
| Preference (Yellow) | Female | 56.895 | 36.4564 | 38 |
| | Male | 47.682 | 35.3787 | 22 |
| | Total | 53.517 | 36.0421 | 60 |
| Preference (Green) | Female | 65.289 | 34.6253 | 38 |
| | Male | 76.818 | 29.5162 | 22 |
| | Total | 69.517 | 33.0657 | 60 |
| Preference (Blue) | Female | 80.658 | 26.3513 | 38 |
| | Male | 84.182 | 18.5052 | 22 |
| | Total | 81.950 | 23.6704 | 60 |
| Preference (Purple) | Female | 70.895 | 34.5040 | 38 |
| | Male | 37.500 | 30.8031 | 22 |
| | Total | 58.650 | 36.7109 | 60 |
| Preference (White) | Female | 34.237 | 37.4573 | 38 |
| | Male | 50.409 | 37.2567 | 22 |
| | Total | 40.167 | 37.8906 | 60 |

Mauchly's test of sphericity indicated that the assumption of sphericity had been violated ($\chi^2$ (14) = 44.69, $p$ < .05); therefore degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\varepsilon$ = .77). Table 8.19 presents color and gender interactions and the results showed that the interaction between gender and color preference was significant, *F* (3.86, 223.96) = 5.31, *p* < .05, partial eta squared = .08 which indicates a moderate effect size.

TABLE 8.19
Color and Gender Interactions in Pediatric Outpatients Group

Measure: MEASURE_1

| Source | | Type III Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|---|
| prefer | Sphericity Assumed | 57856.908 | 5 | 11571.382 | 11.814 | .000 | .169 |
| | Greenhouse-Geisser | 57856.908 | 3.861 | 14983.498 | 11.814 | .000 | .169 |
| | Huynh-Feldt | 57856.908 | 4.242 | 13637.492 | 11.814 | .000 | .169 |
| | Lower-bound | 57856.908 | 1.000 | 57856.908 | 11.814 | .001 | .169 |
| prefer * Gender | Sphericity Assumed | 25985.042 | 5 | 5197.008 | 5.306 | .000 | .084 |
| | Greenhouse-Geisser | 25985.042 | 3.861 | 6729.478 | 5.306 | .001 | .084 |
| | Huynh-Feldt | 25985.042 | 4.242 | 6124.952 | 5.306 | .000 | .084 |
| | Lower-bound | 25985.042 | 1.000 | 25985.042 | 5.306 | .025 | .084 |
| Error(prefer) | Sphericity Assumed | 284042.733 | 290 | 979.458 | | | |
| | Greenhouse-Geisser | 284042.733 | 223.960 | 1268.276 | | | |
| | Huynh-Feldt | 284042.733 | 246.064 | 1154.343 | | | |
| | Lower-bound | 284042.733 | 58.000 | 4897.289 | | | |

TABLE 8.20
Contrasts of Color and Gender Interactions in Pediatric Outpatients Group

Measure: MEASURE_1

| Source | prefer | Type III Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|---|
| prefer | Level 1 vs. Level 6 | 25434.121 | 1 | 25434.121 | 10.075 | .002 | .148 |
| | Level 2 vs. Level 6 | 5534.734 | 1 | 5534.734 | 2.058 | .157 | .034 |
| | Level 3 vs. Level 6 | 46005.770 | 1 | 46005.770 | 17.239 | .000 | .229 |
| | Level 4 vs. Level 6 | 89605.857 | 1 | 89605.857 | 47.450 | .000 | .450 |
| | Level 5 vs. Level 6 | 7858.479 | 1 | 7858.479 | 3.561 | .064 | .058 |
| prefer * Gender | Level 1 vs. Level 6 | 18978.655 | 1 | 18978.655 | 7.518 | .008 | .115 |
| | Level 2 vs. Level 6 | 8978.734 | 1 | 8978.734 | 3.338 | .073 | .054 |
| | Level 3 vs. Level 6 | 300.437 | 1 | 300.437 | .113 | .738 | .002 |
| | Level 4 vs. Level 6 | 2229.057 | 1 | 2229.057 | 1.180 | .282 | .020 |
| | Level 5 vs. Level 6 | 34232.613 | 1 | 34232.613 | 15.510 | .000 | .211 |
| Error(prefer) | Level 1 vs. Level 6 | 146425.529 | 58 | 2524.578 | | | |
| | Level 2 vs. Level 6 | 155990.916 | 58 | 2689.499 | | | |
| | Level 3 vs. Level 6 | 154789.213 | 58 | 2668.780 | | | |
| | Level 4 vs. Level 6 | 109529.127 | 58 | 1888.433 | | | |
| | Level 5 vs. Level 6 | 128010.371 | 58 | 2207.075 | | | |

To break down this interaction, contrasts were performed comparing color preferences across males and females. Table 8.20 displays contrasts of the interactions and the results revealed that the females expressed an increased preference for red to white, $F$ (1, 58) = 7.52, $p < .05$, partial eta squared = .15 (a large effect size); and purple to white, $F$ (1, 58) = 15.51, $p < .05$, partial eta squared = .21 (a very large effect size).

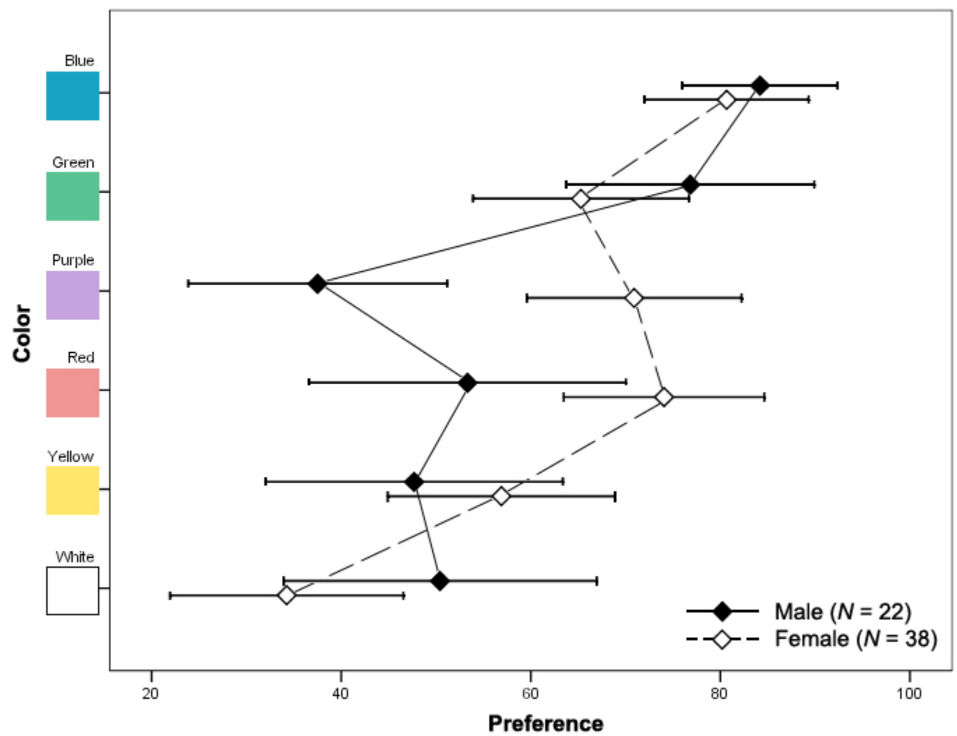



Figure 8.9: Gender Effect in Pediatric Outpatients Group

An inspection of means and confidence intervals indicated that pediatric outpatient males reported lower preference scores for purple than pediatric outpatient females. Pediatric outpatient females showed a tendency to prefer red more than pediatric outpatient males. In contrast, pediatric outpatient males tended to prefer green more than pediatric outpatient females. Figure 8.9 displays gender effect in pediatric outpatients group.

8.1.3.6 Gender Differences in Pediatric Inpatients Group

A mixed between-within subjects ANOVA was conducted to investigate gender differences in the pediatric inpatient group. Subjects were divided into males (*N* =21) and females (*N* = 12). Again, this comparison used the same six dependent variables. The means and standard deviations are presented in Table 8.21.

TABLE 8.21
Means and Standard Deviations of Pediatric Inpatients Group

| | Gender | Mean | Std. Deviation | N |
|---|---|---|---|---|
| Preference (Red) | Female | 68.750 | 28.3007 | 12 |
| | Male | 51.476 | 39.9482 | 21 |
| | Total | 57.758 | 36.6598 | 33 |
| Preference (Yellow) | Female | 45.750 | 33.7373 | 12 |
| | Male | 52.524 | 35.6968 | 21 |
| | Total | 50.061 | 34.6211 | 33 |
| Preference (Green) | Female | 61.750 | 30.9020 | 12 |
| | Male | 76.000 | 26.3894 | 21 |
| | Total | 70.818 | 28.4950 | 33 |
| Preference (Blue) | Female | 75.250 | 27.7820 | 12 |
| | Male | 78.048 | 26.1982 | 21 |
| | Total | 77.030 | 26.3848 | 33 |
| Preference (Purple) | Female | 85.250 | 15.2204 | 12 |
| | Male | 35.381 | 31.1295 | 21 |
| | Total | 53.515 | 35.7597 | 33 |
| Preference (White) | Female | 19.083 | 32.1374 | 12 |
| | Male | 30.571 | 38.4481 | 21 |
| | Total | 26.394 | 36.1999 | 33 |

Mauchly's test of sphericity indicated that the assumption of sphericity had been met ($\chi^2(14) = 6.71$, $p = .95 > .05$). Table 8.22 shows color and gender interactions and the results showed that the interaction between gender and color preference was significant, $F$ (5. 155) = 4.95, $p < .05$, partial eta squared = .14 which indicates a large effect size.

TABLE 8.22
Color and Gender Interactions in Pediatric Inpatients Group

Measure: MEASURE_1

| Source | | Type III Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|---|
| prefer | Sphericity Assumed | 50215.426 | 5 | 10043.085 | 10.825 | .000 | .259 |
| | Greenhouse-Geisser | 50215.426 | 4.630 | 10845.914 | 10.825 | .000 | .259 |
| | Huynh-Feldt | 50215.426 | 5.000 | 10043.085 | 10.825 | .000 | .259 |
| | Lower-bound | 50215.426 | 1.000 | 50215.426 | 10.825 | .003 | .259 |
| prefer * Gender | Sphericity Assumed | 22948.517 | 5 | 4589.703 | 4.947 | .000 | .138 |
| | Greenhouse-Geisser | 22948.517 | 4.630 | 4956.597 | 4.947 | .000 | .138 |
| | Huynh-Feldt | 22948.517 | 5.000 | 4589.703 | 4.947 | .000 | .138 |
| | Lower-bound | 22948.517 | 1.000 | 22948.517 | 4.947 | .034 | .138 |
| Error(prefer) | Sphericity Assumed | 143808.413 | 155 | 927.796 | | | |
| | Greenhouse-Geisser | 143808.413 | 143.527 | 1001.963 | | | |
| | Huynh-Feldt | 143808.413 | 155.000 | 927.796 | | | |
| | Lower-bound | 143808.413 | 31.000 | 4638.981 | | | |

TABLE 8.23
Contrasts of Color and Gender Interactions in Pediatric Inpatients Group

Measure: MEASURE_1

| Source | prefer | Type III Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|---|
| prefer | Level 1 vs. Level 6 | 38031.584 | 1 | 38031.584 | 21.762 | .000 | .412 |
| | Level 2 vs. Level 6 | 18050.926 | 1 | 18050.926 | 9.245 | .005 | .230 |
| | Level 3 vs. Level 6 | 59264.069 | 1 | 59264.069 | 29.998 | .000 | .492 |
| | Level 4 vs. Level 6 | 82028.610 | 1 | 82028.610 | 58.990 | .000 | .656 |
| | Level 5 vs. Level 6 | 38469.095 | 1 | 38469.095 | 19.870 | .000 | .391 |
| prefer * Gender | Level 1 vs. Level 6 | 6317.160 | 1 | 6317.160 | 3.615 | .067 | .104 |
| | Level 2 vs. Level 6 | 169.714 | 1 | 169.714 | .087 | .770 | .003 |
| | Level 3 vs. Level 6 | 58.251 | 1 | 58.251 | .029 | .865 | .001 |
| | Level 4 vs. Level 6 | 576.732 | 1 | 576.732 | .415 | .524 | .013 |
| | Level 5 vs. Level 6 | 28748.610 | 1 | 28748.610 | 14.849 | .001 | .324 |
| Error(prefer) | Level 1 vs. Level 6 | 54176.476 | 31 | 1747.628 | | | |
| | Level 2 vs. Level 6 | 60529.619 | 31 | 1952.568 | | | |
| | Level 3 vs. Level 6 | 61243.810 | 31 | 1975.607 | | | |
| | Level 4 vs. Level 6 | 43106.905 | 31 | 1390.545 | | | |
| | Level 5 vs. Level 6 | 60016.905 | 31 | 1936.029 | | | |

To break down this interaction, contrasts were performed comparing color preferences across males and females. Table 8.23 displays contrasts of the interactions and the results revealed that the increased preference found among females was significantly higher than for males when comparing purple to white, $F$ (1, 31) = 14.85, $p$ < .05, partial eta squared = .31 (a very large effect size). An inspection of means and confidence intervals indicated that pediatric inpatient males reported lower preference scores for purple than pediatric inpatient females. Figure 8.10 presents gender differences in pediatric inpatients group.

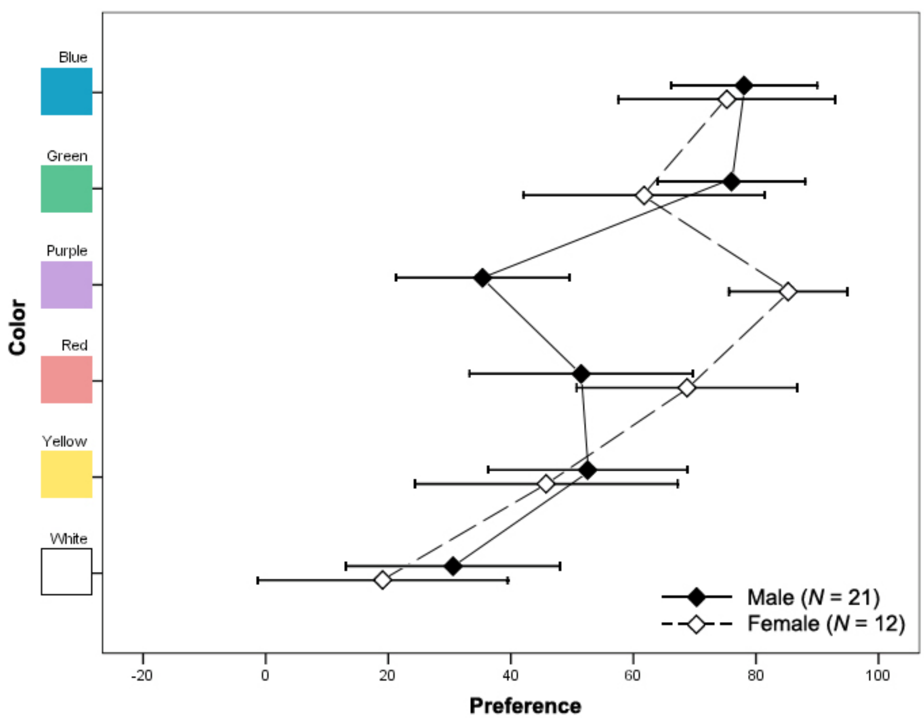



Figure 8.10: Gender Effect in Pediatric Inpatients Group

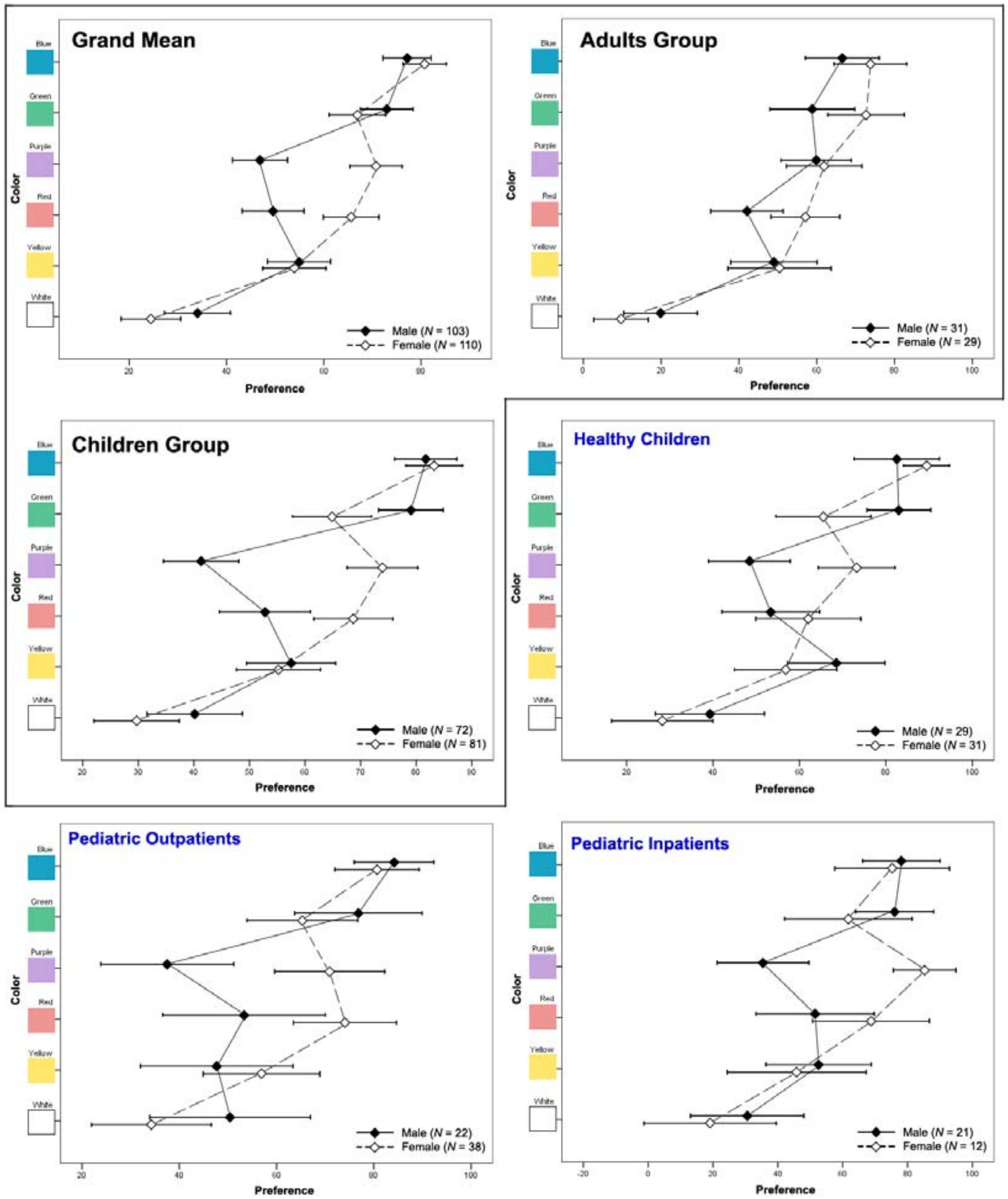



Figure 8.11: Comparison of Gender Effects among Children and Adults Groups

To summarize, gender effects were found across all of the children groups but not the adult group. In the children group with all three groups combined (healthy children, pediatric outpatients, and pediatric inpatients), gender differences were found in red, green, and purple. Males reported significantly lower preference scores for red and purple when compared to females. In contrast, males preferred green more than females. Having found these gender effects, each of the children groups was investigated further. In the healthy children group, males less preferred purple than did females. In both pediatric outpatient and inpatient groups, males also showed significantly lower preference scores for purple than did females. Both male outpatients and inpatients tended to prefer red and purple less than female patients. Figure 8.11 displays comparison of gender effects from all groups.

**8.1.4 Caucasian versus Non-Caucasian Group Differences**

A mixed between-within subjects ANOVA was conducted to investigate Caucasian versus non-Caucasian differences. Caucasians ($N$ =130) and non-Caucasians ($N$ = 83) were used as independent variables. The same six dependent variables were used again. The means and standard deviations are presented in Table 8.24.

Mauchly's test of sphericity indicated that the assumption of sphericity had been violated ($\chi^2$ (14) = 53.67, $p$ < .05); therefore degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity (ε = .91). Table 8.25 shows tests of interaction effects between color and groups but the results showed that the interaction was not significant, $F$ (4.57, 964.31) = 1.65, $p$ > .05, partial eta squared = .01 which indicates a very small effect size. There was no statistically significant difference between Caucasian and non-Caucasian groups with an inspection of means and confidence intervals.

