

The Influence of Pattern and Color Interaction in Object Color Preference

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ABSTRACT

A mixed method study was conducted to examine the influence of pattern density and color contrast in object color preference for two-color combinations. This study answered four questions: What colors are selected by participants when shown a set of solid colored hues? Which density and contrast levels are preferred by participants? Which objects do participants prefer for a specific colored pattern swatch? Why do participants prefer specific objects for a specific colored pattern swatch?

A convenience sample of 30 undergraduate design students from the College of Design at the University of Minnesota participated in this research. Each participant was tested individually through an experiment of two stages followed by an interview.

Four main conclusions were the result of this research:

First, color influences pattern more than pattern influences color. The same pattern of the same density appears different and would be preferred for big or small objects based on its colors. For example, the participants preferred the soft contrast color combinations (clear or non-vibrating edges) for big or primary objects, and the harsh contrast color combinations (ambiguous or vibrating edges) for small or secondary objects.

Second, the most preferred combinations have medium value or chroma (middle), low chroma (muted), high value (light). The least preferred combinations have very high chroma (saturated), or low value (dark).

Third, the most preferred color combinations create sufficient contrast (high or mid) between the foreground element and background. The least preferred color combinations create low or no contrast between the foreground element and background.

Fourth, the participants' responses were varied between subjective and objective. Some responses were more subjective than objective. In this case, the participants related their

preferences to their personal life and experience. Other responses were more objective than subjective. In this case, the participants related their preferences to the properties of color, pattern and the object size or purpose.

The findings of this research are theoretically significant, and add new knowledge to strengthen the body of color preference research. In addition, the findings are empirically significant for designers from surface, interior, fashion, and product design fields for understanding viewers' preferences before applying two-color combinations to a specific object.

Key Words: surface design, pattern, color, density, contrast, object color preference, aesthetics.

TABLE OF CONTENTS

LIST OF TABLES.....	vi
LIST OF CHARTS.....	vii
LIST OF FIGURES.....	viii
CHAPTER 1: INTRODUCTION.....	1
Problem Statement.....	4
Statement of Purpose.....	5
Research Questions.....	5
Research Approach.....	5
Significance of the Research.....	7
Role of the Researcher.....	8
Researcher Assumption.....	9
Definition of Terms.....	10
Organization of the Dissertation.....	11
CHAPTER 2: LITERATURE REVIEW.....	13
Pattern History.....	14
Pattern Types.....	26
Pattern Properties.....	30
Repeating Methods.....	32
Density.....	33
Color.....	34
Munsell Color System.....	35
Color Contrast.....	40
Research on Color Preference.....	42
Conceptual Framework.....	52
Chapter Summary.....	53
CHAPTER 3: METHODOLOGY.....	55
Research Design.....	55
Research Setting.....	56
Research Content.....	56
Research Sample.....	62
Data Collection Methods.....	63
Data Collection Methods Model.....	71
Data Analysis Methods.....	72
Issues of Trustworthiness.....	73
Limitations & Delimitations.....	74
Chapter Summary.....	74
CHAPTER 4: FINDINGS.....	77
Introduction.....	77
Participants.....	78

Quantitative Findings.....	78
Qualitative Findings.....	94
Chapter Summary.....	112
CHAPTER 5: ANALYSIS.....	114
First Theme: Solid Color Selection.....	114
Second Theme: Preferred Density and Contrast Level.....	116
Third Theme: Colored Pattern & Object Preference.....	120
Findings Model.....	130
Issues of Trustworthiness.....	131
CHAPTER 6: CONCLUSION.....	132
Conclusions.....	132
Recommendations.....	135
REFERENCES.....	138
APPENDICES.....	145
APPENDIX A: MUNSELL CHARTS.....	145
APPENDIX B: SOLID COLOR & COLORED PATTERN SWATCHES (QUANTITATIVE).....	146
APPENDIX C: COLORED PATTERN SWATCHES (QUALITATIVE).....	166
APPENDIX D: DATA COLLECTION FORM.....	173
APPENDIX E: EXPERIMENT SET-UP (FIRST STAGE).....	174
APPENDIX F: EXPERIMENT SET-UP (SECOND STAGE).....	176
APPENDIX G: INTERVIEW SET-UP.....	177
APPENDIX H: QUALITATIVE TRANSCRIPTS.....	179
APPENDIX I: CONSENT FORM.....	188

LIST OF TABLES

Table 1: Participants' Characteristics.....	78
Table 2: Solid Color Swatches (Quantitative).....	79
Table 3: Preferred Level of Contrast for Each Level of Density (Quantitative).....	83
Table 4: Colored Pattern & Object Preference (Quantitative).....	85
Table 5: Interview Responses (Qualitative).....	94
Table 6: Primary & Secondary Objects (Qualitative).....	104

LIST OF CHARTS

Chart 1: Selected Solid-Color Swatches in Total.....	80, 115
Chart 2: Selected Solid-Color Swatches by Females.....	80
Chart 3: Selected Solid-Color Swatches by Males.....	80
Chart 4: Preferred Contrast Level for Each Level of Density.....	83, 117
Chart 5: Objects & Preferred Pattern Swatches.....	93, 121
Chart 6: Qualitative Findings.....	111, 121

LIST OF FIGURES

Figure 1: Oceania Patterns.....	15
Figure 2: African Patterns Printed or Weaved on Textiles.....	16
Figure 3: Ancient Egyptian Patterns.....	17
Figure 4: Byzantine patterns.....	17
Figure 5: Chinese Patterns.....	18
Figure 6: Japanese Patterns.....	18
Figure 7: Traditional Indian Patterns.....	19
Figure 8: Islamic Mughal Patterns.....	19
Figure 9: Paisley Motif from Different Periods.....	20
Figure 10: Arabian Patterns.....	20
Figure 11: Arabian Manuscript.....	21
Figure 12: Moorish Arabesque & Calligraphic Patterns.....	21
Figure 13: Moorish Geometric Patterns.....	21
Figure 14: Persian Patterns Throughout the Centuries.....	22
Figure 15: Ottoman Patterns.....	23
Figure 16: Celtic Patterns.....	23
Figure 17: Medieval Patterns from Different Places.....	24
Figure 18: Renaissance Patterns that were Inspired by Different Styles.....	25
Figure 19: Art & Craft Patterns by William Morris & Christopher Dresser.....	25
Figure 20: Examples of the 20th Century Patterns.....	26
Figure 21: Naturalistic Motif from India.....	27
Figure 22: Abstract Motif from Africa.....	27
Figure 23: Stylized Motif from Europe.....	27
Figure 24: Symbolic Motifs from Chinese, Persian & Renaissance Styles that Represent Strength & Longevity.....	27
Figure 25: Representative Motifs of Events, Stories or Traditions from Egyptian, Indian & Western Cultures.....	27
Figure 26: Stylized Floral Motifs from Indian, Persian and Arts & Crafts Periods.....	28
Figure 27: Abstract Floral Motifs from Turkish, Medieval, Arts & Crafts and Contemporary Periods.....	28
Figure 28: Naturalistic Floral Motifs from Chinese, Arts & Crafts and Art Nouveau Periods.....	28
Figure 29: First Pattern Represents African Style & Last Two Patterns Represent Egyptian Style.....	29
Figure 30: First Two Patterns Represent Arabic Style & Last Pattern Represents Celtic Motif.....	29
Figure 31: Range of Contemporary Motifs Including Different Geometric Shapes.....	29
Figure 32: Arabic, Persian & Moorish Motifs Using Islamic Phrases.....	30
Figure 33: First Two Images Represent Celtic Motifs & Last Two Images Represent Medieval Motifs.....	30
Figure 34: Changing Motif Scale.....	31
Figure 35: Changing Spacing Between Motifs.....	32
Figure 36: Block Repeat Varied (Changing Spacing Between Motifs).....	32
Figure 37: Drop Repeat Varied (Changing Spacing Between Motifs).....	33

Figure 38: Brick Repeat Varied (Changing Spacing Between Motifs).....	33
Figure 39: Three Levels of Density (low, mid, high).....	34
Figure 40: Munsell Color Wheel Represents Hue.....	37
Figure 41: Munsell Charts Represent Value & Chroma Scales for Different Hues in 5 Scale.....	37
Figure 42: Munsell 3D Model.....	37
Figure 43: Example of Each Method (Complementary, Single Hue, Neighboring Hues).....	39
Figure 44: Value Contrast in Three Levels (Low, Mid, High).....	42
Figure 45: Chroma Contrast in Three Levels (Low, Mid, High).....	42
Figure 46: Conceptual Framework Model.....	52
Figure 47: Munsell Charts of Yellow (Y) & Purple Blue (PB).....	58
Figure 48: Three Levels of Contrast for Y & PB (Changing Value & Keeping Chroma).....	58
Figure 49: Three Levels of Contrast for Y & PB (Keeping Value & Changing Chroma).....	58
Figure 50: Solid Swatch Size.....	58
Figure 51: Solid Swatch Code.....	58
Figure 52: Creating New Motif Process.....	60
Figure 53: New Umayyad Motif.....	60
Figure 54: Repeating Motif to Create Different Levels of Density.....	60
Figure 55: Applying Colors to Patterns.....	61
Figure 56: Colored Pattern Swatch Code.....	61
Figure 57: Objects List.....	62
Figure 58: Quantitative Method Set-Up.....	63
Figure 59: Qualitative Method Set-Up.....	63
Figure 60: Tables for Recording Swatch Code.....	64
Figure 61: Tables for Recording Quantitative Data.....	65
Figure 62: Presented Colored Swatches.....	66
Figure 63: Selected Swatches by One Participant.....	66
Figure 64: Example of Selected Color Swatch with Pattern by One Participant.....	67
Figure 65: Example of Preferred Colored Pattern Swatch with Two Objects.....	67
Figure 66: Another Example of Selected Color Swatches with Pattern by One Participant.....	68
Figure 67: Another Example of Preferred Colored Pattern Swatch with Two Objects	68
Figure 68: Selected Swatches for Interview.....	69
Figure 69: Color Combination for Each Pattern Swatch that Selected for Interview..	69
Figure 70: Qualitative Data Collection Form.....	70
Figure 71: Example of Interview Set-Up for One Participant.....	70
Figure 72: Example of Preferred Swatches.....	70
Figure 73: Data Collection Methods Model.....	71
Figure 74: Findings Model.....	130

CHAPTER 1: INTRODUCTION

This research seeks to examine the influence of pattern density and color contrast in object color preference. To conduct this research, a mixed approach was used to collect the data, starting with a quantitative method followed by a qualitative method for further exploration. In this chapter, an overview of previous knowledge, problem statement, research purpose and questions will be presented. This is followed by an overview of the methodology, rationale and significance of the research, role of the researcher, research assumptions, definition of key terms, as well as the organization of the remaining chapters.

Introduction

In our visual world, as a part of our daily life, we are exposed to myriad surfaces that attract our attention, change our mood or preferences for specific objects. Surfaces appear in various colors, which could be solid, textured or patterned. This research will focus on pattern and color as two basic components of the surface of any object that we interact with and use for interior, clothing and other fields. Each component has its own properties that interact with other properties and change the appearance of a covered surface, which affect our preferences.

Pattern is the first component of the surface that will be considered in this research. Patterns have been created since ancient times and remain in use until present. Throughout the centuries, artists used their imaginations to create motifs to express their feelings, represent their cultures and traditions, show their religions and beliefs or decorate their surrounding spaces. Earlier motifs were created with very simple forms that became more and more detailed over time, then the motifs were created in both simple and complex forms (Justema, 1982). Motifs were created in various forms and styles, repeated or integrated with other similar or different motifs to create patterns. Some patterns were created based on a structure that allowed the motifs to be expanded in any direction to create an endless design.

In pattern design, there are three main properties that any pattern should be based on: structure, scale and spacing. A single pattern may be varied by changing its properties one at a time to create unlimited variations. Each property affects the other property and changes the appearance of the covered surface. For example, the same pattern may appear in various densities by keeping the structure and scale, but changing the space between its motifs. A pattern appears in high density when it covers most of the surface and low density when it covers little area of the surface (Justema, 1968). In addition to pattern, color is the other component of the surface that is associated with pattern to complement the covered surface.

Color is the vital component of the surface that interacts with pattern and adds new characteristics, dimensions or variations to the covered surface. Color never appears alone, but is always associated with other elements of the surface, which could be shapes, patterns, figures, etc. Color allows the associated element to stand out by itself or blend in with other elements. This phenomenon is known as ‘contrast,’ which refers to the relationship between two or more colors within a combination. Hundreds of years ago, many theories were constructed to understand color relationships. These helped designers and artists create pleasing combinations. One of the most logical and accurate theories that is used by designers, especially in surface design is the Munsell Color System.

The Munsell System is a three-dimensional system based on three attributes: hue (color name), value (lightness) and chroma (saturation). Changing the scale of each attribute one at a time allows millions of colors to be created. Unlimited color combinations can be created by combining two or more colors using several methods, such as the complementary method, the neighboring hues method and the single hue method. Designers and artists use any of these methods to create combinations that please the senses and attract the viewer’s attention. This can change the viewer’s preference for any object.

Scholars including Moon & Spencer, Granger, Guilford and others have been interested in understanding color preference considering several concepts to answer various questions. They asked, how is color preference shaped? Is it subjective or objective? Is it related only to the viewer's characteristics or influenced by other surrounding variables? Today, scholars are still interested in understanding color preference, considering different concepts.

A wide range of studies was conducted to examine colors as single or a combination using various concepts, methods and theories. Some studies examined color preference without context and claimed that preference is not fixed, but it is a matter of personal taste that changes based on other associated elements. Other studies claimed that context plays an important role in shaping color preference, by examining different contexts, such as shape, object and even pattern. As a result of these studies, many subjective and objective factors were explored that affect color preference including personal characteristics (gender, age, education, art training, personality, etc.) (Camgoz & Yener, 2002; Granger, 1952; Holmes & Buchanan, 1984; Silver & Ferrante, 1995;), personal experience, color attributes, contrast, context properties, context purpose and more (Jonaskaite & Mohr, 2016; Ou & Luo, 2011; Reber & Schwarz, 2004; Schloss & Palmer, 2010; Tangkijviwthat & Rattanakasamsuk, 2010).

While, the topic of color preference has been widely considered, there is still a lack of research that used pattern as a context. At the time of conducting this research, only three studies were found that used pattern as context to examine color preference. These studies will be summarized as follows: The first study examined the relationship between pattern and preference using several pattern types, styles, arrangements and color combinations (Rodemann, 1999). This study explored several factors that affect preference, including age, income, personality, lifestyle and education and other factors that are related to color and pattern. The second study examined the relationship of pattern style and color preference, considering four different styles, including

classic, original, modern and hyper-modern (Chang & Guan, 2014). This study found a high correlation between pattern style and color attributes regarding people's age. The third study examined the influence of Taiwanese floral patterns in color preference (Hsu & Ou, 2015). This study explored several factors that affect color preference, including color harmony, interaction between patterns and colors, general liking for the colored object and being a cultural symbol. Those three studies shared a general finding, which indicates that the interaction between pattern and color is a factor that influences color preference. This finding should be considered by surface designers, since pattern and color are the fundamental components of surface design in which they interact to influence viewer's preference. The following section will address this consideration that leads to the idea of this research.

Problem Statement

It is important for surface designers to create designs that please the senses for a specific object. To create pleasing design, designers should be aware of each component and its properties. In surface design, there are two basic components, which include pattern and color; each has its own properties. Changing the properties of each changes its characteristics, which influences the appearance of the covered surface. There are three properties of pattern, including structure, scale and spacing; and three properties (attributes) of color as well, including hue, value (lightness) and chroma (saturation). Changing pattern properties affects the density of the pattern (amount of information in the space), while changing color properties (attributes) of each color in the combination affects the contrast between its colors.

Previous studies claimed that pattern and color interaction affect color preference as a general finding (Rodemann, 1999; Chang & Guan, 2014; Hsu & Ou, 2015). This finding raises many questions: How do pattern and color interact to affect preference? Is this interaction related to the properties of each? How can this factor be considered by surface designers to create

pleasing designs? Since surface design can be a part of any object, which pattern and color properties should be used for this specific object? This study intends to fill the gap that was found in previous research.

Statement of Purpose

The primary purpose of this research is to examine the influence of pattern density and color contrast in object color preference for two-color combinations. Density (amount of information) and contrast are two important variables that interact with each other differently based on their levels, which affect the appearance of the covered object and influence color preference. Preference is considered an aesthetic term: It could be influenced by aesthetic features of the surface that were addressed by Gombrich (1984, 1995), which included the amount of information (density), contrast, balance, symmetry, complexity and clarity.

Research Questions

Four main research questions emerged to conduct this research, as follows:

- (1) What colors are selected by participants when shown a set of solid colored hues?
- (2) Which density and contrast levels are preferred by participants?
- (3) Which objects do participants prefer for a specific colored pattern swatch?
- (4) Why do participants prefer specific objects for a specific colored pattern swatch?

Research Approach

The purpose of this research is to examine the influence of pattern density and color contrast in color preference for a specific object. A mixed approach was used to collect the data. The quantitative method was used to understand the relationship between three variables (density, contrast, and color preference) and explore the preferred level of density and contrast. The qualitative method was used to support the quantitative data with the participants' views and thoughts.

The participants were 30 undergraduate students, including 24 females and 6 males. The participants were taking courses related to color or pattern in the College of Design at the University of Minnesota. All the participants were from creative fields including graphic design, interior design, apparel and art. Each participant was tested individually at a design studio in McNeal Hall for 5-10 min. Each participant was tested through an experiment of two stages to collect the quantitative data, then an interview to collect the qualitative data.

The experiment included two stages: In the first stage, the participant was shown a set of 20 solid color swatches (each contains two complementary colors, one for the foreground and one for the background) that were placed on a white table in 5 hue scale and various scales of value (lightness) and chroma (saturation) in medium contrast. Then, the participant was asked to select three swatches and placed them on the table. In the second stage, the participant was shown a group of nine patterned swatches (in three levels of contrast for three density levels) for each selected solid-color swatch. The participant was then asked to select one preferred swatch. Then, the participant was asked to select two objects from a list of 15 objects (varied in their sizes and uses). The data of each stage were recorded on a table (see appendix D, p.173). The participant was then asked to move to a different table for the interview.

At the beginning of the interview 20 patterned swatches were presented in various densities and contrasts for various two-color combinations on a white table. Then, each participant was asked four questions:

- (1) Pick two swatches that you prefer.
- (2) Identify two objects for each swatch?
- (3) Why did you prefer these two objects for these swatches? Explain.
- (4) What did you learn from these steps?

The interview was documented and recorded for each participant. Finally, the quantitative and qualitative data were analyzed separately, then compared to each other to explore the similarities and differences.

The quantitative data were analyzed using basic count of each variable for each stage of the experiment. The data of the first stage (selecting the solid color swatch) were analyzed by counting the selection times of each swatch and organized from highest to lowest count. The data of the second stage (selecting the preferred patterned swatch and object) were analyzed by counting the selection times of each level of density and contrast. Then, the selected swatches were organized in a table along with the preferred objects.

The qualitative data were analyzed using the participants' transcripts by connecting their thoughts to create themes that related to each research question. One theme was identified, which is 'colored pattern and object preference.' The participants' words were also used as evidence to support the findings. At the end, the quantitative and qualitative findings were compared to each other and connected to two theories that related to object color preference: Ecological Valence Theory (EVT) and Processing Fluency Theory (Theory of Beauty). Also, the findings were compared to other findings of previous studies to support this research and provide the reader with rich written content.

Significance of the Research

This research provides rich written and visual content that may be beneficial empirically and theoretically for designers and scholars.

Empirically, the visual content may be used as a guide and educational tool for designers, not only in the surface design field, but even in other creative fields. The visual document includes the process of creating the pattern by extracting the motif from its original context and reshaping it to be used in different contexts, as well as the technique of creating various color

combinations in three contrast levels based on the Munsell system. In addition to the process, the findings may be significant for practical use by considering the relationship between density and contrast when applying colors to pattern. Other designers, including interior, product, fashion and graphic designers, may benefit from the findings as well, since pattern can be a part of any application used for different purposes. For instance, it is always difficult for designers to create patterned products with specific colors that please the senses and attract the client's attention. The findings may be used to resolve this problem by showing the preferred density and contrast levels for various objects, supported with participants' quotes and previous theories.

Theoretically, the verbal content could be used as a model for scholars to conduct new studies that relate to pattern, color or preference. Also, the other verbal content could provide a brief description of previous studies and findings that could be used as a starting point for new studies. Also, the history of pattern could be used for education to give an organized overview of pattern and color changes over the centuries that is supported with images. Furthermore, the methods and findings could be expanded to other fields not only creative fields, such as marketing and the psychology of perception.

Role of the Researcher

As a surface and graphic designer, I believe that any pleasing decorative design should be based on three qualities, beauty, imagination, and order. Beauty is related to personal taste. Imagination is related to the designers, and their ability to draw inspiration from the surrounding visual or verbal context. Order is related to design created based on a logical system.

I also believe based on my experience and background in surface and graphic design that the basis of any aesthetically pleasing design is to understand the viewers' preferences.

From this point, I was interested in researching the relationship between surface design and viewer's preference, which was the starting point of this study. I started with reviewing the

literature that related to color preference in general, then pattern and color preference in specific. As a result, I found a few studies that examined color preference in relation to pattern. I also identified a gap that led me to the purpose of this research.

As the purpose of this research is to examine the influence of pattern density and color contrast in object color preference, my responsibilities will be the following:

First, to create the color and pattern swatches for many reasons: adjusting the properties of pattern and color in different densities and contrasts; showing designs that don't represent specific shapes or meanings, so it doesn't affect the participants' decisions; and having my rights to adjust the designs without asking for permission.

Second, to provide the reader with a rich verbal and visual content that is supported with numbers and words. This content is possible using a mixed method approach starting with a quantitative method supported with a qualitative method.

Researcher Assumption

Several assumptions were illustrated based on previous methods, theories, and findings of previous studies that related to color and pattern:

First, pattern and color properties interact in certain levels and affect color preference for a specific object. This assumption originates from the previous studies' findings that color preference was influenced by the interactions between color and pattern.

Second, high-contrast color combinations are more preferred than other combinations. This assumption originates from the Fluency Theory, which indicated that "the more fluently the perceiver can process an object, the more positive is his or her aesthetic response" P.365 (Reber & Schwarz, 2004). Also, there is support from Gombrich (1984, 1995) regarding the role of aesthetic features: amount of information (density), contrast, balance, symmetry, complexity and clarity.

Third, there is a correlation between pattern density, color contrast and the object's purpose. This assumption originates from the previous findings, which indicated that color preference is influenced by object purpose and function (Schloss & Palmer, 2011).

At the end of this research, these three assumptions will be revisited for accuracy in the analysis chapter.

Definition of terms

Pattern: The result of repeating a single motif in systematic and consistent order based on different structures. Pattern is endless and can be extended in every direction to cover almost any three-dimensional surface. Pattern can be seen in different types, arrangements or styles that developed throughout the periods. Pattern is not just used for decoration purpose, but also for communication to send a specific message or change moods (Kraft, 2004).

Density: An aspect of pattern that is influenced by its properties: structure, scale of the motif or space between the motifs. Density can appear in different levels: high, that covers the entire surface; medium, that covers some of the surface; and low, that covers a small part of the surface (Rodemann, 1999).

Color: Defined as “fundamentally a contextual phenomenon, dependent on both the sensory information that has come before and that emanates simultaneously from the surroundings” (Best, 2017). Color can be characterized by three attributes, including hue, value (lightness) and chroma (saturation). Changing the scales of the three attributes allows humans with normal color vision to see over ten million colors under normal light conditions (Wilson, 2011).

Contrast: An aspect of color that is defined as the relationship of two or more colors that appear next or against each other. It is used to distinguish colors from each other by using several methods: hue contrast, value contrast (light-dark contrast), chroma contrast (saturation contrast), cold-warm contrast, complementary contrast, simultaneous contrast and proportion contrast.

Contrast can be seen in different levels: high, that allows distinguishing colors from each other; to low, that blends in the colors with each other. These levels can be adjusted by changing the color attributes scales (hue, value and chroma).

Preference: One of the aesthetic terms defined as the interaction between human and object by liking or disliking the object. It is influenced by the characteristics of humans and objects, in addition to the personal experience with the object.

Organization of the Dissertation

The remaining chapters of this document are organized as:

Chapter two explores in-depth the research variables, which includes pattern, color and preference. The first section presents pattern historically throughout the centuries, supported with images. Then, an overview of pattern types and properties, is presented. The second section is related to color, considering the Munsell Color System, which is the most popular system used in surface design. Contrast plays a significant role in pattern design and aesthetic preference. The third section provides a detailed analysis of previous studies in color preference that examined color combinations as solid and within different contexts including pattern as well. This chapter ends with a conceptual framework to illustrate the preferred contrast and density level for a specific object.

Chapter three illustrates the research design, which is a mixed methods approach that started with a quantitative method supported by a qualitative method. A description of the participants, stimuli and procedures follows, ending with data analysis method, limitations and summary of the chapter.

Chapter four presents the results of the data collected quantitatively and qualitatively, each included in a section related to the research questions. The quantitative part includes selected solid color, preferred contrast level for each density level, preferred objects for each

colored pattern swatch, as well as charts and tables to support the findings. The qualitative part includes codes organized in one theme extracted from the participants' transcripts and organized in tables.

Chapter five analyzes the quantitative and qualitative findings separately. It compares both types of findings to explore the similarities and differences. It also includes a comparison of new and previous findings, as well as Ecological Valence Theory and Fluency Theory.

Chapter six summarizes the entire document by concluding the research findings, and providing recommendations for future research, as well as ways to incorporate the findings in practical use.

CHAPTER 2: LITERATURE REVIEW

The purpose of this research was to examine the influence of pattern density and color contrast in object color preference for two-color combinations. Density is an aspect of pattern while contrast is an aspect of color that interact differently in different levels to change the appearance of the covered object and influence color preference. The level of density is influenced by pattern properties, including structure, scale and spacing. The level of contrast is influenced by color attributes (properties), including hue, value (lightness) and chroma (saturation).

To explore this relationship between pattern, color and object color preference, a number of keywords were used while reviewing the literature, including “surface pattern history,” “pattern design,” “surface design,” “structure,” “textile design,” “color theory,” “color combination,” “pattern perception,” “color perception,” “color preference,” “object preference” and “color aesthetic.” Several sources were found, including books, journal articles and web articles.

The literature is organized in three sections, which includes pattern, color and color preference. Each section is divided into subsections that include specific details of each variable, which helps to achieve the goal of this study. First section, ‘Pattern,’ includes pattern history, types and properties. Second section, ‘Color,’ includes color system and contrast. Third section, ‘Research on Color Preference,’ includes research related to solid color and color within context.

At the end of this chapter, a conceptual framework is constructed that illustrates the research concept, which is related to three variables: pattern density, color contrast and object color preference. Later, in the analysis chapter, the conceptual framework will be compared to the findings of this research to evaluate its accuracy.

Pattern History

This section illustrates a brief history of pattern starting from the ancient time, two million years ago, until the 20th century. The history emerged from several books, including *The World of Ornament* (Batterbam, 2012), *1000 Patterns: Design Through the Centuries* (Cole, 2003), *The Illustrated History of Textiles* (Ginsburg, 1995), *The Grammar of Ornament* (Jones, 1972), *20th Century Pattern Design* (Jackson, 2012), and *History of Design: Decorative Arts and Material Culture, 1400-2000* (Kirkham, 2013). The organization of this section is based on the pattern style of each culture that was described in these sources. Each style is described in terms of its founders, influencers, characteristics, motif types, colors, development and use, supported with images. The history will be discussed to show the importance of pattern throughout the centuries that linked different cultures and periods (Phillips & Bunce, 1993).

Millions of years ago, cavemen used their imaginations to create motifs that express their feelings, reflect their traditions or beliefs, or decorate their own bodies and surroundings (Smeets, 1982). Earlier motifs were created with very simple forms. Later, more details and characteristics were added and new complex forms were created. The created motifs were varied between simple and complex forms (Justema, 1982). Not only the form has been changing, but also the colors and techniques have become more complex. During the time of the Middle and Contemporary centuries, the old motifs were revived and extracted from their original contexts to produce new motifs and create endless patterns with various color combinations and techniques.

Earlier pattern was curved, weaved or drawn by hand in simple lines and basic shapes (diamond, triangle, rectangle or circle) colored with one or two colors. Then, pattern became more naturalistic and representative. They were more colorful and created with complex techniques. After that, the pattern was transferred from place to place and changed by adding new characteristics and mixing elements from different cultures to produce new forms. Pattern has

been used to cover every possible surface starting from a small object as a jewelry piece to a very big object as a wall.

The following is a brief description of the most recognizable styles throughout the centuries, including the Oceania, African, Egyptian, Byzantine, Chinese, Japanese, Indian, Arabian, Persian, Moorish, Ottoman, Celtic, Medieval, Renaissance, Arts & Crafts and the 20th century style.

It is important to note that the motif of this research was extracted from the Umayyad dynasty, which was one of the greatest Islamic periods and saw a significant development of Islamic motifs. The extracted motif was reshaped by adding modern characteristics to its Islamic form. Then, the new motif was repeated to create patterns that were used to examine the influence of density and contrast in object color preference. The process of creating this motif will be described in-depth later in the methodology chapter (p.59).

Oceania Style (Polynesia):

The Oceania style was based on freehand drawings using abstract and geometric or organic motifs that were created with simple lines and shapes, then repeated into patterns. The Oceania motifs were colored with neutral and subdued tones of two or three colors that were found in their surroundings, such as red, black and off-white (figure 1).

Later, in the 19th century, the elements of the Oceania style were adopted by Western artists to produce new motifs that were applied to textiles and wallpaper using different printing techniques (Cole, 2003).

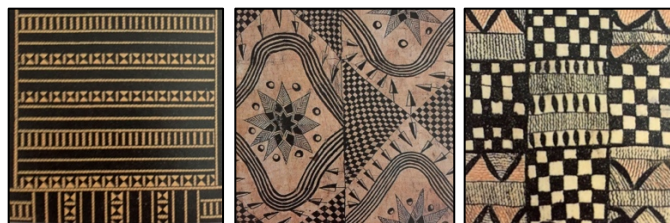


Figure 1: Oceania Patterns

African Style:

The African style was similar to the Oceania style, also being based on abstract and geometric forms, but produced in bright and warm colors that reflect the African tradition and life. A wide range of patterns were created in horizontal or vertical arrangements using stripes or basic shapes, such as diamond, square and triangle. The motifs of the African style were colored with highly saturated and contrasting colors of simple combinations using primary and secondary colors, or sometimes neutral and subtle colors (figure 2).

Later, in the 20th century, the traditional African patterns were reproduced to decorate the modern African textiles that were imported to Europe and became popular at that time (Cole, 2003).



Figure 2: African Patterns Printed or Weaved on Textiles

Ancient Egyptian Style:

The Ancient Egyptian style was based on abstract geometrical, vegetal and figural forms that reflect the hieroglyphic system of Ancient Egypt and the surrounding nature. Motifs included rising sun, lotus flowers, feathers, animals' heads, spiral lines, zigzag lines and basic shapes (circle, diamond, triangle). Motifs were combined and repeated to create a range of colorful patterns (figure 3). Motifs were curved or painted to decorate outside and inside the buildings (the temples, king's place), tombs, fabrics and other objects. Ancient motifs were colored with highly saturated and bright colors that were outlined with black or white lines to create illusions and keep the eye busy all the time.

Later, in the 19th century, European artists adopted and reshaped the Egyptian motifs to decorate several objects in contemporary style and vibrant colors (Batterham, 2012; Jones, 1972).



Figure 3: Ancient Egyptian Patterns

Byzantine style:

The Byzantine style was produced in Europe and Asia between the 4th century and 11th century. This style was characterized as conventional, abstract and detailed, and combined geometrical, vegetal and figural motifs to create various patterns (figure 4). Motifs were inspired by figures, animals, plants and still objects. Motifs were colored in primary and secondary colors, mostly gold, blue, red and black. The Byzantine style influenced other styles that were produced later in different places, including the Turkish style, Moorish style and Mediaeval style (Ginsburg, 1995; Jones, 1972).



Figure 4: Byzantine Patterns

Chinese and Japanese Styles:

The Chinese and Japanese styles were very similar regarding their characteristics and elements, but each had its own taste. Motifs of these styles were created in several forms: some were abstract and geometric, while others were vegetal, naturalistic and representational. The geometric motifs included lines, diamonds, circles, hexagons and other shapes. The vegetal

motifs were inspired by nature and included bamboo stems, plum, flowers and scrolling lotuses. The representational motifs were created as symbols to reflect several meanings that related to Chinese and Japanese myths and traditions. For instance, a bat reflects longevity, a dragon reflects energy, a butterfly reflects happiness, and bamboo reflects fortitude. Motifs were colored using primary, secondary and tertiary colors in light, dark, fresh, subdued or bright colors (figures 5 & 6).

Motifs were combined in several arrangements to create patterns that covered a wide range of surfaces, such as textiles, paintings, ceramics, metalwork, woodwork, buildings and many more.

Later, in the 19th century, the traditional Chinese and Japanese motifs became very popular in Europe. The traditional motifs were extracted from their original contexts and used to decorate other contexts with new color combinations, including wallpaper, fabric, furniture, books, etc. (Batterham, 2012; Cole, 2003; Jones, 1972; Kirkham, 2013).



Figure 5: Chinese Patterns



Figure 6: Japanese Patterns

Indian Style:

The Indian style was mostly floral and inspired by nature and other surrounding styles. It was characterized as very detailed, delicate, precise, naturalistic, rich and balanced. Some motifs reflected different meanings, including fertility, prosperity and happiness. These motifs included peacocks, birds, animals and flowers (figure 7). The Indian motifs were repeated in diamond or block repeats and integrated with thin lines to create patterns that filled out the entire space. The most popular motif was the Paisley motif, which was produced in various forms throughout the centuries (figure 9). The motifs were colored with vibrant, bright and saturated colors against light or dark ground to create high contrast between colors.

During the 16th century, Mughal empire was ruled by Muslims and took over India. At that time, a new and distinctive style was created that combined characteristics of traditional Indian and Islamic styles. Many new motifs were produced in geometric, calligraphy and arabesque forms (figure 8) to decorate textiles, metalwork, ceramics, woodwork, jewelry, buildings (mosque), furniture, carpet, glass, etc.

Later, in the 17th – 19th century, the Paisley motif was produced in Europe in various forms and used to decorate fabric, furniture, wallpaper and jewelry (Batterham, 2012; Cole, 2003; Jones, 1972; Kirkham, 2013).



Figure 7: Traditional Indian Patterns



Figure 8: Islamic Mughal Patterns



Figure 9: Paisley Motif from Different Periods

Arabian Style:

The Arabian style was seen during two Islamic empires: the Fatimid empire in Cairo, Egypt from the 10th to the 12th centuries; and the Mamluk empire in Cairo, Egypt and Damascus, Syria from the 12th to the 13th centuries. The Arabian style was new and different from other previous styles. It combined characteristics from different styles, including old Roman, Byzantine, Chinese and ancient Persian, in addition to its own Islamic characteristics. The Arabian motifs were created in three forms, including vegetal (arabesque), geometric and calligraphy motifs. These motifs were repeated, combined, integrated, twisted and arranged based on geometrical structure to create endless patterns (figure 10). The dominant colors of this style were gold and blue with some touches of green, red and ivory. Patterns were used to decorate a wide range of surfaces, such as textiles, metalwork, woodwork, glass, ceramics, buildings (mosques and houses) and manuscripts of the Quran (figure 11; Batterham, 2012; Jones, 1972; Kirkham, 2013).



Figure 10: Arabian Patterns



Figure 11: Arabian Manuscript

Moorish Style:

In the 12th century, a new Islamic style was produced in Spain during the Nasrid dynasty. This style was recognized in the interior decoration, architecture and furnishing of Alhambra. The Moorish style was inspired by Egyptian, Greek, Roman, Byzantine and Arab styles. This style was recognized with its interlacement of the motifs; each motif was connected or growing from the other motifs with straight, curved or twisted lines in a way that moves the eye without distraction. The entire space was filled with organized and small detailed motifs that appeared in three forms: arabesque, geometric and calligraphy. The gold was the dominant color beside other colors including, blue, red, orange, purple and green (figures 12 & 13; Batterham, 2012; Jones, 1972; Kirkham, 2013).



Figure 12: Moorish Arabesque and Calligraphic Patterns



Figure 13: Moorish Geometric Patterns

Persian Style:

The Persian style was established in Iran and combined characteristics of Arabian, Moresque and Indian styles. The Persian style was characterized as delicate, rich, bold, elegant, detailed and representational based on geometrical structures. In the 6th century, the ancient Persian motifs combined arabesques and figural motifs (winged dogs, winged horses, lions and birds). The peacock motif was created to represent longevity and paradise (during the Islamic period). In the 15th century during the Safavid period, the Persian motifs were mostly based on floral and geometric forms, but the peacock motif was still used and combined with other motifs. Motifs were repeated and integrated using geometrical structures in a mixture of horizontal, vertical and diagonal lines (figure 14). Motifs were applied using various techniques to different surfaces, such as outside and inside the buildings, tiles, textiles, carpets, manuscripts, vases and other objects.

In the 19th century, the Persian motifs inspired many Victorian artists and used to decorate textiles, wallpapers and furniture (Batterham, 2012; Cole, 2003; Jones, 1972; Kirkham, 2013).



Figure 14: Persian Patterns Throughout the Centuries

Ottoman Style:

In the 13th century, the Ottoman Empire was established in Istanbul, Turkey and expanded to other places, including Anatolia, the Balkans, the Crimea, Iraq, Syria, the Arabian Peninsula, Egypt and North Africa. The Ottoman Empire was one of the most powerful Islamic empires beside the Safavid in Persia and Mughals in India (Krikham & Weber, 2013). At that

time, a new style was produced that mixed characteristics from Byzantine, Arabian, Persian and other European styles. This style was characterized as complex, detailed, delicate, conventional, abstract, bold, curved, angular and rich. The Ottoman motifs were mostly arabesques that linked to each other with thin lines and small elements and colored with blue, red and gold (figure 15). The Ottoman motifs were used to decorate buildings, ceramics, textiles, metalwork, accessories, carpets and other objects (Cole, 2003; Jones, 1972; Kirkham, 2013).



Figure 15: Ottoman Patterns

Celtic Style:

The Celtic style was seen in different parts of the world during the time between the 4th and 10th centuries, including Russia, China, North America, Europe and others. This style was mostly based on geometric forms that integrated with figures, but the vegetal motifs was never seen as a part of this style. The motifs were formed as ribbons that integrated with each other and repeated to create complex, rich, symmetrical and linear patterns. In the 10th century, the motifs were varied and created based on natural forms. The motifs of this style were colored with various tints against a black background to create a high contrast effect (figure 16; Batterham, 2012; Cole, 2003; Jones, 1972).



Figure 16: Celtic Patterns

Medieval Style:

The Medieval style was seen in different parts of Europe and Asia during the period between the 7th and 17th centuries. This style was a mixture of the Celtic, Byzantine, Greek, Persian, Egyptian and other earlier styles. At that time, a wide range of motifs were created, either representational and non-representational. Motifs included animals, flowers, lines, geometrical shapes and others. Some motifs were created to represent different meanings: lions represent strength, geese represent wisdom, and Aster flowers represent Zoroastrians Religion. Motifs were arranged based on various structures that could be horizontal, vertical or diagonal in different types of repeats. Motifs were used to cover various surfaces and colored with primary and secondary colors in different shades, tones and contrasts (figure 17; Batterham, 2012; Cole, 2003; Jones, 1972; Kirkham, 2013).



Figure 17: Medieval Patterns from Different Places

Renaissance Style:

In the 14th century, the Renaissance style was produced in Italy and expanded to other parts of Europe during the 16th and 17th centuries. This style was created by extracting the ancient motifs from their original contexts from different cultures and reshaping them by adding new characteristics or elements to them. Sometimes, the characteristics and elements of two or more styles were combined in one design. For instance, the Persian motif was blended with Roman motif. Renaissance motifs were delicate, elegant, simple, heavy, precise, naturalistic and stylized. The Renaissance style combined arabesque, geometric and figural motifs to create patterns by

repeating and integrating them using various methods (figure 18). The colors of this style were light and bright, created in harmonies combinations (Batterham, 2012; Cole, 2003; Jones, 1972).



Figure 18: Renaissance Patterns that were Inspired by Different Styles

Art & Crafts Style:

In the 19th century, specifically in England, a creative, new and original style was founded by William Morris and other artists, including Christopher Dresser, John Henry Dearle and others. The motifs of this style were inspired by nature and other previous styles, such as medieval and Gothic styles. This style was mostly based on floral motifs that sometimes combined with birds in naturalistic or abstract forms and repeated to create myriad patterns with rich and various colors. Some patterns were dense, complex and highly detailed, while others were very simple and abstract (figure 19). Patterns were used to decorate textile, glass, ceramic, wallpaper, metalwork, woodwork and graphic (Cole, 2003; Ginsburg, 1995; Jackson, 2012).



Figure 19: Art & Craft Patterns by William Morris & Christopher Dresser

20th Century Style:

The 20th century style was produced in various places and included various movements, such as Art Nouveau, Art Deco, Victorian and others. This style was characterized by reviving the ancient motifs and reproducing them in new and different forms and arrangements. Motifs were created in many forms that could be organic, abstract or realistic forms. Motifs included

spots, stripes, calligraphy, flowers, geometric shapes, symbols, animals, figures and a wide range of traditional and new motifs. Artists of this style were interested in keeping the space around the motifs interesting as the motifs themselves (Cole, 2003; Ginsburg, 1995; Jackson, 2012). Some examples are as the following images (figure 20).



Figure 20: Examples of the 20th Century Patterns

Pattern Types

Pattern can be seen in many varieties and forms on historical monuments and current applications. Pattern can be created by a single motif or multiple motifs that are inspired by culture, belief, surrounding nature or lifestyle. There are many types of motifs, including the figural motif, floral motif, geometric motif and calligraphic motif. Each type can be highly decorative and don't have any meaning or connection to meanings representing religion, culture, belief or event. The following are descriptions of each type in terms of its characteristics, forms and colors, along with some historical and contemporary images that were collected from different sources.

Figural Motif:

The figural motif represents the living things in the surrounding nature, including human and animals. This motif has been seen in a different format, such as a very naturalistic format that includes the characteristic of the figure as it appears in nature (figure 21), or an abstract format that includes only the outline of the figure without any details (figures 22 & 23).



Figure 21: Naturalistic Motif from India Figure 22: Abstract Motif from Africa Figure 23: Stylized Motif from Europe

The motif of this type has been created since ancient time not only for decoration, but also for communication as symbols to represent different events, stories, specific cultural or religious meanings (figures 24 & 25). This type was popular in some cultures but less popular in others. In the African, Egyptian, Chinese, Japanese and Western cultures, it was applied to any applications. In Arabic, Persian and Moorish cultures, it was applied to various applications, except for religious places and manuscripts (Fisher, 2000).



Figure 24: Symbolic Motifs from Chinese, Persian & Renaissance Styles that Represent Strength and Longevity



Figure 25: Representative Motifs of Events, Stories or Traditions from Egyptian, Indian & Western Cultures

Floral Motif:

The floral motif is highly decorative, inspired by nature and doesn't represent any meaning. It is the most popular motif that has been recognized from different periods in various forms. This motif can be stylistic, realistic, rich and detailed, or abstract, very simple (figures 26, 27 & 28). The floral motif can be created using flowers, leaves, grass, vines, seeds, plants, etc. The colors of this motif are applied based on natural laws as they appear in nature, for example using the secondary colors for the secondary elements and the primary colors for the main elements, or using the green for leaves and red, yellow and orange for flowers (Fisher, 2000).



Figure 26: Stylized Floral Motifs from Indian, Persian and Arts & Crafts Periods



Figure 27: Abstract Floral Motifs from Turkish, Medieval, Arts & Crafts and Contemporary Periods



Figure 28: Naturalistic Floral Motifs from Chinese, Arts & Crafts and Art Nouveau Periods

Geometric Motif:

The geometric motif is an abstract motif that was inspired from the surrounding shapes and objects. This motif has been created since the historical periods for decoration or communication to reflect different meanings that were assigned to geometric shapes, or the number of lines used to create these shapes. The geometric motif can be created using basic shapes, symbols, lines, dots, etc. The geometric motif appears in various colors inspired by the surroundings in different shades, tints and tones (Fisher, 2000).

Some examples include: The African motifs reflected the African lifestyle and traditions. The ancient Egyptian motifs were created using basic lines and shapes (figure 29). The Celtic motifs were formed as intertwined ribbons to create decorative patterns (figure 30). The 20th century motifs used stripes, dots and other shapes (figure 31).



Figure 29: First Pattern Represents African Style & Last Two Patterns Represent Egyptian Style



Figure 30: First Two Patterns Represent Arabic Style & Last Pattern Represents Celtic Motif



Figure 31: Range of Contemporary Motifs Including Different Geometric Shapes

Calligraphic Motif:

The calligraphic motif has been a popular motif during different periods that used letters for decoration and communication. This motif was used to represent religious phrases, beliefs or other phrases in a stylistic format during different periods, such as Egyptian (hieroglyphic writing system), Arabic, Persian, Moorish, Celtic, Medieval, Renaissance and Contemporary periods (figures 32 & 33).



Figure 32: Arabic, Persian & Moorish Motifs With Islamic Phrases



Figure 33: First Two Images Represent Celtic Motifs & Last Two Images Represent Medieval Motifs

Pattern Properties

Pattern is the result of repeating a single motif using any repeating method, including block repeat, half-drop repeat or brick repeat. Any repeating method should be based on three main properties that affect the density of pattern. Pattern properties include structure, scale and spacing. Each property is described as the following:

1- Structure

Structure is the fundamental property of any repeating pattern; every pattern should be constructed based on a structure (Jones, 1972). The structure allows the elements to be repeated in any direction to create an endless pattern that covers almost any surface (Phillips & Bunce, 1993). Any repeating pattern cannot be perceived if there is no logical structure that creates its

appearance. Structure connects the elements of pattern based on a consistent relationship, which allows the eye to move easily from one element to another without disturbing or losing attention. The logical and organized structure brings unity, continuity and balance, all of which are aesthetic aspects (Arnheim, 1974; Gombrich, 1979).

2- Scale

Scale is the second property that comes after structure. It refers to the size of individual motif determined by the number and complexity of the motif itself (Justema, 1982). Changing the scale affects the space around the motif, which changes the pattern to be simple or complex, heavy or light. For instance, using a same space for small-scale or large-scale motifs makes the surface empty or full. In pattern design, different types of surfaces determine the scale of the repeated motif. The following images show three different scales of the same motif using the same space and repeat method (figure 34).

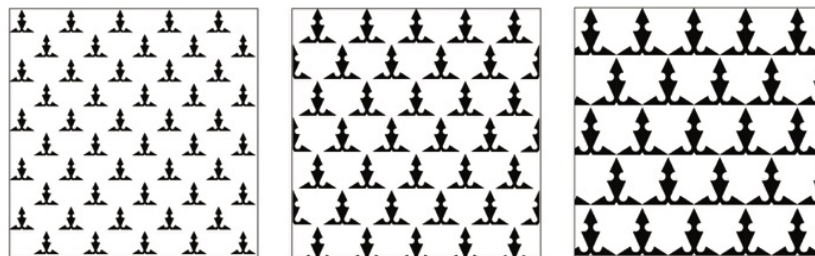


Figure 34: Changing Motif Scale

3- Spacing

Spacing is the third property that refers to the distance between two motifs, which can be varied (Justema, 1982). The distance between two or more motifs determines the amount of background shown from the covered surface. A small distance between two motifs shows little or no background, while a large distance between two motifs shows wide area of the background (figure 35).

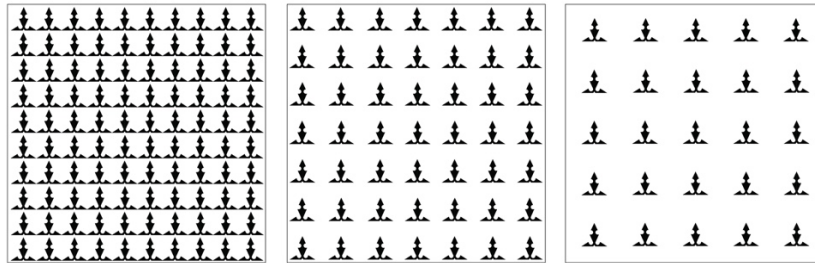


Figure 35: Changing Spacing Between Motifs

Repeating Methods

In surface design, there are three main methods of repeats, including block repeat, drop repeat and brick repeat. Any of these three methods can be varied by changing the structure of the pattern, changing the spacing between the motifs, or changing the directions or scales of the motifs. These methods are described as the following:

Block repeat: The simplest repeating method that refers to repeating the motifs side by side based on a simple structure. Changing the spacing between the motifs creates several sub-types, such as Pillar, Stripe, Open and Diamond (figure 36; Ginsburg, 1995).

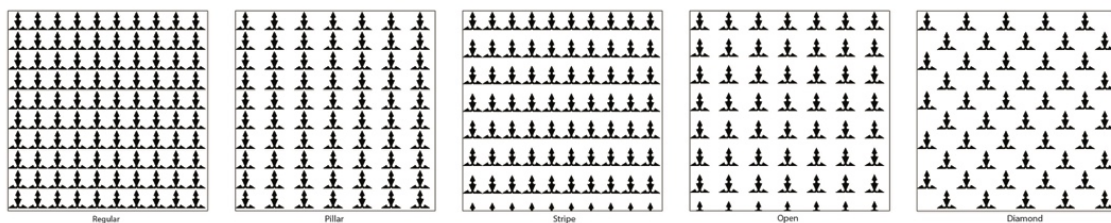


Figure 36: Block Repeat Varied (Changing Spacing Between Motifs)

Drop repeat: The most common repeating method in surface design. This method is based on repeating the motif based on vertical lines in various ways, such as half drop, step drop, one-third drop or quarter drop. The following images show the half drop variation by changing the space between the motifs. This also can be applied to other types of the drop repeat (figure 37; Ginsburg, 1995).

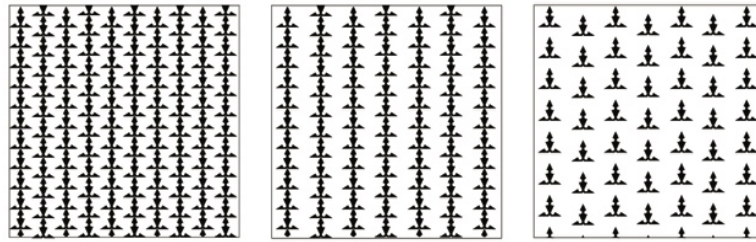


Figure 37: Drop Repeat Varied (Changing Spacing Between Motifs)

Brick repeat: This method is similar to the drop repeat, but it is based on repeating the motif using horizontal lines instead of vertical lines. The following images show the brick repeat by moving each motif half block from the adjacent motif. The variation can be achieved by changing the space between the motifs. This also can be applied to other types of the brick repeat (figure 38; Ginsburg, 1995).

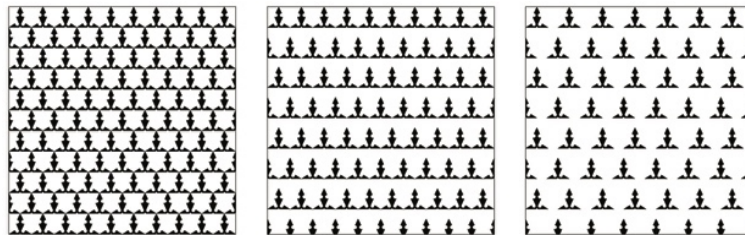


Figure 38: Brick Repeat Varied (Changing Spacing Between Motifs)

In this research the three density levels were created by changing the space between the motifs and keeping the same structure and scale. The process of creating the stimuli for the experiment will be explained in detail in the methodology chapter (p.56).

Density (Amount of Information)

Density is an aspect of pattern that changes by changing pattern properties, which include structure, scale and spacing. It is defined as “the amount of configuration in a given space” (Justema, 1982) that determined by scale, spacing and repeating of the motifs (Rodemann, 1999). Any pattern can appear in different levels of density (high, medium or low). The low level shows a large amount of the uncovered space around the motifs. The medium level shows an amount of uncovered space similar to the covered space. The high level shows a small amount of the

uncovered space around the motifs. The following is an example of three density levels (figure 39).

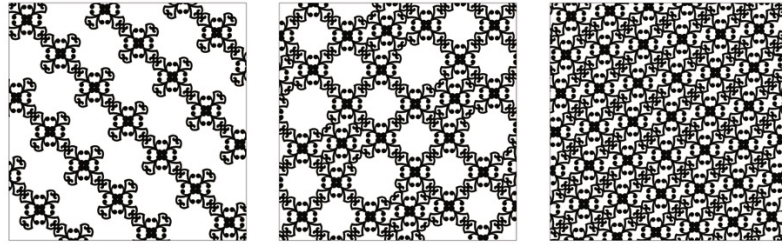


Figure 39: Three Levels of Density (Low, Mid, High)

Color

Color is the other component of surface design that interacts with pattern to influence the appearance of the surface. Color is the communication tool between the viewer and the surroundings. Color is used to attract the viewer's attention to an object and convey different messages. Color never appears alone, but it always appears in association with another color or element of the surface. Colors can be combined to create simple or complex combinations. Each color within the combination affects other adjacent colors, which can change the appearance of the covered surface to be pleasing or displeasing.

Hundreds of years ago, psychologists and theorists were interested in understanding color interactions and relationships both physically and psychologically. Since that time, many systems were developed and used by designers, artists and educators within their disciplines. Some examples of these theories include the Munsell System, Natural Color System, Pantone System and others. The Munsell Color System is one of the most popular systems that has been used globally due to its accuracy and language that would be easy to understand by designers who speak different languages.

For the purpose of this research, this system was used to create various color combinations. This system's accuracy allows the researcher to determine the levels of color attributes for each color and compare the colors based on a mathematical relationship. In addition, Munsell System was used in previous research that examined color preference using different concepts. The process of selecting colors will be explained in detail in the methodology chapter (p.56).

Munsell Color System

The Munsell Color System is a very accurate, organized and logical system, unlike any other system developed earlier. It was developed by an American artist and educator, Albert Munsell in 1915. Munsell brought art to science, considering both physical and psychological aspects of color. Munsell was the first theorist who added the psychological aspect to the color system. Designers and artists used this system to create various color combinations that used for textile, interior, graphic, painting, etc. (Fraser & Banks, 2004).

The Munsell System is defined as “perceived equidistant,” which means that the variations between each color and its adjacent one is perceived as identical (DeLong & Martinson, 2012). Munsell divided his system into two parts: one part is related to the physical aspect of color, which is known as the color chart ‘Atlas,’ and the other part is related to the psychological aspect, which is known as the color space (Cochrane, 2014). In this study, the color chart was used for color selections, while the color space was used to create the color combinations.

Color Chart ‘Atlas’

Munsell developed a three-dimensional model divided into three parts, each part representing one color attribute, including hue, value and chroma. Based on the three attributes, Munsell system was known as the HVC System (Monsef, 2011). Munsell defined each attribute in his book *‘A Grammar of Color’* as follows: hue is “the quality of the color by which we distinguish one color from another, as a red, yellow, green, blue or purple” (figure 40; Munsell & Birren, 1973; p.18); value is “the quality by which we distinguish a lighter color from a darker one” (Munsell & Birren, 1973; p.21); chroma is the intensity or purity of the color by which we distinguish the weak color, more grayish, from the strong one, less grayish (figure 41).

Each attribute has its own position on the 3D model. Hue is the ring that surrounds the cylinder. This ring is divided into ten equal parts, one position for each primary color (red, yellow, green, blue and purple) and each secondary color (yellow-red, green-yellow, blue-green, purple-blue and red-purple). The ring moves up, down and around the cylinder to change the levels of other attributes (value and chroma). Value is the cylinder that includes pure white on the top and pure black on the bottom. The value (lightness) of a specific hue changes by moving the ring up and down. As the ring moves up toward white the color becomes lighter. As the ring moves down toward black the color becomes darker. As the ring moves toward the middle the color becomes purer. Chroma (saturation) is the space between the ring and the cylinder. The chroma (saturation) of a specific hue changes by increasing or decreasing the space. As the space increases the color becomes less gray or saturated. As the space decreases the color becomes grayer or desaturated (figure 42).

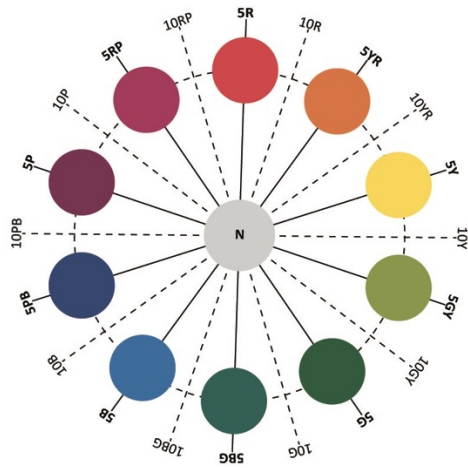


Figure 40: Munsell Color Wheel Represents Hue

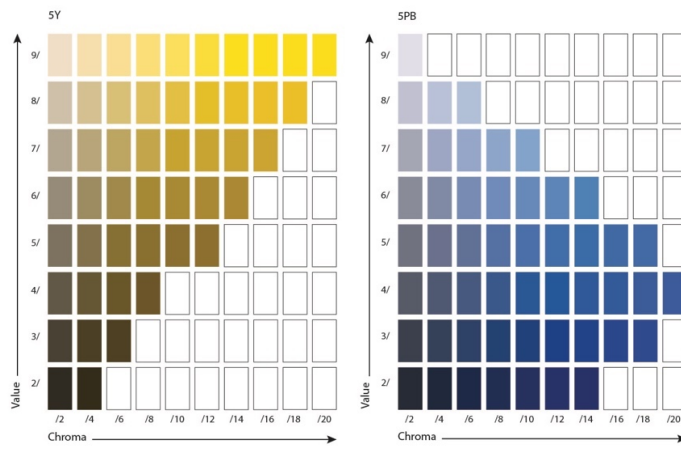


Figure 41: Munsell Charts Represent Value & Chroma Scales for Different Hues in 5 Scale

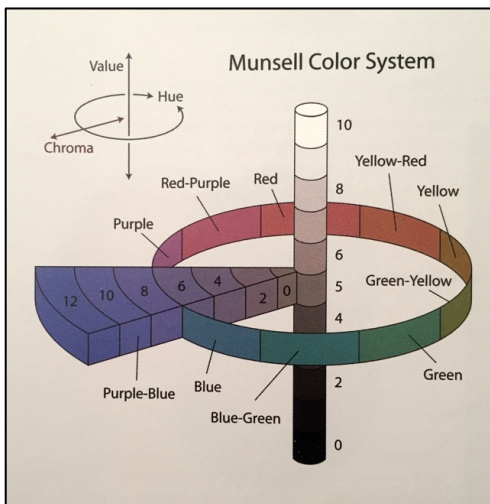


Figure 42: Munsell 3D Model

To make this system effective for practical use, Munsell developed a coding system using numbers and letters that represent each color attribute. A number (ranges from 0 to 10) followed by a letter (R for red, G for green, B for blue, etc.) represents hue (Example: 5R or 10PB). A number followed by a slash represents value (lightness), such as 5/, 7/, 10/, etc. The value scale ranges from 0/ for pure black to 10/ for pure white and the middle 5/ is the neutral gray. The value scale can be applied to any chromatic and neutral color. Three terms are used to describe value, including dark (low value), middle (medium value) and light (high value). A slash followed by a number represents chroma (saturation), such as /1, /2, /3, etc. The chroma scale ranges from 0 and extended to 20 for some colors, which means that the highest chroma is different for each color (some colors reach high chroma at 10, while other colors reach high chroma at 20). Many terms are used to describe chroma, including weak or muted (low chroma), moderate (medium chroma) and strong or saturated (high chroma).

Example: **5B 5/10** refers **5B**: pure Blue, **5/** medium value (lightness), **/10** high chroma (saturation).

Munsell used his system to create an unlimited number of colors by changing each attribute one at a time. He also developed several methods to combine these colors into unlimited pleasing combinations based on the psychological aspect of the color (color space). These methods were described in his book *A Grammar of Color* that was first published in 1921.