TABLE 8.24
Means and Standard Deviations of Caucasian and Non-Caucasian Group

| | Caucasian vs Non-caucasian | Mean | Std. Deviation | N |
|---|---|---|---|---|
| Preference (Red) | Caucasian | 56.635 | 32.3025 | 130 |
| | Non-caucasian | 59.759 | 32.6252 | 83 |
| | Total | 57.852 | 32.3877 | 213 |
| Preference (Yellow) | Caucasian | 56.085 | 33.2673 | 130 |
| | Non-caucasian | 51.807 | 34.3449 | 83 |
| | Total | 54.418 | 33.6756 | 213 |
| Preference (Green) | Caucasian | 70.042 | 30.1495 | 130 |
| | Non-caucasian | 69.518 | 28.2711 | 83 |
| | Total | 69.838 | 29.3654 | 213 |
| Preference (Blue) | Caucasian | 78.454 | 23.4445 | 130 |
| | Non-caucasian | 79.855 | 26.2270 | 83 |
| | Total | 79.000 | 24.5149 | 213 |
| Preference (Purple) | Caucasian | 59.900 | 29.5078 | 130 |
| | Non-caucasian | 58.108 | 33.1239 | 83 |
| | Total | 59.202 | 30.9026 | 213 |
| Preference (White) | Caucasian | 24.731 | 31.4391 | 130 |
| | Non-caucasian | 35.867 | 36.3358 | 83 |
| | Total | 29.070 | 33.7899 | 213 |

TABLE 8.25
Tests of Interaction Effects

Measure: MEASURE_1

| Source | | Type III Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|---|
| prefer | Sphericity Assumed | 277635.948 | 5 | 55527.190 | 62.797 | .000 | .229 |
| | Greenhouse-Geisser | 277635.948 | 4.570 | 60749.169 | 62.797 | .000 | .229 |
| | Huynh-Feldt | 277635.948 | 4.706 | 58996.510 | 62.797 | .000 | .229 |
| | Lower-bound | 277635.948 | 1.000 | 277635.948 | 62.797 | .000 | .229 |
| prefer * Race | Sphericity Assumed | 7285.720 | 5 | 1457.144 | 1.648 | .145 | .008 |
| | Greenhouse-Geisser | 7285.720 | 4.570 | 1594.179 | 1.648 | .151 | .008 |
| | Huynh-Feldt | 7285.720 | 4.706 | 1548.186 | 1.648 | .149 | .008 |
| | Lower-bound | 7285.720 | 1.000 | 7285.720 | 1.648 | .201 | .008 |
| Error(prefer) | Sphericity Assumed | 932871.659 | 1055 | 884.239 | | | |
| | Greenhouse-Geisser | 932871.659 | 964.313 | 967.396 | | | |
| | Huynh-Feldt | 932871.659 | 992.960 | 939.485 | | | |
| | Lower-bound | 932871.659 | 211.000 | 4421.193 | | | |

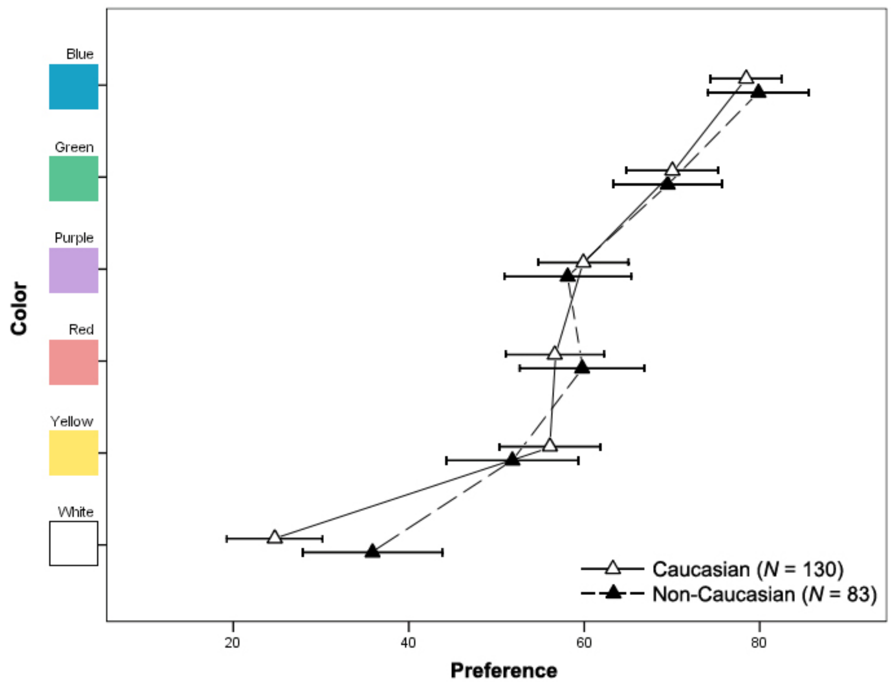



Figure 8.12: Overall Caucasians and Non-Caucasians Effects

Overall Caucasians and Non-Caucasians Effects are presented in Figure 8.12. Additional analyses and inspections were performed in order to further investigate the Caucasian versus non-Caucasian differences for each of the healthy children, pediatric outpatients, pediatric inpatients, and design professionals groups. Throughout the analyses, there were no statistical significances in the Caucasian versus non-Caucasian groups.

For reference, the mean plots of color preferences from the adult group (design professionals) and children groups are presented in Figure 8.13.

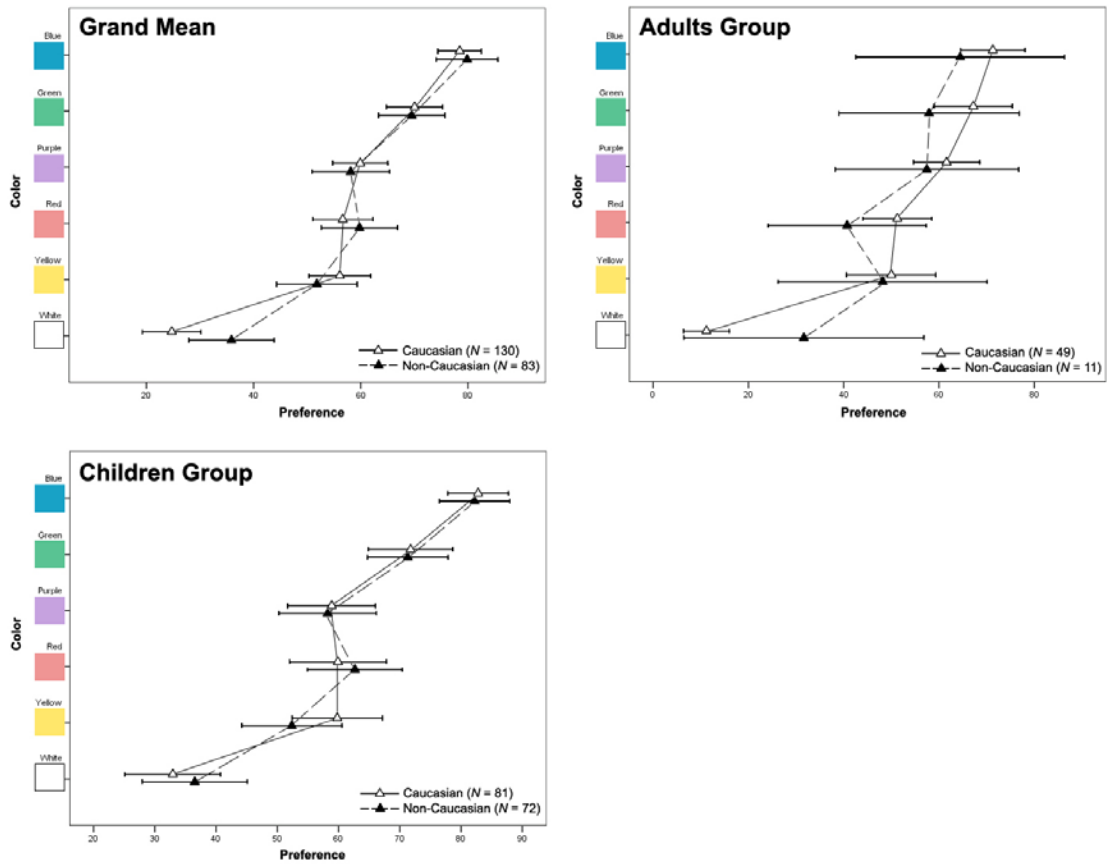



Figure 8.13: Comparison of Caucasians and Non-Caucasians Effects

### 8.1.5 Emotions as Covariates in Color Preference

Multivariate Analysis of Covariance (ANCOVA) was conducted to explore whether emotional states influence color preference scores. Since emotions are associated with colors (Boyatzis & Varghese, 1994; Hemphill, 1996; Zentner, 2001), a quick mood test was performed prior to the color preference rating tasks for all participants. All participants indicated their emotional states using the SAM: happiness, from 1 (very sad) to 9 (very happy); arousal, from 1 (very calm) to 9 (very excited); and confidence, from 1 (less confident) to 9 (very confident). Using the quantified data, the effects of correlations between emotional states and color preferences were investigated.

Since there were significant differences in gender, gender was used as an independent variables: male ($N$ =103) and female ($N$ = 110). This test also employed the same six dependent variables as did previous tests. Scores for pleasure, arousal, and dominance were used as covariates to control for gender differences. Unadjusted means and standard deviations are presented in Table 8.26 and adjusted means and standard errors are shown in Table 8.27.

Preliminary checks were performed to ensure that there was no serious violation of the assumptions of normality, linearity, homogeneity of variances, homogeneity of regression slopes, and reliable measurement of covariates.

TABLE 8.26
Unadjusted Means and Standard Deviations

| | Gender | Mean | Std. Deviation | N |
|---|---|---|---|---|
| Preference (Red) | Female | 65.609 | 30.3445 | 110 |
| | Male | 49.568 | 32.5888 | 103 |
| | Total | 57.852 | 32.3877 | 213 |
| Preference (Yellow) | Female | 53.945 | 34.3756 | 110 |
| | Male | 54.922 | 33.0720 | 103 |
| | Total | 54.418 | 33.6756 | 213 |
| Preference (Green) | Female | 66.909 | 30.5925 | 110 |
| | Male | 72.966 | 27.8033 | 103 |
| | Total | 69.838 | 29.3654 | 213 |
| Preference (Blue) | Female | 80.727 | 23.7282 | 110 |
| | Male | 77.155 | 25.3136 | 103 |
| | Total | 79.000 | 24.5149 | 213 |
| Preference (Purple) | Female | 70.736 | 28.3270 | 110 |
| | Male | 46.883 | 28.8211 | 103 |
| | Total | 59.202 | 30.9026 | 213 |
| Preference (White) | Female | 24.427 | 32.3798 | 110 |
| | Male | 34.029 | 34.7070 | 103 |
| | Total | 29.070 | 33.7899 | 213 |

TABLE 8.27
Adjusted Means and Standard Errors

| Dependent Variable | Gender | Mean | Std. Error | 95% Confidence Interval Lower Bound | 95% Confidence Interval Upper Bound |
|---|---|---|---|---|---|
| Preference (Red) | Female | 65.896[a] | 2.965 | 60.050 | 71.741 |
| | Male | 49.262[a] | 3.065 | 43.219 | 55.305 |
| Preference (Yellow) | Female | 54.217[a] | 3.256 | 47.798 | 60.637 |
| | Male | 54.632[a] | 3.366 | 47.995 | 61.268 |
| Preference (Green) | Female | 67.528[a] | 2.795 | 62.017 | 73.039 |
| | Male | 72.305[a] | 2.890 | 66.607 | 78.003 |
| Preference (Blue) | Female | 81.062[a] | 2.354 | 76.421 | 85.703 |
| | Male | 76.798[a] | 2.434 | 71.999 | 81.596 |
| Preference (Purple) | Female | 71.013[a] | 2.718 | 65.656 | 76.371 |
| | Male | 46.588[a] | 2.810 | 41.049 | 52.127 |
| Preference (White) | Female | 24.592[a] | 3.226 | 18.231 | 30.953 |
| | Male | 33.853[a] | 3.336 | 27.277 | 40.429 |

a. Covariates appearing in the model are evaluated at the following values: Pleasure = 7.71, Arousal = 4.51, Dominance = 6.77.

Table 8.28 shows results of between-subjects effects. The preliminary results indicated that arousal correlated with red color preferences, $F$ (1, 208) = 8.61, $p$ = .004, partial eta squared = .04 (small effect size), and dominance correlated with green color preferences, $F$ (1, 208) = 4.2, $p$ = .04, partial eta squared = .02 (small effect size), at the .05 alpha level. However, a higher alpha level is recommended in order to reduce the probability of a Type I error since a number of separate analyses were conducted. The most common way to do this is with a Bonferroni adjustment: simply divide the original alpha level of .05 by the number of conducted analyses (Pallant, 2005). In this study six dependent variables were used to investigate, therefore .05 was divided by 6 to produce a new alpha level of .008.

TABLE 8.28

Tests of Between-Subjects Effects

| Source | Dependent Variable | Type III Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|---|
| Corrected Model | Preference (Red) | 23654.021[a] | 4 | 5913.505 | 6.189 | .000 | .106 |
| | Preference (Yellow) | 745.313[b] | 4 | 186.328 | .162 | .957 | .003 |
| | Preference (Green) | 6158.516[c] | 4 | 1539.629 | 1.813 | .128 | .034 |
| | Preference (Blue) | 2112.590[d] | 4 | 528.147 | .877 | .479 | .017 |
| | Preference (Purple) | 35500.679[e] | 4 | 8875.170 | 11.057 | .000 | .175 |
| | Preference (White) | 6729.469[f] | 4 | 1682.367 | 1.487 | .207 | .028 |
| Intercept | Preference (Red) | 15100.489 | 1 | 15100.489 | 15.805 | .000 | .071 |
| | Preference (Yellow) | 19834.595 | 1 | 19834.595 | 17.213 | .000 | .076 |
| | Preference (Green) | 24276.350 | 1 | 24276.350 | 28.584 | .000 | .121 |
| | Preference (Blue) | 42247.613 | 1 | 42247.613 | 70.134 | .000 | .252 |
| | Preference (Purple) | 10234.338 | 1 | 10234.338 | 12.750 | .000 | .058 |
| | Preference (White) | 1690.304 | 1 | 1690.304 | 1.494 | .223 | .007 |
| Pleasure | Preference (Red) | 292.170 | 1 | 292.170 | .306 | .581 | .001 |
| | Preference (Yellow) | 13.264 | 1 | 13.264 | .012 | .915 | .000 |
| | Preference (Green) | 101.707 | 1 | 101.707 | .120 | .730 | .001 |
| | Preference (Blue) | 203.141 | 1 | 203.141 | .337 | .562 | .002 |
| | Preference (Purple) | 798.412 | 1 | 798.412 | .995 | .320 | .005 |
| | Preference (White) | 518.391 | 1 | 518.391 | .458 | .499 | .002 |
| Arousal | Preference (Red) | 8228.142 | 1 | 8228.142 | 8.612 | .004 | .040 |
| | Preference (Yellow) | 48.314 | 1 | 48.314 | .042 | .838 | .000 |
| | Preference (Green) | 459.970 | 1 | 459.970 | .542 | .463 | .003 |
| | Preference (Blue) | 311.630 | 1 | 311.630 | .517 | .473 | .002 |
| | Preference (Purple) | 1512.772 | 1 | 1512.772 | 1.885 | .171 | .009 |
| | Preference (White) | 259.475 | 1 | 259.475 | .229 | .633 | .001 |
| Dominance | Preference (Red) | 1711.710 | 1 | 1711.710 | 1.792 | .182 | .009 |
| | Preference (Yellow) | 624.361 | 1 | 624.361 | .542 | .462 | .003 |
| | Preference (Green) | 3570.296 | 1 | 3570.296 | 4.204 | .042 | .020 |
| | Preference (Blue) | 1118.952 | 1 | 1118.952 | 1.858 | .174 | .009 |
| | Preference (Purple) | 1652.987 | 1 | 1652.987 | 2.059 | .153 | .010 |
| | Preference (White) | 583.426 | 1 | 583.426 | .516 | .473 | .002 |
| Gender | Preference (Red) | 14356.525 | 1 | 14356.525 | 15.026 | .000 | .067 |
| | Preference (Yellow) | 8.914 | 1 | 8.914 | .008 | .930 | .000 |
| | Preference (Green) | 1184.171 | 1 | 1184.171 | 1.394 | .239 | .007 |
| | Preference (Blue) | 943.505 | 1 | 943.505 | 1.566 | .212 | .007 |
| | Preference (Purple) | 30957.933 | 1 | 30957.933 | 38.569 | .000 | .156 |
| | Preference (White) | 4450.764 | 1 | 4450.764 | 3.934 | .049 | .019 |
| Error | Preference (Red) | 198726.570 | 208 | 955.416 | | | |
| | Preference (Yellow) | 239672.499 | 208 | 1152.272 | | | |
| | Preference (Green) | 176654.146 | 208 | 849.299 | | | |
| | Preference (Blue) | 125295.410 | 208 | 602.382 | | | |
| | Preference (Purple) | 166953.640 | 208 | 802.662 | | | |
| | Preference (White) | 235322.475 | 208 | 1131.358 | | | |
| Total | Preference (Red) | 935263.250 | 213 | | | | |
| | Preference (Yellow) | 871175.000 | 213 | | | | |
| | Preference (Green) | 1221688.250 | 213 | | | | |
| | Preference (Blue) | 1456741.000 | 213 | | | | |
| | Preference (Purple) | 948990.000 | 213 | | | | |
| | Preference (White) | 422056.000 | 213 | | | | |
| Corrected Total | Preference (Red) | 222380.592 | 212 | | | | |
| | Preference (Yellow) | 240417.812 | 212 | | | | |
| | Preference (Green) | 182812.662 | 212 | | | | |
| | Preference (Blue) | 127408.000 | 212 | | | | |
| | Preference (Purple) | 202454.319 | 212 | | | | |
| | Preference (White) | 242051.944 | 212 | | | | |

a. R Squared = .106 (Adjusted R Squared = .089)

b. R Squared = .003 (Adjusted R Squared = -.016)

c. R Squared = .034 (Adjusted R Squared = .015)

d. R Squared = .017 (Adjusted R Squared = -.002)

e. R Squared = .175 (Adjusted R Squared = .159)

f. R Squared = .028 (Adjusted R Squared = .009)

TABLE 8.29
Parameter Estimates

| Dependent Variable | Parameter | B | Std. Error | t | Sig. | 95% Confidence Interval Lower Bound | 95% Confidence Interval Upper Bound | Partial Eta Squared |
|---|---|---|---|---|---|---|---|---|
| Preference (Red) | Intercept | 36.441 | 11.569 | 3.150 | .002 | 13.634 | 59.249 | .046 |
| | Pleasure | -.733 | 1.326 | -.553 | .581 | -3.348 | 1.881 | .001 |
| | Arousal | 2.225 | .758 | 2.935 | .004 | .730 | 3.720 | .040 |
| | Dominance | 1.248 | .932 | 1.339 | .182 | -.590 | 3.086 | .009 |
| | [Gender=1] | 16.634 | 4.291 | 3.876 | .000 | 8.174 | 25.093 | .067 |
| | [Gender=2] | 0[a] | . | . | . | . | . | . |
| Preference (Yellow) | Intercept | 51.504 | 12.705 | 4.054 | .000 | 26.457 | 76.551 | .073 |
| | Pleasure | -.156 | 1.456 | -.107 | .915 | -3.027 | 2.715 | .000 |
| | Arousal | -.171 | .833 | -.205 | .838 | -1.812 | 1.471 | .000 |
| | Dominance | .754 | 1.024 | .736 | .462 | -1.265 | 2.772 | .003 |
| | [Gender=1] | -.414 | 4.712 | -.088 | .930 | -9.705 | 8.876 | .000 |
| | [Gender=2] | 0[a] | . | . | . | . | . | . |
| Preference (Green) | Intercept | 59.139 | 10.908 | 5.422 | .000 | 37.636 | 80.643 | .124 |
| | Pleasure | .433 | 1.250 | .346 | .730 | -2.032 | 2.898 | .001 |
| | Arousal | -.526 | .715 | -.736 | .463 | -1.936 | .883 | .003 |
| | Dominance | 1.802 | .879 | 2.050 | .042 | .069 | 3.535 | .020 |
| | [Gender=1] | -4.777 | 4.046 | -1.181 | .239 | -12.753 | 3.199 | .007 |
| | [Gender=2] | 0[a] | . | . | . | . | . | . |
| Preference (Blue) | Intercept | 72.733 | 9.186 | 7.918 | .000 | 54.623 | 90.843 | .232 |
| | Pleasure | -.611 | 1.053 | -.581 | .562 | -2.687 | 1.464 | .002 |
| | Arousal | .433 | .602 | .719 | .473 | -.754 | 1.620 | .002 |
| | Dominance | 1.009 | .740 | 1.363 | .174 | -.450 | 2.468 | .009 |
| | [Gender=1] | 4.264 | 3.407 | 1.252 | .212 | -2.453 | 10.981 | .007 |
| | [Gender=2] | 0[a] | . | . | . | . | . | . |
| Preference (Purple) | Intercept | 24.635 | 10.604 | 2.323 | .021 | 3.730 | 45.539 | .025 |
| | Pleasure | 1.212 | 1.216 | .997 | .320 | -1.184 | 3.609 | .005 |
| | Arousal | .954 | .695 | 1.373 | .171 | -.416 | 2.324 | .009 |
| | Dominance | 1.226 | .854 | 1.435 | .153 | -.458 | 2.911 | .010 |
| | [Gender=1] | 24.426 | 3.933 | 6.210 | .000 | 16.672 | 32.180 | .156 |
| | [Gender=2] | 0[a] | . | . | . | . | . | . |
| Preference (White) | Intercept | 19.605 | 12.589 | 1.557 | .121 | -5.213 | 44.424 | .012 |
| | Pleasure | .977 | 1.443 | .677 | .499 | -1.868 | 3.822 | .002 |
| | Arousal | .395 | .825 | .479 | .633 | -1.232 | 2.022 | .001 |
| | Dominance | .728 | 1.014 | .718 | .473 | -1.271 | 2.728 | .002 |
| | [Gender=1] | -9.261 | 4.669 | -1.983 | .049 | -18.467 | -.056 | .019 |
| | [Gender=2] | 0[a] | . | . | . | . | . | . |

a. This parameter is set to zero because it is redundant.

Using the new alpha level of .008, there was a statistically significant correlation between arousal and red color preference. Contrasts revealed that arousal has a positive relationship with red preference scores (the value of *b* from parameter estimates is 2.23, see Table 8.29). In other words, if arousal scores increase by one unit, then red color preference scores increase by roughly two units.

To summarize, emotional states have no strong relationship with color preferences overall. Only arousal states influence red color preferences. After controlling for emotions (pleasure, arousal, and dominance), the main effects of gender were statistically significant for red and purple. This result is same as the results without controlling the emotional states as covariates.

### 8.1.6 Other Considerations Regarding Color Blindness

Based on data from the National Health Interview Survey by U.S. Department of Health and Human Services (1996), the overall rate of people with color blindness was approximately 1 percent in the United States. The survey data indicated that 0.4 percent of those who are under 18 years were color blind, whereas 1.6 percent of those who age 45 to 64 years were color blindness. However, no participants were excluded from this study because of color deficiency. It is worth noting that it resulted from the uniqueness of participants and recruitment process, not resulted from any problem of sampling method.

Prior to participation, parental permissions were obtained for subjects (healthy children, pediatric outpatients, and pediatric inpatients). The process of obtaining parental permissions likely filtered ineligible children since ineligibility of children with color deficiencies was indicated on the parental permission forms. Design professionals were also given consent forms. The consent forms noted the exclusion of people with color deficiencies and only consentient design professionals participated. The design professionals were considered as a unique sample since they have been trained in environmental design fields which demands normal color vision.

### 8.2 CONCLUSIONS

This study addressed two hypotheses. One was that healthy children's color preferences are different from pediatric patients' color preferences. The above results indicated that there was no statistically significant difference between healthy children and pediatric patients.

The other hypothesis was that design professionals' appreciation of color on pediatric patient room design is different from that of pediatric patients. The mean of design professionals was significantly different from pediatric outpatients but not from pediatric inpatients. The mean difference between design professionals and healthy children was also significant. Although the mean differences were significant, the overall color preference patterns of all four groups were almost same, excluding slight differences in red, yellow, and purple.

Blue and green were the most preferred colors and white was the least preferred color for all the groups. The color preferences of pediatric patients were slightly different from those of the other groups. Pediatric patients reported higher preference scores specifically towards red. The children groups reported higher preference scores across all the colors than did the design professionals. The overall color preference orders of the four groups are as follows from most to least:

• Healthy children: blue, green, yellow, purple, red, and white

• Pediatric outpatients: blue, green, red, purple, yellow, and white

• Pediatric inpatients: blue, green, red, purple, yellow, and white

• Design professionals: blue, green, purple, yellow, red, and white

Design professionals selected green and blue as the most appropriate colors for pediatric patient room design. The rationale for their choices was explained above in the opening of this chapter. In general, green and blue were considered soothing natural colors. By contrasts, the other color choices were all considered to possess various negative characteristics.

Gender effects were found across all of the children's groups but not the adult group. Overall, males reported significantly lower preference scores for red and purple than did females. In the healthy children group, males less preferred purple than females. In both pediatric outpatient and inpatient groups, males also showed significantly lower preference scores for purple than females. In contrast, male patients tended to prefer green more than female patients.

Caucasian versus non-Caucasian color difference was investigated, but there were no significant effects across all the groups.

Since emotions are associated with colors, correlations between emotions and color preferences were also investigated. Participants' emotional states were measured by three categories (happiness, arousal, and dominance) across six colors (red, yellow, green, blue, purple, and white). The results indicated that there was a positive relationship between arousal and red color preference (effect size was small); those who were more aroused preferred red more. Other than the relationship between arousal and red color preferences, no other relationship between emotions and color preferences was found. After controlling for the emotions (happiness, arousal, and dominance), the main effects of gender were statistically significant for red and purple – the same as the results without considering the emotional adjustment as covariates.

# CHAPTER IX

# CONCLUSIONS AND RECOMMENDATIONS

This final chapter summarizes the theoretical foundation, research methods, hypotheses, and results from this study. Recommendations for color application are provided as guidelines for designers and researchers based on the findings from the study, the researcher's observations, and a literature review.

## 9.1 SUMMARY OF THE RESEARCH

There are millions of children that must be accommodated by the health care system. Serving their needs is an enormous challenge for healthcare designers, planners, and providers. Most of the existing design research is focused on adult environments and cannot always be confidently applied to children's environments since children can have different ways of thinking and behavior than adults.

In order to meet this challenge, evidence-based design is a critical method through which socially responsible designers can create healing environments for specific needs. Designers use empirically-based knowledge and conduct their own research in practice in order to share their findings with other designers (Shepley et al., 1998). In other words, applying research findings to practice is essential (Shepley et al., 1998).

The review of literature presented earlier in this dissertation confirmed the physiological and psychological effects of color on human beings. There are numerous color preference studies, but they are typically done with small color chips or papers, which is very different from seeing a color applied to a wall surface. In addition, a lack of control of color attributes was pervasive throughout the surveyed studies. To investigate the values of color in real contexts, and to control confounding variables, two experiments (the pilot study and main study) were conducted using the simulation method due to its inherent feasibility and reliability. Ten 1:12 scale-models of patient rooms, each with a single interchangeable side wall, were built by the researcher and utilized for the experiments. The layout and environment of all models were identical, excluding the single interchangeable side wall's color. The luminance levels inside the scale-models were maintained among all the models used by the researcher.

The theoretical foundation of this research was based on the Conceptual Model of the Effects of Physical Environments on Children's Health-Related Outcomes proposed by Sherman, Shepley, and Varni (2005). This model indicates that physical environments can influence children's health-related outcomes. They proposed that environmental satisfaction is a significant mediator between the built environment and children's well-being.

This dissertation study aimed to investigate the effects of environmental colors as applied to wall surfaces. According to the model, color preference can mediate children's well-being through their satisfaction with colors as components of the physical environment. Since the number of color options is virtually limitless, narrowing down color samples in a meaningful way was a necessity. Therefore, the researcher investigated what was the most preferred color among various samples within their own hue families. For example, there were numerous red samples, but the most preferred red color among those samples was not clear.

### 9.1.1 Summary of Experiment I (Pilot Study)

The first experiment (the pilot study) addressed the above issue and investigated children's most preferred colors from each of the five hue families as defined by the Munsell color system. The five major hue families are red, yellow, green, blue, and purple. The Munsell color system is a method of accurately specifying surface colors and is the most often used color system among those found in the literature (Beach, Wise, & Wise, 1988) because of it's feasibility and international acceptance (Indow, 1988).

Sixty-three children ages seven to eleven years were recruited because they are fully developed in understanding the representation of a symbol to its referent. Age group was important because the main study went on to compare children's preferences to those of adults. By using this age group the experiment ensured that the child subjects could reference the models akin to the adult subject's capacity.

Ten samples from each of the five hues were selected for the pilot study. This produced fifty color samples as independent variables. Participants performed the experiment individually at their own pace based on a first-available first-participate principle. Subjects with color deficiencies were excluded. Participants were asked to indicate the three most preferred colored rooms and three least preferred ones among ten different colored rooms in each of the five hue families.

After comparing means and standard deviations, the most preferred colors were configured and used in the main study as independent variables. White was also included because of its pervasiveness in healthcare facilities.

### 9.1.1 Summary of Experiment II (Main Study)

The purpose of the second experiment (the main study) was to investigate the value of color as a component in a healing environment for pediatric patient rooms. Three different groups' color preferences were investigated and compared in order to test the following two hypotheses.

- Hypothesis I: Healthy children's color preferences are different from pediatric patients' color preferences.
- Hypothesis II: Design professionals' concept of appropriate colors for pediatric patient rooms is different from pediatric patients' perception of color for patient rooms.

The first hypothesis was derived from the facts that sick children may not perceive their surroundings in the same way as healthy children. More specifically, patients in negative emotional states tend to process their feelings and emotions in negative ways (Carpman & Grant, 1993).

The second hypothesis addressed whether designers' aesthetic preferences assessed the value of color in pediatric patient room design. Since there is no empirical evidence regarding color applications for pediatric patients, design professionals may follow their own aesthetic preferences which can be different from the pediatric patients.

Six different hue colors were used as independent variables: the most preferred red, yellow, green, blue, and purple configured by the pilot study, and white. A total of 213 individuals participated, including sixty healthy children, sixty pediatric outpatients, thirty-three pediatric inpatients, and sixty design professionals. Data collection from pediatric inpatients was extremely slow, so outpatient data collection was suggested as it was more expeditious to include both pediatric outpatients and inpatients.

The inpatients conducted the experiments in their patient rooms based on a first-available first-participate principle. A quick mood test was performed prior to the color preference rating tasks since emotions have been associated with color preferences. After the mood test, each participant was asked to rate his/her preferences of the six colored rooms. All procedures for other groups were identical with those for pediatric inpatients except for the locations of the experiments.

## 9.2 SUMMARY OF FINDINGS

### 9.2.1 Findings from Pilot Study

The pilot study generated healthy children's five most preferred colors among each of the five hue families based on the Munsell color system. The five colors were red (5R 7/8), yellow (5Y 9/8), green (5G 7/8), blue (5B 6/8), and purple (5P 7/8).

Within the limited color samples, children tended to prefer highly saturated and brighter colors. Gender differences were found in two samples from each of the red and purple hue families. Boys reported higher preferences for darker and less saturated colors than did girls; specifically 5R 7/2 and 5P 6/2. In contrast, girls showed higher preferences for brighter and more saturated colors; that is, 5R 8/5 and 5P 7/8. Other than these four colors, there were no statistically significant gender effects. Caucasian and non-Caucasian children groups were compared, but there were no significant differences.

### 9.2.2 Findings from Main Study

A mixed between-within subjects ANOVA was conducted to investigate group differences, gender effects, Caucasian versus non-Caucasian differences, and correlations between emotions and color preference among the four different groups: healthy children, pediatric outpatients, pediatric inpatients, and design professionals groups.

#### 9.2.2.1 Test Results of Hypothesis I

Group differences were investigated using healthy children and pediatric patients groups in terms of color preferences. The results indicated that there were no significant mean differences between healthy children, pediatric outpatients, and pediatric inpatients. It rejected the hypothesis that color preferences from pediatric patients were different from healthy children. This information may be valuable because color studies from healthy children can be applied to the pediatric patient population.

However, the overall color preferences showed a tendency that the healthier group preferred the colors more. The healthy children's color preferences were higher than the pediatric outpatients and the pediatric inpatients, respectively. Although this observation was not statistically significant, it raised an additional issue that the sickest pediatric patients may response differently than healthy children in terms of color preference. Most of pediatric patients who participated in this study were not severely ill. It was hard to recruit sicker patients because either their parents refused to permit their child's participation or medical staff denied the researcher the opportunity to contact the patients. Data about the patients' disease or health status were not available to the researcher because of disclosure concerns. This study focused on children ages seven to eleven, so younger children may behave differently than older children as age development and changes in color preferences are suggested by the literature.

One outstanding difference was that both pediatric outpatients and inpatients reported lower preference scores than the healthy children did for yellow. All pediatric outpatients, pediatric inpatients, and healthy children groups reported blue and green as their most preferred colors with white as the least preferred.

9.2.2.2 Test Results of Hypothesis II

To test Hypothesis II, the mean differences between design professionals, pediatric outpatients, and pediatric inpatients were compared. The results indicated that there were significant differences between the design professionals and the pediatric outpatients. The pediatric outpatients reported higher preference scores than the design professionals for red, blue, and white. Although the mean differences for red, blue, and white were significant, blue was the most preferred and white was the least preferred by both groups. Both groups also showed very similar preferences for the rest of the colors. In addition, no significant differences were found between the design professionals and the pediatric inpatients.

The results were not supportive to the hypothesis that design professionals' color appreciation for pediatric patient room design was different from pediatric patients. It is worth noting that pediatric patients valued colors more than design professionals since the patients' mean scores were higher than design professionals'.

Design professionals selected green and blue as the most appropriate colors for pediatric patient room design. Green was considered to represent nature and induce positive feelings; blue was considered to be calming and restful.

Design professionals selected white as the least appropriate color for pediatric patient room design because white was considered too stark and institutional, and likely to create negative feelings. Yellow was selected as the second least appropriate color because the reflection on a patient's skin can make them appear ill or mask symptoms.

9.2.2.3 Gender Effects in Color Preference

Gender effects were found across all of children groups, but not across the design professionals group. Overall, males reported significantly lower preference scores for red and purple than females.

In the children group with all three groups combined (healthy children, pediatric outpatients, and pediatric inpatients), gender differences were found in red, green, and purple. Males reported significantly lower preference scores for red and purple when compared to females. In contrast, males preferred green more than females. Since there was a gender effect in the children groups, additional investigations were conducted using healthy children, pediatric outpatients, and pediatric inpatients separately. In the healthy children group, significant gender differences were found in that males had lower preferences for purple than females. In both pediatric outpatients and inpatients groups, male patients also reported significantly lower preference scores for purple than female patients.

#### 9.2.2.4 Emotions in Color Preference

Correlations between emotions and color preferences were investigated using multivariate ANCOVA. It not only facilitated the analysis of the relationship between emotion and color preferences, it also reduced the possibility of an alternative explanation of causal relations.

Participants' emotional states were measured by three categories (happiness, arousal, and dominance). The results indicated that there was a positive relationship between arousal and red color preference. In other words, subjects which were more aroused preferred red more. This finding is interesting because other studies also found an arousal effect in red but the causal direction was the opposite. When red and blue were presented, subjects reported red was more arousing than blue (Gerard, 1958; Wilson, 1966; Nourse & Welch, 1971; Ali, 1972; Jacobs & Hustmyer, 1974). Other than the relationship between red and arousal, no relationships were found.

After controlling the emotional states as covariates, the main effects of gender were still significant in red and purple. This result was same as the results from analysis without the adjustment of emotions as covariates.

9.2.2.5 Overall Color Preferences

Regardless of gender differences, overall color preferences among the groups are presented in Table 9.1. Blue and green were the most preferred colors and white was the least preferred one for all the groups. All children groups reported higher preference scores on the colors than the design professionals.

TABLE 9.1
Overall Color Preference Orders

| Preference Order | 1 (Most) | 2 | 3 | 4 | 5 | 6 (Least) |
|---|---|---|---|---|---|---|
| Healthy Children | Blue | Green | Yellow | Purple | Red | White |
| Pediatric Outpatients | Blue | Green | Red | Purple | Yellow | White |
| Pediatric Inpatients | Blue | Green | Red | Purple | Yellow | White |
| Design Professionals | Blue | Green | Purple | Yellow | Red | White |

## 9.3 SUMMARY OF RECOMMENDATIONS

The following recommendations for color application are summarized as architectural design guidelines for children based on the findings from the experiments, the researcher's observations, and the literature review. The guidelines are not prescriptive and definite because color effects can be influenced by many confounding variables. It is hoped that the recommendations will help design professionals understand color more.

Colors need to be specified carefully when describing color selections because there is too little terminology to discriminate existing colors. For example, the word 'red' can be any red sample among numerous red ones in the red hue family; but one red sample (5R 6/5) may not have same impact as another red one (7.5R 7/8). This issue is parallel to other hue families as well. A color consists of three dimensions (hue, brightness, and saturation) and is specified by them by the notation of hue brightness/saturation (H B/S) in the Munsell color system. To avoid any confusion, specific notation must be used for systematic color application.

The findings from this study focused on a single color effect on an accent wall. Findings from studies in specific contexts should be interpreted carefully so the application will not be prescriptive for all situations. Table 9.2 summarizes recommendations for color application.

TABLE 9.2
Recommendations for Color Application

| Color | Effect | Reference |
|---|---|---|
| Brighter color | ◇ More bright, more preferred | Pilot study; Guilford, 1934 |
| | ◇ Evokes positive feelings | Boyatzis & Varghese, 1994; Hemphill, 1996; Zentner, 2001 |
| More saturated color | ◇ More saturation, more preference by children | Pilot study; Guilford, 1934; Granger, 1955; Child, Hansen, & Hornbeck, 1968 |
| | ▶ Reflects on patient's skin, can mask or impersonate illnesses | Designer's comment |
| Blue | ◇ Most preferred by children and adults | Main study; Granger, 1955; Guilford & Smith, 1959; Child, Hansen, & Hornbeck, 1968; Silver et al., 1988 |
| | ◇ Most preferred by pediatric patients (5B 6/8) | Main study |
| | ▶ Higher depression scores by adults | Kwallek, Lewis, & Robbins, 1988 |
| Green | ◇ Most preferred by children and adults | Granger, 1955; Guilford & Smith, 1959; Child, Hansen, & Hornbeck, 1968 |
| | ◇ Most preferred by pediatric patients (5G 7/8) | Main study |
| | ◇ Preference of green increases with age | Choungourian, 1969; Meerum Terwogt & Hoeksma, 1995; Dittmar, 2001 |
| Red | ◇ Most preferred by younger children | Bornstein, 1975; Adams, 1987; Zentner, 2001 |
| | ◇ More arousing and exciting | Gerard, 1958; Wilson, 1966; Nourse & Welch, 1971; Ali, 1972; Jacobs & Hustmyer, 1974 |
| | ◇ Female patients prefer red (5R 7/8) more than males | Main study |
| | ▶ Higher anxiety scores by adults | Jacobs & Suess, 1975; Kwallek, Lewis, & Robbins, 1988 |
| Yellow | ▶ Less preferred by pediatric patients (5R 9/8) | Main study |
| | ▶ Higher anxiety scores | Kwallek, Lewis, & Robbins, 1988 |
| White | ▶ Least preferred for pediatric patient rooms (N 9.5) | Main study |

Note: ◇ Positive Effect; ▶ Negative Effect

## 9.4 LIMITATIONS OF THE STUDY

As an experimental design, this study had high internal validity, but it had relatively low external validity because of the nonrandom sampling and context dependency; that is, the generalizations of the study would be limited within the specific contexts in which it was conducted. However, research that provides limited generalization is as equally important as those which provide broad generalizations (Shadish, Cook, & Campbell, 2002).

All participants were recruited based on a first-available first-participate principle. This approach is categorized as convenience sampling, which is nonrandom. This nonrandom sampling may be a factor which decreases generalization. Instead of randomizing subjects to experiments, the color samples used in this study were displayed randomly using the Latin Square Design in order to reduce the order effect.

The context of this main study is context-dependent. The environments of the scale-model rooms were adjusted to the illumination level from 12 pm to 2 pm during the fall season (October to February) in Bryan, Texas. Environmental color effects were investigated using one color at a time applied on the accent wall so the effect of interactions between two adjacent colors or multiple colors were not applied. These specific contexts can decrease the external validity; this study is limited to generalizing findings applied for the above specific contexts.

## 9.5 SUGGESTIONS FOR FUTURE RESEARCH

This research only focused on color preferences for pediatric patient room design. Although no significant differences were found between healthy children and pediatric patients in terms of color preferences, the sickest children (Pediatric Intensive Care Unit) may response differently. Therefore, color effects on different types of subjects such as the sickest children, children with autism, or Alzheimer patients would be valuable. Color effects can also be extended for making design decisions for other building typologies, including education settings, correctional facilities, or commercial offices.

Further investigations on what are determinants in color preferences (e.g. hue, saturation, brightness, background color, illuminants, gender, ethnicity, etc.), the effects of multiple color combinations, magnitude of color impacts among other environmental stimuli, the value of color on human performance, and different age groups' color perception are necessary. Therefore, color studies using various ages, races, regions, and settings should be conducted over a longitudinal time frame. Although culture did not impact the results of this research, a cross-cultural study with a larger sample may provide valuable information to verify cultural effects.

The study of color is deceivingly complex. Color perception is heavily interwoven with interaction between light, eyes, and the brain. Color studies demand an interdisciplinary approach that incorporates a fundamental knowledge of color science, visual perception, psychophysiology, etc. Color science helps control the quality of a color. Visual perception theories provide the operational mechanism of the human visual system. In psychophysiology, non-invasive physiological recording techniques such as electroencephalography (EEG), heart rate, and skin conductance are useful techniques for measuring non-verbal subjects such as infants and special populations. By incorporating physiological records with psychological measurements, more rigorous conclusions can be drawn and used for generating design guidelines about color for architectural designers, interior designers, healthcare designers, and healthcare providers.

This research provided the basic foundation of color studies in real contexts by using scale model simulation. Although using a simulation design is reliable methodology, color studies in real settings will provide more viable information about the value of color in the environmental design filed. For a successful color study, the confounding variables such as subjects' age, gender, emotion, hue, brightness, saturation, light sources, adjacent colors, contexts, and cultural factor must be precisely controlled.

## 9.6 CONCLUSIONS

This study provides information regarding color preferences of healthy children, pediatric patients, and design professionals. According to this study, children ages seven to eleven years prefer brighter and more saturated colors across age and gender. In particular, white is a pervasive color in healthcare facilities, but it is the least preferred color by both children and design professionals. It is hoped that the findings and recommendations from this study will provide designers with a better understanding of color and help them to create better environments for children and their families.

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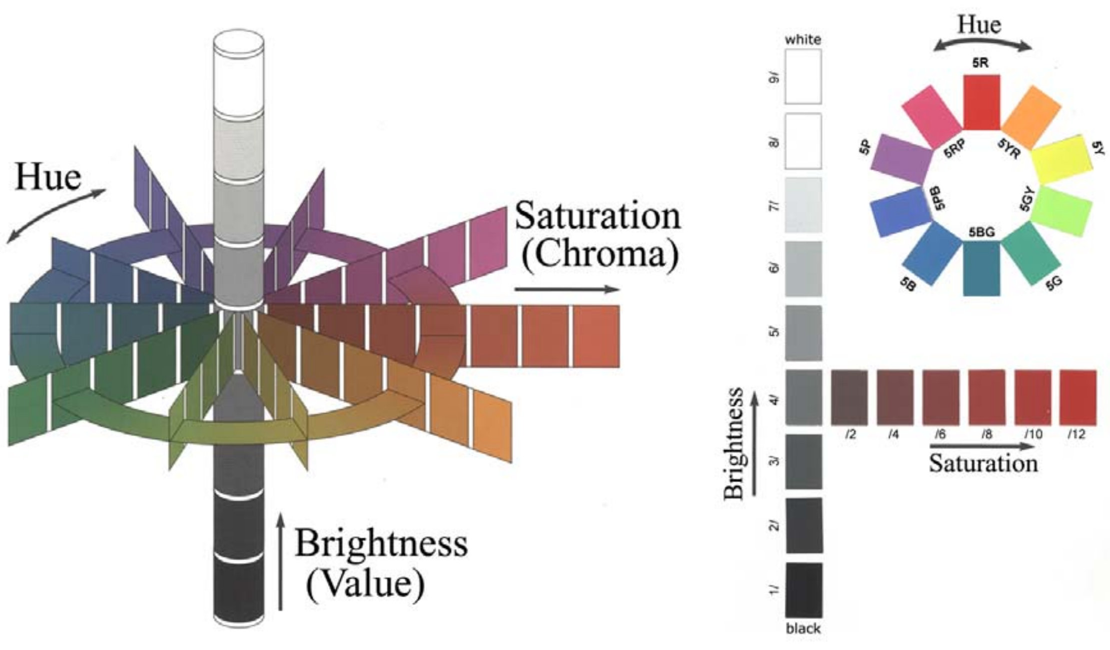
# APPENDIX A

## THREE ATTRIBUTES OF COLOR IN MUNSELL COLOR SYSTEM

The Munsell color system is a method of accurately specifying surface colors using three interrelated dimensions: hue, brightness (value), and saturation (chroma).

**Hue** refers to the attribute of color by which distinguishes red from yellow, green from blue, and so on.
**Brightness** refers to lightness of a color. The point of brightness ranges from 0 for black and 10 for white. In-between colors from black to white are grays; and they are called neutral colors. These colors are also called **achromatic colors** since they do not have hue. Colors that have hues are defined as **chromatic colors**.
**Saturation** refers to the degree of departure of a color from the neutral color of the same lightness. Saturation often indicates the strength of a color: colors of low saturation are said to be weak colors while those of high saturation are called strong ones.

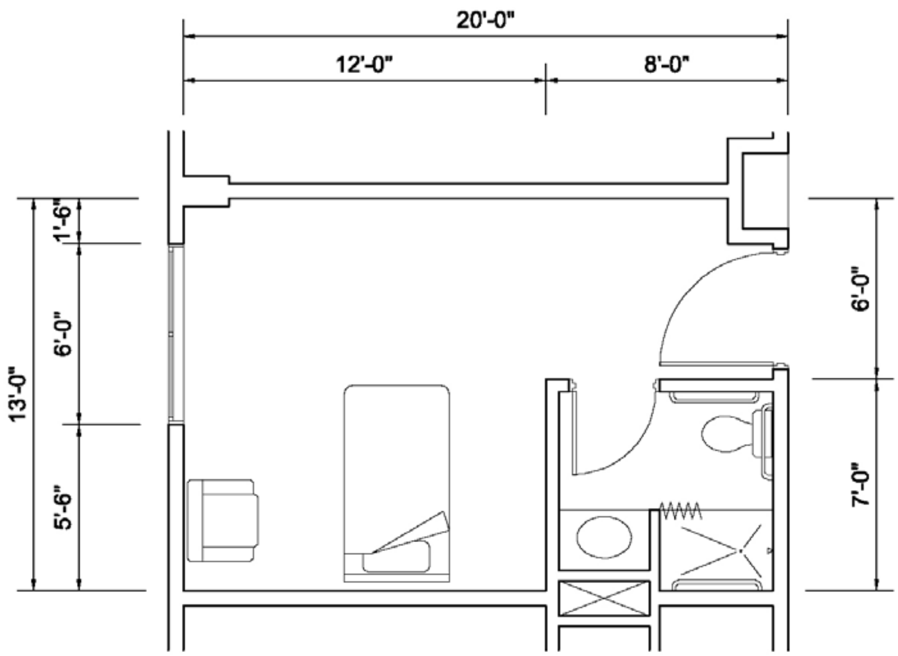
A chromatic color is specified by a notation of hue brightness/saturation (H B/S); and a neutral color is written by neutral brightness/ (N B/) in the Munsell color system



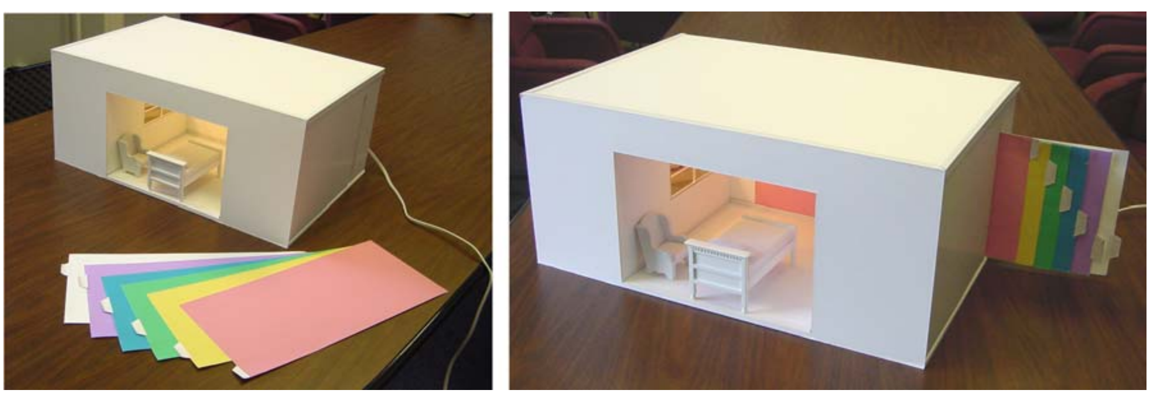

Source: Partially adapted and reprinted with permission from *The Munsell Book of Color: A Language for Color*, by Turner Luke, Joy, 1994, Fairchild Publications, New York. Copyright 1994 by Fairchild Publications, Inc.