Color Space

Munsell used logical and orderly methods to create a range of unlimited balanced combinations, which included three methods. The **Complementary method** refers to combining two colors that appear opposite to each other on the color wheel by drawing straight lines to connect any two colors (Munsell, 1921). The **Single Hue method (Monochromatic harmonies)** refers to combining different scales of value and chroma of a single hue. For example, combining

low value of Red color with high value of the same color or weak chroma of Purple color with stronger chroma of the same color; or combining low value and weak chroma with high value and stronger chroma or vice versa (Munsell, 1921). The **Neighboring Hues method** refers to combining two hues that appear next to each other on the color wheel. For example, combining Green with Green-Yellow, Red with Yellow-Red, etc. Hues can be varied by changing the scales of value or chroma to create different shades (adding black), tints (adding white) and tones (adding gray). Any of these methods is applicable to create multiple-color combinations: For instance, combining color from one side of the color wheels with the mixture of its opposite Yellow-Red (Orange), which is an admixture of Yellow and Red (figure 43).

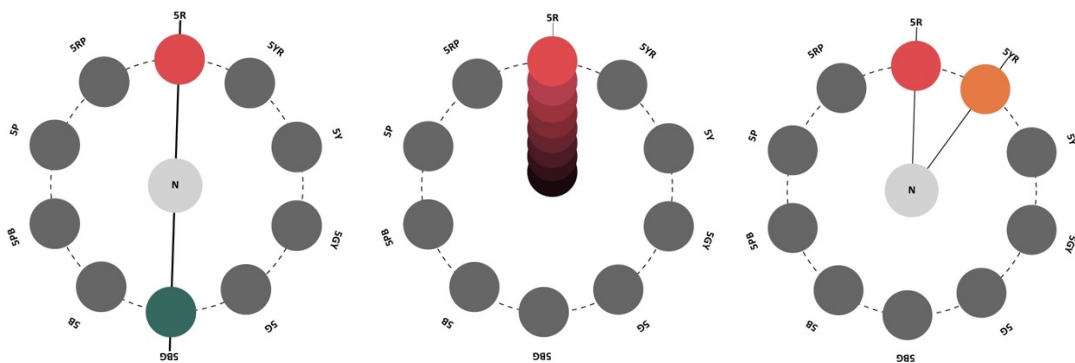


Figure 43: Example of Each Method (Complementary, Single Hue, Neighboring Hues)

In this study, the color combinations were created in three levels of contrast based on Munsell's method of complementary colors. This method is one of the most used methods in design to create pleasing combinations (DeLong & Martinson, 2012). In this case, the participants will have a number of combinations to choose from that vary in their contrast levels and types (value contrast or chroma contrast).

Color Contrast

Contrast is defined as the interaction between two colors that allows one color to be distinguished when viewed against other colors. It can be created between any two or more colors that could be primary, secondary, complementary or ranges of the same color. It can be soft or harsh, high or low, pleasant or unpleasant based on the relationship between color attributes (hue, value, chroma) (Best, 2017). According to Itten (1961), there are seven types of contrast:

(1) **Hue Contrast:** The simplest type that refers to combining colors of different hues, but same value and chroma. In this type, colors are combined in their most intensity level. Some combinations can be vibrant when the combined colors are complementary (Example: Yellow + Blue + Green, or Yellow + Red + Blue or other combinations).

(2) **Light-Dark Contrast (Value Contrast):** The contrast between different value scales of the same or different hues. The highest contrast can be achieved by combining very light (high value) with very dark (low value) colors, such as combining Yellow (the lightest color) and Purple (the darkest color).

(3) **Saturation Contrast (Chroma Contrast):** Also known as intensity contrast. It is the combination of pure, intense colors with dull, subdued colors of the same or different hues. The colors can be subdued by adding black, white, gray or its complementary color. Some combinations of this type can be vibrant or harsh.

(4) **Cold-Warm Contrast:** The combination of cold hues (Green, Blue-Green, Blue, Purple-Blue, Purple) with warm hues (Red-Purple, Red, Yellow-Red, Yellow, Green-Yellow). The highest contrast can be achieved by combining the coldest hue (Blue-Green) with the warmest one (Yellow-Red).

(5) **Complementary Contrast:** The contrast between two colors that are opposite to each other in the color wheel. Colors can be combined in different value (shade, tint) or chroma (tone) to create different levels of contrast. The most vibrant complementary contrast can be created by combining colors in their most saturated level, which creates vibrating boundaries and illusions that can be irritating to the viewer's eye. In addition, each two complementary colors represent not only this type of contrast, but also other types as well. For example, Yellow + Purple represent the highest light-dark contrast; Orange + Blue represent cold-warm contrast; Red + Green represent hue contrast.

(6) **Simultaneous Contrast:** Related to the effect that appears when two colors are viewed against each other. Some colors appear lighter or darker, weaker or stronger based on their background or other adjacent colors. Also, some colors create illusions or unpleasant feelings when two highly saturated colors are combined. This type can be seen within some other types of contrast, such as hue contrast, complementary contrast, saturation contrast or other types.

(7) **Proportion (Extension) Contrast:** The relation between the form size and the hue weight (that varies based on the color attributes). This type combines large and small, long and short, wide and narrow, or thick and thin forms to create balanced designs. It also can be applied to any other type of contrast. It can be used to reduce the illusions caused when combining two highly saturated colors.

Contrast Types Used for the Current Research:

Two types of contrast were considered in this research, including value contrast (contrast between light and dark colors), and chroma contrast (contrast between muted and saturated colors). For each type of contrast, three levels of contrast (low, mid, high) were created by changing the scale of value or chroma one at a time. In this case, color combinations were varied

to include soft or harsh, and pleasing or unpleasing. The contrast levels were determined based on Munsell scales of value and chroma, as the following examples:

Value contrast: A combination of Green Yellow (GY) for the foreground and Purple (P) for the background was created in three levels of contrast by changing the value scale and keeping the chroma scale for the foreground color (GY), while keeping the background color the same (P). These three levels: low contrast (5GY 9/4 + 5P 9/4), medium contrast (5GY 8/4 + 5P 9/4), and high contrast (5GY 7/4 + 5P 9/4) (figure 44).

Chroma contrast: A combination of Yellow Red (YR) for the foreground and Blue (B) for the background was created in three levels of contrast by keeping the value scale and changing the chroma scale for the foreground color (YR), and keeping the background color the same (B). These three levels: low level (5YR 8/4 + 5B 8/4), medium (YR 8/8 + 5B 8/4), high (5YR 8/12 + 5B 8/4) (figure 45).



Figure 44: Value Contrast in Three Levels (Low, Mid, High)



Figure 45: Chroma Contrast in Three Levels (Low, Mid, High)

Research on Color Preference

For decades, color preference has been considered by a number of scholars to explore the factors that shape human preference for colors as solid or within context. Color preference has been examined for single colors and color combinations using several concepts and theories. This section of the literature is divided into two subsections: solid colors and color with different contexts.

Solid Color

Previous studies have explored the factors that influence color preference for solid colors individually or in combinations. Several theories and methods were used to collect the data quantitatively and qualitatively, such as experiments, surveys, interviews and other methods. Some of the explored factors were related to the subject (the viewer), including personal characteristics (gender, age, education, experience). Other factors were related to the object, including color attributes (hue, value, chroma), contrast, density, and object size or purpose.

The Effect of Personal Characteristics on Color Preference

Several subjective factors were explored that influence personal taste, including gender, age, background, educational level, culture and lifestyle. Granger (1952) believed that color preference is an objective variable but personal taste plays an important role in shaping it. Silver & Ferrante (1995) proved that gender influences preference for single colors when asking the participants to report their favorite colors in general. They found differences and similarities among the participants when choosing their favorite colors. For instance, blue was preferred by both males and females equally, while black and purple were preferred by females more than males. Also, red was preferred over pink by males, but red and pink were preferred equally by females. However, a recent study found that gender has no effect on color preference, when examining the effect of hue, value and chroma on preference for colors on colored background (Camgoz & Yener, 2002).

In addition, Ou & Luo (2011) proved that age influences preference for single color and color combinations when asking the participants to rate number of colors using four-word pairs rating scale: warm/cool, heavy/light, active/passive, like/dislike and harmonious/disharmonious for the color combinations. Their findings indicated that older participants rated the light color pairs as less active and cooler more frequently than the younger participants. Also, the older

participants rated the color pairs that were similar in chroma as less liked and less harmonious more frequently than the younger participants.

The Effect of Art Training on Color Preference

Other studies proved subjects' preferences for color combinations differ based on their amount of art training. Lo (1936) asked groups of different art levels (non-artists, art students and artists) to sort a number of two-color combinations into two piles of like and dislike. The findings indicated that color preference of two-color combinations varied based on the amount of art training. For example, color preference increases with the blue combinations (short wavelengths) and decreases with the red combinations (long wavelengths). In addition, Palmer & Griscom (2012) examined color preference in relation to harmony and art training levels. They asked the participants to rate their preferences and harmony levels for a number of color pairs in various attributes. The findings indicated that color preference for harmony decreases consistently with art training.

The Effect of Color Attributes on Color Preference

Many studies found that the color attributes factor plays an important role in changing color preference. Different colors are preferred in specific levels of value (lightness) or chroma (saturation). For instance, Granger (1952) indicated that single colors with high chroma (saturation) are preferred more than colors with low chroma (saturation) when viewed on a natural gray (N5) background. Also, the brightest and most saturated colors (high value and chroma) are preferred on the brightest and most saturated background (high value and chroma) of other colors (red, yellow, yellow-green, green, cyan, blue, purple, magenta) (Camgoz & Yener, 2002; Tangkijwiwthat & Rattanakasamsuk, 2010).

The Effect of Contrast on Color Preference

Earlier studies indicated that contrast is an important aspect of color that changes color preference. When two colors are viewed against each other, preference increases as the similarity between them decreases. For instance, the participants preferred warm colors (red, orange and yellow) on cooler backgrounds (blue, cyan and green) and vice versa, but not warm colors on warm backgrounds (Schloss & Palmer, 2010). Also, the participants preferred high saturation colors (high chroma) on low saturation backgrounds (low chroma), or light colors (high value) on dark backgrounds (low value) and vice versa (Schloss & Palmer, 2010). Previously, similar findings were achieved by Reber & Schwarz (2004) who asked the participants to rate figure-ground contrast (value contrast) of circles that were presented to them for one second. The results showed that the high-contrast circles were liked more than the low-contrast circles.

Processing Fluency Theory (Theory of Beauty)

The above findings related to contrast were supported by the Processing Fluency Theory (Theory of Beauty) that was developed by Reber & Schwarz (2001). This theory was defined by Reber & Schwarz (2001) as “the aesthetic experience is a function of the perceiver’s processing dynamics: The more fluently the perceiver can process an object, the more positive is his or her aesthetic response” (p.365). This theory is based on both subjective and objective factors: the subjective factor is the human perception when viewing the object, and the objective factor is the object’s properties. Also, this theory was used to examine many objective variables that influence aesthetics judgment, including balance, proportion, symmetry, amount of information, complexity, contrast and clarity (Arnheim, 1974; Brikhoff, 1933; Gombrich, 1995).

Later in this document, the Processing Fluency Theory will be used to support the findings of the current research. In order to test the findings and their relation to this theory the color combinations were created in various levels of contrast and density.

Color and Context

This section presents studies that explored the relationship between preference and colors within different contexts, including objects, forms and patterns, using various concepts, methods and theories.

Context plays an important role in changing color preference, which makes it an important aspect to be considered by many scholars. Previous studies found that color preferences differ based on the associated contexts. Many factors were explored that are similar to the factors that affect solid colors. Some were subjective, including personal characteristics, lifestyle, education, culture and experience. Others were objective, including context appropriateness, context function and color attributes.

Colored Object

Previous studies indicated that people's favorite colors in general may be different than their preferred colors for a specific context, depending on purpose and usage.

Context Related Factors

The appropriateness of the color for a specific object is one of the factors that were explored by many scholars. Holmes & Buchanan (1984) asked the participants to name their favorite colors, and their preferred colors for specific objects, such as automobile, shirt, sofa, carpet and others. They found that the participants preferred a specific object to be in a different color than their favorite. For example, the brown (including dark and light brown) and blue colors were preferred for several objects. The blue color was identified as the participants' favorite color, but not the brown color.

The same findings were supported by other studies of color attributes. In general, the participants preferred muted (low chroma) objects more than saturated (high chroma) objects because the participants preferred to see harmonious combinations when they interact with

different objects in the environment (Schloss & Palmer, 2012). The participants preferred colors to be in different levels of value and chroma based on the object purpose or size. For example, the participants preferred big objects, such as walls and trims to be light (high value) and muted (low chroma), but small objects, such as t-shirts and pillows to be dark (low value) and saturated (high chroma) (Schloss & Palmer, 2012). In addition, other studies claimed that the overall preferred color is different from the preferred color for interior walls and t-shirts. For instance, Jonauskaitė & Mohr (2016) found that the overall preferred colors were red, blue and green-blue, but not orange, yellow and purple. In addition, the walls were preferred mostly to be colored with light colors, as light colors make the appearance of interior space larger. Also, the t-shirts were mostly preferred to be colored with dark or less chromatic colors.

Subject Related Factors

In addition to the previous factors related to context, the personal characteristics factor is another factor that influences color preference for specific objects. Significant differences were found among gender, age, education and personality while choosing the preferred colors for clothing and interiors in general. In relation to gender, females preferred muted (low chroma) colors more than males who preferred saturated (high chroma) colors. For clothing (ties and scarves) or interior walls and trim, females preferred muted (low chroma) colors, unlike males who preferred saturated (high chroma) colors (Schloss & Palmer, 2012). In relation to age, different age groups prefer dark (low value) colors for clothing and light (high value) colors for interiors. For example, Bakker & Voordt (2013) found that the older participants preferred blue and dark blue for clothing, while the younger participants preferred black for clothing.

Personality is another factor that influences color preference. For example, in relation to interior environment, Bakker & Voordt (2013) found that the participants preferred white for being quiet and focused, and red for being energetic, but no specific color for being creative.

Personal experience with the object is another subjective factor that plays a significant role in shaping color preference. To understand this relationship between personal experience, color preference and objects, Schloss & Palmer (2010) developed the Ecological Valence Theory and tested it using several concepts.

Ecological Valence Theory (EVT):

Schloss & Palmer (2010), argued that color preferences are not fixed, but are shaped by people's affective experiences with the colored objects. People like objects whose colors "look good" to them and avoid objects whose colors "look bad" to them. For example, people like blue and green because they are associated with health (blue sky, clean water and vegetables); in contrast, people dislike brown because it is associated with unhealthy or rotting objects. Later in this document, this theory will be used to support the findings of the current research.

Colored Form

The Effect of Density (Amount of Information) on Color Preference

The influence of the number of figures in color preference was considered by Schloss & Palmer (2010). In their research, different densities of colored squares (30%, 40%, 50% and 60%) in various color combinations were examined on a colored square background. The results showed that the preference of light and dark figures and backgrounds varied based on the number of figures. For example, the small number of figures were preferred to be lighter than the background; the large number of figures were preferred to be darker than the background.

Colored Pattern

The effect of pattern on color preference is another topic that was examined by many scholars using various concepts and methods, but the number of these studies is limited compared to other contexts. Those studies explored many factors: some were related to the pattern and color, and others were related to the viewer. The factors that related to pattern and color included

style, color combinations, contrast and finishes. The factors that related to viewer included personal characteristics (gender, age, background and personality), lifestyle, occupation, educational level and income.

Rodemann (1999, 2009) conducted several studies to examine the relationship between color preference and pattern using several types, styles, arrangements and color combinations. She collected the data quantitatively and qualitatively using different methods including semantic differential, adjective checklists, bipolar adjective pairs, rating scales, scale models and slides. The findings indicated that there is a correlation between pattern style and color combinations that varied among participants based on their characteristics, income, personalities and lifestyles. For example, the participants with upper-middle-income preferred Victorian-romantic and casual contemporary patterns to be colored with white, rose, pink, light gray colors. The participants with high-income preferred Victorian-romantic and traditional patterns to be colored with green, garnet, dark blue, velvet brown and gold colors. Also, the participants with an active life preferred modern and casual contemporary patterns to be colored in warm natural colors, such as cream, tan, copper, brown and black. Furthermore, the participants with high-education preferred casual contemporary, Asian and modern patterns to be colored with almond, red and black colors.

Another study conducted by Chang & Guan (2014) examined the relationship between pattern style and color preference using four different styles of textile products, including classic, original, modern and hyper-modern. The patterns used in their study were not repeated patterns, such as the pattern used by Rodemann. Instead, they used pictures of different destinations to show different styles and color combinations, which make their findings not accurate in relation to patterns. In this study, the participants were asked to write their preference for twelve pictures of four styles in high, middle, low and non-saturated colors of fabric. This study found a significant relationship between age and style regarding color attributes. For instance, old

participants preferred combining classic and hyper-modern styles with high saturation (Chroma) and warm colors, or middle saturation (Chroma) combined with cold and warm color for coats, scarves and ties. However, they preferred original and modern styles for heavy clothes. Young participants with low-income preferred original, modern and super-modern styles to be in high saturation (Chroma) and middle warm color.

Another study was conducted by Hsu & Ou (2015) that examined the influence of Taiwanese Floral patterns in color preference. The participants were asked to evaluate a number of images of Taiwanese fabrics on a neutral gray background using a semantic scale of nine adjectives. Their findings indicated that color preference is affected by several factors as follows: First, color harmony: the light color fabric was preferred more than other fabric as it appeared more harmonious. Second, pattern and color interaction: the high-saturated (Chroma) floral patterns were preferred more than other patterns, which reflected the Taiwanese style. Third, general liking for the colored object affects color preference as well as the experience with the object. This factor is related to the EVT (Ecological Valence Theory) which indicated that people general liking for the object influences by their experience with the colored object. Fourth, being a cultural symbol.

The number of studies that focused on understanding the relationship between color preference and pattern were limited. Only three studies were found up to the time of conducting this research. All three studies concluded that the interaction between pattern and color affects color preference. This finding will be the starting point for the current research. At this time, many questions will be raised: how do pattern and color interact to affect preference? Is this interaction related to pattern and color properties? How may this factor be considered by surface designers to create pleasing designs that may be applied for various objects?

Pattern and color are two main components of surface design, and each has its own properties. Pattern properties include structure, scale and spacing, while color properties (attributes) include hue, value and chroma. Changing pattern properties affects the pattern density (amount of information). Changing color properties affects the contrast between two colors in a combination. Density (amount of information) and contrast were considered by Gombrich (1984, 1995) as aesthetic features, which are related to preference.

Moreover, surface designers always pay attention to color choices when designing patterns to create designs that please the viewer's senses. This means that it is important for designers to consider the relationship between pattern density and color contrast, since they are two aesthetic features of surface design that influence the viewer's object color preference.

From this point, this research was conducted to examine the influence of pattern density and color contrast in object color preference for two-color combination. Density and contrast are two important variables that interact with each other differently based on their levels, which affect the appearance of the colored object and influence color preference. In order to conduct this research, four research questions emerged as follows:

- (1) What colors are selected by participants when shown a set of solid colored hues?
- (2) Which density and contrast levels are preferred by participants?
- (3) Which objects do participants prefer for a specific colored pattern swatch?
- (4) Why do participants prefer specific objects for a specific colored pattern swatch?

Conceptual Framework

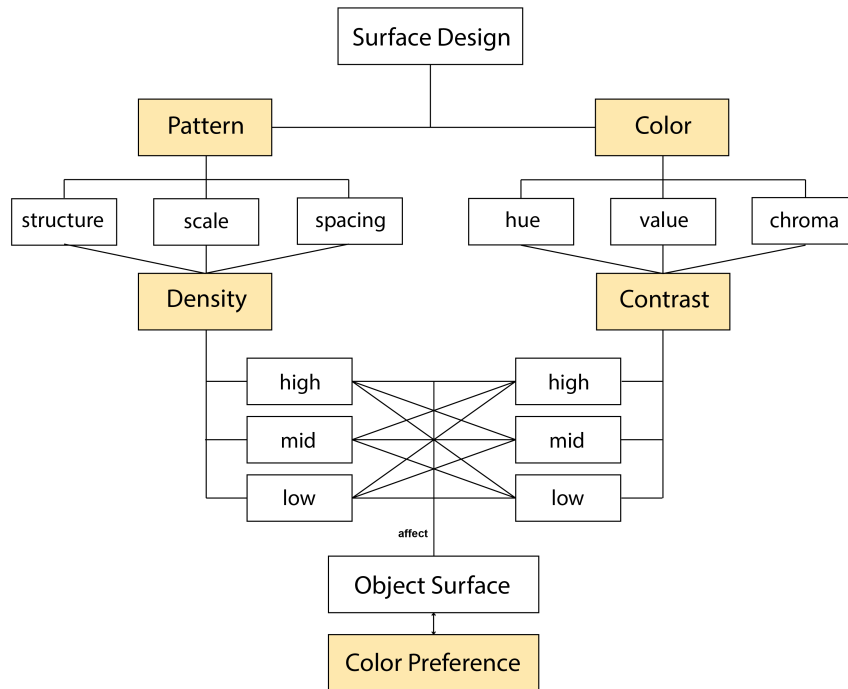


Figure 46: Conceptual Framework Model

The conceptual framework of this research (figure 46) is constructed based on the research questions to include three main variables: ‘Pattern Density,’ ‘Color Contrast’ and ‘Object Color Preference.’

The framework shows the aspects of pattern and color that changed by changing the properties of each. Changing pattern properties (structure, scale, spacing) one at a time affects its density, while changing color properties (hue, value, chroma) one at a time affects the contrast between two adjacent colors. These changes allow density and contrast to appear in different levels that range from high to low, so when pattern and color are combined each level of density interacts with different levels of contrast. As a result, the appearance of the covered objects differ based on the relationship between the density and contrast, which influences color preference.

Chapter Summary

This chapter is organized in three sections based on the main three variables, which includes pattern, color and object color preference. Each section is divided into subsections that provided more details about each variable. At the end of this chapter, a conceptual framework is constructed based on the research questions.

The pattern section includes the following:

First: the history part illustrates the history of pattern starting from ancient times until the 20th century. This part is organized based on pattern styles of different periods, including Oceania, African, Ancient Egyptian, Byzantine, Chinese & Japanese, Indian, Arabian, Moorish, Persian, Ottoman, Celtic, Medieval, Renaissance, Art & Crafts and 20th Century. Each style is described in terms of its founder, influences, characteristics, motif types, colors, development and usage.

Second: the pattern in general part discusses motif types, which included figural motif, floral motif, geometric motif and calligraphic motif. Then, pattern properties is discussed, which affect a pattern's density. Pattern properties included structure, scale and spacing. Last, repeat methods, which included block repeat (repeating the motif side-by-side based on a simple structure), drop repeat (repeating the motif based on vertical lines using various ways that could be half drop, one-third drop, quarter drop), and brick repeat (repeating the motif based on horizontal lines instead of vertical lines).

The color section includes the following:

First: the color system part describes the Munsell Color System, which is the system that has been most used in design fields, due to its accuracy, logic and organization. The Munsell System includes two parts: one is physical, which is the color chart based on color attributes (hue,

value, chroma); the other one is psychological, which is the color space based on the relationship between two or more colors.

Second: the contrast part defines contrast and discusses the most popular contrast types that were established by Itten (1961). These types included hue contrast, value contrast, chroma contrast, cold-warm contrast, complementary contrast, simultaneous contrast and proportion contrast.

The color preference section includes the following:

First: the solid color part describes the research that related to solid colors as individuals or in combinations. Many factors affecting color preference were explored, including subjective and objective factors, such as personal characteristics (gender, age, education, experience), color attributes, contrast and others.

Second: the color and context part describes the research that examined color within various contexts, such as form, object and pattern. Many subjective and objective factors were explored, including personal characteristics, lifestyle, education, culture and experience. Other factors related to the context, including appropriateness, function, color attributes, usage, density (amount of information) and many more.

At the end of this chapter, the research statement is shaped based on the previous findings, then a conceptual framework is constructed based on the research questions. The following chapter, methodology, will introduce the method that will be used to collect and analyze the data to answer the questions of this research.

CHAPTER 3: METHODOLOGY

The previous chapters gave an overview of this research, followed by describing the gap that was found in the literature, which leads to the idea of this research. This chapter will address the research design that will help to answer the research questions, followed by describing the settings, research sample, stimuli, data collection and data analysis methods. At the end of this chapter, the issues of trustworthiness (validity and reliability) will be discussed, as well as the limitations and delimitations of this research.

Research Design

The primary purpose of this research was to examine the influence of pattern density and color contrast in object color preference for two-color combination. Density and contrast are two important variables that interact with each other in different levels and affect the appearance of the covered object, which influence color preference.

Four research questions emerged to conduct this research, as follows:

- (1) What colors are selected by participants when shown a set of solid colored hues?
- (2) Which density and contrast levels are preferred by participants?
- (3) Which objects do participants prefer for a specific colored pattern swatch?
- (4) Why do participants prefer specific objects for a specific colored pattern swatch?

To answer these questions, a mixed method approach using quantitative and qualitative methods was selected. The two methods will be used to support each other and provide a complete and comprehensive explanation of the research problem to strengthen the research. The quantitative data was collected to understand the cause-and-effect relationship between the independent variables (density, contrast) and dependent variable (object color preference). The qualitative data was collected to provide in-depth explanation of the collected quantitative data based on the participants' views and thoughts. Using both methods of data collection provides the

research with numbers that supported by words, since this research is based on understanding the relationship between the subject who interacts with a specific object.

Research Setting

In order to collect the data using both quantitative and qualitative methods at the same time for each participant, the data were collected in a laboratory experimental setting. The quantitative data were obtained through an experiment of two stages, while the qualitative data were obtained through an interview. Each participant was tested individually for 5-10 minutes in a studio at McNeal Hall at the University of Minnesota.

The data were collected under the same conditions for all the participants: two tables were covered with white matte paper and used as displays for each method. The light in the studio was used as the only light source for both methods. Prior to the meeting the swatches were organized randomly on each table and photographed for every participant.

Research Content

This research included two types of swatches: solid-color swatch & pattern swatch. It also included an objects list that was used for the quantitative experiment.

Colored Swatches Types:

Both solid-color and colored pattern swatches types were used for the experiment, while only the colored pattern type was used for the interview.

The Processing Fluency Theory & Ecological Valence Theory were considered when creating the color combinations. The combinations were created in three levels of contrast and density in order to show acceptable or unacceptable combinations. Also, the combinations were created in various colors that are muted or saturated (changing chroma), and light or dark (changing value). Later in the analysis chapter, these two theories will be used to evaluate the current research.

All the swatches were created using Adobe Illustrator and printed on a matte paper, then cut in a square shape. The following is a description of the process of creating each swatch type:

1| Solid Color Swatch

The Munsell color charts were used for color selection after converting each color to RGB values using Centore (2013) source. Then, the RGB values were converted to CMYK to be ready for printing. Munsell charts were created for each hue in 5 scale and various scales of value and chroma. Each included 9 scales of value and 20 scales of chroma (figure 47). Then, the color combinations were created using the complementary method. The combinations included Red + Blue Green, Yellow Red + Blue, Yellow + Purple Blue, Green Yellow + Purple and Green + Red Blue.

Each two-color combination was created in three contrast levels (low, medium, high). The contrast levels were obtained in two ways: (1) to create value contrast, changing the value scale and keeping the chroma the same; (2) to create chroma contrast, changing the chroma scale and keeping the value the same to provide the participants with various options. These two changes were applied to the foreground color, but the background color was kept the same for all three levels of contrast of each color combination. Then, the contrast levels were determined based on the distance between the two colors in Munsell charts (See figures 48 & 49).

The color swatches were created in various tints, shades, and tones (light, dark, muted and saturated). Each combination included two solid colors (foreground and background). Each swatch contained two squares: a 1.25" X 1.25" square for the foreground that centered on a 2.5" X 2.5" square for the background (figure 50). Then, each swatch was coded using a coding system. Each code included: swatch number, Munsell scales for value & chroma, as well as the contrast level (figure 51).

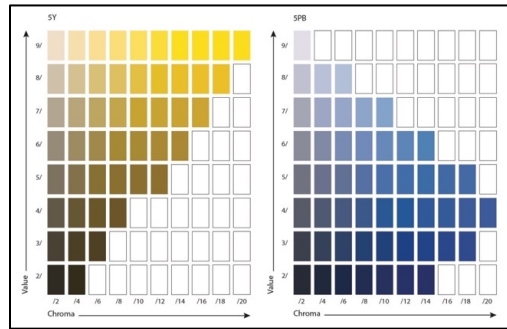


Figure 47: Munsell Charts of Yellow (Y) & Purple Blue (PB)

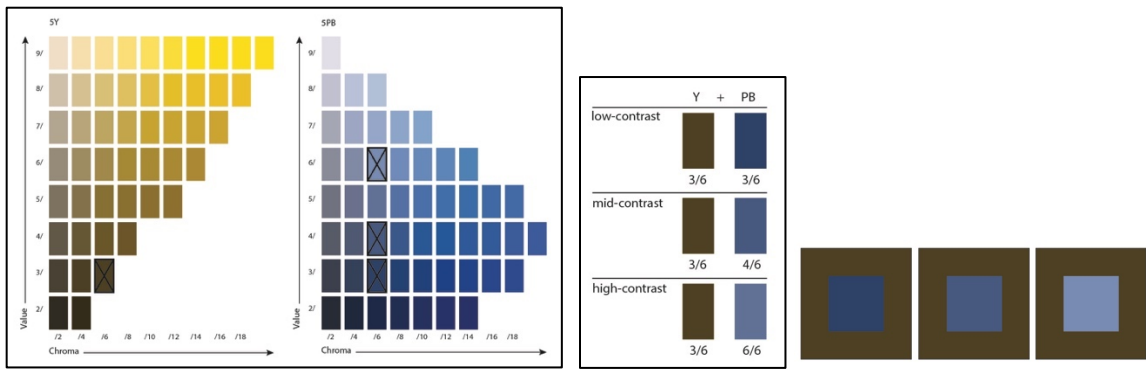


Figure 48: Three Levels of Contrast for Y & PB (Changing Value & Keeping Chroma)

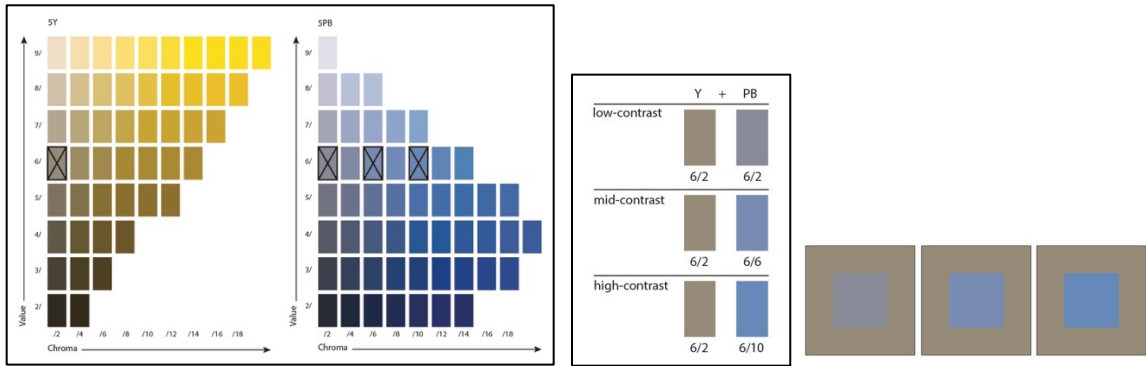


Figure 49: Three Levels of Contrast for Y & PB (Keeping Value & Changing Chroma)

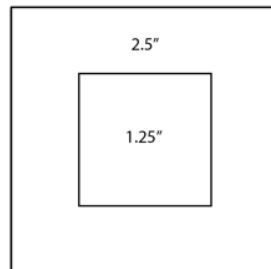


Figure 50: Solid Swatch Size

Swatch# 37
Solid Colors
Low Contrast
5G 2/2
SRP 2/6

Figure 51: Solid Swatch Code

2| Colored Pattern Swatch

The colored pattern swatches were created in two steps: First, creating the pattern in three levels of density. Second, applying the three levels of contrast that were created earlier for the solid color swatches to each level of density (a total of nine swatches were created for each combination).