# APPENDIX B

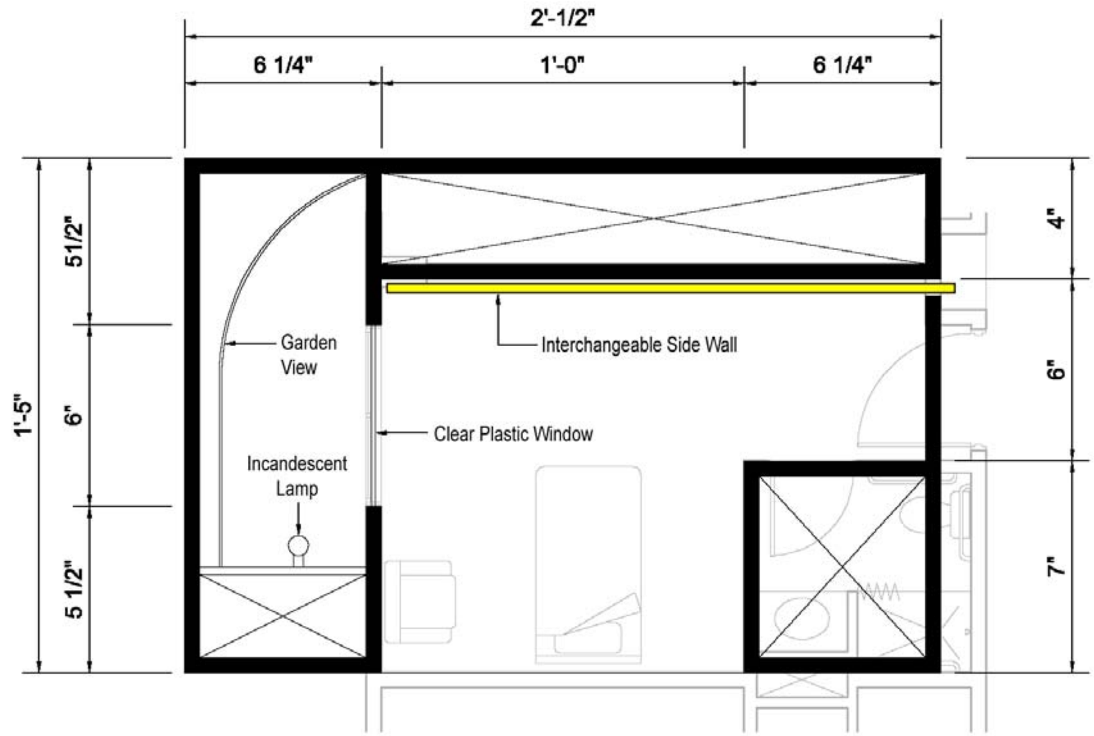
## SCALE-MODEL OF PATIENT ROOM



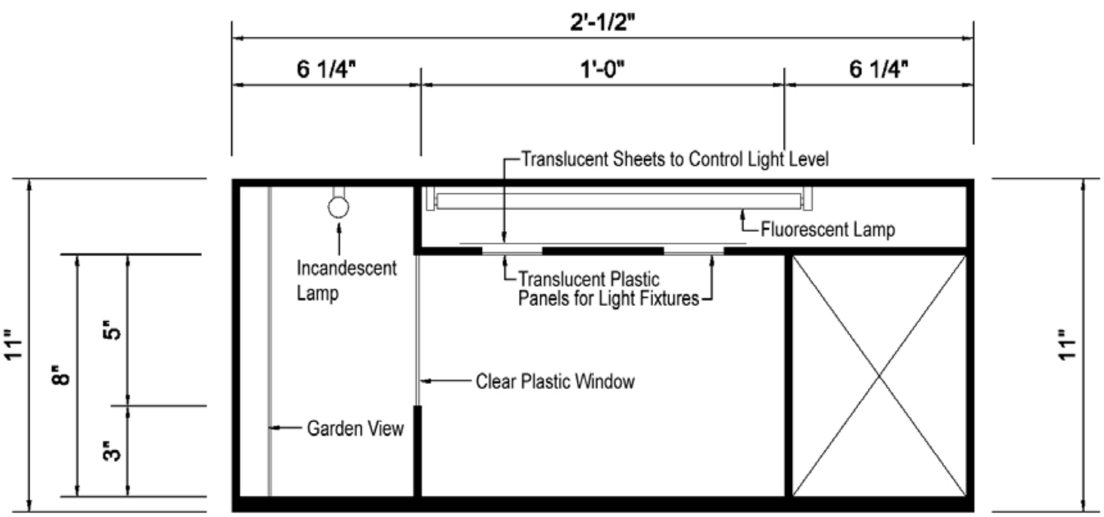

**Floor Plan of Typical Patient Room**



**Images of the Scale-Models**




**Floor Plan of the 1:12 Scale-Model**




**Section of the 1:12 Scale-Model**

# APPENDIX C

## INSTITUTIONAL REVIEW BOARD OF TEXAS A&M UNIVERSITY

## FOR EXPERIMENT I (PILOT STUDY)

VPR
Office of the Vice President for Research
Texas A&M University

Office of Research Compliance

Academy for Advanced Telecommunication and Learning Technologies

Center for Information Assurance and Security

Comparative Medicine Program

Institute for Scientific Computation

Institute for Telecommunications and Information Technology

Integrative Center for Homeland Security

Microscopy Imaging Center

Office of Business Administration

Office of Distance Education

Office of Graduate Studies

Office of Organizational Development and Diversity

Office of Proposal Development

Office of Sponsored Projects

Professional Development Group

Technology Commercialization Center

Texas A&M University Research Park

December 1, 2005

**MEMORANDUM**

**TO:** Jin Gyu Park
Architecture
MS 3137

**FROM:** Dr. J. Steven Moore, Chair
Institutional Review Board
MS 1186

**SUBJECT:** IRB Protocol Review

---

**Title:** Children's Preferences for Environmental Color

**Protocol Number:** 2005-0603
**Review Category:** Expedited Review
**Approval Date:** December 1, 2005 to November 30, 2006

**The approval determination was based on the following Code of Federal Regulations:**
45 CFR 46.110(b)(1) - Some or all of the research appearing on the list and found by the reviewer(s) to involve no more than minimal risk.

**Remarks:** Expedited Review Category 7

---

The Institutional Review Board - Human Subjects in Research, Texas A&M University has reviewed and approved the above referenced protocol. Your study has been approved for one year. As the principal investigator of this study, you assume the following responsibilities:

***Renewal:*** Your protocol must be re-approved each year in order to continue the research. You must also complete the proper renewal forms in order to continue the study after the initial approval period.

***Adverse Events:*** Any adverse events or reactions must be reported to the IRB immediately.

***Amendments:*** Any changes to the protocol, such as procedures, consent/assent forms, addition of subjects, or study design must be reported to and approved by the IRB.

***Informed Consent/Assent:*** All subjects should be given a copy of the consent document approved by the IRB for use in your study.

***Completion:*** When the study is complete, you must notify the IRB office and complete the required forms.

Texas A&M University

1186 TAMU

1500 Research Parkway

Suite B 150

College Station, Texas

77843-1186

979.458.1467
FAX 979.862.3176

# APPENDIX D

## COLLEGE STATION INDEPENDENT SCHOOL DISTRICT RESEARCH REVIEW FOR EXPERIMENT I (PILOT STUDY)

***College Station Independent School District***

*Success....each **life**....each **day**....each **hour***

December 1, 2005

Mr. Jin Gyu Park
College of Architecture
Texas A&M University
College Station, TX 77843-3137

Dear Mr. Park:

The College Station ISD Research Review Committee met yesterday to review your proposal and accompanying documentation. The committee chose to approve your research study, with a few changes and considerations, which are detailed below:

- Due to the short time before the winter break, we suggest you begin your study in January 2006.
- You will need to work with Mrs. Judy McLeod and Ms. Jana Church to coordinate the scheduling of your study. Mrs. McLeod (College Station ISD) and Ms. Church (City of College Station) coordinate the Kids Klub program. Mrs. McLeod can be reached at 764-5465.
- Since you want to include 11 year-olds in the study, you would most likely need to include one of our intermediate schools that serve 5th and 6th grade students. Cypress Grove Intermediate is located on Graham Road, and Oakwood Intermediate is located on Holik, across from the A&M Golf Course.
- Before beginning your study, you would also need to contact Debbie Hudson, principal of College Hills Elementary, to arrange for a room to conduct the study.
- Most importantly, the Research Review Committee stated that there would need to be a CSISD or Kids Klub employee in the room with the student and the principal investigator. Mrs. McLeod and Ms. Church would need to determine if they even have the staff available for this.

If you should need any additional information, please contact my office at 764-5569.

Truly,

Clark C. Ealy, Ph.D.
Research Review Committee, Chair
College Station ISD

cc: Eddie Coulson
Research Review Committee
Debbie Hudson
Judy McLeod

CLARK C. EALY, Ph.D.
*Director of Program Assessment*
*Evaluation and Accountability*

1812 Welsh Street
College Station, Texas 77840
979-764-5569 FAX 979-764-5425

JIMMY CREEL, Ed.D.
*Superintendent of Schools*

# APPENDIX E

## BRYAN INDEPENDENT SCHOOL DISTRICT RESEARCH REVIEW

## FOR EXPERIMENT I & II (PILOT & MAIN STUDY)

neo @Texas A&M University

[Mail] Main | Mail | Contacts | Directory | Preferences | Help | Logout

logged in as **jgpark**@neo.tamu.edu

Folders: 2006-01Spring

View Folder

Reply | Reply to all | Forward | Print View | Delete | Move | Recompose | New message | Back to "2006-01Spring"

87 Go

**Date:** Thursday, March 9 2006 12:09 pm
**From:** Lucy Larrison <larrison@bryanisd.org>
**To:** jgpark@neo.tamu.edu
**Reply-To:** Lucy Larrison <larrison@bryanisd.org>
**Subject:** Research Proposal and Partnership with Bryan ISD
**Full Headers:** Display Headers
**Attachments:** Part 1 noname (TEXT/PLAIN 8bit 812 bytes) Hide
Part 2 noname (TEXT/HTML quoted-printable 1461 bytes) View

Dear Mr. Park,

Your Research Project proposal was distributed to the BISD Research Committee immediately after receiving it. I have managed to make contact with all the committee members and your project has been approved. Dr. Holley Mohr will be supervising the study with students "after school" as stipulated in your proposal.

We look forward to seeing the results of your work and how this information may be beneficial to our own students.

Please make contact with Dr. Mohr for more details regarding when you may begin and the protocol for getting parent permission, etc....

Good Luck to you and have a wonderful Spring Break. If I may assist you further at this time, feel free to call me at 209-1079.

Lucy Larrison
Executive Director for Accountability and Research

https://neoweb.tamu.edu/index.php3?ts=1144297579&twigsi=7&twig_contex... 4/5/2006

# APPENDIX F

# PARENTAL PERMISSION FORM AND CHILD ASSENT FORM

# FOR EXPERIMENT I (PILOT STUDY)

*inglés aquí y español al otro lado*

**PARENTAL PERMISSION FORM**
**Children's Preferences for Environmental Color**

My child has been asked to participate in a pilot study which investigates children's preferences for environmental colors. My child was selected to be a possible participant because he/she is in the age range appropriate for this study (7~11 years old). A maximum of 60 children have been asked to participate in this study. This pilot study is performed in preparation for the researcher's doctoral dissertation, which investigates the value of color to children's environments. As a part of the main study, this pilot study will ensure that the research design and tools are valid to answer the main research questions. The refined tool developed from this study will improve the validity and reliability of the data generated during the final study.

The purpose of this study is to investigate children's most preferred colors among five major color families. If I agree to have my child in this study, my child will only be asked to indicate his/her color preferences of different colored 1:12 scale-model rooms. To keep the colors uniform the models have their own lights inside, so the classroom light will be off during the experiment. This experiment will be conducted under continuous supervision from an observer, Janet Sandera. It will take approximately 20 minutes per child to complete. The risk associated with this study is minimal which might be the possibility of uncomfortable feeling from being in new situation. My child's participation will not benefit nor harm him/her in any way.

This study is anonymous and my child's name will not be recorded and released. Only my child's age, gender, ethnicity, and responses to the colors will be recorded. The records of this study will be kept private and only the researcher will have access to the records. No identifiers related to my child to the study will be included in any sort of report that might be published. The records will be stored in a locked cabinet for 3 years after the completion of the study and then destroyed. I understand that if child abuse or neglect is detected, the researcher is required by law to report this abuse to the appropriate authorities.

I understand that my child's participation is strictly voluntary and that my decision to allow my child to participate or not will not affect his/her academic activities or performances. Upon completion of the study, I understand that I may request a copy of the results.

This research study has been reviewed and approved by the Institutional Review Board - Human Subjects in Research, Texas A&M University. For research-related problems or questions regarding subjects' rights, I can contact the Institutional Review Board through Ms. Angelis M. Raines, Director of Research Compliance, Office of the Vice President for Research at (979)458-4067, araines@vprmail.tamu.edu.

I have read above information. I have asked questions and have received answers to my satisfaction. I understand that I may withdraw my consent for my child at any time without penalty. I also understand that my signature on this form gives my child permission to participate in the current study. I have been given a copy of this consent form.

Date: ____________ Initial: __________

**FORMULARIO DE PERMISO PARENTAL**
**Preferencias de Niños por Color Ambiental**

Mi niño/niña ha sido solicitado para participar en un estudio piloto (experimental) que investigará las preferencias de colores de los niños y sus preferencias de colores ambientales. Mi niño/niña fue seleccionado/a para ser un posible participante porque está en la categoría de edad apropiada para este estudio (7~11 años de edad). Un máximo de 60 niños serán escogidos para participar en este estudio. Este estudio piloto será realizado en preparación para la disertación doctoral del investigador, que investigará el valor de color en ambientes de niños. Como parte del estudio principal, este estudio piloto asegurará de que el diseño de investigación y las herramientas utilizadas son válidas para responder las preguntas de la investigación principal. La herramienta desarrollada mediante este estudio mejorará la validez y el nivel de confianza de datos generados durante el estudio final.

El propósito de este estudio es investigar los colores preferidos de niños en cinco familias de colores. Si yo apruebo la participación de mi niño/niña en este estudio, el/ella solo será preguntado/a su color preferido de una selección de modelos de habitaciones de diferente color. Para mantener los colores uniformes, los modelos tendrán su propia luz adentro, así que la luz del salón de clase estará apagada durante el experimento. Este experimento sera conducido bajo supervisión continua por una observadora, Janet Sandera. Este experimento tomará aproximadamente 20 minutos para completar por cada niño/niña. El riesgo asociado con este estudio es mínimo y podría ser la posibilidad de sentirse incómodo en una situación nueva. La participación de mi niño/niña no lo/la beneficiara ni le hará daño in ninguna forma.

Este estudio es anónimo y el nombre de mi niño/niña no será registrado ni distribuido. Solo la edad, el género, el grupo étnico, y las respuestas a los colores de mi niño/niña serán registrados. Los archivos de este estudio serán mantenidos en privado y solo el investigador tendrá acceso a los archivos. Ninguna información que identificaría a mi niño/niña será incluida en ningún reporte publicado en relación a este estudio. Los datos estarán archivados en un gabinete seguro por tres años después de que el estudio finalice y posteriormente serán destruidos. Entiendo que si hay detección de abuso o negligencia a mi niño/niña, la ley requiere que el investigador reporte este abuso a las autoridades apropiadas.

Entiendo que la participación de mi niño/niña es estrictamente voluntaria y que mi decisión de permitir que mi niño/niña participe no afectará sus actividades o realizaciones académicas. Cuando el estudio termine, entiendo que puedo pedir una copia de los resultados.

Este estudio investigativo ha sido revisado y aprobado por el Comité Examinador Institucional – Sujetos Humanos en Investigación de Texas A&M University. Para problemas o preguntas del estudio relacionadas con los derechos de los sujetos, puedo comunicarme con el comité mediante la Señorita Angelis M. Raines, Directora de Conformidad Investigativa en la Oficina del Vicepresidente de Investigación, (979)458-4067, araines@vprmail.tamu.edu.

He leído la información anterior. He hecho preguntas y he recibido respuestas satisfactorias. Entiendo que puedo retirar mi consentimiento a cualquier hora sin penalización. También entiendo que mi firma en este formulario da permiso para que mi niño/niña participe en este estudio. He recibido una copia de este formulario.

Fecha: ______________ Inicial: ____________

*inglés y español juntos aquí*

**PARENTAL PERMISSION FORM (*FORMULARIO DE PERMISO DE PARIENTES)***
**Children's Preferences for Environmental Color (*Preferencias de Niños por Color Ambiental*)**

| Signature of Parent<br>*Firma del Pariente* | Printed Name<br>*Nombre Imprenta del Pariente* | Date<br>*Fecha* |
|---|---|---|
| Printed Name of Child<br>*Nombre Imprenta del Niño/Niña* | Child's Date of Birth<br>*Fecha de Nacimiento (Niño/a)* | Child's Gender<br>*Género* |

Child's Ethnicity (Please check the most appropriate one):
*Grupo Étnico del Niño/Niña (Por favor seleccione la opción más apropiada):*

- ☐ Caucasian/White *Caucásico/Blanco*
- ☐ African American/Black *Afro-Americano/Negro*
- ☐ Asian American/Asian *Americano Asiático/Asiático*
- ☐ Hispanic/Latino *Hispano/Latino*
- ☐ Native American/American Indian *Indígena Americano/Indio Americano*
- ☐ Other. Please specify:__________________ *Otro. Por favor especifique:*____________

Jin Gyu Park (Principal Investigator / *Investigador Principal*) — Date
Department of Architecture, Texas A&M University
College Station, TX 77843-3137
(979)204-6596, jgpark@neo.tamu.edu

Dr. Mardelle M. Shepley (Advisor of Investigator / *Consejera del Investigador*)
Department of Architecture, Texas A&M University
College Station, TX 77843-3137
(979)845-7009, mardelle@archone.tamu.edu

☐ I would appreciate a copy of a summary of the results when the study is completed.
*Yo apreciaría una copia del resúmen de los resultados cuando finalice el estudio.*

Address:
*Dirección* ______________________________________
Number and Street / *Número y Calle*

______________________________________ ____________________
City and State / *Ciudad y Estado* Zip Code / *Código Postal*

Date (*Fecha*):__________ Initial (*Inicial*):_____________

*inglés aquí y español al otro lado*

**CHILD ASSENT FORM**

Title of Research: Children's Preferences for Environmental Color

1. I am asked to be in a research study. Research helps people learn new things. The researcher is trying to learn more about children's favorite colors.

2. If I want to join this study, I will do it in a room at my school. In the room, I will see small size model rooms. Those rooms have different color-painted walls. I will be asked to think about how much I like those rooms with the different colors. I only need to look at the models and give my feelings about them. To keep the colors looking clear the models have their own lights inside; this means that the light in my room will be off during the experiment. To make sure I am comfortable, Janet Sandera will be there to observe the experiment. The whole process takes only 20 minutes. Other than the researcher, no one will know my responses. There are no right or wrong answers because this is not a test.

3. To join this study will not reward me directly. But, people will learn more about children's favorite colors because of my help. It will also be fun to see colorful models. There will be no danger.

4. I need talk to my parents about it before I say "yes" or "no". My parents will also be asked to give their permission for me to join this study. But even if my parents say "yes", I can still say "no".

5. If I say "no", I don't have to do this. No one will be upset if I don't want to. Even if I change my mind later and want to stop, nothing bad will happen to me.

6. If I do not feel comfortable, I can stop at any time.

7. I can ask questions any time.

8. My parents and I will be given a copy of this form to keep after I have signed it.

**My parent has said it's okay for me to join if I want to. I know that I can stop at any time and nothing bad will happen to me after I stop. I have read this letter and I want to be in this study. If I cannot read the letter, my mom or dad has read it to me and I understand what it says.**

________________________________________

Name of Child (please print)

________________________________________ _______________

Signature of Child Date

________________________________________ _______________

Jin Gyu Park (Signature of Investigator) Date

Department of Architecture, Texas A&M University
College Station, TX 77843-3137
(979)204-6596 / jgpark@neo.tamu.edu

**FORMULARIO DE CONSENTIMIENTO DE NIÑOS**

Titulo de Investigación: Preferencias de Niños por Color Ambiental

1. Me han pedido estar en un estudio investigativo. Investigaciones ayudan a las personas a aprender cosas nuevas. El investigador esta tratando de aprender mas sobre los colores favoritos de niños.
2. Si yo quiero estar en este estudio, lo tendría que hacer en un salón de mi colegio. En el salón veré pequeños modelos de habitaciones. Esas habitaciones tienen paredes de diferente color. Me van a preguntar sobre que tanto me gustan esas habitaciones con los colores diferentes. Solo necesito ver los modelos y dar mis opiniones sobre ellos. Los modelos tienen su propia luz para mantener los colores necesarios; esto quiere decir que la luz en mi salón estará apagada durante el experimento. Para estar seguro de que estoy cómodo, Janet Sandera estará conmigo para observar el experimento. El proceso tomará solamente 20 minutos para completar. Aparte del investigador, nadie sabrá mis respuestas. No hay respuestas correctas o incorrectas porque no es un exámen.
3. Participar en este estudio no me va a recompensar directamente. Pero, hay personas que pueden aprender más sobre los colores favoritos de niños por mi ayuda. También será divertido ver los modelos. No estaré en peligro.
4. Necesito hablar con mis padres sobre esto antes de decir "si" o "no". Mis padres también serán preguntados por su permiso para yo participar este estudio. Aunque mis padres den su permiso, yo no tengo que participar si no quiero.
5. Si digo "no", no tengo que hacerlo. Nadie estará bravo conmigo si no lo hago. Aunque quiera dejar de participar luego, nada malo me pasará.
6. Si no me siento cómodo/cómoda, puedo parar en cualquier momento.
7. Puedo hacer preguntas a cualquier hora.
8. Mis padres y yo tendremos una copia de este formulario después de yo firmarlo.

**Mi padre/made ha dicho que esta bien que yo participe si quiero. Se que puedo parar a cualquier hora y nada malo me pasará después de parar. He leído esta carta y quiero estar en este estudio. Si no pude leer la carta, mi papá o mi mamá me lo ha leído y entiendo lo que dice.**

________________________________________

Nombre del Niño/a *(Printed Name of Child)*

________________________________________ ________________

Firma del Niño/a *(Signature of Child)* Fecha *(Date)*

________________________________________ ________________

Jin Gyu Park (Signature of Investigator) Date

Department of Architecture, Texas A&M University
College Station, TX 77843-3137
(979)204-6596 / jgpark@neo.tamu.edu

# APPENDIX G

# INSTITUTIONAL REVIEW BOARD OF TEXAS A&M UNIVERSITY

# FOR EXPERIMENT II (MAIN STUDY)

TEXAS A&M UNIVERSITY
VICE PRESIDENT FOR RESEARCH - OFFICE OF RESEARCH COMPLIANCE
1186 TAMU
College Station, TX 77843-1186
1500 Research Parkway, Suite B-150
979.458.1467
FAX 979.862.3176
http://researchcompliance.tamu.edu

Institutional Biosafety Committee | Institutional Animal Care and Use Committee | Institutional Review Board

**DATE**: April 5, 2006

**MEMORANDUM**

**TO**: Jin Gyu Park
Architecture MS 3137

**FROM**: Dr. Steven Moore, Chair
Institutional Review Board

**SUBJECT**: Initial Review

---

**Protocol Number: 2006-0108**

**Title**: Environmental Color for Pediatric Patient Room Design

**Review Category**: Full Board

**Approval Period**: April 5, 2006 to April 4, 2007

---

**Approval determination was based on the following Code of Federal Regulations**:
45 CFR 46 Subpart A.

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**Provisions**:

---

This research project has been approved for one (1) year. As principal investigator, you assume the following responsibilities:

1) **Continuing Review**: The protocol must be renewed each year in order to continue with the research project. A Continuing Review along with required documents must be submitted 30 days before the end of the approval period. Failure to do so may result in processing delays and/or non-renewal.
2) **Completion Report**: Upon completion of the research project (including data analysis and final written papers), a Completion Report must be submitted to the IRB Office.
3) **Adverse Events**: Adverse events must be reported to the IRB Office immediately.
4) **Amendments**: Changes to the protocol must be requested by submitting an Amendment to the IRB Office for review. The Amendment must be approved by the IRB before being implemented.
5) **Informed Consent**: Information must be presented to enable persons to voluntarily decide whether or not to participate in the research project.

# APPENDIX H

# COLLEGE STATION INDEPENDENT SCHOOL DISTRICT RESEARCH REVIEW, PARENTAL PERMISSION FORM, AND CHILD ASSENT FORM FOR EXPERIMENT II (MAIN STUDY)

College Station Independent School District

Success....each life....each day....each hour

April 21, 2006

Mr. Jin Gyu Park
College of Architecture
Texas A&M University
College Station, TX 77843-3137

Dear Mr. Park:

The College Station ISD Research Review Committee met recently to review your proposal and accompanying documentation. The committee chose to approve your research study, with a few considerations, which are detailed below:

- You will need to work with Mrs. Judy McLeod and Ms. Jana Church to coordinate the scheduling of your study. Mrs. McLeod (College Station ISD) and Ms. Church (City of College Station) coordinate the Kids Klub program. Mrs. McLeod can be reached at 764-5465.

- Mrs. Church does have some concerns with space availability at some of the elementary schools. For example, if you want to use South Knoll Elementary, or another campus with limited space, you would need to coordinate with the campus principal to determine what space would be available, if any.

If you should need any additional information, please contact my office at 764-5569.

Truly,

Clark C. Ealy, Ph.D.
Research Review Committee, Chair
College Station ISD

cc: Eddie Coulson
Research Review Committee
Elementary and Intermediate Principals
Judy McLeod

CLARK C. EALY, Ph.D.
*Director of Program Assessment*
*Evaluation and Accountability*

1812 Welsh Street
College Station, Texas 77840
979-764-5569 FAX 979-764-5425

JIMMY CREEL, Ed.D.
*Superintendent of Schools*

*inglés aquí y español al otro lado*

**PARENTAL PERMISSION FORM**
**Environmental Color for Pediatric Patient Room Design**

My child has been asked to participate in a research study on "Environmental Color for Pediatric Patient Room Design". This study needs three different groups which include healthy children as normal, unhealthy children as users of patient rooms, and design professionals as decision-makers for pediatric patient room design. My child was selected to be a possible participant as healthy child because he/she is in the age range appropriate for this study (7~11 years old). A maximum of 60 healthy children have been asked to participate in this study.

The purpose of this study is to investigate the value of color as a component in a healing environment for pediatric patient rooms. If I agree to have my child in this study, my child will only be asked to indicate his/her color preferences of different colored 1:12 scale-model rooms. To keep the colors uniform the models have their own lights inside, so the classroom light will be off during the experiment. This experiment will be conducted under continuous supervision from an observer, Janet Sandera. It will take approximately 20 minutes per child to complete. The risk associated with this study is minimal which might be the possibility of uncomfortable feeling from being in a novel research situation. My child's participation will not benefit nor harm him/her in any way.

This study is anonymous and my child's name will not be recorded and released. Only my child's age, gender, ethnicity, and responses to the colors will be recorded. The records of this study will be kept private and only the researcher will have access to the records. No identifiers related to my child to the study will be included in any sort of report that might be published. The records will be stored in a locked cabinet for 3 years after the completion of the study and then destroyed. I understand that if child abuse or neglect is detected, the researcher is required by law to report this abuse to the appropriate authorities.

I understand that my child's participation is strictly voluntary and that my decision to allow my child to participate or not will not affect his/her academic activities or performances. Upon completion of the study, I understand that I may request a copy of the results.

This research study has been reviewed and approved by the Institutional Review Board - Human Subjects in Research, Texas A&M University. For research-related problems or questions regarding subjects' rights, I can contact the Institutional Review Board through Ms. Angelis M. Raines, Director of Research Compliance, Office of the Vice President for Research at (979)458-4067, araines@vprmail.tamu.edu.

I have read above information. I have asked questions and have received answers to my satisfaction. I understand that I may withdraw my consent for my child at any time without penalty. I also understand that my signature on this form gives my child permission to participate in the current study. I have given a copy of this consent form.

Date:____________ Initial:________

**FORMULARIO DE PERMISO PARENTAL**
**Colores Ambientales para el Diseño de Habitaciones de Pacientes Pediátricos**

Mi niño/niña ha sido solicitado para participar en un estudio investigativo sobre "Colores Ambientales para el Diseño de Habitaciones de Pacientes Pediátricos". Este estudio necesitará tres grupos que incluirán niños sanos como normales, niños enfermos como usuarios de las habitaciones, y diseñadores profesionales como los que toman las decisiones sobre el diseño de habitaciones pediátricas. Mi niño/niña fue seleccionado/a para ser un posible participante porque está en la categoría de edad apropiada para este estudio (7~11 años de edad). Un máximo de 60 niños sanos serán escogidos para participar en este estudio.

Este estudio investigará el valor de colores como componentes en un ambiente de recuperación para habitaciones de pacientes pediátricos. Si yo apruebo la participación de mi niño/niña en este estudio, el/ella solo será preguntado/a su color preferido de una selección de modelos de habitaciones de diferente color. Para mantener los colores uniformes, los modelos tendrán su propia luz adentro, así que la luz del salón de clase estará apagada durante el experimento. Este experimento será conducido bajo supervisión continua por una observadora, Janet Sandera. Este experimento tomará aproximadamente 20 minutos para completar por cada niño/niña. El riesgo asociado con este estudio es mínimo y podría ser la posibilidad de sentirse incómodo en una situación nueva. La participación de mi niño/niña no lo/la beneficiara ni le hará daño in ninguna forma.

Este estudio es anónimo y el nombre de mi niño/niña no será registrado ni distribuido. Solo la edad, el género, el grupo étnico, y las respuestas a los colores de mi niño/niña serán registrados. Los archivos de este estudio serán mantenidos en privado y solo el investigador tendrá acceso a los archivos. Ninguna información que identificaría a mi niño/niña será incluida en ningún reporte publicado en relación a este estudio. Los datos estarán archivados en un gabinete seguro por tres años después de que el estudio finalice y posteriormente serán destruidos. Entiendo que si hay detección de abuso o negligencia a mi niño/niña, la ley requiere que el investigador reporte este abuso a las autoridades apropiadas.

Entiendo que la participación de mi niño/niña es estrictamente voluntaria y que mi decisión de permitir que mi niño/niña participe no afectará sus actividades o realizaciones académicas. Cuando el estudio termine, entiendo que puedo pedir una copia de los resultados.

Este estudio investigativo ha sido revisado y aprobado por el Comité Examinador Institucional – Sujetos Humanos en Investigación de Texas A&M University. Para problemas o preguntas del estudio relacionadas con los derechos de los sujetos, puedo comunicarme con el comité mediante la Señorita Angelis M. Raines, Directora de Conformidad Investigativa en la Oficina del Vicepresidente de Investigación, (979)458-4067, araines@vprmail.tamu.edu.

He leído la información anterior. He hecho preguntas y he recibido respuestas satisfactorias. Entiendo que puedo retirar mi consentimiento a cualquier hora sin penalización. También entiendo que mi firma en este formulario da permiso para que mi niño/niña participe en este estudio. He recibido una copia de este formulario.

Fecha:____________ Inicial:______

*inglés y español juntos aquí*

**PARENTAL PERMISSION FORM (*FORMULARIO DE PERMISO DE PARIENTES)***
**Environmental Color for Pediatric Patient Room Design**
***(Colores Ambientales para el Diseño de Habitaciones de Pacientes Pediátricos)***

| Signature of Parent<br>*Firma del Padre o Madre* | Printed Name<br>*Nombre del Padre o Madre* | Date<br>*Fecha* |
|---|---|---|
| Printed Name of Child<br>*Nombre del Hijo o Hija* | Child's Date of Birth<br>*Fecha de Nacimiento (Hijo/a)* | Child's Gender<br>*Género* |

Child's Ethnicity (Please check the most appropriate one):
*Grupo Étnico del Niño/Niña (Por favor seleccione la opción más apropiada):*

- ☐ Caucasian/White *Caucásico/Blanco*
- ☐ Hispanic/Latino *Hispano/Latino*
- ☐ African American/Black *Afro-Americano/Negro*
- ☐ Native American/American Indian *Indígena Americano/Indio Americano*
- ☐ Asian American/Asian *Americano Asiático/Asiático*
- ☐ Other. Please specify:__________ *Otro. Por favor especifique:*__________

Jin Gyu Park (Principal Investigator/ *Investigador Principal*) Date
Department of Architecture, Texas A&M University
College Station, TX 77843-3137
(979)204-6596, jgpark@neo.tamu.edu

Dr. Mardelle M. Shepley (Advisor of Investigator/*Consejera del Investigador*)
Department of Architecture, Texas A&M University
College Station, TX 77843-3137
(979)845-7009, mardelle@archone.tamu.edu

☐ I would appreciate a copy of a summary of the results when the study is completed.
*Yo apreciaría una copia del resúmen de los resultados cuando finalice el estudio.*

Address:
*Dirección* ____________________
Number and Street / *Número y Calle*

____________________ __________
City and State / *Ciudad y Estado* Zip Code / *Código Postal*

Date: *Fecha:*________ Initial: *Inicial:*________

*inglés aquí y español al otro lado*

**CHILD ASSENT FORM**

Title of Research: Environmental Color for Pediatric Patient Room Design

1. I am asked to be in a research study. Research helps people learn new things. The researcher is trying to learn more about children's favorite colors.

2. If I want to join this study, I will do it in a room at my school. In the room, I will see small size model rooms. Those rooms have different color-painted walls. I will be asked to think about how much I like those rooms with the different colors. I only need to look at the models and give my feelings about them. To keep the colors looking clear the models have their own lights inside; this means that the light in my room will be off during the experiment. To make sure I am comfortable, Janet Sandera will be there to observe the experiment. The whole process takes only 20 minutes. Other than the researcher, no one will know my responses. There are no right or wrong answers because this is not a test.

3. To join this study will not reward me directly. But, people will learn more about children's favorite colors because of my help. It will also be fun to see colorful models. There will be no danger.

4. I need talk to my parents about it before I say "yes" or "no". My parents will also be asked to give their permission for me to join this study. But even if my parents say "yes", I can still say "no".

5. If I say "no", I don't have to do this. No one will be upset if I don't want to. Even if I change my mind later and want to stop, nothing bad will happen to me.

6. If I do not feel comfortable, I can stop at any time.

7. I can ask questions any time.

8. My parents and I will be given a copy of this form to keep after I have signed it.

**My parent has said it's okay for me to join if I want to. I know that I can stop at any time and nothing bad will happen to me after I stop. I have read this letter and I want to be in this study. If I cannot read the letter, my mom or dad has read it to me and I understand what it says.**

________________________________________

Name of Child (please print)

________________________________________ _______________

Signature of Child Date

________________________________________ _______________

Jin Gyu Park (Signature of Investigator) Date

Department of Architecture, Texas A&M University
College Station, TX 77843-3137
(979)204-6596 / jgpark@neo.tamu.edu

*Las copias blancas de los formularios son para sus archivos.*

**FORMULARIO DE CONSENTIMIENTO DE NIÑOS**
Colores Ambientales para el Diseño de Habitaciones de Pacientes Pediátricos

1. Me han pedido estar en un estudio investigativo. Investigaciones ayudan a las personas a aprender cosas nuevas. El investigador esta tratando de aprender mas sobre los colores favoritos de niños.
2. Si yo quiero estar en este estudio, lo tendría que hacer en un salón de mi colegio. En el salón veré pequeños modelos de habitaciones. Esas habitaciones tienen paredes de diferente color. Me van a preguntar sobre que tanto me gustan esas habitaciones con los colores diferentes. Solo necesito ver los modelos y dar mis opiniones sobre ellos. Los modelos tienen su propia luz para mantener los colores necesarios; esto quiere decir que la luz en mi salón estará apagada durante el experimento. Para estar seguro de que estoy cómodo, Janet Sandera estará conmigo para observar el experimento. El proceso tomará solamente 20 minutos para completar. Aparte del investigador, nadie sabrá mis respuestas. No hay respuestas correctas o incorrectas porque no es un exámen.
3. Participar en este estudio no me va a recompensar directamente. Pero, hay personas que pueden aprender más sobre los colores favoritos de niños por mi ayuda. También será divertido ver los modelos. No estaré en peligro.
4. Necesito hablar con mis padres sobre esto antes de decir “si” o “no”. Mis padres también serán preguntados por su permiso para yo participar este estudio. Aunque mis padres den su permiso, yo no tengo que participar si no quiero.
5. Si digo “no”, no tengo que hacerlo. Nadie estará bravo conmigo si no lo hago. Aunque quiera dejar de participar luego, nada malo me pasará.
6. Si no me siento cómodo/cómoda, puedo parar en cualquier momento.
7. Puedo hacer preguntas a cualquier hora.
8. Mis padres y yo tendremos una copia de este formulario después de yo firmarlo.

**Mi padre/made ha dicho que esta bien que yo participe si quiero. Se que puedo parar a cualquier hora y nada malo me pasará después de parar. He leído esta carta y quiero estar en este estudio. Si no pude leer la carta, mi papá o mi mamá me lo ha leído y entiendo lo que dice.**

____________________________________
Nombre del Niño/a *(Printed Name of Child)*

____________________________________ ______________
Firma del Niño/a *(Signature of Child)* Fecha *(Date)*

____________________________________ ______________
Jin Gyu Park (Signature of Investigator) Date

Department of Architecture, Texas A&M University
College Station, TX 77843-3137
(979)204-6596 / jgpark@neo.tamu.edu

# APPENDIX I

# INSTITUTIONAL REVIEW BOARD OF ST. JOSEPH HEALTH SYSTEM, PARENTAL PERMISSION FORM, AND CHILD ASSENT FORM FOR EXPERIMENT II (MAIN STUDY)

ST. JOSEPH REGIONAL HEALTH CENTER
2801 Franciscan Dr. • Bryan, Texas 77802-2544 • (979) 776-3777

Date: February 28, 2006

TO: Jin Gyu Park

RE: Environmental Color for Pediatric Patient Room Design. Protocol and Consent Form.

The above referenced protocol and consent have received

- O Full IRB Review
- ● Expedited Review
- O Emergency Review
- O Compassionate Review
- O Review for Exemption

and have been:

- ● Approved until February 28, 2007
- O Conditionally approved (see conditions below):
- O Tabled for future consideration
- O Disapproved
- O Closed
- O Reviewed and closed to new patients

by Peter Gray, Chair of the Institutional Review Board of St. Joseph Health System, effective immediately. You must report any serious, unanticipated outcomes to the IRB within 30 days. If the study involves a device you must report a serious, unanticipated outcome to the IRB within 10 days.

If you have questions about the IRB or its policy, please contact me.

Respectfully,

Peter Gray
Chair, Institutional Review Board
St. Joseph Health System
FWA# 00006042

**PARENTAL PERMISSION FORM**
**Environmental Color for Pediatric Patient Room Design**

My child has been asked to participate in a research study on "Environmental Color for Pediatric Patient Room Design". This study needs three different groups which are healthy children as normal, hospitalized children as users of patient rooms, and design professionals as decision-makers for pediatric patient room design. My child was selected to be a possible participant because he/she is in the age range appropriate for this study (7~11 years old). A maximum of 60 children have been asked to participate in this study.

The purpose of this study is to investigate the value of color as a component in a healing environment for pediatric patient rooms. If I agree to have my child in this study, my child will only be asked to indicate his/her color preferences of different colored 1:12 scale-model rooms. To keep the colors uniform the models have their own lights inside, so the patient room light will be off during the experiment. This experiment will be conducted under continuous supervision from an observer. It will take approximately 20 minutes per child to complete.

The risk associated with this study is minimal which might be the possibility of uncomfortable feeling from being in a novel situation. My child's participation will not benefit nor harm him/her in any way.

This study is anonymous and my child's name will not be recorded and released. Only my child's age, gender, ethnicity, and responses to the colors will be recorded. The records of this study will be kept private and only the researcher will have access to the records. No identifiers related to my child to the study will be included in any sort of report that might be published. The records will be stored in a locked cabinet for 3 years after the completion of the study and then destroyed. I understand that if child abuse or neglect is detected, the researcher is required by law to report this abuse to the appropriate authorities.

I understand that my child's participation is strictly voluntary and that my decision to allow my child to participate or not will not affect his/her treatments. Upon completion of the study, I understand that I may request a copy of the results.

This research study has been reviewed and approved by both the Institutional Review Board in St. Joseph Regional Health Center and the Institutional Review Board - Human Subjects in Research, Texas A&M University. For research-related problems or questions regarding subjects' rights, I can contact the Institutional Review Board through Mr. Peter Gray, Chair of Institutional Review Board, St. Joseph Regional Health Center at (979) 776-5338, pgray@st-joseph.org or Ms. Angelis M. Raines, Director of Research Compliance, Office of the Vice President for Research, Texas A&M University at (979)458-4067, araines@vprmail.tamu.edu.

I have read above information. I have asked questions and have received answers to my satisfaction. I understand that I may withdraw my consent for my child at any time without penalty. I also understand that my signature on this form gives my child permission to participate in the current study. I have given a copy of this consent form.

Date: ______________ Initial: ____________



See backside

**PARENTAL PERMISSION FORM**
**Environmental Color for Pediatric Patient Room Design**

| Signature of Parent | Printed Name | Date |
|---|---|---|
| Printed Name of Child | Child's Date of Birth | Child's Gender |

Child's Ethnicity (Please check the most appropriate one):

- ☐ Caucasian/White
- ☐ Hispanic/Latino
- ☐ African American/Black
- ☐ Native American/American Indian
- ☐ Asian American/Asian
- ☐ Other. Please specify:__________________

Jin Gyu Park (Principal Investigator) Date

Department of Architecture, Texas A&M University
College Station, TX 77843-3137
(979)204-6596, jgpark@neo.tamu.edu

Dr. Mardelle M. Shepley (Advisor of Investigator)
Department of Architecture, Texas A&M University
College Station, TX 77843-3137
(979)845-7009, mardelle@archone.tamu.edu

☐ I would appreciate a copy of a summary of the results when the study is completed.

Address: ________________________________________
Number and Street

City and State / Zip Code

Date:__________ Initial:__________

**CHILD ASSENT FORM**

Title of Research: Environmental Color for Pediatric Patient Room Design

1. I am asked to be in a research study. Research helps people learn new things. The researcher is trying to learn more about children's favorite colors.

2. If I want to join this study, I will do it in my room. In the room, I will see small size model rooms. Those rooms have different color-painted walls. I will be asked to think about how much I like those rooms with the different colors. I only need to look at the models and give my feelings about them. To keep the colors looking clear the models have their own lights inside; this means that the light in my room will be off during the experiment. To make sure I am comfortable, an observer will be there to observe the experiment. The whole process takes only 20 minutes. Other than the researcher, no one will know my responses. There are no right or wrong answers because this is not a test.

3. To join this study will not reward me directly. But, people will learn more about children's favorite colors because of my help. It will also be fun to see colorful models. There will be no danger.

4. I need talk to my parents about it before I say "yes" or "no". My parents will also be asked to give their permission for me to join this study. But even if my parents say "yes", I can still say "no".

5. If I say "no", I don't have to do this. No one will be upset if I don't want to. Even if I change my mind later and want to stop, nothing bad will happen to me.