First: Creating Pattern:

The patterns were created in two steps: (1) creating the motif, (2) creating the pattern.

1| Creating the Motif:

The motif was inspired by the vegetal motif of the Umayyad period, which was one of the greatest Islamic periods. The motif was created as a part of previous practical research that was done by Nahhas (2014) (figure 52). This motif was created by extracting the original motif from its historical monument and reshaping it to be more contemporary and applied to various contexts. The new motif has the characteristics of both its original style (Islamic style) and contemporary style. This method has been used by William Morris and other artists as discussed in the pattern history section in the literature review chapter. The (figure 53) shows the new Umayyad motif after reshaping it.

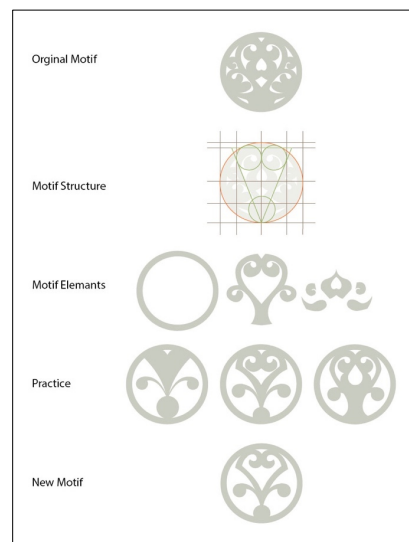


Figure 52: Creating New Motif Process

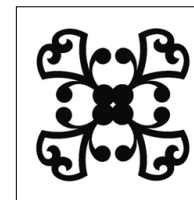


Figure 53: New Umayyad Motif

2| Creating the Pattern:

The new motif was repeated using the block repeat method by keeping its size, but changing the space between the motifs. Three levels of density were created using this method (low, medium and high) (figure 54).

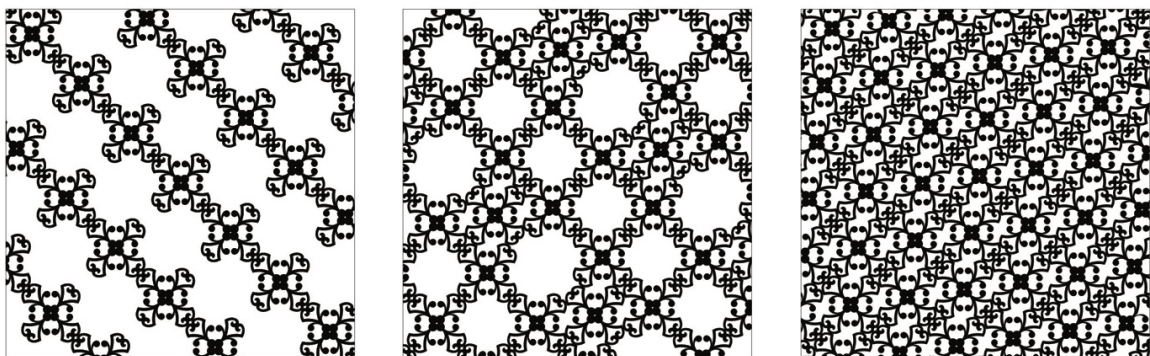


Figure 54: Repeating Motif to Create Different Levels of Density

Second: Applying Colors:

Each color combination that was created earlier in three levels of contrast was applied to the pattern in three density levels, which creates a total of nine swatches for each combination (figure 55). The swatches were printed on a matte paper as a 5" X 5" square. Then, each swatch

was coded using a coding system. Each code included: swatch number, Munsell scales for value & chroma, as well as the contrast level and density levels (low, medium, high) (figure 56; See Appendix B, p.146).

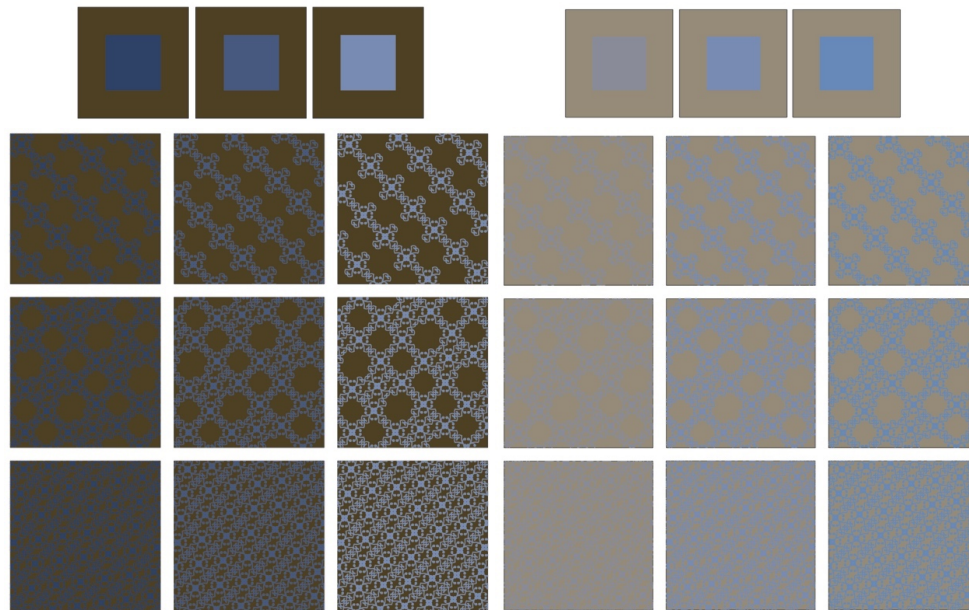


Figure 55: Applying Colors to Patterns

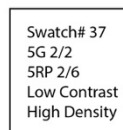


Figure 56: Colored Pattern Swatch Code

Objects list:

The list included objects of different sizes and purposes (figure 57). Most of the objects were inspired by previous research that tested the relationship between objects and color preference using different concepts. Some examples include: Holmes & Buchanan (1984) used objects that differ in their purposes for clothing and interior, such as shirts, sofas and carpets. Schloss & Palmer (2012) and Jonauskaitė & Mohr (2016) examined objects that were ranged in size from small (t-shirts and pillows) to large (walls and trims). Also, some other objects were

added to give the participants various options, such as interior objects, fashion objects or stationery objects.

Notebook	Sofa	Chair	Pillow	Apparel
Wallpaper	Wall Art	Tiles	Mug	Bag
Blanket	Tie	Greeting Cards	Wrapping Paper	Carpet

Figure 57: Objects List

Research Sample

The sample of this research was a convenience sample of 30 undergraduate design and art students who were taking courses that related to color or pattern at the University of Minnesota-Twin Cities. The students were contacted in their classes and asked if they were interested in participating in the research. Most participants were females, but a few were males with ages ranging from 18 to 34. Participants were studying Graphic Design, Interior Design, Apparel Design and Art.

For the purpose of this research that focused on pattern and color, all the participants were from design and art related fields with normal color vision (able to distinguish over sixteen million color) (Briggs-Goode & Townsend, 2011). Color vision was self-reported by each participant before the examination. The reason for selecting undergraduate students as the research sample is because of their limited experience in color and pattern, but having enough basic knowledge to express their opinion using vocabulary that related to color and pattern. Therefore, both specific and general data can be obtained, specifically from a designer's perspective and generally from a personal perspective.

Before recruiting the participants, IRB permission in conducting this research was obtained and the consent and data collection forms were approved by IRB. Since the research design is a mixed methods design, the following section will be divided into two parts: a

quantitative method and qualitative method. Each method will be discussed in terms of the research questions, stimuli, instruments and procedures.

Data Collection Methods

Prior to the data collection the following steps were repeated for each participant:

- (1) The swatches were placed on two tables that were covered with white matte paper, one table for the quantitative (figure 58) and one for the qualitative (figure 59).
- (2) The swatches were placed randomly and photographed for each participant.
- (3) The code of each swatch was documented in a table (figure 60)
- (4) Each participant was asked to review an IRB consent form (see appendix I, p.188) for permission to collect the participant demographics and record the interview.
- (5) Each participant was asked about their color vision status (normal or not).
- (6) Each participant's demographics were collected including (gender, age and major).



Figure 58: *Quantitative Method Set-up*



Figure 59: *Qualitative Method Set-up*

Quantitative:					

Qualitative:					

Figure 60: Tables for Recording Swatch Code

First: Quantitative Method

An experiment was conducted to answer the research questions of ‘What colors are selected by participants when shown a set of solid colored hues?’ ‘Which density and contrast levels are preferred by participants?’ ‘Which objects do participants prefer for a specific colored pattern swatch?’

Variables:

Two independent variables and one dependent variable were extracted from the research questions. The independent variables are ‘Density’ and ‘Contrast.’ Each variable included three levels (low, medium, high). The dependent variable is ‘Object Color Preference’

Instrument:

To collect the data for the first question, the codes of selected solid color swatches were recorded using the table of stage 1 (figure 61). For the last two questions related to colored pattern swatches and object, the codes of preferred swatches and objects names were recorded using the table of stage 2 (figure 61).

Quantitative Data			
Stage 1			
Solid Swatches #			
Stage 2			
Pattern Swatch #			
Object 1			
Object 2			

Figure 61: Tables for Recording Quantitative Data

Experiment:

Each participant was examined individually through two stages: solid color combination selection and colored pattern and object matching. The second stage included two sub-stages: (a) colored pattern selection; (b) object selection.

Stage 1: Two-Solid Color Combination Selection

The data of this stage were collected to answer the question of ‘What colors are selected by participants when shown a set of solid colored hues?’

Stimuli: 20 solid-color swatches (created prior the experiment) were selected in various tints, shades and tones of medium contrast. This allowed the participant to select the color combination regardless of the contrast level.

Procedures:

In this stage, each participant was shown 20 solid-color swatches that were placed randomly next to each other on a white background (figure 62). Then, the participant was asked to select three swatches and place them on the table based on the selection order (figure 63). The number of each swatch was recorded in the table of stage 1 (figure 61).

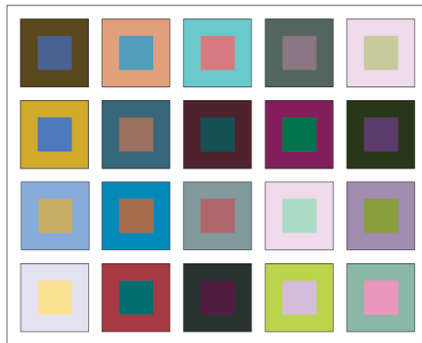


Figure 62: Presented Colored Swatches



Figure 63: Selected Swatches by One Participant

Stage 2: Colored Pattern and Object Preference

The data of this stage were used to answer the question of ‘Which density and contrast levels are preferred by participants?’ and ‘Which objects do participants prefer for a specific colored pattern swatch?’

Stimuli: The colored pattern swatches used for this stage were colored with the same combinations of the first stage, but in three levels of contrast and density (a total of nine swatches for each solid-color combination).

Procedures:

This stage is divided into two sub-stages, one for selecting the preferred colored pattern swatch, and one for matching the preferred colored pattern swatch with two objects from a list provided by the researcher. The two sub-stages were repeated for each selected solid-color combination that the participant select in the first stage.

(a) Colored Pattern Selection

The collected data of this sub-stage were used to answer the question of ‘Which density and contrast levels are preferred by participants?’

In this sub-stage, the participant was shown the selected color combination in stage one in three levels of density and contrast (a total of nine swatches) that were placed randomly on the table along with the solid-color swatch (figure 64). Then, the participant

was asked to select one preferred swatch and place it on the table. The code of the preferred swatch was documented on the data collection form (figure 61, p.65).

(b) Object Selection

The collected data of this sub-stage were used to answer the question of ‘Which objects do participants prefer for a specific colored pattern swatch?’

In this sub-stage, the participant was asked to select two objects from a list of fifteen objects for their preferred colored pattern swatch (figure 65). Another example of these two sub-stages (figure 66 & 67). Then, the participant was asked to move to the next table for the interview in order to collect qualitative data.

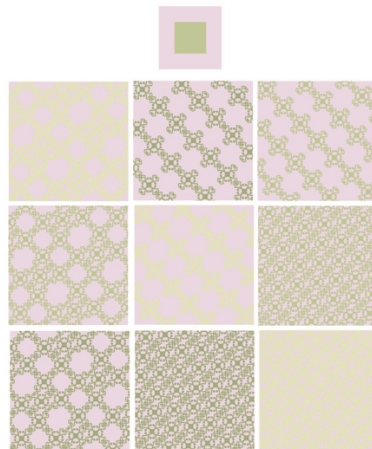


Figure 64: Example of Selected Color Swatch with Pattern by One Participant (Swatch 1)

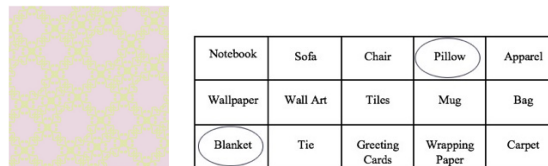


Figure 65: Example of Preferred Colored Pattern Swatch with Two Objects (Swatch 1)

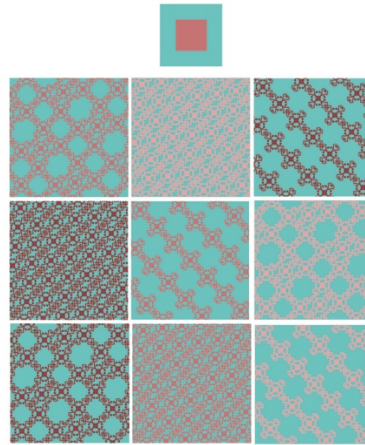


Figure 66: Another Example of Selected Color Swatch with Pattern by One Participant (Swatch 2)

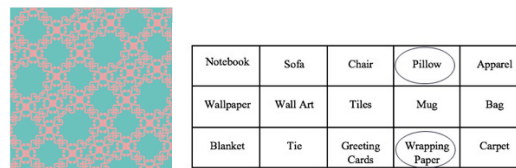


Figure 67: Another Example of Preferred Colored Pattern Swatch with Two Objects (Swatch 2)

Second: Qualitative Method

An interview was conducted to support and explore further the quantitative data, and answer the question of ‘Which objects do participants prefer for a specific colored pattern swatch?’ and ‘Why do participants prefer specific objects for a specific colored pattern swatch?’

Stimuli: 20 colored pattern swatches (created prior to the interview) were selected in various density levels, contrast levels and color combinations (various shades, tints and tones) (figure 68 & 69). The selected combinations were different than the combinations used for the quantitative method, but similar in their value and chroma. This provided the participant with a variety of options.



Figure 68: Selected Swatches for Interview

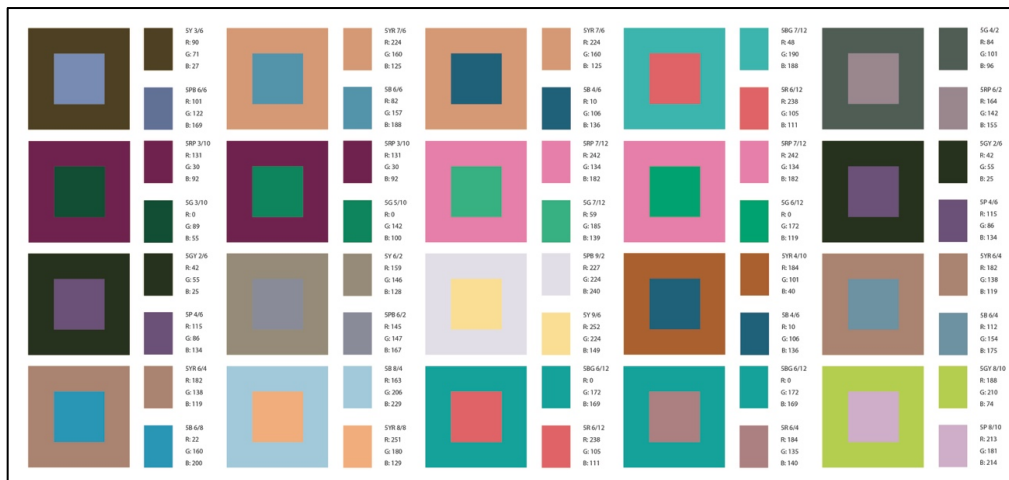


Figure 69: Color Combinations for Each Pattern Swatch that Selected for Interview

Interview Questions:

- (1) Pick two swatches that you prefer.
- (2) Identify two objects for each swatch?
- (3) Why did you prefer these two swatches for these objects? Explain.
- (4) What did you learn from these steps?

The code of each preferred swatch along with the objects was recorded using a table. The interview was also documented using the form (figure 70) and recorded using a digital recorder.

Qualitative Data

Pattern Swatch #		
Object 1		
Object 2		

Why did you pick this specific swatch for these objects? Explain

1)

2)

Additional Comments:

Figure 70: Qualitative Data Collection Form

Procedures:

Prior to the interview 20 colored pattern swatches were placed randomly on a white table (figure 71). Then, the participant was asked to select two preferred swatches and identify two objects for each swatch (figure 72). The swatch number and the objects were recorded using the table (figure 70). Then, the participant was asked to explain their reasoning.



Figure 71: Example of Interview Set-up for One Participant

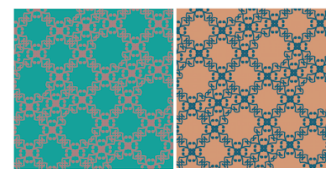


Figure 72: Example of Preferred Swatches

Data Collection Methods Model

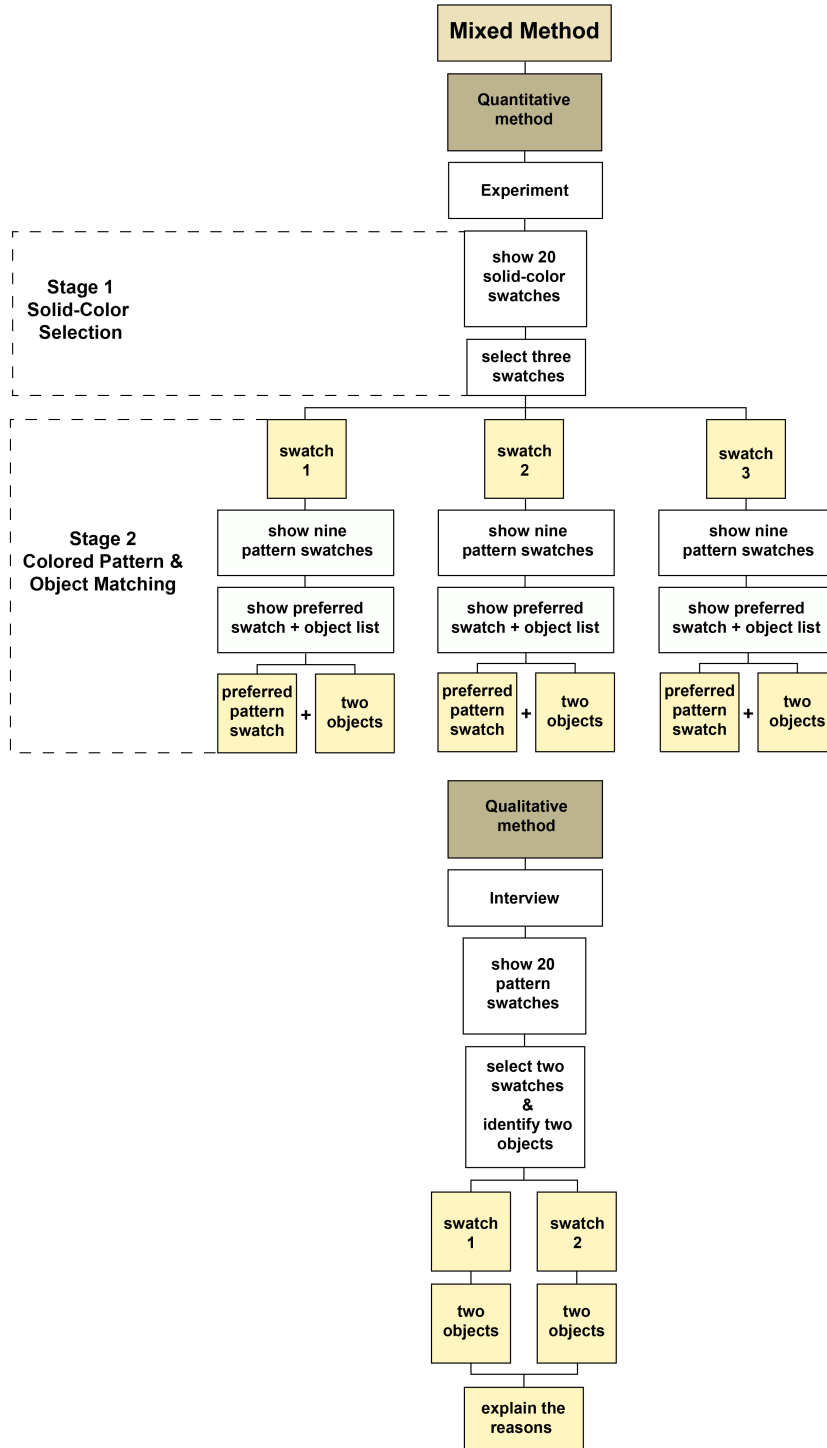


Figure 73: Data Collection Methods Model

Data Analysis Methods

Two methods were used to analyze the data:

- (1) Basic counts to analyze the quantitative data.
- (2) Thematic interpretations to analyze the qualitative data.

Participant Characteristics:

Participant data were organized on a table that included three main variables. Each was divided into sub-variables: gender, female or male; age, under 25 or 25 and above; and major, including graphic, interior, apparel and art.

Quantitative Data:

The collected data were organized in a table based on the research variables. A table was created for each stage of the experiment: A solid color selection table, preferred density and contrast table, and colored pattern and object preference table.

For the first stage, the table included each color combination, organized based on the selection count from high to low. The Munsell code for each color was also included.

For the second stage, two tables were created:

- (1) The table of preferred density and contrast level. This table included nine variables, each density level in three contrast levels, in order to determine the preferred level of contrast for each level of density. The data were organized based on the selection count from high to low. The most preferred level has the higher count, and the least preferred has the lower count.
- (2) The table of preferred objects for each colored pattern swatch.

Qualitative Data:

The qualitative data were analyzed using the thematic interpretation method. A number of codes and themes were identified that relate to the research question. Also, the participants' own words were used as evidence to support the data.

Issues of Trustworthiness (Validity & Reliability)

Validity:

The validity of this research was tested internally and externally: The internal validity was tested by checking the following criteria:

- (1) Effectiveness of the measuring instrument for collecting the data.
- (2) Triangulation, which means that the data were collected using different methods and sources that prove the findings.

The external validity was tested by checking the following points:

- (1) Generalizing the quantitative data to a wider population.
- (2) Transforming the qualitative data to other contexts and settings.

Reliability:

The reliability of this research was tested internally and externally by checking the following points:

- (1) The researcher described in-depth every aspect in the study, including the participants, methods of data collection and analysis.
- (2) Methods of collecting and analyzing the data are consistent.
- (3) The same findings can be obtained by other researchers using the same data collection and analysis method.
- (4) The findings and conclusions can be compared with previous research with the recent findings.

Limitations & Delimitations

Many limitations and delimitations were identified during the process of conducting this research that will be revisited in the last chapter to provide solutions and ideas for future research as follows:

First: The research sample was a convenience sample of undergraduate students at the University of Minnesota studying design. This will not allow generalizing the findings to a wider population including students outside creative fields.

Second: Sample size limited the findings. The female sample size was larger than the male sample size. In this case, the females' preferences cannot be compared to the males' preferences.

Third: Motif type used to create the pattern was only one type (vegetal), which will not allow generalizing the findings to include different motif types (geometric, calligraphy and others).

Fourth: Color combinations were very simple that limited to two-color, which might be not applied to three or more combinations.

Chapter Summary

This chapter is organized by explaining the research design, settings, content, sample, as well as the data collection methods and model, data analysis methods, issues of trustworthiness (validity and reliability), and limitations and delimitations of the research.

The purpose of this research is to examine the influence of pattern density and color contrast in object color preference for two-color combinations. The data were collected using a mixed approach, starting with a quantitative method, followed by a qualitative method to provide the study with numbers supporting specific explanations.

Sample and Setting: The participants were 30 undergraduate students from the College of Design at the University of Minnesota. The participants were taking classes that related to color

or pattern. Each participant was tested individually under the same conditions at a design studio in McNeal Hall at the University of Minnesota.

Content: Printed matte swatches were used to examine the relationship between three variables: pattern density, color contrast, and object color preference. Two types of swatches were created by the researcher for each data collection method. First type: solid two-color combination swatches were printed as a 2.5" X 2.5" square. Second type: colored pattern swatches in three levels of density and contrast for each color combination (created a total of nine swatches for each combination). The pattern swatches were printed as a 5" X 5" square.

Data Collection Methods: The data were collected using two methods, quantitative and qualitative.

The quantitative data were collected through an experiment of two stages to explore the relationship between pattern density, color contrast and object color preference based on numbers. Stage one was 'two-solid color combination selection.' In this stage, 20 solid color swatches were presented for each participant. Then, each participant was asked to select three swatches. Stage two was 'colored pattern & object preference.' This stage is divided into two sub-stages. The first sub-stage is colored pattern selection. In this sub-stage, nine colored pattern swatches were presented for each selected color combination in stage one. Then, the participant was asked to select the preferred swatch. The second sub-stage is object selection. In this sub-stage the participant was asked to select two objects from a list (provided by the researcher). The second stage of the experiment was repeated for each solid-color combination that the participant selected in the first stage. The data of each stage were recorded using a data collection form (see appendix D, p.173).

The qualitative data were collected through an interview to explore the relationship between the preferred colored pattern and objects based on the participant's opinions. Twenty

colored pattern swatches were created in various densities and contrasts of different shades, tints and tones. The swatches were presented for each participant randomly. Then, each participant was asked the following questions:

- (1) Pick two swatches that you prefer.
- (2) Identify two objects for each swatch.
- (3) Why did you prefer these two swatches for these objects? Explain.
- (4) What did you learn from these steps?

The interview was documented and recorded for each participant.

Data Analysis Methods: The methods of analyzing the quantitative and qualitative data were established in this chapter. The quantitative data were analyzed using basic counts as a statistical method. The qualitative data were analyzed by identifying themes that related to the research questions.

At the end of this chapter, the validity, and reliability of this research were discussed, and the limitations and delimitations were described.

CHAPTER 4: FINDINGS

Introduction

The purpose of this research was to examine the influence of pattern density and color contrast in object color preference for two-color combinations. The data were collected using a mixed methods approach, starting with a quantitative method followed by a qualitative method. The quantitative data were collected through an experiment of two stages. The qualitative data were collected through an interview to provide more explanation for the quantitative data. Each method was described in detail in the previous chapter.

In this chapter the collected data will be presented separately, starting with the participants' characteristics, followed by describing the quantitative and qualitative data.

The data will be organized in themes that relate to the research questions, which include the following:

- (1) What colors are selected by participants when shown a set of solid colored hues?
- (2) Which density and contrast levels are preferred by participants?
- (3) Which objects do participants prefer for a specific colored pattern swatch?
- (4) Why do participants prefer specific objects for a specific colored pattern swatch?

The quantitative data will be organized in three themes: 'solid color selection,' 'preferred density and contrast,' 'colored pattern and object preference.' The qualitative data will be organized in one theme: 'colored pattern and object preference.'

Participants

Characteristics:

Thirty undergraduate students completed an experiment and interview, including six males and twenty-four females. Twenty-six participants were under the age of 25 and four were 25 and above. At the time of data collection, the participants were taking courses in the College of Design at the University of Minnesota-Twin Cities. The participants were from different creative fields: twenty five from Graphic Design, three from Apparel, one from Interior Design and one from Art. All the participants have normal color vision as each one self-reported the status of their color vision. The participants' data were organized in Table 1 below.

Table 1: Participants' Characteristics

Characteristics	Gender		Age		Major			
	female	male	18-24	25-34	graphic	apparel	interior	art
Count	24	6	26	4	25	3	1	1

Quantitative Findings

The quantitative data were collected to answer three research questions through an experiment:

- (1) What colors are selected by participants when shown a set of solid colored hues?
- (2) Which density and contrast levels are preferred by participants?
- (3) Which objects do participants prefer for a specific colored pattern swatch?

The experiment included two stages:

First: Solid color selection to answer the first question;

Second: Colored pattern and object preference to answer the other two questions.

The following section will describe the data of each stage organized in themes, each theme is related to one research question.