6. If I do not feel comfortable, I can stop at any time.

7. I can ask questions any time.

8. My parents and I will be given a copy of this form to keep after I have signed it.

**My parent has said it's okay for me to join if I want to. I know that I can stop at any time and nothing bad will happen to me after I stop. I have read this letter and I want to be in this study. If I cannot read the letter, my mom or dad has read it to me and I understand what it says.**

______________________________

Name of Child (please print)

______________________________ ______________

Signature of Child Date

______________________________ ______________

Jin Gyu Park (Signature of Investigator) Date

Department of Architecture, Texas A&M University
College Station, TX 77843-3137
(979)204-6596 / jgpark@neo.tamu.edu

# APPENDIX J

# SCOTT & WHITE INSTITUTIONAL REVIEW BOARD,

# PARENTAL PERMISSION FORM, AND CHILD ASSENT FORM

# FOR EXPERIMENT II (MAIN STUDY)

Scott & White Institutional Review Board
Federalwide Assurance #00003358

Notification of IRB Action

| | | | |
|---|---|---|---|
| To: Jin Gyu Park | | cc: | Tasha Burwinkle, Ph.D.<br>Emily C. Brockway<br>Grants Administration Office<br>Biostatistics Department<br>Texas A&M University IRB |

Project ID: 060728

Title: Environmental Color for Pediatric Patient Room Design

Level of Review: Expedited
Expedited Review Category: 45 CFR 46.110(b)(1)(7)

Type of Action: Approval

Date of Action: 10/13/2006

Pediatric Category: 45 CFR 46.404 *(Research not involving greater than minimal risk)*

Approval period: 10/13/2006 to 10/9/2007

Continuing review deadline: 8/31/2007*

***You are responsible for ensuring IRB approval is obtained for the continuation of your project by submitting the required progress report and supporting documentation by the continuing review deadline.**

1. Review Response Submission Form, Version 1.0
2. Research Application Form, Version 1.0
3. Protocol, Environmental Color for Pediatric Room Design, Version 1.0
4. Child Assent Form dated 9/21/2006
5. Consent Form with Privacy Authorization dated 10/12/2006
6. Research Design, Version 1.0
7. Parent Form, Version 1.0
8. Ishihara sample plate, Version 1.0
9. Self Assessment Manikin, Version 1.0
10. PedsQL, Version 1.0
11. Six Differently Colored Rooms, Version 1.0
12. Cover letter, Version 1.0
13. TAMU IRB approved application
14. TAMU IRB approval letter

2401 S. 31st St., Alexander Bldg., Temple, Texas 76508 Phone: 254-724-7773/8393 Fax: 254-724-1710

Investigator Responsibilities:

- Conduct the informed consent process without coercion or undue influence, while giving subjects sufficient time to consider participation in the research
- Obtain consent with the currently approved and IRB-stamped version of the consent form
- Document the consent process in the subject's case history record prior to their participation in the research
- Conduct the study according to the currently approved protocol, institutional policies, and all applicable regulations
- Obtain approval from the IRB of any changes in the research prior to implementation except where necessary to eliminate apparent immediate hazards to human subjects. Such urgent changes must be reported to the IRB within five (5) working days.
- Personally supervise or conduct the research and ensure appropriate delegation of tasks
- Maintain complete and accurate study records and make them available for inspection
- Notify the IRB Office of any external inspections of the research
- Report unexpected adverse outcomes to the IRB within five (5) working days of knowledge of each occurrence
- Assume responsibility for initial and continuing review of the research by the IRB

IRB Responsibilities:

- Review and have authority to approve, require modifications in or disapprove all research activities
- Ensure all requirements for approval of research are satisfied in accordance with federal regulations
- Report any serious or continuing non-compliance by investigators to the appropriate institutional officials, the Office for Human Research Protections, the Food and Drug Administration and any other appropriate regulatory agencies
- Suspend or terminate approval of research that is not being conducted in accordance with the IRB's requirements or that has been associated with unexpected serious harm to subjects
- Determine that all criteria for IRB approval of research are met as stipulated in the federal regulations
- Require that information given to subjects as part of informed consent is in accordance with federal regulations
- Conduct continuing review of research at intervals appropriate to the degree of risk but not less than once per year, including the authority to observe or have a third party observe the consent process and research

Signature applied by Stephanie A. Worley on 10/13/2006 12:04:00 PM

IRB Administrator and Authorized Representative of the Scott & White IRB

2401 S. 31st St., Alexander Bldg., Temple, Texas 76508 Phone: 254-724-7773/8393 Fax: 254-724-1710

December 18, 2006

**CONSENT FORM and**
**AUTHORIZATION FOR USE AND DISCLOSURE**
**OF HEALTH INFORMATION for Research Purposes**

*Environmental Color for Pediatric Patient Room Design*

**SCOTT & WHITE CLINIC**
**SCOTT AND WHITE MEMORIAL HOSPITAL AND**
**SCOTT, SHERWOOD AND BRINDLEY FOUNDATION**
**TEMPLE, TEXAS 76508**

This is a non-funded research project. Neither the investigator nor Scott & White will receive payment from an outside source for the costs related to the conduct of this study.

Before you agree to volunteer to take part in this research study, it is very important that you understand the purpose of the study, the nature of the tests and procedures you will be asked to undergo and how health information about you may be used or given to others during the study and after the study is finished.

**Purpose and Background**

This research study is being conducted by Mr. Jin Gyu Park (Principal Investigator), a doctoral student in the Department of Architecture at Texas A&M University. Mr. Park is not an employee of Scott & White. The information collected in this research study will be used in Mr. Park's doctoral dissertation.

The purpose of this study is to investigate the value of color as a component in a healing environment for pediatric patient rooms. We want to find out more about children's color preferences in a healing environment. We are studying and comparing pediatric patients' color preferences to healthy children's color preferences and to design professionals' color preferences on pediatric patient room design. Your child will be one of 120 children in this project.

**Procedures**

1. Your child will be shown a picture and asked to tell the researcher what he/she sees. This picture tests color deficiency. If your child cannot correctly identify the picture he/she will not be eligible to participate.
2. Your child will choose a picture that best represents his/her current mood.
3. Your child will be shown a picture of six differently colored rooms will pick which color room he/she likes the best.

December 18, 2006

4. Your child will be shown a model displaying six differently colored patient rooms, and asked to indicate his/her preferences for each color. These will be illuminated and shown to your child with the main room lights off and the windows covered. This is so the colors appear the same for everyone who participates in this research study. Your child can ask for the lights to be turned on or the blinds to be opened at any time.
5. Your child can refuse to answer any questions he/she wishes.

**Length of Study and Number of Visits**
Your child will participate in one session which is expected to last about 20 minutes. This will take place in his/her patient room. When the session is over your child has completed his/her participation in the research study.

**Exclusions**
You should not participate in this study if any of the following apply to you:
There are several reasons that your child may not be eligible to participate. For example, this research study focuses on color preferences so if your child is color blind he/she should not participate. If your child has any mental illness or chronic condition that may impair your child's ability to participate will be determined on an individual basis by the research staff.

**Discomfort and Risks**
We do not think that you or your child will be at any significant risk or discomfort if you participate in this study. You may find some questions difficult to answer (but there are no wrong answers!). Other questions might make your child feel uncomfortable. Your child can refuse to answer any of the questions and can stop participation at any time.

**Benefits**
There is no direct benefit to you or your child for participating in this study. However, you may help us find the best colors to use in pediatric patient rooms.

**Alternative Therapies**
You have the alternative of not participating in this study.

**Cost and Compensation**
There is no cost to you for participating. There is no compensation for participation in this research study.

**Compensation for Medical Treatments for Research-Related Adverse Events**

December 18, 2006

In the event of injury or illness resulting from this research procedure, medical care will be available to you. There are no plans for financial compensation or free medical treatment to be offered by Scott & White Clinic or Scott and White Memorial Hospital, and Scott, Sherwood and Brindley Foundation.

**Termination of Subject Participation**
Your or your child's participation may be terminated at any time by the research staff and/or the Principal Investigator without your consent. Examples for removal from the study are: at your request, the study closes, or if it is in the best interest of your child.

**Confidentiality**
Study records that identify you will be kept confidential as required by law. The health information that may be used and/or disclosed to conduct the study includes medical records and information created or collected during the study.

Health information that identifies you will be used for medical, statistical and regulatory purposes related to research. By agreeing to participate in this research, you are giving authorization for the research team to use and report the results of treatments, tests and examinations conducted for the purposes of this research and for matters related to study oversight and data analysis to:

- the Scott & White Institutional Review Board (IRB – a group of people who strive to protect the rights of subjects)
- the Scott & White Research Compliance Office or Privacy Office.
- Scott & White employees involved in this study.
- local, state and federal agencies (such as the Office for Human Research Protections and the U.S. Food and Drug Administration) when required by law.
- other non-Scott & White collaborators at Texas A&M University who are participating in this study.

Once health information about you has been disclosed to anyone outside of this study, the information may no longer be protected by the federal privacy regulation.

This study is anonymous and the subject's name will not be recorded and released. Only subject's age, gender, ethnicity, and responses to the colors will be recorded. The records of this study will be kept private and only the researcher will have access to the records. No identifiers relating to your child to the study will be included in any sort of report that might be published. You will not be identified by name, picture or any other personally identifying manner if information from this study is presented publicly or published in a medical journal. The records will be stored in a locked cabinet for 3 years after the completion of the study and then destroyed.

**Right to Withdraw Consent and Authorization**

Participation in this study is voluntary. You may withdraw from participation and/or revoke your authorization for the use of private information at any time during the study. Your decision to withdraw and/or revoke your authorization will not result in any penalty or loss of benefits to which you are entitled. Your decision will not affect the medical care you receive at Scott & White. You have a right to revoke your authorization. A request to revoke an authorization must be submitted in writing to *Jin Gyu Park, Department of Architecture, Texas A&M University, College Station, TX 77843-3137*. Revoking your authorization only affects uses and sharing of information collected after your written request has been received. Information collected prior to revoking the authorization may continue to be used and disclosed for research integrity and reporting purposes only.

**Right to Access**

You have a right to access your private health information, including health information that is collected for the research. However, in order to protect the integrity of the study, your right to access your research records may be suspended during the conduct of the study. If you would like a summary of the results when the study is completed you can indicate this on the Parent Form.

This Authorization does not have an expiration date.

**Whom to Contact for Questions or Emergencies**

If you have additional questions during the course of this study about your rights as a research subject, you may address them to the IRB Office at (254) 724-4072. If you have any questions about the research or in the case of injury or illness resulting from the research, please contact Jin Gyu Park at (979) 204-6596 or Tasha Burwinkle, PhD at (254) 724-9518.

If you have not already received a copy of the Notice of Privacy Practices, you may request one. If you have any questions or concerns about your privacy rights, you should contact the Scott & White Privacy Office at Ph: (254) 724-7600.

December 18, 2006

**Participation**
Participation in this study is voluntary and refusal to participate will involve no penalty or loss of benefits to which you are otherwise entitled. If you decide not to sign the Authorization, you will not be allowed to participate in the research study. You and your child can skip or refuse to answer any questions you wish.

**Statement of Consent and Authorization**
The research study has been explained to me and I have had an opportunity to read this consent form/authorization and have all of my questions answered. I have been informed that I may leave the study at any time without affecting my medical care and the Investigator or my doctor may withdraw me from the study without my consent. I freely agree to take part in this research and authorize the research team to create, obtain, use or disclose personally identifiable information in connection with this study. A signed copy of this consent form/authorization will be given to me.

__________________________
**Printed Name of Subject (Child)**

| __________________________ | __________________________ | __________ |
|---|---|---|
| **Printed Name of Legal Representative** | **Signature** | **Date** |

________________________________________
**Legal Relationship to Subject**

**Statement of Person Obtaining Consent**
I have carefully explained to the subject the nature of the study. I hereby certify that to the best of my knowledge the subject signing this consent form/authorization understands clearly the nature, demands, risks and benefits involved in participating in this study. A medical problem or language or educational barrier has not prevented a clear understanding of the subject's involvement in this study.

| __________________________ | __________________________ | ________ |
|---|---|---|
| Printed Name of Person Obtaining Consent | Signature | Date |

9/21/06
Rev. 10/12/06
Rev. 12/18/06

September 21, 2006

ASSENT FORM
AND
INFORMATION ABOUT

Environmental Color for Pediatric Patient Room Design

SCOTT & WHITE CLINIC
SCOTT AND WHITE MEMORIAL HOSPITAL AND
SCOTT, SHERWOOD AND BRINDLEY FOUNDATION
TEMPLE, TEXAS 76508

*What is a research study?*
A research study is something like a school science project, but harder to do. When a doctor and scientists want to learn more about what children think, they have ask them.

*Why do you want me in this study?*
We are trying to learn more about children's favorite colors and what colors they like to see in a hospital room.

*What do I have to do?*
If you choose to be in this study, Mr. Park will:

- Ask your parent to fill out a form that tells us a little bit about who you are
- Show you a picture and ask you to tell him what you see
- Ask you to pick a picture that shows your mood right now
- Show you a picture of six differently colored rooms and ask you to pick which one you like the best
- Show you six differently colored rooms and ask you to tell him what you think about each one. Because we want the colors to look the same for everyone, the main lights in your room will be turned off and the blinds will be closed during this part of the research study. You can tell Mr. Park if you would like him to turn the lights back on.

You don't have to answer any questions that you don't want to answer.

You can ask any questions you want before you decide if you want to be in this research study or not. Mr. Park will answer your questions. If you have a question later that you didn't think of now, you can ask later.

September 21, 2006

*What if I do not want to be in this study?*
You do not have to be in this study if you do not want to. No one will be mad at you. Your doctors will continue to take good care of you. If you decide to be in the study, but change your mind, you can stop being in the study.

If you do not want to be in the study anymore, tell Mr. Park.

*Will anything good happen if I am in the study?*
If you decide to be in the study, we might find out things that will help other children some day.

If you want to be in this study, please sign your name.

I, ________________________________, want to be in this research study.
(write your name here)

| ______________________________ | ______________________________ | __________ |
|---|---|---|
| Printed Name of Person Obtaining Assent | Signature | Date |

9/21/06

# APPENDIX K

## CONSENT FORM AND QUESTIONNAIRE

## FOR DESIGN PROFESSIONALS FOR EXPERIMENT II (MAIN STUDY)

**CONSENT FORM**
**Environmental Color for Pediatric Patient Room Design**

I have been asked to participate in a research study on "*Environmental Color for Pediatric Patient Room Design*". This study needs three different groups which include healthy children, unhealthy children (as users of patient rooms), and design professionals. I was selected to be a possible participant because I am a design professional. A total of 60 design professionals have been asked to participate in this study.

The purpose of this study is to investigate the value of color as a component in a healing environment for pediatric patient rooms. If I agree to participate in this study, I will be asked to indicate my color preferences from a series of scale-models. This study will take approximately 20 minutes to complete. There is no risk associated with this study other than the possibility that I might feel uncomfortable being in a novel research setting. My participation will not benefit nor harm me in any way.

This study is anonymous and my name will not be recorded and released. Only my age, gender, ethnicity, field of work, and responses to the colors will be recorded. The records of this study will be kept private and only the researcher will have access to the records. No identifiers related to me to the study will be included in any sort of report that might be published. The records will be stored in a locked cabinet for 3 years after the completion of the study and then destroyed.

I understand that my participation is strictly voluntary and my decision whether or not to participate will not affect my current or future relations with Texas A&M University. If I decide to participate, I am free to refuse to answer any of the questions that may make me uncomfortable. Upon completion of the study, I understand that I may request a copy of the results.

This research study has been reviewed and approved by the Institutional Review Board - Human Subjects in Research, Texas A&M University. For research-related problems or questions regarding subjects' rights, I can contact the Institutional Review Board through Ms. Angelis M. Raines, Director of Research Compliance, Office of the Vice President for Research at (979)458-4067, araines@vprmail.tamu.edu.

I have read above information. I have asked questions and have received answers to my satisfaction. I understand that I may withdraw my consent at any time without penalty. I have given a copy of this consent document for my records. By signing this document, I consent to participate in the study.

Date:____________ Initial:__________

**CONSENT FORM**
**Environmental Color for Pediatric Patient Room Design**

*I agree to participate in this study and I have been given a copy of this consent form.*

| ______________________ | ______________________ | __________ |
| --- | --- | --- |
| Signature of Participant | Printed Name | Date |

______________________ __________

Jin Gyu Park (Principal Investigator) Date

College of Architecture
Texas A&M University
College Station, TX 77843-3137
(979)204-6596
jgpark@neo.tamu.edu

Dr. Mardelle M. Shepley (Advisor of Investigator)
College of Architecture
Texas A&M University
College Station, TX 77843-3137
(979)845-7009
mardelle@archone.tamu.edu

☐ I would appreciate a copy of a summary of the results when the study is completed.

Address: ______________________
Number and Street

______________________ __________
City and State Zip code

Date: __________ Initial: __________

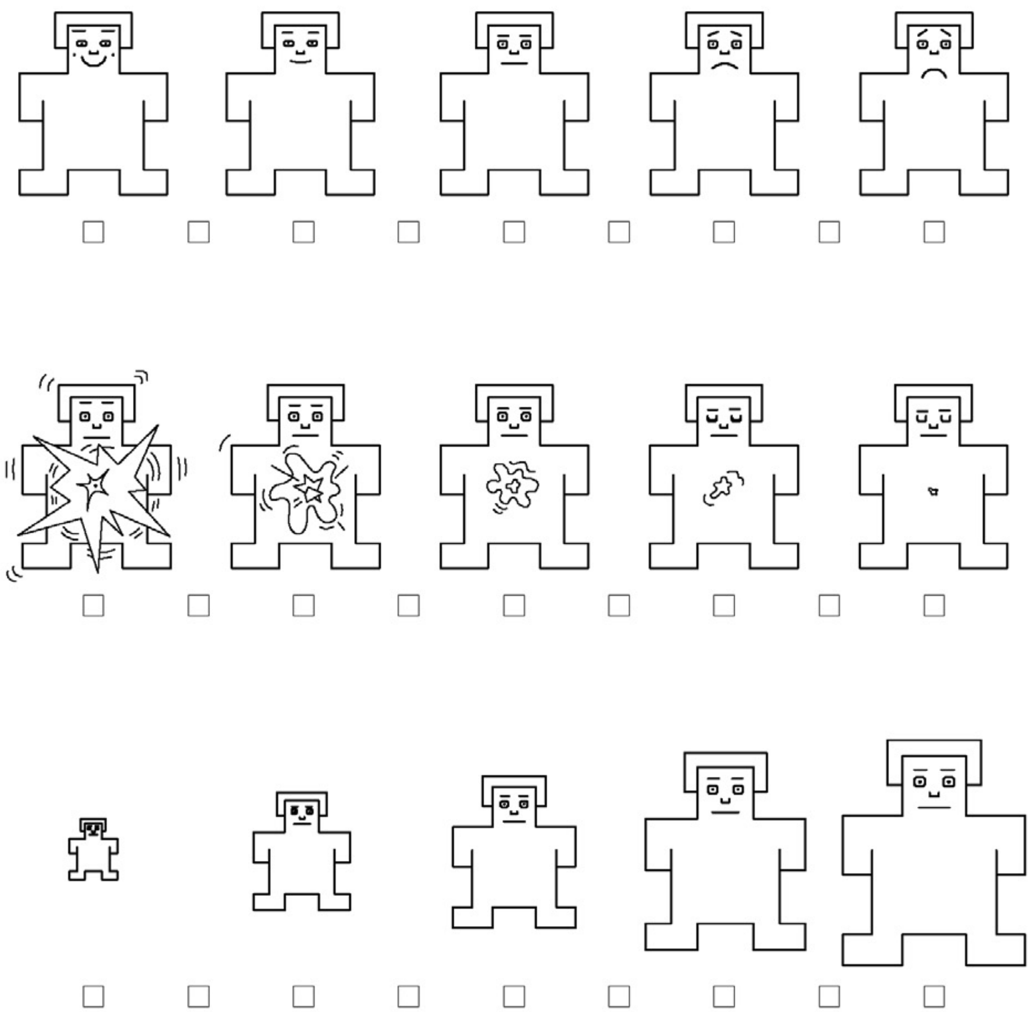
## COLOR PREFERENCE FOR DESIGN PROFESSIONALS

Please take a few minutes to look at the patient rooms and answer the following questions. The purpose of this questionnaire is to investigate the color preferences of design professionals. Thank you for your participation in this research study.

**PART 1. EMOTIONAL STATE**

Please check on the boxes in each row that best shows **how you feel now**.

# How do you feel now?



Self-Assessment Manikin (SAM), adapted from Bradley, M. M., & Lang, P. J. (1994). Measuring emotion: The Self-Assessment Manikin and the semantic differential. *Journal of Behavior Therapy and Experimental Psychiatry, 25*, 49-59.

**PART 2. COLOR SELECTIONS FOR PEDIATRIC PATIENT ROOM**

Please indicate your response by writing in the blanks provided and by checking the most appropriate selection.

1. Which color is the most appropriate for a pediatric patient room?
   Room # ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ Don't know

2. Why did you choose the above color in question 1?

   ______________________________________________________________

   ______________________________________________________________

3. Which color is the least appropriate for a pediatric patient room?
   Room # ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ Don't know

4. Why did you choose the above color in question 3?

   ______________________________________________________________

   ______________________________________________________________

   ______________________________________________________________

**PART 3. PREFERENCE RATING**

**DIRECTIONS**

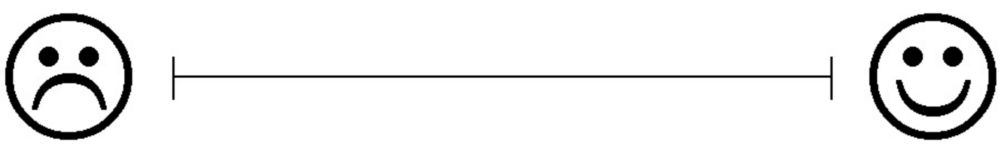
Please put a vertical mark on the line that best shows **how much you like this color for <u>a pediatric patient room</u>.**

If you like this color a lot, put a vertical mark at the end of the line by the happy face.

If you do not like this color that much, put a vertical mark near the middle of the line.

If you do not like this color at all, put a vertical mark by the sad face.

# How much do you like this color for <u>a pediatric patient room</u>? (Room # 1)



**Not at all**
**Inappropriate**

**A lot**
**Appropriate**

PART 3. PREFERENCE RATING (CONTINUED)

**DIRECTIONS**

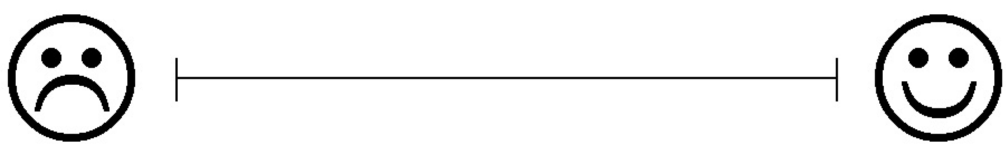
Please put a vertical mark on the line that best shows **how much you like this color for a pediatric patient room.**

If you like this color a lot, put a vertical mark at the end of the line by the happy face.

If you do not like this color that much, put a vertical mark near the middle of the line.

If you do not like this color at all, put a vertical mark by the sad face.

# How much do you like this color for a pediatric patient room? (Room # 2)



**Not at all Inappropriate**

**A lot Appropriate**

PART 3. PREFERENCE RATING (CONTINUED)

**DIRECTIONS**

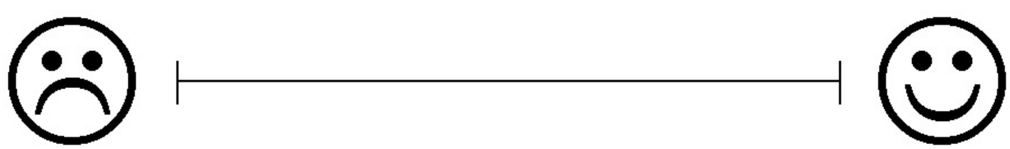
Please put a vertical mark on the line that best shows **how much you like this color for <u>a pediatric patient room</u>.**

If you like this color a lot, put a vertical mark at the end of the line by the happy face.

If you do not like this color that much, put a vertical mark near the middle of the line.

If you do not like this color at all, put a vertical mark by the sad face.

# How much do you like this color for <u>a pediatric patient room</u>? (Room # 3)



**Not at all Inappropriate**

**A lot Appropriate**

PART 3. PREFERENCE RATING (CONTINUED)

**DIRECTIONS**

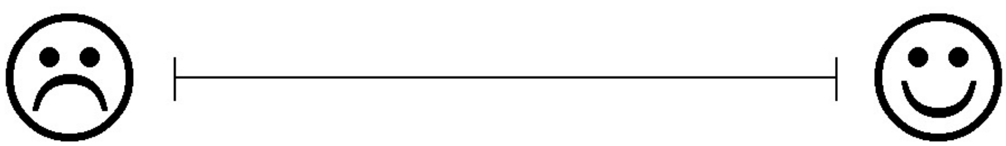
Please put a vertical mark on the line that best shows **how much you like this color for <u>a pediatric patient room</u>.**

If you like this color a lot, put a vertical mark at the end of the line by the happy face.

If you do not like this color that much, put a vertical mark near the middle of the line.

If you do not like this color at all, put a vertical mark by the sad face.

# How much do you like this color for <u>a pediatric patient room</u>? (Room # 4)



**Not at all**
**Inappropriate**

**A lot**
**Appropriate**

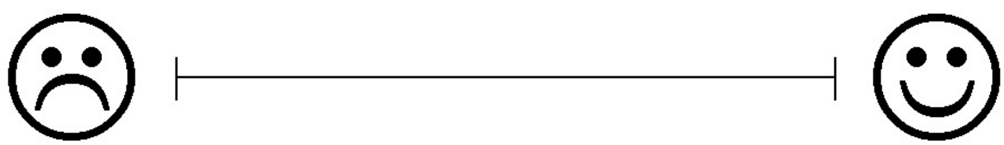
PedsQL 3.0
07/02

PART 3. PREFERENCE RATING (CONTINUED)

**DIRECTIONS**

Please put a vertical mark on the line that best shows **how much you like this color for <u>a pediatric patient room.</u>**
If you like this color a lot, put a vertical mark at the end of the line by the happy face.
If you do not like this color that much, put a vertical mark near the middle of the line.
If you do not like this color at all, put a vertical mark by the sad face.

# How much do you like this color for <u>a pediatric patient room</u>? (Room # 5)



**Not at all**
**Inappropriate**

**A lot**
**Appropriate**

PART 3. PREFERENCE RATING (CONTINUED)

**DIRECTIONS**

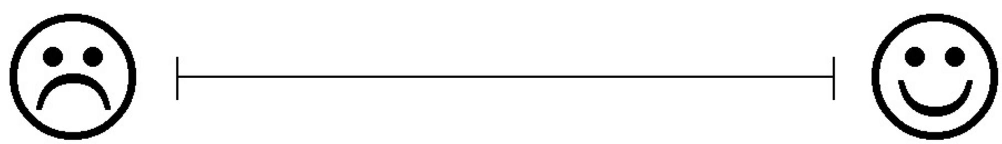
Please put a vertical mark on the line that best shows **how much you like this color for a pediatric patient room.**

If you like this color a lot, put a vertical mark at the end of the line by the happy face.

If you do not like this color that much, put a vertical mark near the middle of the line.

If you do not like this color at all, put a vertical mark by the sad face.

# How much do you like this color for a pediatric patient room? (Room # 6)



**Not at all Inappropriate** | **A lot Appropriate**

**PART 4. PERSONAL INFORMATION**

Please indicate your response by writing in the blanks provided or by checking the most appropriate selection.

1. Date of Birth (month/day/year):____________________

2. Gender:
   ☐ Female ☐ Male

3. Ethnicity:
   ☐ Caucasian/White ☐ Hispanic/Latino
   ☐ African American/Black ☐ Native American/American Indian
   ☐ Asian American/Asian ☐ Other. Please specify:_______________

4. Field of Work

| *Field* | *Years of Experience* |
| --- | --- |
| ☐ Healthcare Designer | ____________________ |
| ☐ Architectural Designer | ____________________ |
| ☐ Interior Designer | ____________________ |
| ☐ Other. Please specify:______________________ | ____________________ |

☺☺☺ **Thank you** ☺☺☺

# APPENDIX L

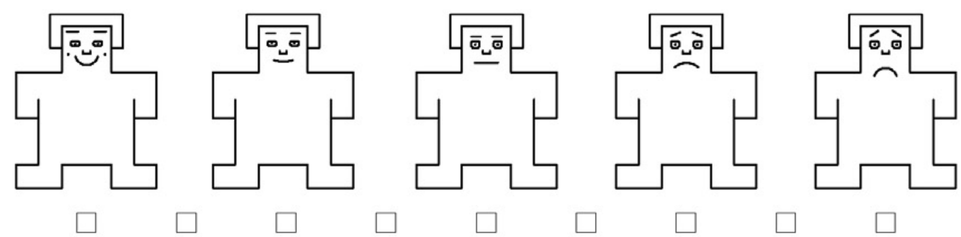
## SELF ASSESSMENT MANIKIN

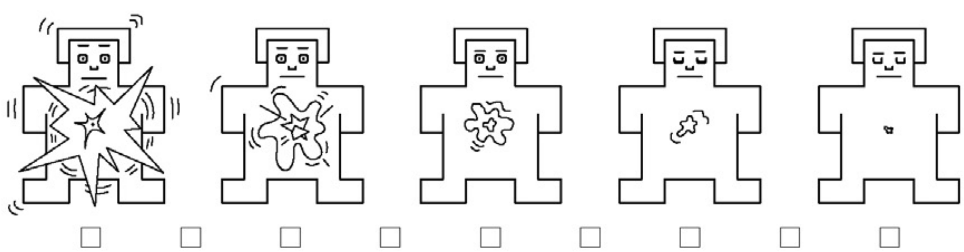
**Self-Assessment Manikin**

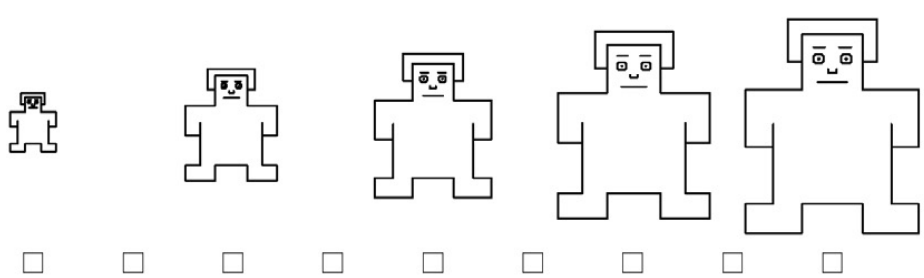
**DIRECTION**

Please check on the boxes in each row that best shows **how you feel now**.

# How do you feel now?







Self-Assessment Manikin (SAM), adapted from Bradley, M. M., & Lang, P. J. (1994). Measuring emotion: The Self-Assessment Manikin and the semantic differential. *Journal of Behavior Therapy and Experimental Psychiatry, 25*, 49-59.

# APPENDIX M

## PEDIATRIC HEALTH-RELATED QUALITY OF LIFE INVENTORY

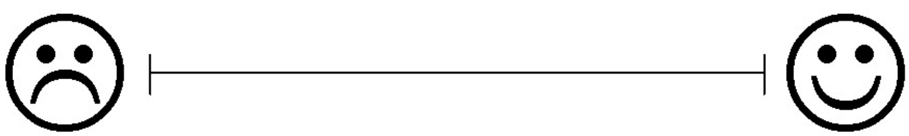
**PedsQL™**

**Child Self-Report**

**DIRECTIONS**

Please put a mark on the line that best shows **how much you like this color**.
If you like this color a lot, put a vertical mark at the end of the line by the happy face.
If you do not like this color that much, put a vertical mark near the middle of the line.
If you do not like this color at all, put a vertical mark by the sad face.

## How much do you like this color?



**Not at all** **A lot**

# APPENDIX N

## TEKTRONIX J18 LUMACOLOR PHOTOMETER SYSTEM

Tektronix J18 LumaColor™ Photometer System has several measurement heads. Two major components for the experiments were a chromaticity head (J1810) and an illuminance head (J1811). The chromacity head measures chromacity readings in either the 1931 CIE system or the 1976 CIE-UCS system. The photometer displays either xy, u'v', or XYZ values. The XYZ tristimulus values are used to calculate the chromaticity of a color. The 1931 CIE (Commission Internationale de L'Eclariage) chromaticity has been used to graphically depict the color characteristics of hue and saturation for cathode ray tube (CRT) phosphors. The illuminance head measures the levels of office lighting, artificial lighting, outdoor lighting, etc. This photometer system is used for measuring and controlling the characteristics of light sources.



**J1810 Performance Characteristics**

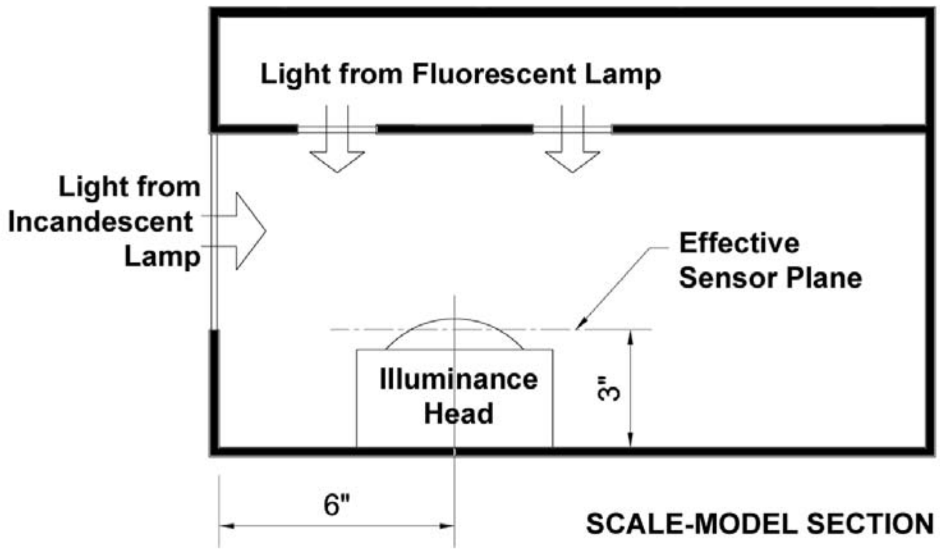
| Characteristic | Standard |
|---|---|
| Accuracy (including non-linearity) | Within ±0.009 of x,y value and ±5% of luminance (D6500, 20° C to 30° C, <75% relative humidity) |
| Spectral Response | CIE Tristimulus |
| Spectral Accuracy | $f_1'$ = <3% (DIN class A) |
| Acceptance Angle | 16° |

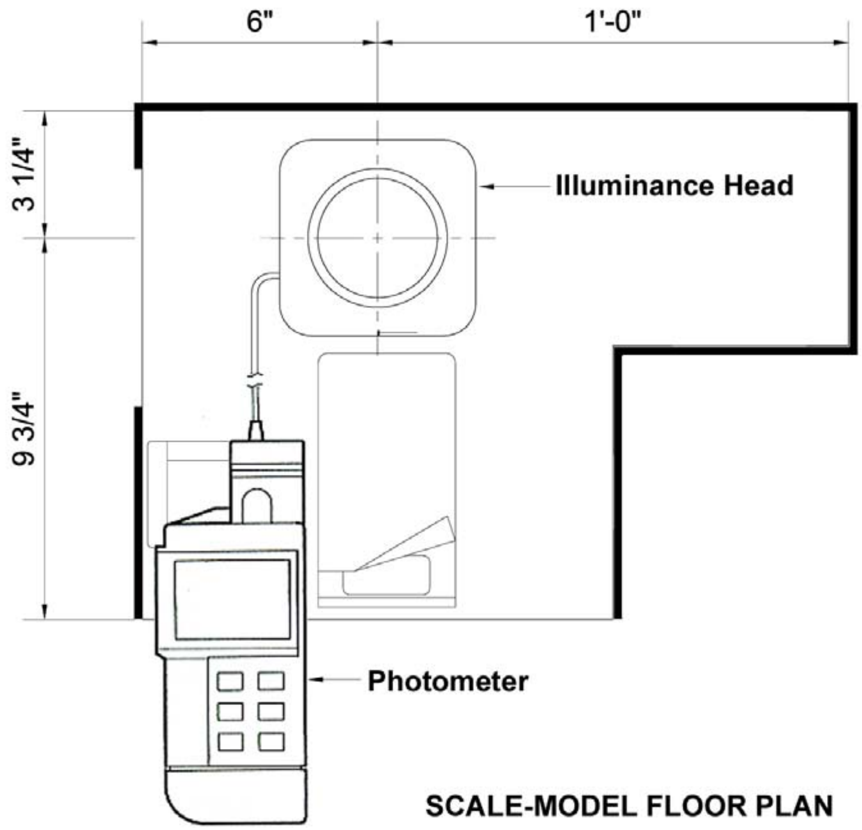
**J1811 Performance Characteristics**

| Characteristic | Standard |
|---|---|
| Accuracy (including non-linearity) | 5% of reading ± 2 counts (Illuminant A at 1000 cd/m$^2$ 20° C to 30° C, <75% relative humidity) |
| Spectral Response | CIE photopic (See Figure A–1 on page A–4) |
| Spectral Accuracy | $f_1'$ = <3% (DIN class A) |
| Acceptance Angle | Cosine corrected (180°) |

# APPENDIX O

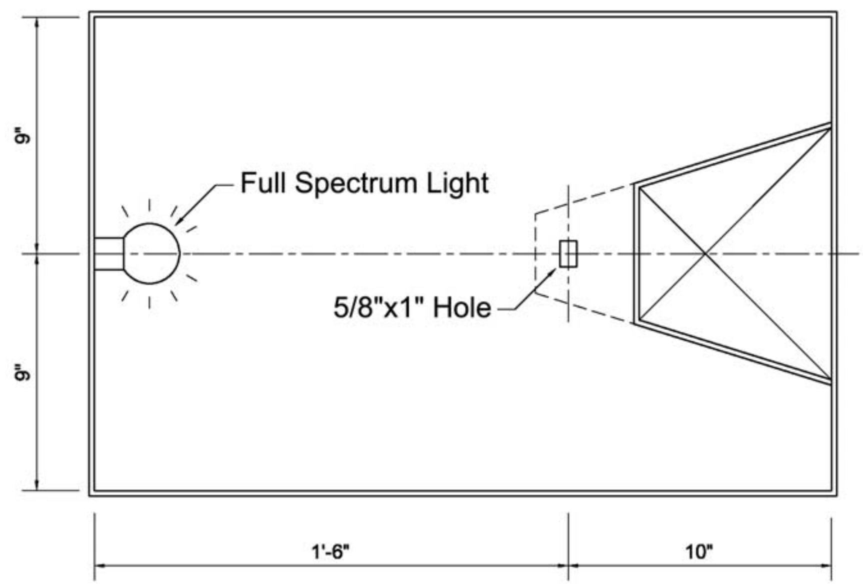
## ILLUMINANCE LEVEL MEASUREMENT INSIDE THE SCALE-MODELS



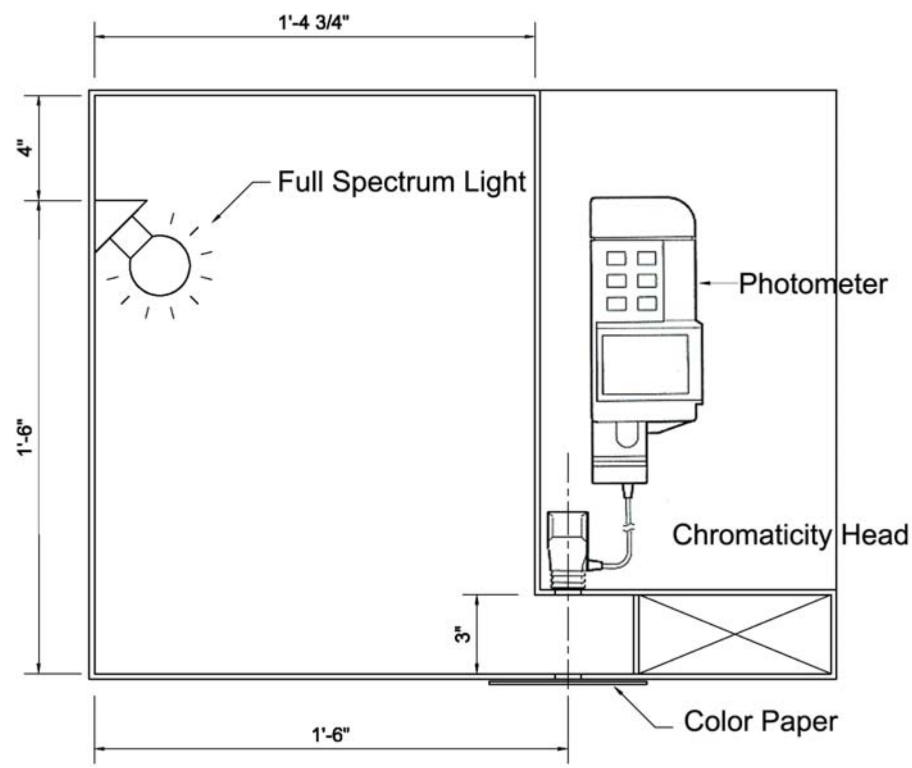



**APPENDIX P**

**CHROMATIC VALUES OF THE COLORS ON MATT PAPER IN ISOLATION**




MEASUREMENT BOX PLAN



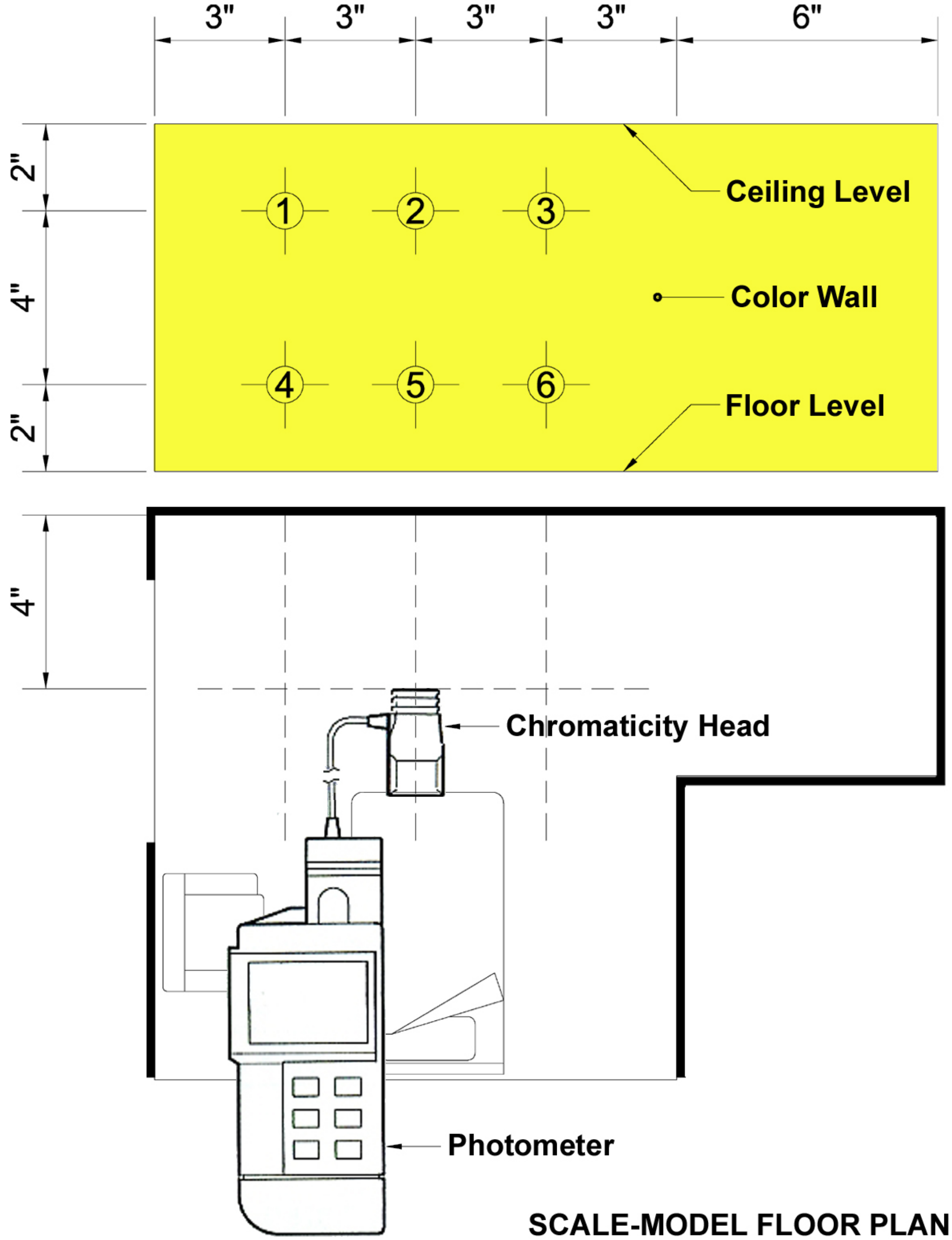

MEASUREMENT BOX SECTION

| Hue | Brightness/Saturation | Chromatic Value | | |
|---|---|---|---|---|
| | | X | Y | Z |
| 5R | 9/2 | 1101.0 | 1133.0 | 789.6 |
| | 8/5 | 992.0 | 912.8 | 560.5 |
| | 8/2 | 844.3 | 870.6 | 615.0 |
| | 7/8 | 862.3 | 718.6 | 380.0 |
| | 7/5 | 749.1 | 683.6 | 420.0 |
| | 7/2 | 633.9 | 643.0 | 442.4 |
| | 6/8 | 632.5 | 515.5 | 280.3 |
| | 6/5 | 553.9 | 497.0 | 310.4 |
| | 6/2 | 458.5 | 465.1 | 324.3 |
| 5Y | 9/8 | 1094.0 | 1151.0 | 283.9 |
| | 9/5 | 1080.0 | 1148.0 | 412.2 |
| | 9/2 | 1050.0 | 1131.0 | 627.2 |
| | 8/8 | 862.4 | 906.1 | 214.8 |
| | 8/5 | 818.1 | 877.1 | 326.7 |
| | 8/2 | 809.4 | 874.4 | 476.8 |
| | 7/8 | 637.0 | 655.8 | 142.4 |
| | 7/5 | 638.9 | 670.3 | 237.8 |
| | 7/2 | 600.2 | 641.7 | 351.7 |
| 5G | 9/2 | 962.4 | 1128.0 | 774.4 |
| | 8/5 | 628.2 | 840.4 | 510.8 |
| | 8/2 | 726.6 | 861.3 | 609.4 |
| | 7/8 | 448.4 | 670.2 | 371.6 |
| | 7/5 | 492.3 | 654.6 | 399.5 |
| | 7/2 | 533.0 | 636.7 | 434.2 |
| | 6/8 | 300.7 | 463.2 | 263.1 |
| | 6/5 | 350.7 | 467.6 | 288.1 |
| | 6/2 | 400.9 | 466.2 | 315.6 |

| Hue | Brightness/Saturation | Chromatic Value | | |
|---|---|---|---|---|
| | | X | Y | Z |
| 5B | 9/2 | 993.2 | 1118.0 | 915.0 |
| | 8/5 | 681.2 | 838.7 | 849.0 |
| | 8/2 | 764.1 | 864.9 | 730.7 |
| | 7/8 | 491.4 | 644.4 | 770.9 |
| | 7/5 | 526.4 | 645.9 | 666.8 |
| | 7/2 | 563.7 | 642.9 | 568.3 |
| | 6/8 | 335.0 | 444.4 | 602.1 |
| | 6/5 | 378.2 | 465.7 | 495.4 |
| | 6/2 | 426.9 | 480.6 | 409.1 |
| 5P | 9/2 | 1099.0 | 1151.0 | 898.3 |
| | 8/5 | 913.0 | 896.3 | 811.5 |
| | 8/2 | 843.0 | 882.2 | 718.4 |
| | 7/8 | 766.7 | 682.1 | 742.9 |
| | 7/5 | 692.1 | 671.3 | 649.0 |
| | 7/2 | 639.2 | 666.7 | 563.9 |
| | 6/8 | 561.1 | 496.1 | 573.9 |
| | 6/5 | 508.1 | 491.1 | 486.5 |
| | 6/2 | 465.0 | 482.6 | 402.0 |
| N | 9.5/ | The light source seemed too bright for the photometer to measure chromatic values of the white on matt paper. | | |