First theme: Solid Color Selection

Related question: What colors are selected by participants when shown a set of solid colored hues?

Table 2: Solid Color Swatches

Swatch	Munsell Code		Contrast Type	General Count	Gender Count		Swatch	Munsell Code		Contrast Type	General Count	Gender Count	
					F	M						F	M
	5BG 8/8	Value	15	12	3		5B 2/6	Value	3	1	2		
	5R 6/8						5YR 3/6						
	5Y 7/10	Value	10	10	0		5P 4/10	Value	3	3	0		
	5PB 5/10						5GY 5/10						
	5R 3/10	Value	10	7	3		5GY 7/2	Value	3	3	0		
	5BG 4/10						5P 6/2						
	5BG 6/2	Chroma	8	7	1		5PB 7/10	Chroma	3	1	2		
	5R 6/6						5Y 7/6						
	5G 8/4	Value	6	5	1		5PB 8/2	Value	2	2	0		
	5RP 7/4						5Y 7/2						
	5B 4/4	Value	5	3	2		5YR 4/12	Value	1	1	0		
	5YR 5/4						5B 5/12						
	5R 2/4	Value	5	5	0		5B 5/10	Chroma	1	1	0		
	5BG 3/4						5YR 5/6						
	5G 7/4	Chroma	5	4	1		5G 2/2	Chroma	1	1	0		
	5RP 7/8						5RP 2/6						
	5RP 9/2	Chroma	5	2	3		5PB 2/4	Value	0	0	0		
	5G 9/6						5Y 3/4						
	5P 9/4	Value	4	4	0		5RP 3/10	Chroma	0	0	0		
	5GY 8/4						5G 3/6						

The selected swatches were organized in Table 2 above from high to low based on the selection counts in total and for each gender.

Chart 1 shows the total selection counts from Table 2 for both genders sorted from high to low (left to right). Charts 2 & 3 show the individual selection counts for females and males.

The charts of both genders can't be compared since the number of females is very large compared to the males. For that, the data will be described in total as follows:

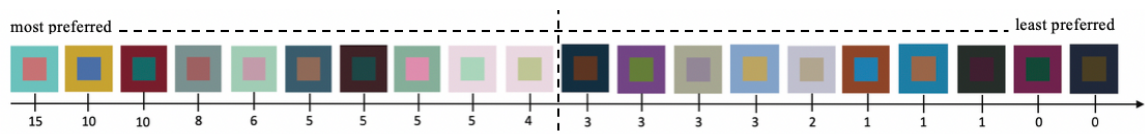


Chart 1: Selected Solid-Color Swatches in Total

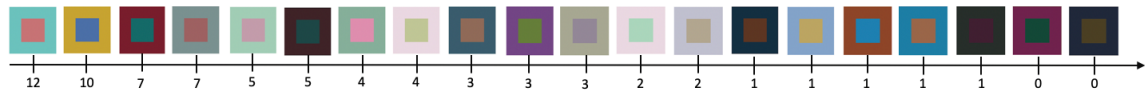


Chart 2: Selected Solid-Color Swatches by Females

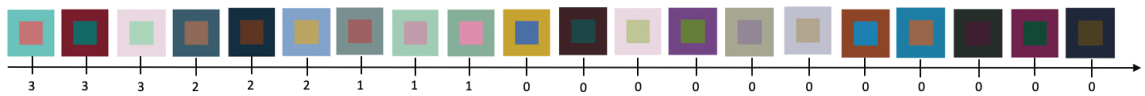


Chart 3: Selected Solid-Color Swatches by Males

Value & Chroma Scales:

The following scales were extracted from Helson & Lansford (1970).

- Value scales: low (2/, 3/, 4/) medium (5/, 6/, 7/) high (8/, 9/)
- Chroma scales: low (/2) medium (/4, /6) high (/8, /10) very high (/12, /14 & above)

Data description:

The data in Table 2 are described as follows:

- (1) In terms of value, the combinations that combine colors with medium value 5/, 6/, 7/ or high value (light) 8/, 9/ were preferred more often than the combinations that combine colors with low value (dark) 2/, 3/, 4/.
- (2) In terms of chroma, the combinations that combine colors with high chroma (saturated) /8, /10 and medium chroma /4, /6 were preferred over the combinations that combine colors with very low chroma (muted) /2 or very high chroma (highly saturated) /12, /14.

Examples:

Most preferred combinations (selected four times or more):



The following combinations were preferred very often (four times or more):





- Most of the above combinations contrast in value (high & medium value scales) and combine colors of high or medium chroma. Two combinations contrast in chroma (low & medium chroma scales) and combine colors of high value.

Value Contrast Combinations




  = (high & medium) value + high chroma


 = (high & medium) value + medium chroma

 = high value + medium chroma

Chroma Contrast Combinations





 = medium value + (low & medium) chroma


 = high value + (low & medium) chroma

- Except for three combinations that contrast in value (low & medium value scales) and combine colors of mid chroma. One combination contrasts in chroma (high & medium chroma scales) and combines colors of medium value.


Value Contrast Combinations 

 = (low & medium) value + medium chroma

 = low value + high chroma

 = low value + medium chroma

Chroma Contrast Combination 

 = medium value + (medium & high) chroma


Least preferred combinations:


The other combinations were rarely or never preferred (less than four times or never selected).





- Most of the combinations contrast in value (low & medium value scales) and combine colors of high or very high chroma. Two combinations contrast in chroma (high & medium chroma scales) and combine colors of medium value.

Value Contrast Combinations 


 = low value + medium chroma


 = (low & medium) value + high chroma


 = (low & medium) value + very high chroma

 = low value + medium chroma

Chroma Contrast Combinations 

 = medium value + (high & medium) chroma


 = medium value + (high & medium) chroma


 = very low value + (low & medium) chroma

 = low value + (high & medium) chroma

- Except for two that contrast in value (high & medium value scales) and combine colors of low chroma.






















 = medium value + low chroma

 = (high & medium) value + low chroma

Second theme: Preferred Density & Contrast:

Related question: Which density and contrast levels are preferred by participants?

Table 3: Preferred Level of Contrast for Each Level of Density

Swatch																				total	
Low dens Low contrast	3	1	3												1						8
Low dens Mid contrast	1				1	2						1								1	6
Low dens High contrast	4		1	2	1		1				1			1							11
Mid dens Low contrast	1		1					1	2	1											6
Mid dens Mid contrast	1		2	1	1		1	1			1			1	1						10
Mid dens High contrast	1	3	2	1	1	3	1	1	1		1	1	1								17
High dens Low contrast	1			2			1	1	1								1	1			8
High dens Mid contrast	1	2		1			1	1	1	1		2	1	1	1						13
High dens High contrast	2	4	1	1	2					1											11

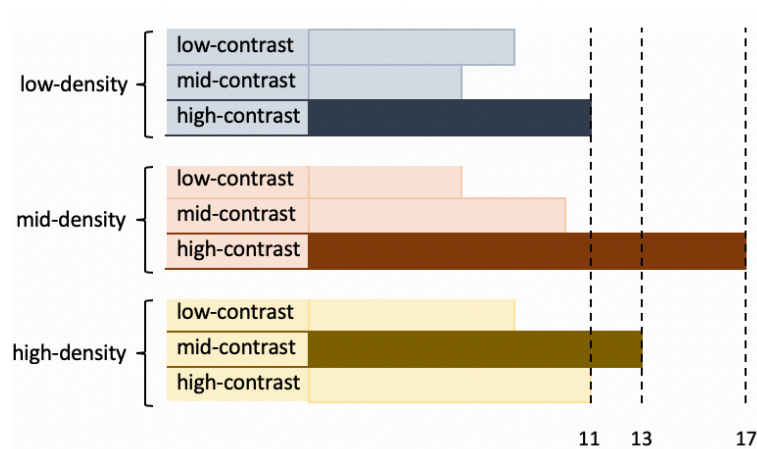


Chart 4: Preferred Contrast Level for Each Level of Density

The findings of this theme are related to the first theme. Since the most selected combinations in the first stage contrast in value, the findings of this theme will be discussed in relation to value contrast.

Color codes (only for sorting purposes)

Table 3 shows three levels of density. Each was organized in three levels of contrast and coded with a different color:

Blue = low-density in three contrast levels.

Orange = mid-density in three contrast levels.

Yellow = high-density in three contrast levels.

Data description:

Table 3 above is described as follows:

(1) Low-Density Level:

The low-density was mostly preferred in high-contrast for most color combinations, followed by low-contrast, then mid-contrast.

(2) Mid-Density Level:

The mid-density was mostly preferred in high-contrast for most color combinations, followed by mid-contrast, then low-contrast.

(3) High-Density Level:

The high-density was mostly preferred to be in mid-contrast for most color combinations, followed by high-contrast, then low-contrast.

Table 3 shows the most preferred contrast level was the high-contrast for both low-density and mid-density, but the mid-level for high density. In contrast, the least preferred contrast level was the low-contrast. In addition, the most preferred level of density and contrast

was the mid-density in high-contrast, which received the higher count 17, followed by the high-density in mid-contrast, with 13, then the low-density in high-contrast with 12.

Third theme: Colored Pattern & Object Preference:

Related question: Which objects do participants prefer for a specific colored pattern swatch?

The data of this question were organized in Table 4 below, which shows the preferred objects for each colored pattern swatch.

Table 4: Colored Pattern & Object Preference










































Solid	Pattern	Munsell Code	Density Level	Contrast Level	Object preference
		5BG 8/8 	low	low	blanket, tie, wall art, bag
		5R 8/8 			
		5BG 8/8 	low	mid	pillow, blanket
		5R 6/8 			
		5BG 8/8 	low	high	notebook, pillow, mug, greeting card, bag, blanket
		5R 4/8 			
		5BG 8/8 	mid	low	pillow, wrapping paper
		5R 8/8 			
		5BG 8/8 	mid	mid	sofa, tie
		5R 6/8 			
		5BG 8/8 	mid	high	pillow, bag
		5R 4/8 			
		5BG 8/8 	high	low	apparel, greeting card
		5R 8/8 			
	5BG 8/8 	high	mid	apparel, wrapping paper	
	5R 6/8 				
	5BG 8/8 	high	high	notebook, mug, chair, wrapping paper	
	5R 4/8 				
		5Y 7/10 	low	low	pillow, tile
		5PB 7/10 			
		5Y 7/10 	mid	high	chair, wrapping paper, blanket, wall art,
		5PB 2/10 			
		5Y 7/10 	high	mid	notebook, pillow, tile, wrapping paper
		5PB 5/10 			
		5Y 7/10 	high	high	wall art, tile, notebook, wrapping paper, wallpaper, apparel
		5PB 2/10 			

Table 4: Colored Pattern & Object Preference





































































Solid	Pattern	Munsell Code	Density Level	Contrast Level	Object preference	
		5R 3/10 	low	low	chair, wrapping paper, wallpaper, tie	
		5BG 3/10 				
		5R 3/10 	low	high	wallpaper, carpet	
		5BG 5/10 				
		5R 3/10 	mid	low	chair, carpet	
		5BG 3/10 				
		5R 3/10 	mid	mid	sofa, wallpaper, bag	
		5BG 4/10 				
		5R 3/10 	mid	high	pillow, tile, chair, sofa	
		5BG 5/10 				
		5R 3/10 	high	high	sofa, carpet	
		5BG 5/10 				
		5BG 6/2 	low	high	pillow, tile, notebook, wallpaper	
		5R 6/10 				
		5BG 6/2 	mid	mid	pillow, bag	
		5R 6/6 				
		5BG 6/2 	mid	high	wallpaper, bag	
		5R 6/10 				
		5BG 6/2 	high	low	notebook, pillow, tile	
		5R 6/2 				
		5BG 6/2 	high	mid	chair, pillow	
		5R 6/6 				
		5BG 6/2 	high	high	tile, wrapping paper	
		5R 6/10 				
		5G 8/4 	low	mid	tile, greeting card	
		5RP 7/4 				
		5G 8/4 	low	high	chair, carpet	
		5RP 6/4 				
		5G 8/4 	mid	mid	pillow, wallpaper	
		5RP 7/4 				
		5G 8/4 	mid	high	notebook, greeting card	
		5RP 6/4 				
		5G 8/4 	high	high	tile, wrapping paper, chair, carpet	
		5RP 6/4 				
			5B 4/4 	low	mid	pillow, bag, tile, tie
			5YR 5/4 			
		5B 4/4 	mid	high	apparel, wallpaper, notebook, tile, bag	
		5YR 7/4 				
		5R 2/4 	low	high	notebook, tie	
		5BG 4/4 				
		5R 2/4 	mid	mid	tile, carpet	
		5BG 3/4 				

Table 4: Colored Pattern & Object Preference










































Solid	Pattern	Munsell Code	Density Level	Contrast Level	Object preference	
		5R 2/4 	mid	high	wallpaper, wrapping paper	
		5BG 4/4 				
		5R 2/4 	high	low	apparel, tie	
		5BG 2/4 	high	mid	apparel, tile	
		5G 7/4 	mid	low	wallpaper, tile	
		5RP 7/4 				
		5G 7/4 	mid	mid	pillow, bag	
		5RP 7/8 	mid	high	wall art, bag	
		5G 7/4 	high	low	greeting card, wrapping paper	
		5RP 7/4 	high	mid	pillow, tile	
			5RP 9/2 	mid	low	greeting card, wrapping paper, pillow, bag
			5G 9/2 			
			5RP 9/2 	mid	high	blanket, wrapping paper
			5G 9/10 	high	low	greeting card, wrapping paper
		5RP 9/2 	high	mid	notebook, carpet	
		5G 9/6 	low	high	wall art, bag	
		5P 9/4 	mid	low	pillow, blanket	
		5GY 9/4 				
		5P 9/4 	high	mid	notebook, greeting card	
		5GY 8/4 	high	high	chair, wallpaper	
			5B 2/6 	low	mid	pillow, greeting card
			5YR 3/6 			
			5B 2/6 	mid	mid	pillow, wallpaper
			5YR 3/6 	mid	high	notebook, apparel

Table 4: Colored Pattern & Object Preference

Solid	Pattern	Munsell Code	Density Level	Contrast Level	Object preference
		5P 4/10	mid	high	notebook, greeting card
		5GY 6/10			
		5P 4/10	high	mid	pillow, wrapping paper, chair
		5GY 5/10			
		5GY 7/2	low	high	wallpaper, wrapping paper
		5P 5/2			
		5GY 7/2	mid	high	chair, bag
		5P 5/2			
		5GY 7/2	high	mid	tile, wrapping paper
		5P 6/2			
		5PB 7/10	low	low	wall art, wrapping paper
		5Y 7/10			
		5PB 7/10	mid	mid	wall art, tile
		5Y 7/6			
		5PB 7/10	high	mid	tile, wrapping paper
		5Y 7/6			
		5PB 8/2	mid	mid	sofa, bag
		5Y 7/2			
		5PB 8/2	high	mid	notebook, tile
		5Y 7/2			
		5YR 4/12	high	low	pillow, tie
		5B 4/12			
		5B 5/10	high	low	tie, wrapping paper
		5YR 5/10			
		5G 2/2	low	mid	chair, wallpaper
		5RP 2/6			

The data of Table 4 above were organized in Chart 5 (p.89).

Data description:

Table 4 shows differences among the preferred objects for different densities and contrasts. Different objects that vary in size and purpose were preferred for different densities and contrasts of the same combination or different combination. In addition, some objects were preferred for combinations that contrast in value, while other objects were preferred for combinations that contrast in chroma.

Some examples:

The examples were organized in three categories based on the area that they related to: Interior (wallpaper, tiles, carpets, sofas, chairs, blankets, pillows and wall arts). Apparel, ties and bags. Others (wrapping paper, notebooks, greeting cards and mugs). Each category included large and primary objects, or small and secondary objects.

Interior objects

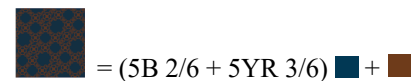
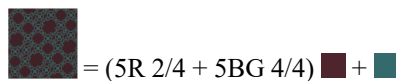
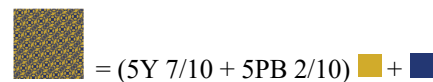
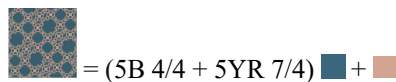
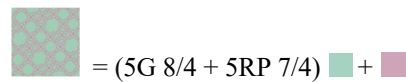
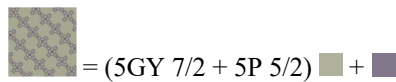
(1) Primary or big objects, such as wallpaper, tiles, carpets and sofas.

These objects were mostly preferred to be colored with combinations that have high or mid-value contrast and combine colors of high, mid or low-chroma. These combinations don't create vibrating edges of pattern when viewed against its background.

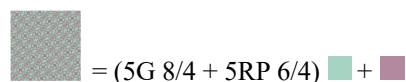
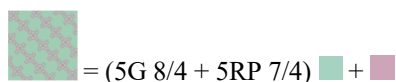
A few combinations have low-value contrast of high-chroma, or high or low-chroma contrast.

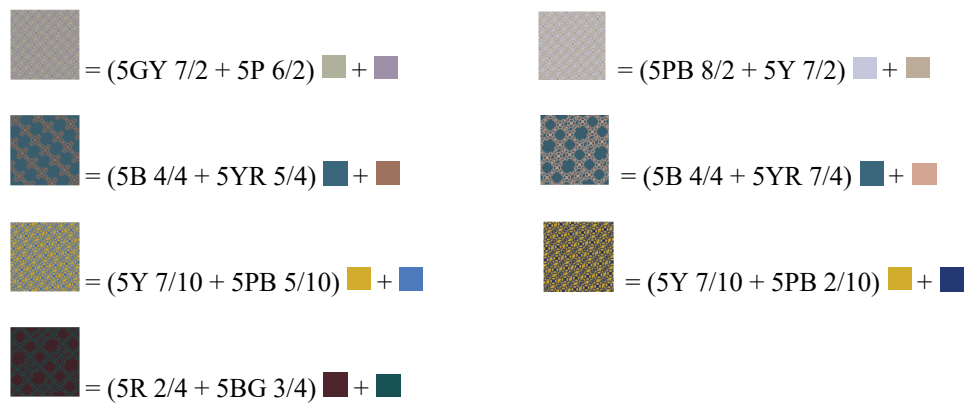
These combinations create vibrating edges of pattern when viewed against its background.

- Wallpaper was preferred in the following combinations. These combinations have high or mid-value contrast.



- Tile was preferred in the following combinations. These combinations have high or mid-value contrast.



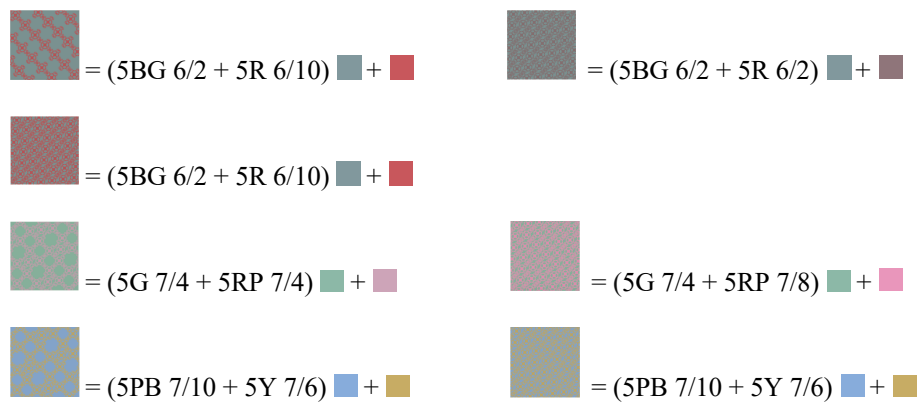


A few combinations that have low-value contrast or chroma contrast were preferred to be applied for wallpaper or tiles.

Low-value contrast



Chroma contrast

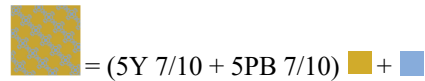
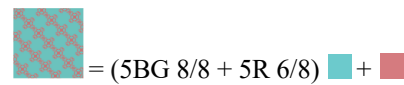
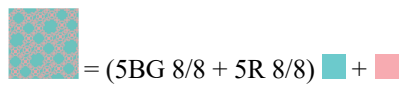


(2) Secondary or small objects, such as chairs, pillows, blankets and wall arts.

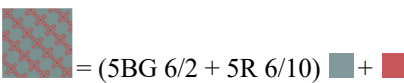
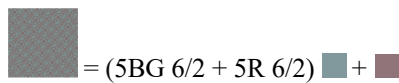
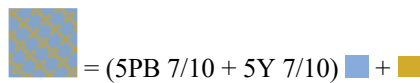
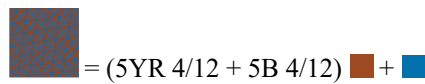
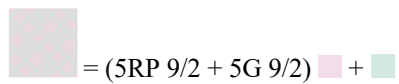
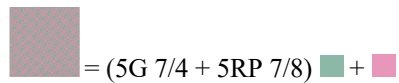
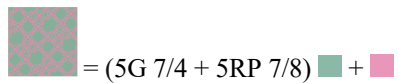
These objects were mostly preferred to be colored with combinations that have any levels of value or chroma-contrast. Most of these combinations were never preferred for primary objects, as most of them create vibrating edges of pattern when viewed against its background.

- Pillow was preferred in the following combinations. Most of the combinations contrast in chroma, while a few contrast in value and combine colors of high value and chroma scales. Some of these combinations were never preferred to be applied for big or primary objects.

Value contrast (high, mid, low), and combined colors with high value and high or mid chroma.

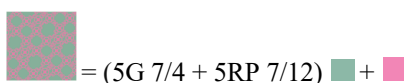
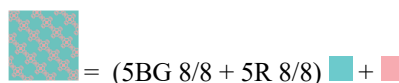


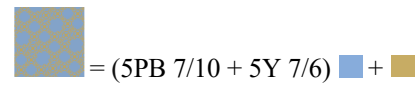
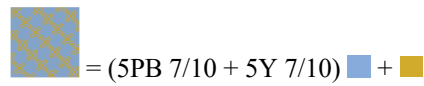
Chroma contrast



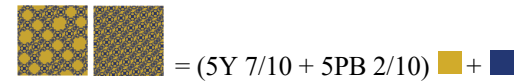
- Wall art was preferred in the following combinations. Most of the combinations that contrast in chroma were never preferred for big or primary objects; while few contrasts in value.

Chroma contrast





Value contrast



Clothing and other objects

These objects were mostly preferred to be colored with any combination, whether contrast in value or chroma. Most of these combinations were preferred for secondary interior objects. These objects included apparel, ties, bags, mugs, notebooks, wrapping paper and greeting cards (see Chart 5, p.93).

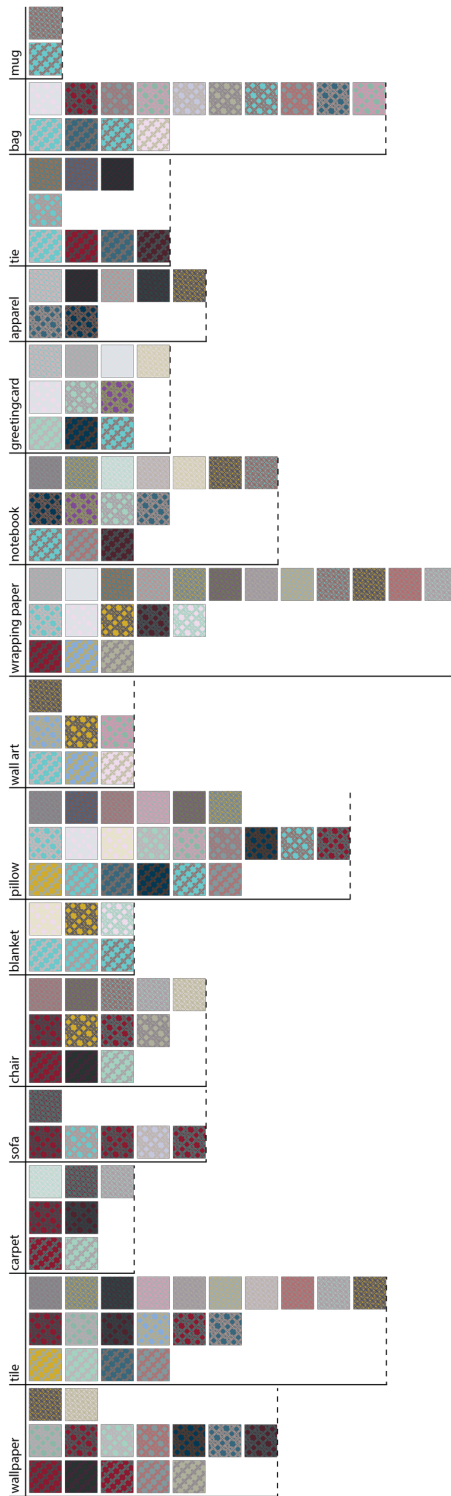


Chart 5: Objects & Preferred Pattern Swatches

Qualitative Findings

The qualitative data were collected to answer one research question: ‘Which objects do participants prefer for a specific colored pattern swatch?’ and ‘Why do participants prefer specific objects for a specific colored pattern swatch?’

The qualitative data were collected through an interview. During the interview, each participant was shown a set of twenty colored patterns in three density and contrast levels for various color combinations. Then, each participant was asked the following questions:

- (1) Pick two swatches that you prefer.
- (2) Identify two objects for each swatch.
- (3) Why did you prefer these two swatches for these objects? Explain.
- (4) What did you learn from these steps?

The participants’ responses were organized in the following theme: ‘colored pattern and object preference.’ Table 5 below shows the swatches organized in nine categories, three contrast levels for low-density, mid-density and high-density, as well as the preferred objects and reasons.

Table 5: Interview Responses



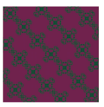
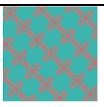
Pattern	Count	Munsell Code	Pattern category	Object preference	Reason
	3	5GY 8/10	low density + low contrast	shoes, t-shirt notebook, accent pillow	Bright and cheery colors. Low-contrast of saturation. Colors work with other neutral colors.
		5P 8/10			
	1	5Y 6/2	low density + low contrast	pillow, whole sheet set, tie	Look classic and conservative with subtle color, which fit for people who have professional job.
		5PB 6/2			
	1	5RP 3/10	low density + low contrast	classic sitting, carpet or rug, wallpaper of a tile, back of the chair	Low-contrast and dark colors for small or part of the objects.
		5G 3/10			
	4	5BG 7/12	low density + mid contrast	blanket, sheets, towel, scarf, bag, tie, notebook, tile, surfboard, gift wrap	Exciting and bright colors. This work well for accessory and something not primary (bedding). The bright colors pops and reminds of beach and sun shine.
		5R 6/12			

Table 5: Interview Responses













Pattern	Count	Munsell Code	Pattern category	Object preference	Reason
	2	5YR 7/6 	low density + mid contrast	pencil bag, tote bag, wallpaper, dress	Appealing colors that don't hurt the eyes. Light with just enough contrast but bright colors that would be perfect for rooms or big objects.
5B 6/6 					
	12	5G 4/2 	low density + high contrast	pillow, interior fabric, blanket, quilt, carpet, sofa, wallpaper, tiles (flooring or bathroom), apparel, tie, scarf, notebook, mug	<p>Work for big or small objects either way because of the contrast and the structured and organized pattern. The colors are subdued with enough contrast that don't pop out very much.</p> <p>Colors work well and contrast together without vibration. The pattern is simple and not overwhelming.</p> <p>Strong colors of light and dark shades.</p> <p>Look classy preferred for wallpaper in a room or bathroom.</p> <p>Not crazy or feminine colors perfect for men tie with a nice suit.</p> <p>Work well for a tile because the pattern is simple and easy to read. (bathroom tiles on the wall, but not all the wall).</p> <p>These colors can be incorporated in any kind of form.</p> <p>Big scale objects calm colors with very simple pattern makes you look calm in the room.</p> <p>Soft colors, both pretty gray for big scale objects. Also, simple pattern with more spread lines help to focus and moves the eye throughout the design elements.</p>
5RP 6/2 					
	2	5GY 2/6 		carpet, cup, mug, pillow, interior fabric	<p>The darker colors are heavy for that is perfect for carpet, which is on the ground.</p> <p>The colors complement each other really well.</p>
5P 4/6 					
	3	5RP 7/12 	mid density + low contrast	wall art, good card, picture frame, blanket, pillow, notebook	Bright colors with low-contrast are hard to look at. For picture frame help the picture to stand out and frame the picture really well. Preferred busy pattern with bright colors for small objects.
5G 7/12 					

Table 5: Interview Responses






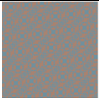
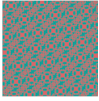
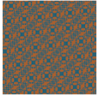


Pattern	Count	Munsell Code	Pattern category	Object preference	Reason
	5	5PB 9/2	mid density + mid contrast	wall art, wallpaper, metal battle, blanket, notebook, decorative pillow, mug	Low-contrast hurt the eye and preferred for something not dominant. These colors perfect for bigger object, but in high-contrast. Bright and warm colors are preferred for wallpaper in the kitchen. Has a lot of breathing room. Vibrant colors with low-contrast that hurt the eye is preferred for small objects or secondary. Not preferred for big object because the contrast is very low, and it would hurt the eye.
		5Y 9/6			
	2	5B 8/4	mid density + mid contrast	notebook, greeting card, chair, sofa	Strange and vibrating colors. Glowing colors with less value contrast. Fun and happy bright colors. Light colors feel welcoming. Has vibrating and light colors, like a real classic French furniture.
		5YR 8/8			
	1	5YR 6/4	mid density + mid contrast	card, cover, notebook, wrapping paper	Vibrate colors. The mix of saturated blue and dull orange work well together.
		5B 6/8			
	5	5BG 6/12	mid density + high contrast	notebook, shirt, scarf, pillow, blanket, wallpaper, tile in a kitchen, tie	Colors not super intense or over stimulating. Fun and feminine colors that woman would like to use as a through blanket on a sofa or something. Preferred for stationary with a pretty pattern. Colorful and bright colors that catch the eye.
		5R 6/4			
	3	5YR 7/6	mid density + high contrast	wallpaper, scarf, tote bag, pillow, wrapping paper	Crabby color scheme for wallpaper of old-style kitchen. Colorful but less muted color in high-contrast look organized from faraway. Soft colors and not vibrating or hurt the eyes. Enough contrast of warm and cool colors that give balance and harmony.
		5B 4/6			

Table 5: Interview Responses

Pattern	Count	Munsell Code	Pattern category	Object preference	Reason
	1	5YR 6/4 5B 6/4	high density + low contrast	chair, apparel	Preferred for secondary object that goes with other primary object in the room because of the low-contrast that makes the colors blend together. Preferred as a part of object not the entire object. For a shirt but not the entire shirt with the background color. Busy pattern preferred for small objects, but not preferred for the big object or object that covers big area.
	4	5BG 6/12 5R 6/12	high density + low contrast	notebook, apparel, pillow, mug children clothing, dishware	Fun colors for children remind of watermelon. Highly saturated colors that very intense and overwhelming for small objects, but not big object like the entire couch. Catch attention and vibrate colors that work for notebook.
	5	5YR 4/10 5B 4/6	high density + mid contrast	wallpaper, wrapping paper, pillow, chair, shower curtain, sofa, apparel, carpet, notebook	Enough contrast not hurting the eye. Preferred for small object because of the deep colors that matched with other neutral objects in the room. Mid saturated with mid desaturated colors work together really well. Use dark hues for secondary object with white surroundings. Mid-contrast makes the colors popped out of each other, but in pleasing amount that doesn't hurt the eyes. These busy patterns could work for big secondary objects.
	4	5Y 3/6 5PB 6/6	high density + high contrast	notebook, pillow, quilt, tile, curtain, wall art	Busy pattern with dark colors not good for wallpaper, but for another small decorative object like pillow. The high-contrast work well for interior, because of its appealing contrast. The dark colors make the object popped out from other objects, and easy to find. Not preferred for big object like carpet or blanket, which will be too much.
	2	5GY 2/6 5P 4/6		folder, notebook, carpet, scarf	For teen room or elementary school. Appealing colors with high-contrast that doesn't hurt the eyes. Detailed enough for carpet when you look close in term of saturation. Heavily patterned scarf.

General Qualitative Findings

Several points will be discussed to clarify the qualitative data that were organized in Table 5 above, as follows:

First: The participants more often picked swatches based on color rather than pattern. The participants' comments most often started with color and its relation to preference and object. As several participants said,

“for me I think we see the colors first then the pattern.” (participant# 21)

“for both of them I thought first about the colors.” (participant# 26)

“first I attracted to the colors.” (participant# 27)

Second: The participants were varied when describing their preferences. Some participants were more subjective than objective. Those participants related their thoughts to their emotions, considering their personal experience. Other participants were more objective than subjective. Those participants related their thoughts to logic, considering the swatch and object characteristics.

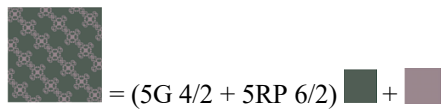
Third: New terms were established based on the participants' responses that related to contrast. These terms described the appearance of the pattern edges when viewed on its background based on value and chroma scales.

The new terms included: Soft contrast and harsh contrast, each is described as follows:

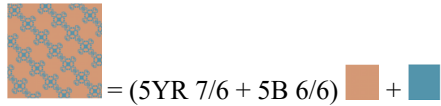
Soft Contrast:

Defined as the contrast that creates clear or non-vibrating edges of pattern when viewed against its background. The clear or non-vibrating edges occur in specific cases, as follows:

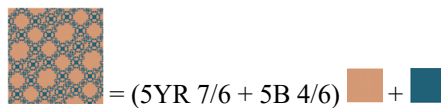
- (1) Two-color combination with high or mid-value contrast, and combine colors of low or medium chroma (muted or middle). Examples:



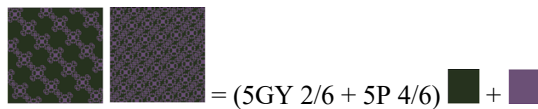
This swatch has high-value contrast, and combines colors of low chroma (muted) and low & medium value (dark & middle).



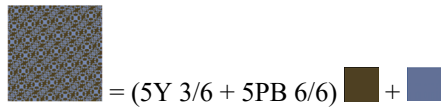
This swatch has mid-value contrast, and combines colors of medium chroma and high & medium value (light & middle).



This swatch has high-value contrast, and combines colors of medium chroma and low & medium value (dark & middle).

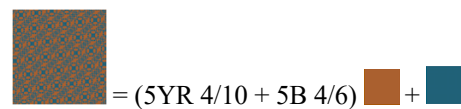


These swatches have high-value contrast, and combine colors of medium chroma.



This swatch has high-value contrast, and combines colors of medium chroma.

- (2) Two-color combination with mid-chroma contrast, but with low (4/) value that close to medium. Example:



This swatch has mid-chroma contrast, and combines colors of low value (dark) and high & medium chroma (saturated & middle).

Harsh Contrast:

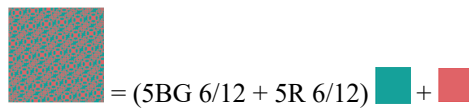
Defined as the contrast that creates ambiguous or vibrating edges of pattern when viewed against its background. The vibrating edges occur in specific cases, as follows:

- (1) Two-color combination with low-value contrast or low-chroma contrast. This means the pattern and its background have the same value and chroma scales.

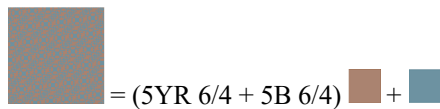
Examples:



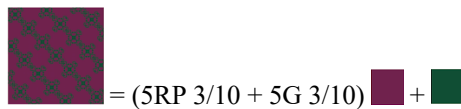
These swatches combine colors of high value (light) and high chroma (saturated).



This swatch combines colors of medium value and very-high chroma (highly-saturated).

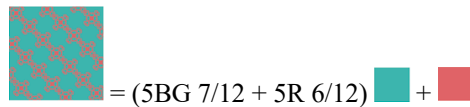


This swatch combines colors of medium value and low chroma (muted).



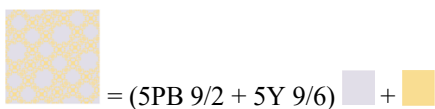
This swatch combines colors of low value and high chroma.

- (2) Two-color combination with mid-value contrast and combines colors of high & medium value and very high (/12) chroma. Example:

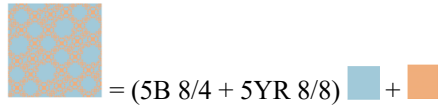


This swatch combines colors of high & medium value (light & middle) and very-high chroma (highly-saturated).

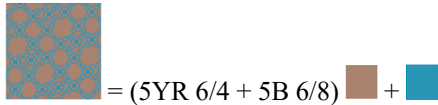
- (3) Two-color combination with mid or high-chroma contrast of the same high (8/, 9/) or medium (6/) value. Examples:



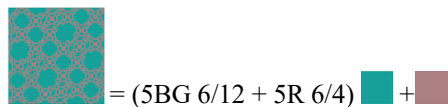
This swatch has mid-chroma contrast, and combines colors of very-high value (very light) and low & medium chroma (muted & middle).



This swatch has mid-chroma contrast, and combines colors of high value (light) and low & high chroma (muted & saturated).



This swatch has mid-chroma contrast, and combines colors of medium value and low & high chroma (muted & saturated).



This swatch has high-chroma contrast, and combines colors of medium value and medium & very-high chroma (middle & highly saturated).

Fourth: Object categories were established based on the participants' responses including: primary and secondary. Each category is defined as the following:

Primary Object:

The object that covers large space, or the big object that is used as the main object. The primary object creates calmness, relaxation and balance. Examples in Interior design include wallpaper, tiles, carpets, sofas, etc. Examples in Apparel design include dresses, shirts or other large pieces.

Secondary Object:

The object that covers small space, or a small object used as an accessory or extra piece. The secondary object adds new characteristics, and brings life to the primary object. Some examples include interior accessories, apparel accessories, stationery, gifts related objects, beach related objects, etc.

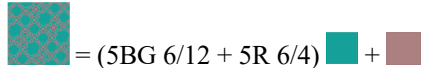
Detailed Qualitative Findings

The participants were varied when describing their thoughts about their preferred objects for a specific swatch. Some responses were more subjective than objective, and some were more objective than subjective. Two categories were identified, as follows:

Subjective Responses:

Some participants described their thoughts more subjectively than objectively, in which they linked their preferences to their personal life or experience. In this case, the participants preferred the swatches that included at least one favorite color, or recalled a favorite person, place, moment or event. In addition, the participants preferred to use the swatches for personal objects, such as clothes, scarves, ties, notebooks, etc. The following are some examples:

- (1) Swatch includes at least one favorite color.

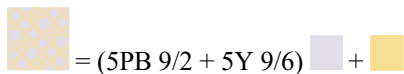


Two participants preferred this swatch for pillows, blankets or ties. The participants said,

“like blue and pink palette, usually leaning to. Colors I see in apartments, I use it at my home.” (participant# 8)

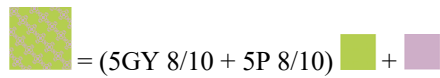
“my two favorite colors... for anything in my house.” (participant# 26)

- (2) Swatch recalls a favorite person, place, moment or event.



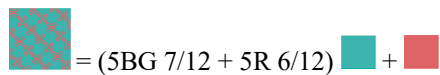
One participant preferred this swatch for wallpaper in the kitchen or decorative pillows. The participant said,

“reminds me of my kitchen. Like it because it’s bright and the color are warm.... my mom picked my pillows and looks like this. White and yellow gives life to it and reminds me of sun shine that we don’t see these days in winter.” (participant# 11)



One participant preferred this swatch for pillows or notebooks. The participant said,

“I have a book that similar colors. The color combinations reminds me of my mom... when I was seven my room was these two colors.” (participant# 14)



Two participants preferred this swatch for blankets, towels, scarves, surfboards or gift wrapping. The participants said,

“it pops, reminds me of beach and sun, something you would like to bring to the beach.” (participant# 17)

“beach resort kind of color or anytype of advertising like surfing purpose, like a surfboard, or Christmas gift wrap because of the blue that almost looks like green, or Valentine day stuff.” (participant# 30)

Objective Responses:

Some participants described their thoughts more objectively than subjectively, and were thinking more logically. In this case, some participants preferred the soft contrast combinations (clear or non-vibrating edges) (see definition p.98); while others preferred the harsh contrast combinations (ambiguous or vibrating edges) (see definition p.99). The participants mostly linked color attributes and contrast to the object size or purpose, such as the soft contrast combinations (clear or non-vibrating edges) with big or primary objects, and the harsh contrast combinations (ambiguous or vibrating edges) with small or secondary objects. The participants' objective responses were organized in Table 6.

Table 6: Primary & Secondary Objects






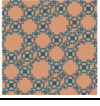



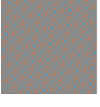
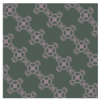
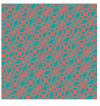

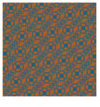
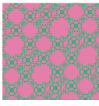
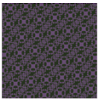
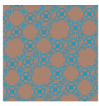
Pattern	Pattern category	Object example	Object category	Pattern	Pattern category	Object example	Object category
	low density + low contrast	pillow, whole sheet set, tie	small or secondary		mid density + mid contrast	wall art, wallpaper, metal battle, blanket, notebook, decorative pillow, mug	small or big secondary or primary
		classic sitting, carpet or rug Wallpaper of a tile, back of the chair				notebook, greeting card, chair, sofa	
		shoes, t-shirt notebook, accent pillow			mid density	wallpaper, scarf, tote bag, pillow, wrapping paper	small or big secondary or primary
	low density + mid contrast	blanket, sheets, towel, scarf, bag, tie, notebook, tile, surfboard, gift wrap	small or secondary		mid density + high contrast	notebook, shirt, scarf, pillow, blanket, wallpaper, tile in a kitchen, tie	
		pencil bag, tote bag, Wallpaper, dress				high density + low contrast	chair, apparel
	low density + high contrast	pillow, interior fabric, blanket, quilt, carpet, sofa, wallpaper, tiles (flooring or bathroom), apparel, tie, scarf, notebook, mug	small or big secondary or primary		high density + low contrast	children clothing, dish wear, notebook, apparel, pillow, mug	

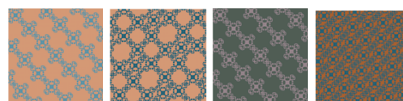
Table 6: Primary & Secondary Objects

Pattern	Pattern category	Object example	Object category	Pattern	Pattern category	Object example	Object category
	low density + high contrast	carpet, cup, mug, pillow, interior fabric	small or big secondary or primary		high density + mid contrast	wallpaper, wrapping paper, pillow, chair, shower curtain, sofa, apparel, carpet, notebook	small or big secondary or primary
	mid density + low contrast	wall art, good card, picture frame, blanket, pillow, notebook	small or secondary		high density + high contrast	folder, notebook, carpet, scarf	small or big secondary or primary
	mid density + mid contrast	card, cover, notebook, wrapping paper	small or secondary			notebook, pillow, quilt, tile, curtain, wall art	small or secondary

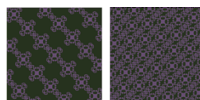
First category: Primary object

The primary objects were mostly preferred in soft contrast combinations (clear or non-vibrating edges) (see definition p.98). These objects were preferred mostly in combination with high or mid-value contrast of low or medium chroma (muted or middle colors); or combinations with mid-chroma contrast of low value (dark). The participants used several words to describe these combinations: calm, soft, pleasing, balanced and appealing.

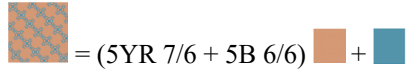
The participants mostly preferred primary objects for the following swatches:



Only carpet was preferred for the following two swatches:

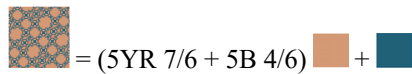


The participants' preferences of each combination are described as follows:




One participant preferred this swatch for wallpaper and dresses. The participant said,

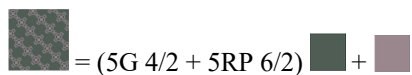
“don't hurt my eyes, appealing colors. I picked these two objects (wallpaper & dress) because it is very light, just enough contrast but bright colors that I would like to put in my room or wear it for fun.” (participant# 16)



Two participants preferred this swatch for wallpaper. The participants said,

“high-contrast colors bring out the negative and positive spaces, so it can be recognized from far away.” (participant# 4)

“doesn't have as many vibrating colors that hurt my eyes. As the green one . Like the contrasting between warmer color with cooler blue, which makes it a balanced pattern and harmonious.” (participant# 13)



A number of participants preferred this swatch for wallpaper, interior fabric, carpets, bathroom tiles or flooring tiles. The participants said,

“like the darker background and lighter pattern, which help to see it easily. High-contrast, it could work with big or small objects either way.” (participant# 3)

“strong colors of light pink and dark gray.” (participant# 9)

“look classy in some rooms even a bathroom... not crazy and overwhelming.”
(participant# 10)

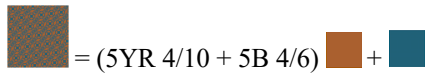
“like how the colors work together, which are muted colors. Simple pattern make the soft color look interesting.” (participant# 23)

“like muted tones a lot. Like the patterns because they look that just enough, but the other ones are too busy to me. But these have more space to breathe.” (participant#25)

“it can be incorporatd in any kind of form this specific color. Color contrast dark greenish with purple pink attracted me. Like the simple pattern, easy to see.”

(participant# 27)

“for big scale objects, calm colors with very simple pattern makes you look calm in the room.” (participant# 28)



Three participants preferred this swatch for wallpaper, carpets and sofas. The participants said,

“not hurting the eyes like some vibrant colors... nice to look at.” (participant# 6)

“it is not dizzying any way, it is clearly orange and blue. It is easy to imagine these darker hues with a white surroundings.” (participant# 22)

“the way the color that pop out of each other, but not hurting your eyes but a pleasing amount... It looks nice because of the color choices.” (participant# 24)

In some cases, the primary objects were preferred in dark colors based on their purpose.

For example, the following two swatches were preferred for carpets due to its purpose.



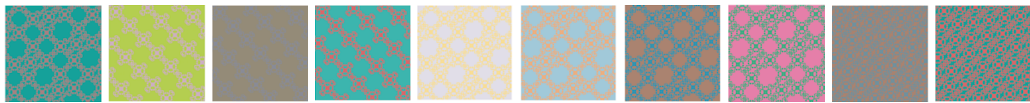
Two participants said,

“for the carpet, heavy, the carpet on the ground for that I picked simple patterns and dark color.” (participant# 18)

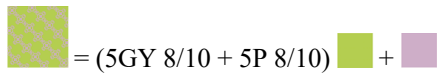
“for carpet because it doesn’t hurt my eyes, appealing colors. Detailed enough for a carpet when you look close to it.” (participant# 6)

Second category: Secondary object

The secondary objects were mostly preferred in harsh contrast combinations (ambiguous or vibrating edges) (see definition p.99), but sometimes the soft contrast combinations were preferred too for these objects. These objects were preferred mostly in combination with high, mid or low-chroma contrast, or low-value contrast. These combinations combine colors of very-high chroma, or very high value and chroma. The participants used several words to describe these combinations: colorful, vibrating, vibrant, overwhelming, bright, cheery, happy, exciting and glowing. The following combinations were preferred for secondary objects:



The participants’ preferences for each combination are described as follows:

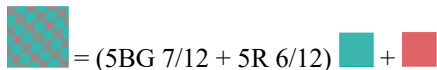


Three participants preferred this swatch for shoes, t-shirts and accent pillows. The participants said,

“bright colors, low-contrast in terms of saturation. Like the shades of greens with purple that worked really well.” (participant# 1)

“nice color works with a lot of neutral in my house.” (participant# 14)

“it is bright and cheery. The pattern is soothing to me.” (participant# 26)

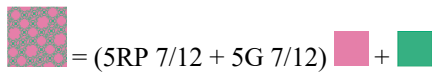


Three participants preferred this swatch for bedding, towels, scarves, bags, ties, notebooks, surfboards or any beach related object. The participants said,

“works well in bedding both colors are bright and exciting.” (participant# 1)

“accessory something not primary, a bag or tie. It pops and reminded me of beach and sun, something you would like to bring to the beach. The simple pattern makes it pop, but it hurt my eyes when I looked at it too much.” (participant# 17)

“the contrast between red and blue makes each one pop, but not too much for the eyes. Brighter hues are good to have a simple pattern.” (participant# 24)

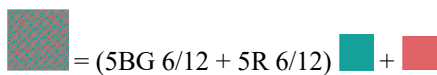


Three participants preferred this swatch for wall arts, greeting cards, picture frames, notebooks and accent pillows. The participants said,

“hard to look at because is so much contrast.” (participant# 14)

“it has a high-contrast, which will help the picture to stand out, frame the picture really well.” (participant# 20)

“bright colors that catches my eyes.... for small scale objects, busy pattern with bright colors makes it really exciting.” (participant# 28)



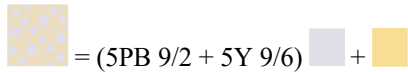
Four participants preferred this swatch for children’s clothing, dishwares, notebooks and accent pillows. The participants said,

“it looks fun reminds me of watermelon... Highly saturated colors that are very intense.”
(participant# 4)

“in class everybody zones out and it would be a perfect to zone out of it. Catch attention and vibrant.” (participant# 12)

“immediately stand out to me... when I look at it almost blend together, but still separate.” (participant# 19)

“very bright and pop to my eyes... go with smaller scale because the colors are overwhelming.” (participant# 29)



Three participants preferred this swatch for wall arts, notebooks, accent pillows and mugs. The participants said,

“contrast is hurting the eye something not dominant.” (participant# 2)

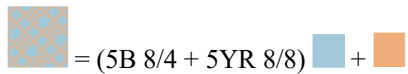
“it is vibrant. Not high-contrast, hurt my eyes when I look at it for a while.”

(participant# 15)

“less contrast doesn’t bother me maybe because the yellow makes it really bright....

I don’t want to use in bigger object because the contrast is very low and it would

hurt my eye.” (participant# 20)

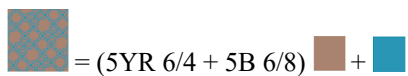


Two participants preferred this swatch for greeting cards, notebooks and chairs. The participants said,

“the colors are strange and vibrating. less value contrast.... Look glowing, fun and happy colors. Not too dark. Light enough feels welcoming.” (participant# 7)

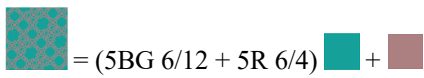
“has vibrating colors. More balanced in terms of both colors are light...

the color combination reminds of a real classic French furniture.” (participant# 13)



One participant preferred this swatch for greeting cards, notebooks and wrapping paper. The participant said,

“vibrate together and the pattern has good open space... the mix of saturated blue and dull orange works really well together.” (participant# 3)



Two participants preferred this swatch for shirts, scarves, ties, bedding, accent pillows, throw blankets and notebooks. The participants said,

“the colors are fun and feminine, so a lot of women will use it as a throw over blanket on a sofa or something.... And use it like a stationary with a pretty pattern.” (participant# 22)

“colorful. the color caught my eye. Bright color and intricate pattern make the color and pattern complement each other really well.” (participant# 23)

In addition to the harsh contrast combinations (ambiguous or vibrating edges), the soft contrast combinations (clear or non-vibrating edges) were preferred for secondary objects as well (see Table 6, p.104).

Chart 6 summarizes the above qualitative findings.

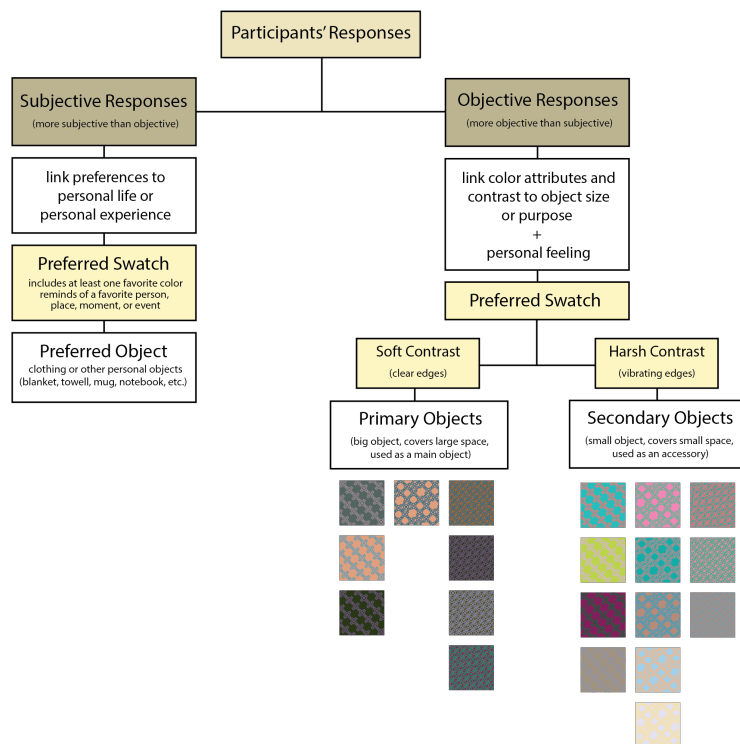


Chart 6: Qualitative Findings

Chapter Summary

This chapter is divided into three sections: participants, quantitative findings and qualitative findings.

The participants section describes their characteristics, including gender, age and major. There were 24 females participants and 6 males participants. The participants ages ranged from 20 to 34. There were 25 participants from the graphic design major, 3 from apparel design, 1 from interior design and 1 from art.

The quantitative data section presents the collected data organized in the following themes:

First theme: ‘solid color selection.’

The data of this theme was collected by asking each participant to pick three solid-color swatches. The collected data are organized based on the selection count from high to low in Table 2 (p.79). The table shows that the most preferred swatches included colors with medium or high value (middle or light), and medium or high chroma (middle or saturated). The least preferred swatches included colors with low value (dark), low chroma (muted), or very high chroma (highly saturated).

Second theme: ‘preferred density and contrast level.’

The data of this theme were collected by asking each participant to select their preferred pattern swatches that were presented in various densities and contrasts. The collected data are organized in Table 3 (p.83) in three levels of contrast for three levels of density. The table shows that the most preferred levels of contrast among all density levels were high and mid-contrast.

Third theme: ‘colored pattern & object preference.’

The data of this theme were collected by asking each participant to match their preferred pattern swatch with two objects from a list (provided by the researcher). The collected data are

organized in Table 4 (p.85), which shows the preferred swatches along with the preferred objects for each swatch. The table shows that different objects that ranges in size or purpose were preferred for different levels of density and contrast.

The qualitative data section presents the collected data through an interview to answer the last research question. The data are organized in one theme, which is ‘colored pattern and object preference.’ This theme is summarized as follows:

The data of this theme were collected when asking each participant to select two swatches and identify two objects for each swatch, then explain their reasoning. The collected data are organized in Table 5 (p.94), which shows each pattern along with the preferred objects and reasons. These responses varied between subjective and objective responses. Some participants were more subjective than objective, in which they related their preferences to their personal life or their experience with colors. Other participants were more objective than subjective, in which they linked their preferences to the swatch and objects characteristics. As a result of the objective responses, new terms were introduced that related to contrast based on the participants’ responses, including soft contrast (clear or non-vibrating edges of pattern when viewed against its background) and harsh contrast (ambiguous or vibrating edges of pattern when viewed against its background). In addition, the participants preferred the soft contrast combinations for big or primary objects and the harsh contrast combinations for small or secondary objects.

Finally, both quantitative and qualitative data will be combined in the following chapter to answer the research questions. Also, two theories will be used to support the data (both theories were described in the literature review), including the Ecological Valence Theory (EVT), and the Processing Fluency Theory (Theory of Beauty). At the end of the following chapter, a finding model will be introduced that will be extracted from the conceptual framework.

CHAPTER 5: ANALYSIS

The purpose of this research was to examine the influence of pattern density and color contrast in object color preference for two-color combinations. The data of this research were collected using a mixed approach starting with a quantitative method, followed by a qualitative method. The collected quantitative and qualitative data were presented in detail in the previous chapter, each separately. In this chapter, the research questions will be answered by combining the quantitative and qualitative data for each related question. Also, the answer to each question will be compared to the findings of previous literature, and connected to the Ecological Valence Theory (EVT) and Processing Fluency Theory. At the end of this chapter, the finding model will be introduced, which will give an overview of all the research findings.

The research questions included the following:

- (1) What colors are selected by participants when shown a set of solid colored hues?
- (2) Which density and contrast levels are preferred by participants?
- (3) Which objects do participants prefer for a specific colored pattern swatch?
- (4) Why do participants prefer specific objects for a specific colored pattern swatch?

This chapter will be organized in three sections that related to the research questions: ‘Solid Color Selection,’ ‘Preferred Density & Contrast Level’ and ‘Colored Pattern & Object Preference.’

Solid Color Selection

Research question: What colors are selected by participants when shown a set of solid colored hues?

The quantitative data used to answer this question were collected through an experiment by asking each participant to select two-solid color swatches. The collected data were organized

in the chart below. The chart shows the most preferred swatches on the left and the least preferred on the right.

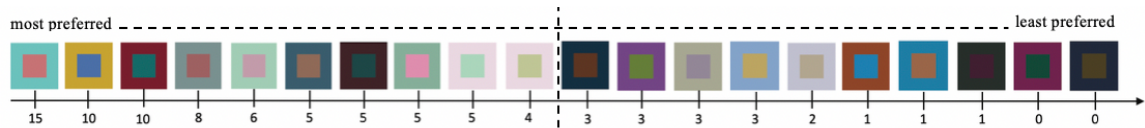


Chart 1: Selected Solid-Color Swatches in Total

The chart was divided into two parts, each part including 10 swatches. As seen in the middle of the chart the most preferred swatches were selected four times and more, while the least preferred swatches were selected less than four times or never selected. The finding of this question will be considered when answering the next question ‘Which density and contrast levels are preferred by participants?’

Findings Overview:

The chart shows that the most preferred swatches have value contrast (lightness contrast), but only three of them have chroma contrast (saturation contrast).

Most preferred combinations

Value contrast combinations



Chroma contrast combinations



Most of the above combinations contrast in value and combine colors of high or medium value and high or medium chroma, except for two that combine colors of very low value (dark colors). In addition, most of the combinations that contrast in chroma combine colors of medium or high value and low & medium chroma, except for one that combines colors of medium & high chroma.

Least preferred combinations

Value contrast combinations



Chroma contrast combinations



Most of the above combinations that contrast in value combine colors of low & medium value and medium or high chroma. In addition, most of the combinations that contrast in chroma combine colors of low or medium value and high, medium & low chroma.

Question Answer:

The most preferred combinations combine colors of medium or high value, but not low value. Participants also preferred the combination of medium and low chroma, but not very high chroma. The most selected combinations look middle, light or muted; while the least selected combinations look dark or highly saturated. The most preferred combinations appear more comfortable to the eyes, unlike the other combinations that appear heavy or overwhelming.

The findings of this question are connected to the following question, since the participants were shown the same combinations that they selected in the first stage, but with pattern in three levels of contrast and density (a total of nine swatches for each combination). Since the most selected combinations contrast in value, the answer to the following question will be applied mostly to value contrast.

Preferred Density and Contrast Level

Research question: Which density and contrast levels are preferred by participants?

The data used to answer this question were collected quantitatively during the second stage of the experiment by asking each participant to select one preferred swatch from nine swatches (three levels of density and contrast) of each solid-colors swatch that the participant selected in the first stage. The collected data is presented in the chart below.