# APPENDIX Q

## VISUAL QUALITIES OF THE COLORS INSIDE THE SCALE-MODELS



| Hue | Brightness/Saturation | Spot # | Chromatic Value | | |
|---|---|---|---|---|---|
| | | | X | Y | Z |
| 5R | 9/2 | 1 | 146.4 | 125.8 | 48.0 |
| | | 2 | 97.8 | 87.6 | 34.8 |
| | | 3 | 68.0 | 64.0 | 26.0 |
| | | 4 | 143.6 | 117.8 | 38.6 |
| | | 5 | 113.2 | 93.5 | 34.6 |
| | | 6 | 86.2 | 73.2 | 28.1 |
| | 8/5 | 1 | 137.2 | 105.7 | 36.5 |
| | | 2 | 90.4 | 71.8 | 25.7 |
| | | 3 | 62.4 | 51.7 | 18.8 |
| | | 4 | 132.2 | 96.9 | 28.0 |
| | | 5 | 104.6 | 76.9 | 25.4 |
| | | 6 | 79.0 | 59.3 | 20.1 |
| | 8/2 | 1 | 109.9 | 94.3 | 38.9 |
| | | 2 | 71.0 | 63.8 | 27.7 |
| | | 3 | 47.5 | 45.2 | 20.3 |
| | | 4 | 107.0 | 86.7 | 30.3 |
| | | 5 | 83.4 | 68.3 | 27.3 |
| | | 6 | 61.5 | 52.1 | 21.7 |
| | 7/8 | 1 | 123.1 | 86.5 | 27.7 |
| | | 2 | 79.6 | 57.3 | 18.9 |
| | | 3 | 53.9 | 40.8 | 13.5 |
| | | 4 | 116.6 | 77.9 | 20.5 |
| | | 5 | 93.0 | 61.7 | 18.7 |
| | | 6 | 68.1 | 46.4 | 14.3 |
| | 7/5 | 1 | 102.4 | 78.1 | 29.3 |
| | | 2 | 64.7 | 51.2 | 20.1 |
| | | 3 | 42.7 | 35.9 | 14.4 |
| | | 4 | 97.3 | 70.3 | 21.8 |
| | | 5 | 76.3 | 55.3 | 19.8 |
| | | 6 | 55.4 | 41.5 | 15.5 |
| | 7/2 | 1 | 82.7 | 69.4 | 30.0 |
| | | 2 | 51.1 | 45.1 | 20.6 |
| | | 3 | 33.2 | 31.5 | 14.9 |
| | | 4 | 79.1 | 62.6 | 22.5 |
| | | 5 | 61.6 | 49.1 | 20.5 |
| | | 6 | 43.9 | 36.5 | 15.9 |

| Hue | Brightness/Saturation | Spot # | Chromatic Value | | |
|---|---|---|---|---|---|
| | | | X | Y | Z |
| 5R | 6/8 | 1 | 89.0 | 61.2 | 22.3 |
| | | 2 | 55.1 | 39.5 | 15.0 |
| | | 3 | 35.6 | 27.2 | 10.5 |
| | | 4 | 83.2 | 54.3 | 15.9 |
| | | 5 | 65.5 | 42.6 | 14.7 |
| | | 6 | 47.1 | 31.5 | 11.2 |
| | 6/5 | 1 | 74.5 | 56.0 | 22.9 |
| | | 2 | 45.8 | 36.0 | 15.4 |
| | | 3 | 29.0 | 24.6 | 10.8 |
| | | 4 | 69.9 | 49.7 | 16.5 |
| | | 5 | 55.1 | 39.1 | 15.2 |
| | | 6 | 38.7 | 28.7 | 11.6 |
| | 6/2 | 1 | 59.0 | 49.3 | 22.7 |
| | | 2 | 35.3 | 31.4 | 15.3 |
| | | 3 | 22.0 | 21.4 | 10.7 |
| | | 4 | 55.6 | 43.9 | 16.6 |
| | | 5 | 42.9 | 34.3 | 15.1 |
| | | 6 | 29.7 | 25.0 | 11.5 |
| 5Y | 9/8 | 1 | 158.4 | 134.2 | 25.1 |
| | | 2 | 106.0 | 93.3 | 16.9 |
| | | 3 | 74.9 | 68.9 | 12.0 |
| | | 4 | 149.5 | 121.7 | 17.9 |
| | | 5 | 123.1 | 99.6 | 16.4 |
| | | 6 | 93.0 | 77.8 | 12.6 |
| | 9/5 | 1 | 152.1 | 131.5 | 30.7 |
| | | 2 | 101.5 | 91.3 | 21.2 |
| | | 3 | 71.1 | 67.1 | 15.3 |
| | | 4 | 143.3 | 118.9 | 22.3 |
| | | 5 | 118.0 | 97.5 | 20.8 |
| | | 6 | 89.3 | 76.0 | 16.1 |
| | 9/2 | 1 | 141.9 | 125.7 | 40.5 |
| | | 2 | 93.5 | 86.8 | 28.7 |
| | | 3 | 64.2 | 63.0 | 20.9 |
| | | 4 | 133.1 | 114.0 | 30.4 |
| | | 5 | 109.5 | 93.3 | 28.5 |
| | | 6 | 82.3 | 72.5 | 22.6 |

| Hue | Brightness/Saturation | Spot # | Chromatic Value | | |
|---|---|---|---|---|---|
| | | | X | Y | Z |
| 5Y | 8/8 | 1 | 117.4 | 99.5 | 20.6 |
| | | 2 | 75.7 | 66.7 | 13.7 |
| | | 3 | 50.6 | 47.4 | 9.5 |
| | | 4 | 110.2 | 88.5 | 14.5 |
| | | 5 | 89.7 | 71.8 | 13.2 |
| | | 6 | 65.8 | 54.7 | 10.0 |
| | 8/5 | 1 | 112.0 | 97.1 | 26.1 |
| | | 2 | 71.8 | 65.0 | 17.7 |
| | | 3 | 47.9 | 46.2 | 12.5 |
| | | 4 | 104.2 | 85.9 | 18.4 |
| | | 5 | 85.1 | 70.2 | 17.2 |
| | | 6 | 62.3 | 53.3 | 13.2 |
| | 8/2 | 1 | 107.0 | 94.4 | 32.6 |
| | | 2 | 68.6 | 63.7 | 22.7 |
| | | 3 | 45.7 | 45.2 | 16.4 |
| | | 4 | 100.6 | 84.9 | 24.2 |
| | | 5 | 81.7 | 68.8 | 22.5 |
| | | 6 | 59.6 | 52.2 | 17.6 |
| | 7/8 | 1 | 86.0 | 71.1 | 15.9 |
| | | 2 | 53.0 | 46.1 | 10.2 |
| | | 3 | 34.4 | 32.0 | 7.0 |
| | | 4 | 80.2 | 62.7 | 10.9 |
| | | 5 | 64.1 | 50.2 | 10.0 |
| | | 6 | 45.5 | 37.3 | 7.4 |
| | 7/5 | 1 | 84.2 | 71.3 | 20.2 |
| | | 2 | 51.8 | 46.2 | 13.3 |
| | | 3 | 33.3 | 32.0 | 9.2 |
| | | 4 | 78.5 | 62.8 | 14.2 |
| | | 5 | 62.6 | 50.2 | 13.0 |
| | | 6 | 44.2 | 37.3 | 9.9 |
| | 7/2 | 1 | 76.3 | 66.6 | 25.0 |
| | | 2 | 46.6 | 42.9 | 16.8 |
| | | 3 | 29.7 | 29.7 | 11.8 |
| | | 4 | 71.0 | 58.5 | 17.9 |
| | | 5 | 56.2 | 46.6 | 16.6 |
| | | 6 | 39.8 | 34.6 | 12.7 |

| Hue | Brightness/Saturation | Spot # | Chromatic Value | | |
|---|---|---|---|---|---|
| | | | X | Y | Z |
| 5G | 9/2 | 1 | 118.5 | 115.3 | 46.3 |
| | | 2 | 76.9 | 79.2 | 33.3 |
| | | 3 | 51.5 | 57.2 | 24.5 |
| | | 4 | 111.3 | 104.4 | 35.4 |
| | | 5 | 91.2 | 85.4 | 33.4 |
| | | 6 | 67.0 | 66.0 | 26.5 |
| | 8/5 | 1 | 75.2 | 80.9 | 33.7 |
| | | 2 | 46.3 | 53.8 | 23.2 |
| | | 3 | 29.7 | 38.0 | 16.7 |
| | | 4 | 69.6 | 72.3 | 24.9 |
| | | 5 | 55.6 | 58.5 | 23.2 |
| | | 6 | 39.5 | 44.2 | 18.0 |
| | 8/2 | 1 | 88.8 | 86.2 | 38.1 |
| | | 2 | 55.3 | 57.1 | 26.6 |
| | | 3 | 35.7 | 39.9 | 19.2 |
| | | 4 | 82.5 | 77.0 | 28.6 |
| | | 5 | 66.1 | 62.0 | 26.7 |
| | | 6 | 47.3 | 46.7 | 20.9 |
| | 7/8 | 1 | 52.1 | 61.6 | 26.8 |
| | | 2 | 31.4 | 40.5 | 18.2 |
| | | 3 | 19.7 | 28.6 | 13.0 |
| | | 4 | 48.0 | 55.0 | 19.6 |
| | | 5 | 38.1 | 44.2 | 18.1 |
| | | 6 | 26.3 | 33.1 | 13.9 |
| | 7/5 | 1 | 58.4 | 62.2 | 27.7 |
| | | 2 | 35.0 | 40.5 | 18.8 |
| | | 3 | 22.1 | 28.3 | 13.3 |
| | | 4 | 53.9 | 55.0 | 20.1 |
| | | 5 | 42.9 | 44.2 | 18.7 |
| | | 6 | 29.6 | 32.7 | 14.2 |
| | 7/2 | 1 | 64.5 | 62.4 | 28.9 |
| | | 2 | 39.0 | 40.5 | 19.7 |
| | | 3 | 24.3 | 27.9 | 14.0 |
| | | 4 | 59.6 | 55.3 | 21.1 |
| | | 5 | 47.4 | 44.3 | 19.7 |
| | | 6 | 32.9 | 32.6 | 15.1 |

| Hue | Brightness/Saturation | Spot # | Chromatic Value | | |
|---|---|---|---|---|---|
| | | | X | Y | Z |
| 5G | 6/8 | 1 | 34.5 | 41.5 | 20.9 |
| | | 2 | 20.2 | 26.7 | 13.8 |
| | | 3 | 12.2 | 18.5 | 9.6 |
| | | 4 | 31.1 | 36.3 | 14.7 |
| | | 5 | 24.5 | 29.2 | 13.6 |
| | | 6 | 16.6 | 21.6 | 10.3 |
| | 6/5 | 1 | 41.2 | 43.6 | 20.9 |
| | | 2 | 24.3 | 27.8 | 13.8 |
| | | 3 | 14.5 | 19.0 | 9.6 |
| | | 4 | 37.5 | 37.9 | 14.8 |
| | | 5 | 29.2 | 30.3 | 13.6 |
| | | 6 | 19.9 | 22.3 | 10.3 |
| | 6/2 | 1 | 48.4 | 45.7 | 21.7 |
| | | 2 | 28.2 | 28.8 | 14.4 |
| | | 3 | 17.2 | 19.6 | 10.0 |
| | | 4 | 44.3 | 39.8 | 15.3 |
| | | 5 | 34.5 | 31.5 | 14.2 |
| | | 6 | 23.4 | 22.9 | 10.6 |
| 5B | 9/2 | 1 | 120.8 | 114.2 | 52.9 |
| | | 2 | 78.4 | 78.4 | 38.7 |
| | | 3 | 53.2 | 56.9 | 29.2 |
| | | 4 | 113.2 | 103.4 | 41.3 |
| | | 5 | 92.8 | 84.6 | 39.0 |
| | | 6 | 68.4 | 65.3 | 31.5 |
| | 8/5 | 1 | 76.5 | 79.6 | 49.2 |
| | | 2 | 47.9 | 53.2 | 35.7 |
| | | 3 | 31.2 | 37.6 | 26.7 |
| | | 4 | 70.8 | 71.2 | 38.1 |
| | | 5 | 57.3 | 57.8 | 36.0 |
| | | 6 | 41.2 | 43.7 | 29.0 |
| | 8/2 | 1 | 91.2 | 86.3 | 43.4 |
| | | 2 | 57.3 | 57.4 | 31.0 |
| | | 3 | 37.5 | 40.5 | 22.9 |
| | | 4 | 84.7 | 76.8 | 33.0 |
| | | 5 | 67.7 | 61.7 | 30.8 |
| | | 6 | 49.5 | 47.1 | 24.7 |

| Hue | Brightness/Saturation | Spot # | Chromatic Value | | |
|---|---|---|---|---|---|
| | | | X | Y | Z |
| 5B | 7/8 | 1 | 51.6 | 58.1 | 44.9 |
| | | 2 | 31.6 | 38.2 | 32.3 |
| | | 3 | 20.0 | 26.7 | 24.0 |
| | | 4 | 47.1 | 51.4 | 34.3 |
| | | 5 | 37.8 | 41.6 | 32.6 |
| | | 6 | 26.4 | 31.1 | 26.0 |
| | 7/5 | 1 | 59.1 | 60.6 | 39.7 |
| | | 2 | 36.1 | 39.5 | 28.2 |
| | | 3 | 22.9 | 27.4 | 20.6 |
| | | 4 | 54.2 | 53.7 | 30.1 |
| | | 5 | 43.1 | 42.8 | 28.1 |
| | | 6 | 30.1 | 31.8 | 22.1 |
| | 7/2 | 1 | 66.4 | 62.9 | 35.0 |
| | | 2 | 40.7 | 40.9 | 24.5 |
| | | 3 | 25.9 | 28.3 | 17.8 |
| | | 4 | 61.4 | 55.5 | 26.0 |
| | | 5 | 49.2 | 44.5 | 24.5 |
| | | 6 | 34.2 | 33.0 | 19.1 |
| | 6/8 | 1 | 34.0 | 38.6 | 36.0 |
| | | 2 | 20.2 | 24.9 | 25.3 |
| | | 3 | 12.6 | 17.3 | 18.5 |
| | | 4 | 30.4 | 34.2 | 27.1 |
| | | 5 | 24.0 | 27.3 | 25.5 |
| | | 6 | 16.6 | 20.2 | 20.0 |
| | 6/5 | 1 | 42.1 | 42.9 | 30.5 |
| | | 2 | 24.7 | 27.3 | 21.0 |
| | | 3 | 15.2 | 18.8 | 15.2 |
| | | 4 | 38.3 | 37.7 | 22.6 |
| | | 5 | 30.0 | 30.1 | 21.2 |
| | | 6 | 20.6 | 21.9 | 16.3 |
| | 6/2 | 1 | 50.3 | 46.8 | 26.2 |
| | | 2 | 29.9 | 29.8 | 17.7 |
| | | 3 | 18.5 | 20.3 | 12.6 |
| | | 4 | 46.5 | 41.1 | 19.1 |
| | | 5 | 36.3 | 32.6 | 17.7 |
| | | 6 | 25.1 | 23.7 | 13.6 |

| Hue | Brightness/Saturation | Spot # | Chromatic Value | | |
|---|---|---|---|---|---|
| | | | X | Y | Z |
| 5P | 9/2 | 1 | 139.1 | 122.6 | 52.2 |
| | | 2 | 91.4 | 84.3 | 38.1 |
| | | 3 | 63.3 | 61.3 | 28.7 |
| | | 4 | 129.4 | 110.0 | 40.3 |
| | | 5 | 107.2 | 90.6 | 38.3 |
| | | 6 | 80.0 | 70.2 | 30.8 |
| | 8/5 | 1 | 113.7 | 95.0 | 47.3 |
| | | 2 | 72.4 | 62.8 | 33.8 |
| | | 3 | 48.8 | 44.9 | 25.5 |
| | | 4 | 105.7 | 84.5 | 36.3 |
| | | 5 | 86.1 | 68.2 | 34.1 |
| | | 6 | 62.8 | 51.6 | 27.3 |
| | 8/2 | 1 | 104.2 | 91.6 | 42.9 |
| | | 2 | 66.2 | 60.9 | 30.5 |
| | | 3 | 43.9 | 43.2 | 22.6 |
| | | 4 | 96.9 | 81.5 | 32.6 |
| | | 5 | 78.5 | 66.0 | 30.6 |
| | | 6 | 57.0 | 49.8 | 24.2 |
| | 7/8 | 1 | 94.1 | 72.9 | 42.8 |
| | | 2 | 59.3 | 47.6 | 30.8 |
| | | 3 | 39.0 | 33.1 | 22.9 |
| | | 4 | 87.3 | 64.4 | 32.7 |
| | | 5 | 70.7 | 51.7 | 31.0 |
| | | 6 | 50.3 | 38.1 | 24.4 |
| | 7/5 | 1 | 84.9 | 69.8 | 38.6 |
| | | 2 | 52.6 | 45.5 | 27.4 |
| | | 3 | 34.1 | 31.4 | 20.0 |
| | | 4 | 78.5 | 61.9 | 29.2 |
| | | 5 | 63.1 | 49.4 | 27.4 |
| | | 6 | 44.9 | 36.7 | 21.7 |
| | 7/2 | 1 | 78.1 | 68.0 | 34.9 |
| | | 2 | 48.0 | 44.1 | 24.2 |
| | | 3 | 30.8 | 30.6 | 17.7 |
| | | 4 | 72.2 | 60.3 | 26.1 |
| | | 5 | 57.9 | 48.1 | 24.3 |
| | | 6 | 41.2 | 35.8 | 19.1 |

| Hue | Brightness/Saturation | Spot # | Chromatic Value | | |
|---|---|---|---|---|---|
| | | | X | Y | Z |
| 5P | 6/8 | 1 | 68.4 | 52.5 | 34.5 |
| | | 2 | 41.5 | 33.3 | 24.0 |
| | | 3 | 26.4 | 22.8 | 17.6 |
| | | 4 | 63.1 | 45.9 | 25.8 |
| | | 5 | 50.0 | 36.2 | 24.2 |
| | | 6 | 35.1 | 26.5 | 18.9 |
| | 6/5 | 1 | 61.5 | 50.5 | 30.1 |
| | | 2 | 37.2 | 32.1 | 20.8 |
| | | 3 | 23.0 | 21.9 | 15.0 |
| | | 4 | 56.7 | 44.3 | 22.3 |
| | | 5 | 44.7 | 35.0 | 20.8 |
| | | 6 | 31.1 | 25.6 | 16.1 |
| | 6/2 | 1 | 56.1 | 48.5 | 25.8 |
| | | 2 | 33.7 | 30.9 | 17.6 |
| | | 3 | 20.8 | 21.0 | 12.4 |
| | | 4 | 51.7 | 42.7 | 18.8 |
| | | 5 | 40.9 | 33.7 | 17.4 |
| | | 6 | 28.3 | 24.6 | 13.4 |
| N | 9.5/ | 1 | 197.0 | 173.7 | 60.9 |
| | | 2 | 135.4 | 124.1 | 45.1 |
| | | 3 | 99.0 | 95.5 | 35.0 |
| | | 4 | 185.8 | 159.4 | 48.4 |
| | | 5 | 153.8 | 131.0 | 45.0 |
| | | 6 | 119.5 | 105.4 | 37.1 |

# VITA

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**EDUCATION**

| | |
|---|---|
| 2007 | Doctor of Philosophy, Architecture, Texas A&M University |
| 2002 | Master of Architecture, Texas A&M University |
| 1992 | Bachelor of Engineering, Pusan National University, Korea |

**GRANTS & AWARDS**

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|---|---|
| 2007 | Nurture by Steelcase Dissertation Grant, Center for Health Systems & Design at Texas A&M University |
| 2006-2007 | Arthur N. Tuttle Jr. Graduate Fellowship, American Institute of Architects |
| 2006-2007 | James A. Wilson ’55 Endowed Scholarship, Texas A&M University |
| 2005-2006 | William W. Caudill Research Fellowship, Texas A&M University |
| 2004-2006 | Graduate Teaching Assistantship, Texas A&M University |
| 2003-2004 | Architecture Graduate Stipend, Texas A&M University |
| 2003-2004 | Family Medicine Center Scholarship, Brazos Family Medicine Residency |
| 2002-2003 | Regents’ Graduate Fellowship, Texas A&M University |
| 2001-2002 | Jesse H. Jones Scholarship, Texas A&M University |

**TEACHING EXPERIENCE**

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| 2006 | ARCH 605: Architectural Design Studio for Master of Architecture, College of Architecture, Texas A&M University |
| 2005 | ENDS 170: Computer Techniques for Design Visualization College of Architecture, Texas A&M University |
| 2004 | ENDS 211: Design Detailing College of Architecture, Texas A&M University |

**PROFESSIONAL EXPERIENCE**

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| 1992-2000 | Boorim Architects & Associates, Seoul, Korea |

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| 2002 | Certificate in Health Systems and Design, Texas A&M University |
| 1997 | Registered Architect, Korean Institute of Architects |