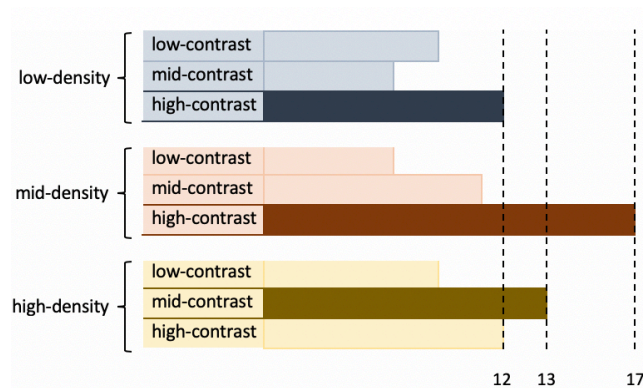


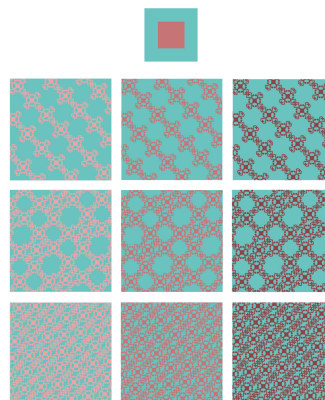
Chart 4: Preferred Contrast Level for Each Level of Density

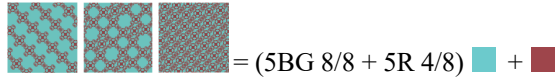
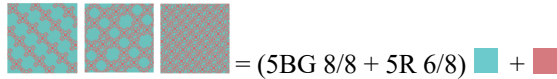
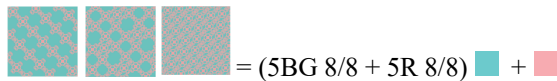
The findings of this question will be applied mostly for the combinations that contrast in value as these combinations were selected more times than the combinations that contrast in chroma.

Findings Overview:

The chart shows that the most preferred contrast levels among all density levels are high or mid-contrast. The least preferred contrast level is the low-contrast. Some examples of high, mid and low-value contrast swatches are as follows:

The participants were shown the following swatches as a group. Regardless of density levels, the swatches that have high or mid-contrast were preferred over the swatches that have low-contrast.

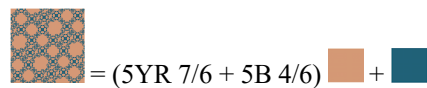


High-Value Contrast (selected at least one time)**Mid-Value Contrast** (selected at least one time)**Low-Value Contrast** (most were never selected)**Question Answer:**

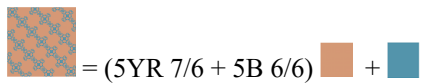
The most preferred value contrast levels among all density levels were high or mid-contrast, while the least preferred level is the low-contrast. This is because, the high or mid-contrast are sufficient to distinguish the pattern from its background with recognizable edges. In contrast, the low-contrast blends in the pattern with its background with unrecognizable edges.

Qualitative Data Support:

The above findings are supported with quotes from the participants' responses during the interview. The participants described the swatches with high-contrast as easy to be seen even from a distance, unlike the swatches with low-contrast that require a closer look to recognize their content. Some participants said,

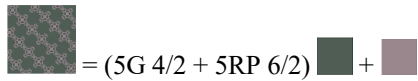


“high-contrast colors bring out the negative and positive spaces, so it can be organized from far away.” (participant# 4)



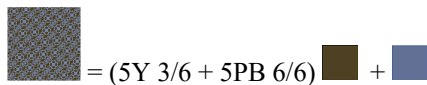
“don’t hurt my eyes, appealing colors.... just enough contrast, but bright colors.”

(participant# 16)

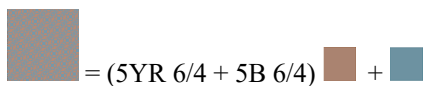


“the darker background and lighter pattern, which help to see it easily,

high-contrast.” (participant# 3)



“I like color contrast because if this one was low-contrast the texture would not be visible, which keep the design simple and clear.” (participant# 27)



“it is hard to tell what is the pattern until you look at it close.” (participant# 21)

“the low-contrast feels weird, it almost blend with the background.” (participant# 28)

Previous Research Support:

The findings of this question are similar to the findings of previous research that examine the influence of contrast in color preference. One study found that two-color combinations that create high-contrast are preferred over combinations that create low-contrast. For example, Reber & Schwarz (2004) found that high-value contrast circles were preferred more than low-value contrast circles. Also, Schloss & Palmer (2010) found that warm colors (red, orange and yellow) were preferred on cool backgrounds (blue, cyan and green) and vice versa; in contrast, the warm colors were not preferred on warm backgrounds. Also, they found that highly saturated (high

chroma) colors were preferred on muted (low chroma) background, or light (high value) colors on dark (low value) backgrounds and vice versa.

Theory Support:

The findings of this question are supported by the Processing Fluency Theory. This theory indicates that “the aesthetic experience is a function of the perceiver’s processing dynamics: the more fluently the perceiver can process an object, the more positive is his or her aesthetic responses.” (P.365). This theory has two parts: subjective, related to the viewer when perceiving the object and objective, related to the object properties.

The findings of this question showed that the participants mostly prefer the high or mid-contrast combinations, but not the low-contrast ones. This is because the participants preferred the combinations with enough contrast (high or mid) to allow their elements to be easily distinguished from each other, and appear more organized and appealing to look at. In contrast, the low-contrast combinations that doesn’t allow their elements to be recognized or distinguished from each other, and appear uncomfortable to look at. This means that the high or mid-contrast combinations are easier to process unlike the low-contrast combinations that are difficult to process and require more attention in order to be recognized.

Colored Pattern & Object Preference**Research questions:**

- (1) Which objects do participants prefer for a specific colored pattern swatch?
- (2) Why do participants prefer specific objects for a specific colored pattern swatch?

The data of this theme were collected both quantitatively and qualitatively. The quantitative data were collected during the second stage of the experiment, by asking the participants to select two objects from a list (provided by the researcher) for each preferred

swatch. The qualitative data were collected through an interview by asking the participants to identify two objects for each preferred swatch and explain their reasoning.

Quantitative & Qualitative Findings Overview:

The overview will be described by connecting the quantitative and qualitative findings (more details of these findings were described in p.78 & 94).

The quantitative data were organized in Chart 5, which shows each object and the swatches that were preferred to be applied for it. The qualitative data were summarized in Chart 6, which gives an overview of the participants’ responses.

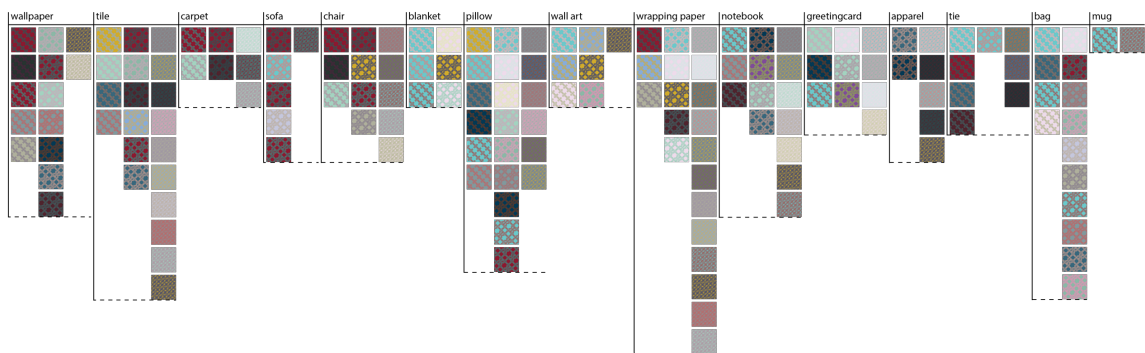


Chart 5: Objects & Preferred Pattern Swatches

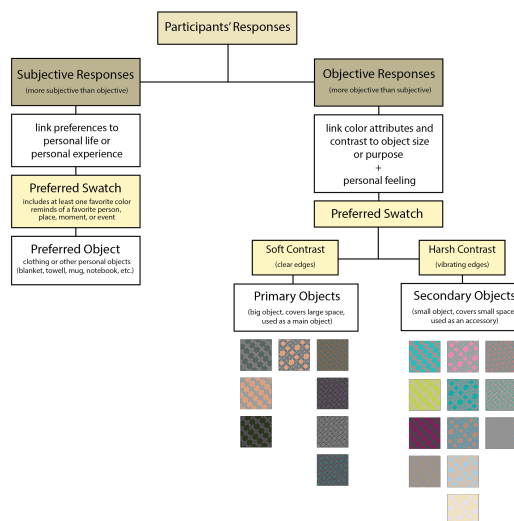


Chart 6: Qualitative Findings

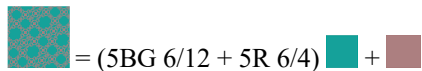
The participants' responses were varied between more subjective and more objective.

Subjective Responses:

The subjective responses are related to personal life or experience with a specific color. In this case, the preferred swatches included at least one favorite color, or recalled a favorite person, moment, place or event. In addition, most of the objects that were preferred for these swatches were clothing, or other personal objects, such as scarves, ties, notebooks, mugs, etc.

The subjective responses cannot be connected to the quantitative findings, since the participants were choosing the swatches without describing their opinions. Some examples as follows (see detailed examples p. 102):

- (1) Swatch includes at least one favorite color.



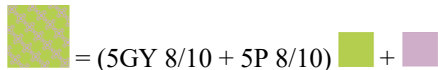
Two participants preferred this swatch for pillows, blankets or ties. The participants said,

“like blue and pink palette, usually leaning to. Colors I see in apartments,

I use it at my home.” (participant# 8)

“my two favorite colors... for anything in my house.” (participant# 26)

- (2) Swatch recalls a favorite place, moment, person or event.



One participant preferred this swatch for pillows or notebooks. The participant said,

“I have a book that similar colors. The color combinations reminds me

of my mom... when I was seven my room was these two colors.” (participant# 14)

Objective Responses:

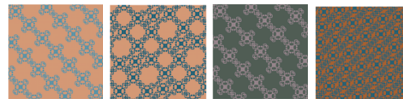
The objective responses are related to the swatch and object properties and influenced by personal feelings about a specific color combination. In this case, the participants were varied

among their preferences, as some preferred the swatches with soft contrast combinations (clear or non-vibrating edges of pattern). These combinations have high or mid-value contrast, or mid-chroma contrast of low value colors. Others preferred the swatches with harsh contrast combinations (ambiguous or vibrating edges of pattern). These combinations have any level of chroma contrast, low-value contrast, or any levels of value contrast of high chroma and high value colors (see detailed definitions of each contrast p.98 & 99). In this case, the participants preferred the soft contrast combinations with primary or big objects (objects that cover large space or used as main objects), the harsh contrast combinations with secondary or small objects (objects that cover small space or used as accessory).

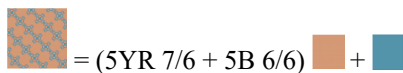
The objective responses can be connected to the quantitative findings, since the participants linked the color combination to specific objects logically. The examples below will combine qualitative and quantitative findings. (see detailed examples p. 103):

Examples of Primary Objects:

The primary objects were mostly preferred in soft contrast color combinations (clear or non-vibrating edges). The participants described the soft contrast color combinations using the following words: calm, soft, pleasing, balanced and appealing. The following swatches were mostly preferred for primary objects:

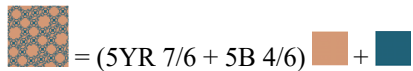


The above swatches were mostly preferred for interiors, such as wallpaper, tiles, carpets, sofas; and some clothes that consider as a main piece. Some examples are as follows:




One participant preferred this swatch for wallpaper and dresses. The participant said,

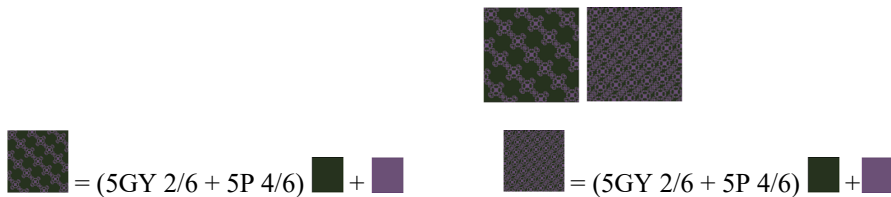
“don’t hurt my eyes, appealing colors. I picked these two objects (wallpaper & dress) because it is very light, just enough contrast but bright colors that I would like to put in my room or wear it for fun.” (participant# 16)



Two participants preferred this swatch for wallpaper. The participants said,

“doesn’t have as many vibrating colors that hurt my eyes. As the green one . Like the contrasting between warmer color with cooler blue, which makes it a balanced pattern and harmonious.” (participant# 13)

Some other swatches were preferred for primary objects based on the purpose of the object. The following swatches were preferred only for carpets, but not wallpaper or tiles. Due to the carpet’s purpose, it was preferred with dark colors that don’t get dirty overtime. This includes the following swatches:



Two participants said,

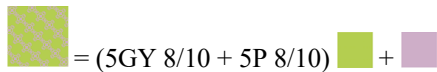
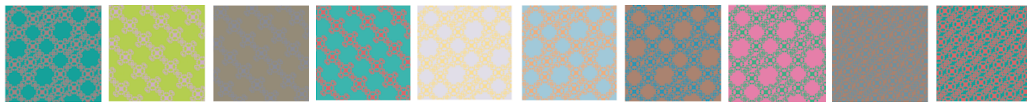
“for the carpet, heavy, the carpet on the ground for that I picked simple patterns and dark color.” (participant# 18)

“for carpet because it doesn’t hurt my eyes, appealing colors. Detailed enough for a carpet when you look close to it.” (participant# 6)

Examples of Secondary Objects:

The secondary objects were mostly preferred in harsh contrast color combinations (ambiguous or vibrating edges), alongside the soft contrast color combinations (clear or non-

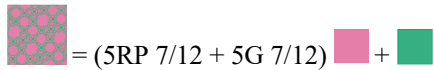
vibrating edges). The secondary objects are mostly used to add characteristics or bring life to the primary objects. The participants described the soft contrast combinations using the following words: colorful, vibrating, vibrant, overwhelming, bright, cheery, happy, exciting and glowing. The following swatches were mostly preferred for primary objects:



Three participants preferred this swatch for shoes, t-shirts and accent pillows. The participants said,

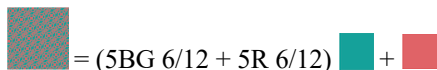
“bright colors, low-contrast in terms of saturation. Like the shades of greens with purple that worked really well.” (participant# 1)

“nice color works with a lot of neutral in my house.” (participant# 14)



Several participants preferred this swatch for wall arts, greeting cards, picture frames, notebooks and accent pillows. One participant said,

“it has a high-contrast, which will help the picture to stand out, frame the picture really well.” (participant# 20)



Several participants preferred this swatch for children’s clothing, dishwares, notebooks and accent pillows. One participant said,

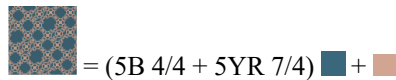
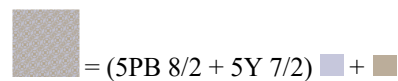
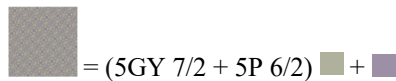
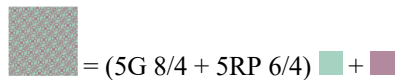
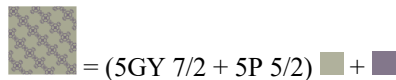
“very bright and pop to my eyes... go with smaller scale because the colors are overwhelming.” (participant# 29)

Similar Quantitative Findings:

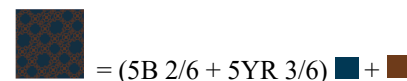
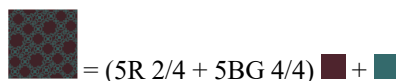
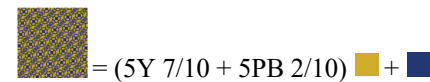
The objective responses were similar to the qualitative findings, as the participants used the same criteria when selecting specific objects for a specific pattern swatch.

(1) The interior primary or big objects, such as wallpaper, tiles, carpets and sofas were mostly preferred for the following swatches:

- Swatches with high or mid-value contrast and combine colors of medium or low chroma, as follows:



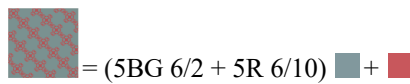
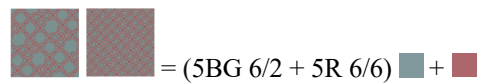
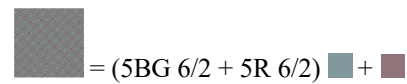
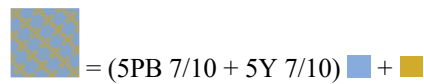
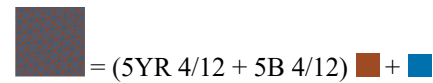
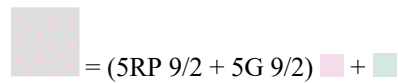
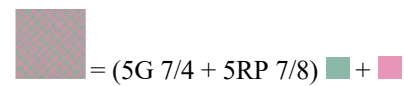
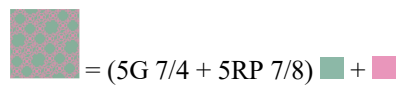
- Swatches with high or mid-value contrast and combine colors of mid & low value, and mid or high chroma, as follows:



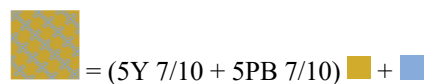
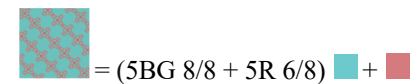
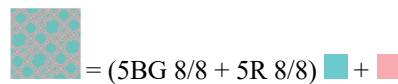
(2) Small or secondary objects, such as interior accessories, apparel, ties, bags, mugs, notebooks, wrapping paper and greeting cards, were mostly preferred for the following swatches:

(some of these swatches were never preferred for primary or big objects).

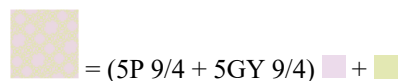
- Swatches with chroma contrast of high or mid value colors.



- Swatches with value contrast and combine colors of high value and high chroma.



- Swatch with low-value contrast.



Question Answer:

The participants were varied among their preferences and when describing their reasoning. Some responses were more subjective, in which the participants connected their preferences to their personal life or experience. In these cases, clothing or other personal objects were preferred for swatches that include at least one favorite color, or recall a favorite moment, person, place or event. Other responses were more objective than subjective, in which the participants linked the colored pattern properties to object properties based on their personal feelings about the colored pattern. In these cases, the participant preferred the primary objects to

be mostly colored with soft contrast color combinations (clear or non-vibrating edges), and the secondary objects mostly with harsh contrast color combinations (ambiguous or vibrating edges).

The subjective responses in the qualitative findings can't be connected to the quantitative findings, but the objective responses can be connected. The findings above showed that the participants used the same criteria when linking the colored pattern to the object. They linked the color combination and its contrast to the object size and purpose.

The participants preferred the swatches that appear calm, balanced, and not overwhelming for large or primary objects. The participants preferred the swatches that appear bright, glowing, and overwhelming for the small or secondary objects.

Previous Research Support:

The findings of this question are similar to the findings of previous research that examined the relationship between color and object preference. Several studies found that people prefer specific object to be colored with different colors that vary in their attributes (hue, value, chroma) based on the object size or purpose. For instance, Schloss & Palmer (2012) found that big objects, such as walls and trims, were preferred in light colors (high value) or desaturated colors (low chroma) while small objects, such as t-shirts and pillows were preferred in dark colors (low value) or saturated colors (high chroma). Another study by Jonauskaitė & Mohr (2016) found that people preferred light and less contrasting colors for walls, but dark and less chromatic colors for t-shirt. Other research found that people like clothing to be colored with their favorite colors, but not interiors (Holmes & Buchanan, 1984).

Theory Support:

The findings of this question are supported by two theories: the Ecological Valence Theory (EVT), and the Processing Fluency Theory (Theory of Beauty).

The Ecological Valence Theory is related to people's experience with the colored object. People's color preferences are not fixed, but shaped based on their experience with the colored object. People like the colors that are associated with positive things, situations or events and avoid the colors that are associated with negative things, situations or events (Schloss & Palmer, 2010). This theory supported the subjective responses, as the participants were connecting their preferences to their personal experience. For example, the participants preferred the pattern swatches colored with their favorite colors or recalled favorite things.

The Processing Fluency Theory indicated that "the aesthetic experience is a function of the perceiver's processing dynamics: the more fluently the perceiver can process an object, the more positive is his or her aesthetic responses." (P.365) (Reber & Schwarz, 2004). This theory supported the objective responses, as the participants linked the colors of the swatch and the contrast to the object size or purpose based on their personal feelings. For example, the participants preferred big or primary objects to be colored with soft contrast color combinations, as these combinations are easy to process because of the clear edges that don't require extra attention. In contrast, the participants preferred the small or secondary objects to be colored with harsh contrast color combinations, as these combinations are difficult to process because of the vibrating edges that require extra attention.

Findings Model

The findings of this research can be combined and illustrated in the following model.

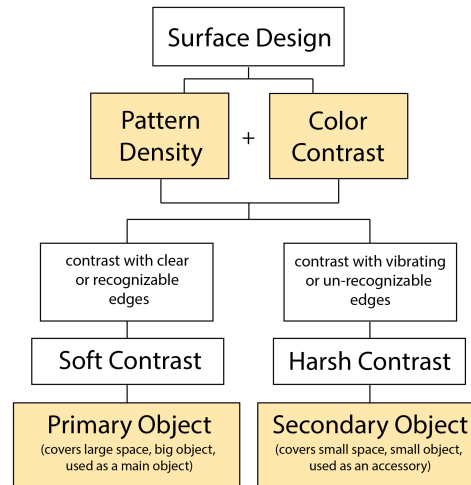


Figure 74: Findings Model

The findings model is described as the following:

When pattern and color are combined, the density of pattern and contrast of color interact and create different appearance of colored patterns: Sometimes the pattern edges appear clear, non-vibrating or recognizable. In this case, the contrast appears soft and acceptable for the human eyes. This type of contrast is mostly preferred for big or primary object, as this object creates calmness or balance. Other times, the pattern edges appear ambiguous, vibrating or unrecognizable. In this case, the contrast appears harsh and overwhelming for the human eyes. This type of contrast is mostly preferred for small or secondary object, as this object add life or character to the primary object.

Issues of Trustworthiness

This research used a mixed approach, starting with a quantitative method, and followed by a qualitative method to ensure answering the research questions effectively. In addition, the answer to each research question was connected to previous findings, and supported with two color preference theories, the EVT and The Processing Fluency Theory, which will strengthen the body of the research with evidence from different sources.

Furthermore, some issues appeared that will limit generalizing the current findings to a wider population to include every design student in the US, since the sample number was low and included only students from the College of Design at the University of Minnesota. Also, the findings can't be generalized to include complex color combinations since the combinations that were used for this research were only simple combinations (two-colors). Also, the findings can't be generalized to include every pattern type, since this research used only one type, which was vegetal pattern.

The following chapter will conclude this document and provide the reader with recommendations for future research.

CHAPTER 6: CONCLUSION

Conclusions

Surface design is a combination of color and pattern. Each component has its own properties that affect its appearance. Pattern properties (Structure, Scale and Spacing) affect its density (amount of information). Color properties or attributes (Hue, Value and Chroma) affect its contrast. Density and contrast are two aspects of pattern and color that interact with each other in certain levels, which influence the covered surface to be pleasant or unpleasant. The appearance of the surface influences people's preferences for certain objects. Designers should consider the interaction of pattern and color and their relation to the object in order to create effective designs that satisfy their clients. This is especially true of designers whose jobs require applying colored pattern to various products that would be purchased by different clients who differ in their personalities and preferences.

From this point, a mixed method study was conducted to examine the influence of pattern density and color contrast in object color preference for two-color combinations. Thirty students from different creative fields, including graphic design, interior design, apparel design and art, at the University of Minnesota were examined individually, through an experiment that was followed by an interview. Some of the current findings are similar to previous findings that examined color preference using different contexts, but not pattern, while others that are new will enrich the body of color preference research. In addition, the current findings are supported by two theories of color preference: The Ecological Valence Theory (EVT) and the Processing Fluency Theory (Theory of Beauty). Each theory is described as follows:

The Ecological Valence Theory (EVT): The theory of people's experience with the colored object. People's color preferences are not fixed, but shaped based on their experience with the colored object. People like colors that are associated with positive things, situations or events and avoid colors that are associated with negative things, situations or events (Schloss & Palmer, 2010).

The Processing Fluency Theory (Theory of Beauty) (Reber & Schwarz, 2004): Defined as "the aesthetic experience is a function of the perceiver's processing dynamics: The more fluently the perceiver can process an object, the more positive is his or her aesthetic response." (P.365).

At this point, four main conclusions can be drawn from the research findings:

First Conclusion:

Color influences pattern more than pattern influences color. The same pattern of the same density appears different by changing its colors. In addition, the same pattern of the same density would be preferred for different objects based on the contrast of its colors soft or harsh. The soft contrast creates clear or non-vibrating edges and more comfortable to look at, while the harsh contrast creates ambiguous or vibrating edges that would hurt the eyes. As the participants were identifying the objects they preferred for each pattern swatch, they considered the contrast between the colors of pattern and its background, and the appearance of the pattern if it hurts the eyes or is convenient to look at.

The same conclusion was claimed previously by Lazreg & Mullet (2001), when examining the relationship between form and color. They concluded that color influences form more than form influences color. Some participants said:

"I have never thought about this. All these patterns are similar, but they are different.

It is interesting because it depends on how the colors complement each other, which the color make them different... ” (participant# 21)

”there are a lot of different ways to make a pattern look different and vary based on the hues. The contrast between the colors will make the eyes dizzy depending on the hues, so the color makes the pattern different.” (participant# 22)

Second Conclusion:

The participants varied in their preferences. Some participants preferred the combinations that combine colors of medium value or chroma (middle), low chroma (muted), high value (light). Others preferred the combinations that combine colors of very high chroma (saturated), or low value (dark). In general, the combinations that combine middle, muted or light colors were more preferred than the other combinations that combine saturated or dark colors.

Third Conclusion:

In terms of contrast level, the most preferred color combination is one that creates enough contrast (high or mid) between the foreground element and background. In this case, the element edges appear clear and recognizable, even from a distance. The least preferred color combination is one that creates low or no contrast between the foreground element and background. In this case, the element edges appear unclear and require close distance to be recognized.

This finding is similar to previous findings that examined two-color combinations, including square swatches (Schloss & Palmer, 2010), and circle forms when viewed against other colors (Reber & Schwarz, 2004).

Moreover, this finding is supported by the Processing Fluency Theory, in which the contrast with recognizable edges is more pleasurable, since it is easier to be seen and process. The contrast with unrecognizable edges, meanwhile, is less pleasurable because it is difficult to process.

Fourth Conclusion:

The participants' preferences were influenced by several factors: Some are subjective and related to the subject. Others are objective and related to the object that the subject interact with. Sometimes, the subjective factors influence people's decisions more than the objective factors. In this case, people's emotions, personal life, and experience with a specific color affect their decisions. Other times, the objective factors influence participants' decisions more than the subjective factors. In this case, the properties of the color, pattern or object affect participants' decisions.

The subjective responses are supported by the Ecological Valence Theory (EVT), in which people prefer the colors that remind them of positive things in their surroundings. The objective responses are supported by the Processing Fluency Theory, in which the soft contrast is preferred for primary objects, since it is easy to process and more pleasing than the harsh contrast, which is difficult to process in the human mind.

Recommendations

This research provided the reader with written and visual content that could be effective for practical and theoretical usage.

Practically, designers whose jobs require applying colored pattern to different applications could use these findings to understand people's' perspectives in terms of object color preference. For example, interior, textile or product designers may use the content to understand the relationship between color attributes, contrast, and different applications to provide their clients with acceptable products. In addition, designers may use the color combinations as an inspiration to create unusual combinations that could be applied to various designs.

Theoretically, the limitations of this research may be taken into account as a starting point for future research in color preference field.

First, the sample size and characteristics limit generalizing the findings to a wider population. For future research, the method of this research may be replicated to examine larger samples. Also, the sample's characteristics may be considered in future research by (1) examining non-designers comparing the results to designers. (2) examining people from other countries. (3) examining equal numbers of males and females to explore gender differences.

Second, using simple two-color combinations limited generalizing the findings to be applied to more complex combinations. Future research may consider several questions, such as: 'would the findings model be applied to complex color combination? Or are there new factors that should be considered when examining object color preference for color combination of three or more colors?

Third, can one type of pattern, which is vegetal, be generalized to other pattern types? Future research may consider the question of 'Do pattern types influence object color preference, or not?

In addition, many other questions might also be considered for future research: Could the findings of this research be applied visually to real objects and how people's reaction would be toward these objects? What are other components of the surface that might influence object color preference? Would people's responses be vary between subjective and objective, if they were non-designers, or would their perspectives be only subjective?

In summary, I would say as we move around our environment, we find objects that catch our eyes. We make decisions, and we admire some objects that look pleasing to us, but we avoid other objects that look un-pleasing. Our decisions are influenced by several factors: Some are subjective, and relate to us as the viewer. Others are objective, and relate to the objects that we interact with. Sometimes, the subjective factors influence us more than the objective factors because our emotions control our decisions. Other times, the objective factors influence us more

than the subjective factor because our knowledge control our decisions. The subjective factors are influenced by our characteristics, background or lifestyle. The objective factors are influenced by the object components, the properties of each component, and the interaction between its components.

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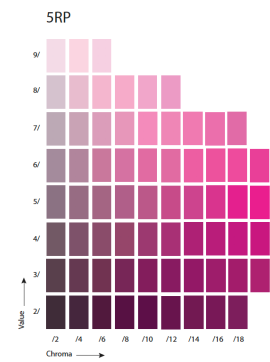
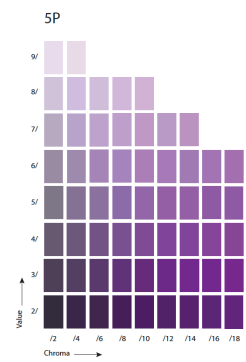
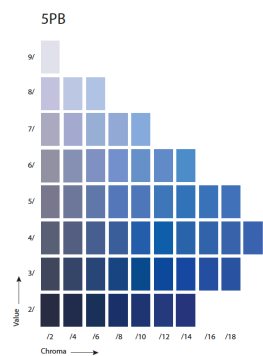
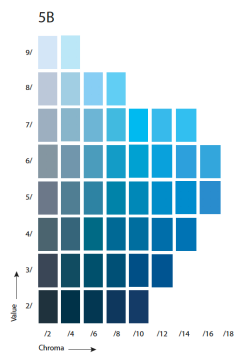
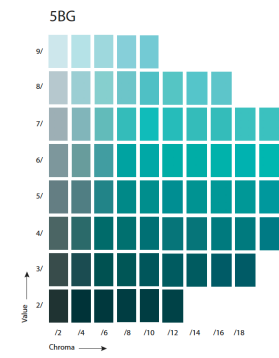
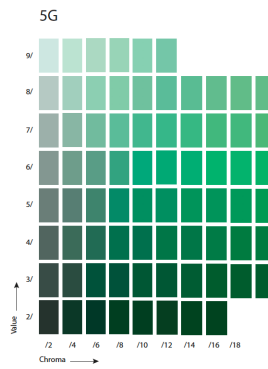
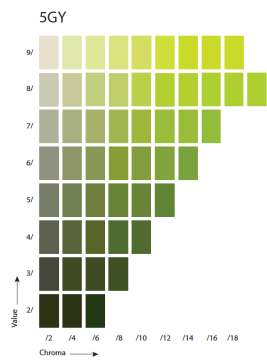
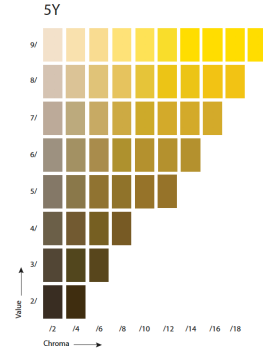
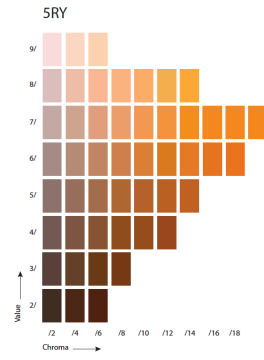
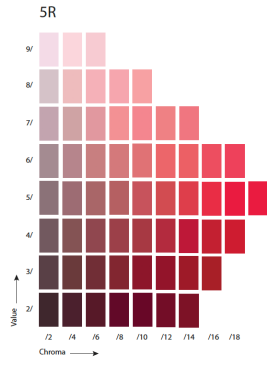
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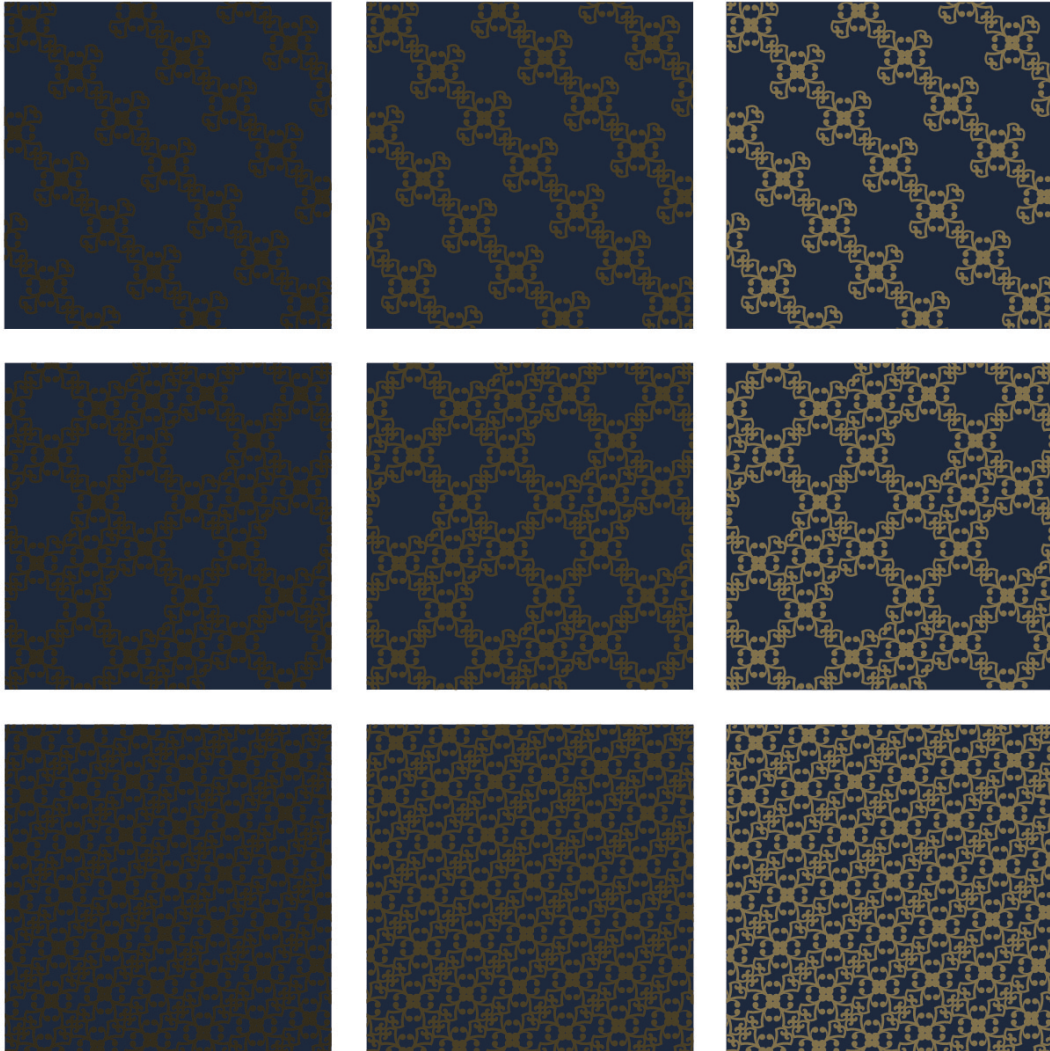
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APPENDIX A MUNSELL CHARTS



APPENDIX B
SOLID COLOR & COLORED PATTERN SWATCHES (QUANTITATIVE)

	5PB 2/4 R: 35 G: 49 B: 79		5Y 3/4 R: 87 G: 70 B: 33
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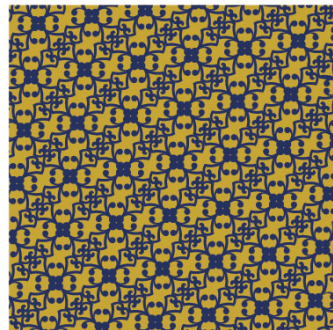
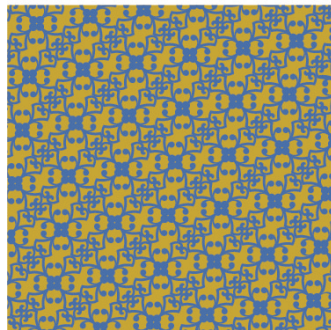
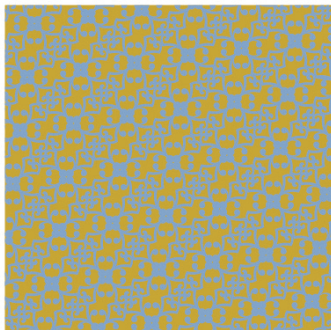
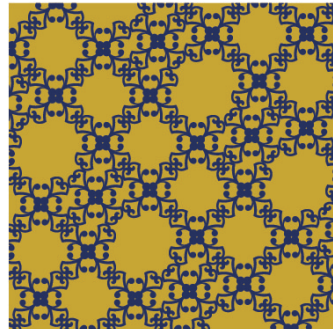
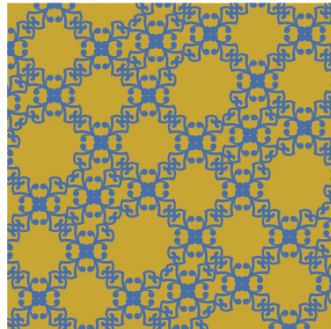
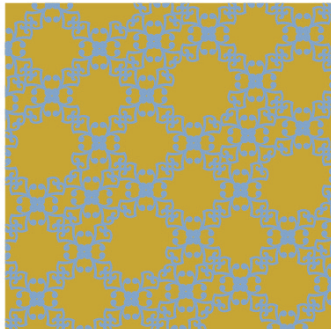
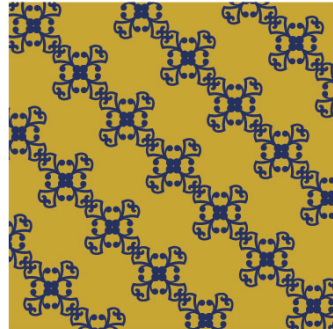
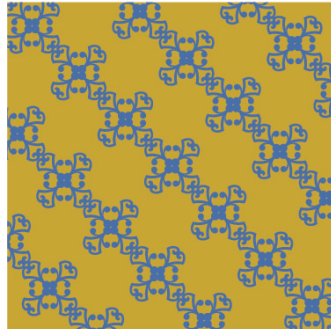
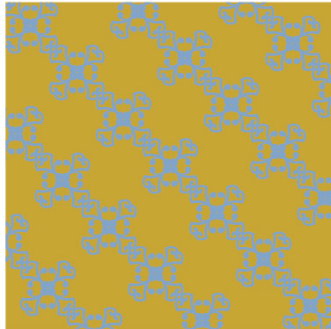


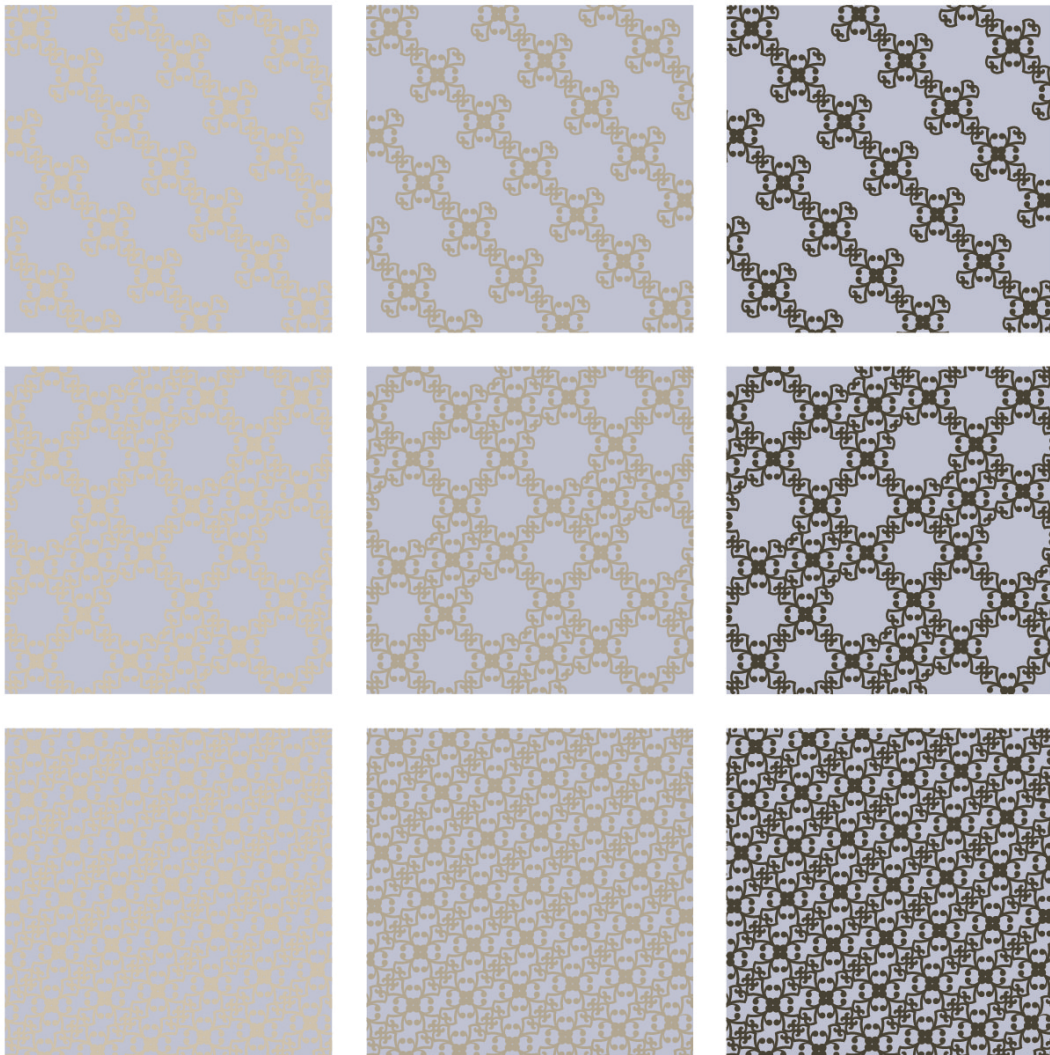
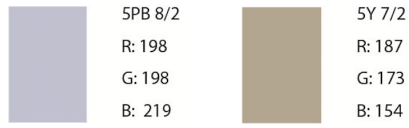


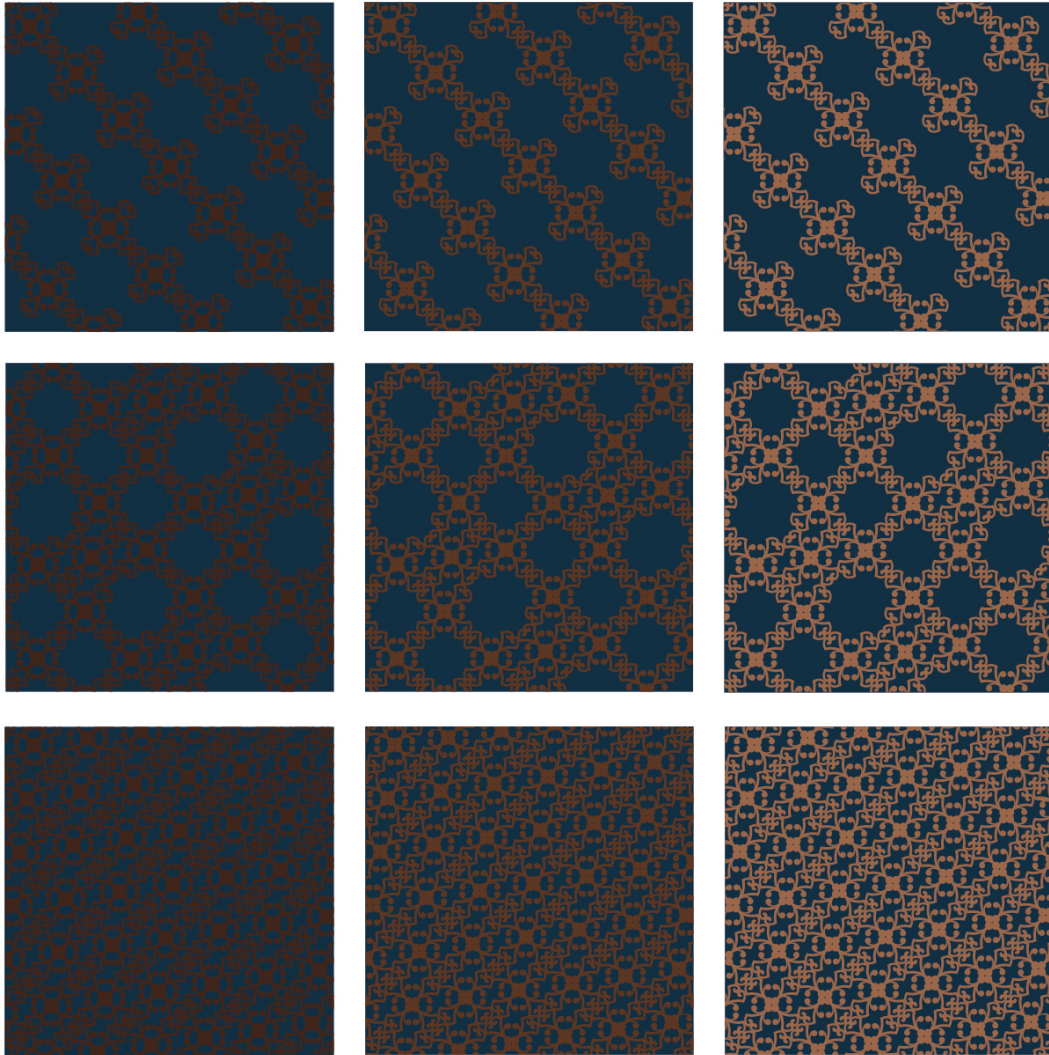
5Y 7/10
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G: 170
B: 43

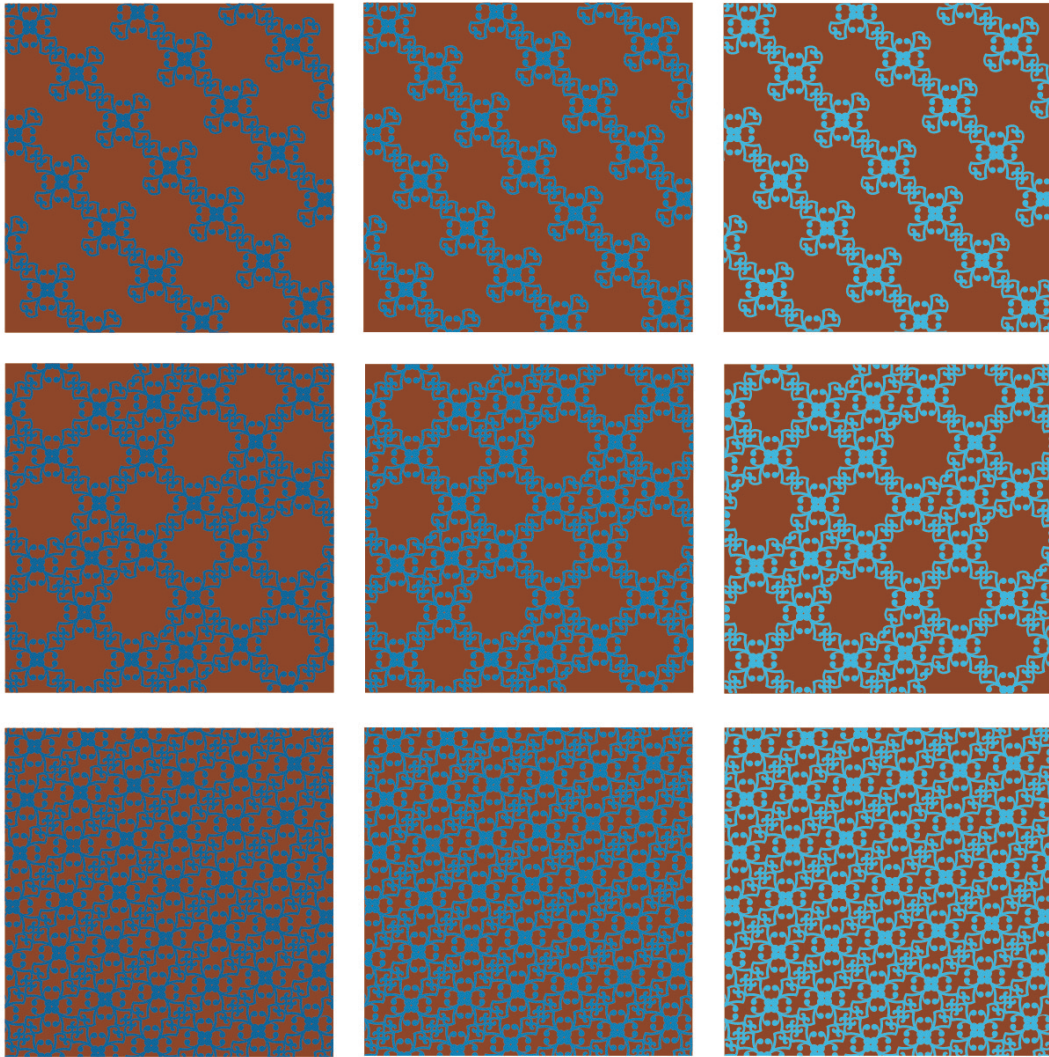


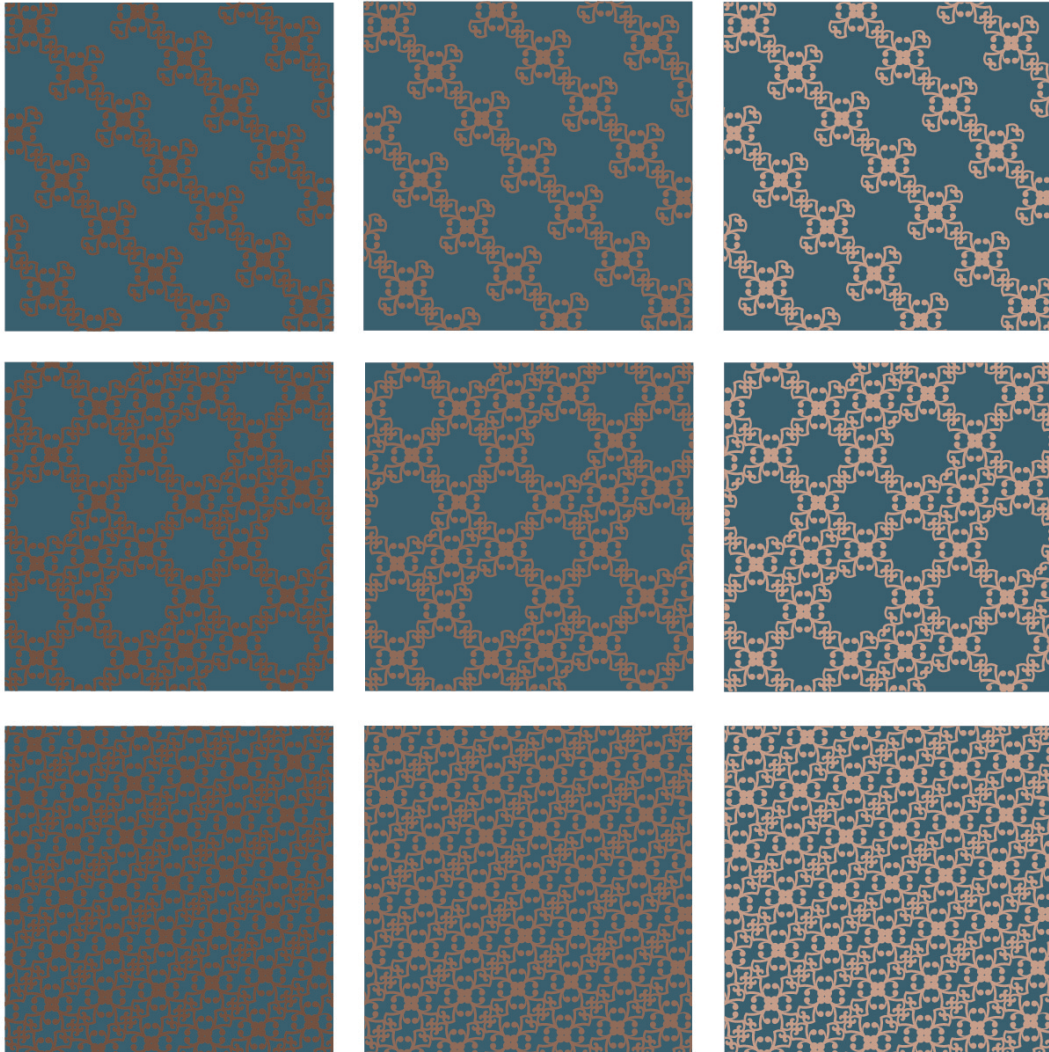
5PB 5/10
R: 76
G: 122
B: 189

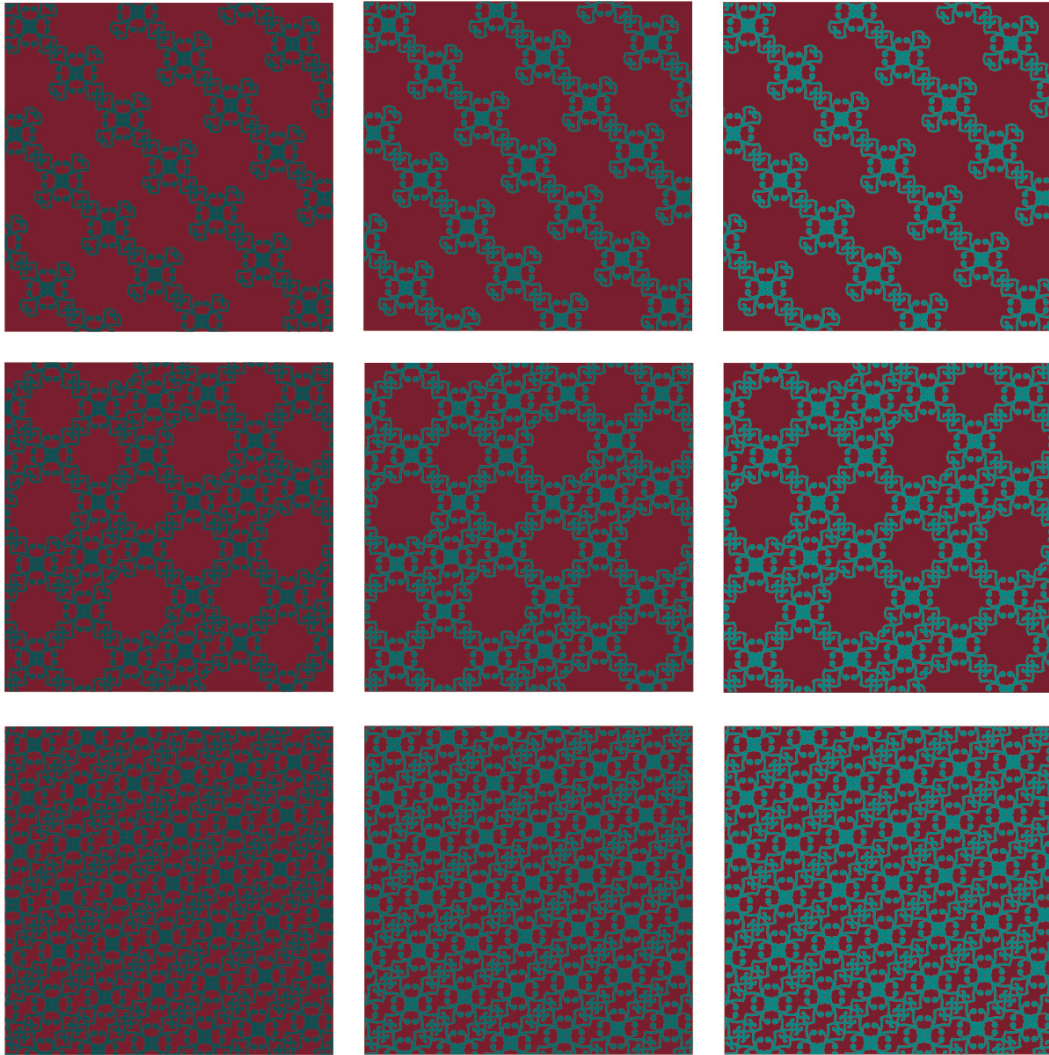
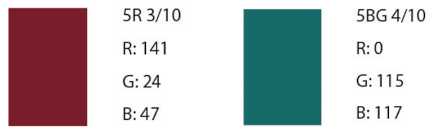


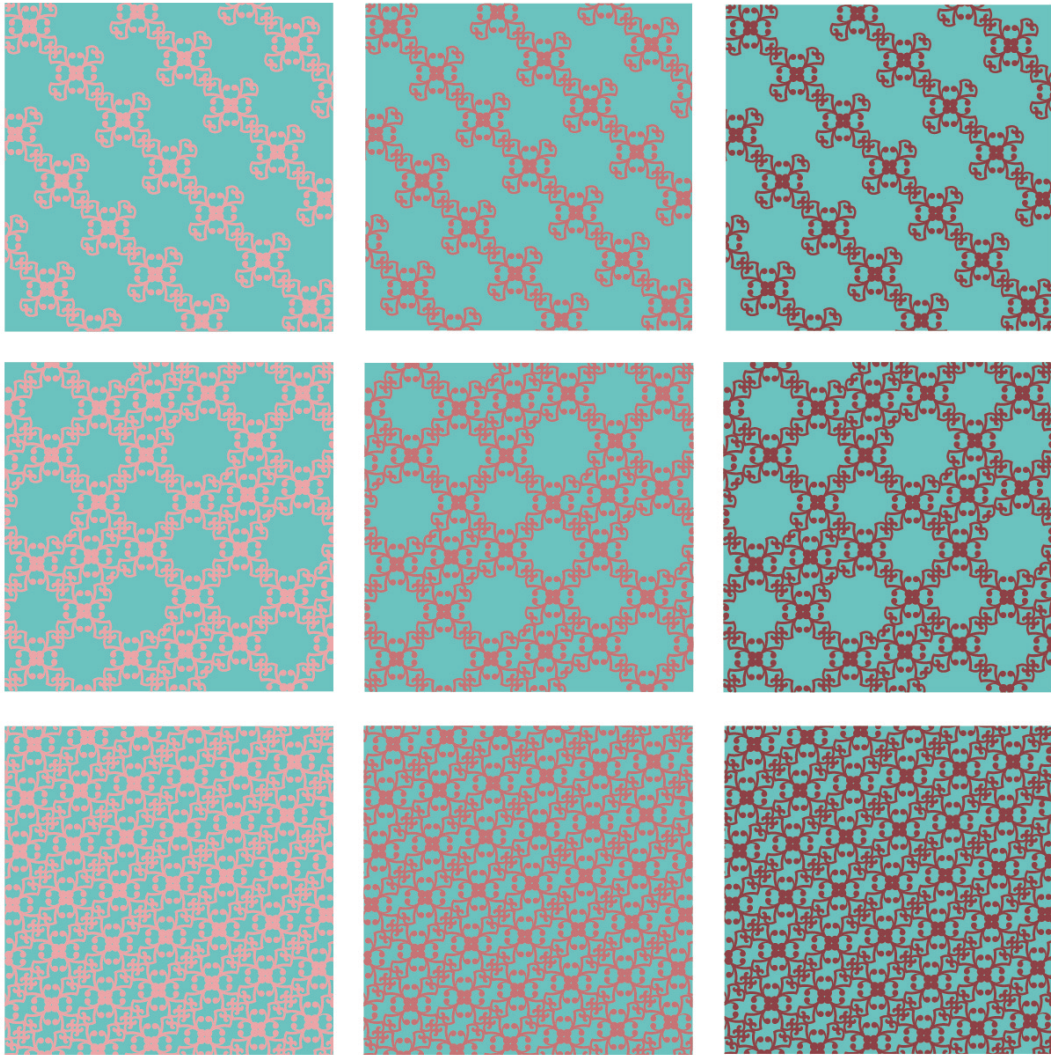
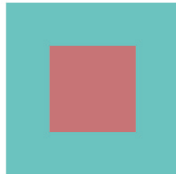
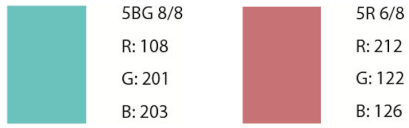


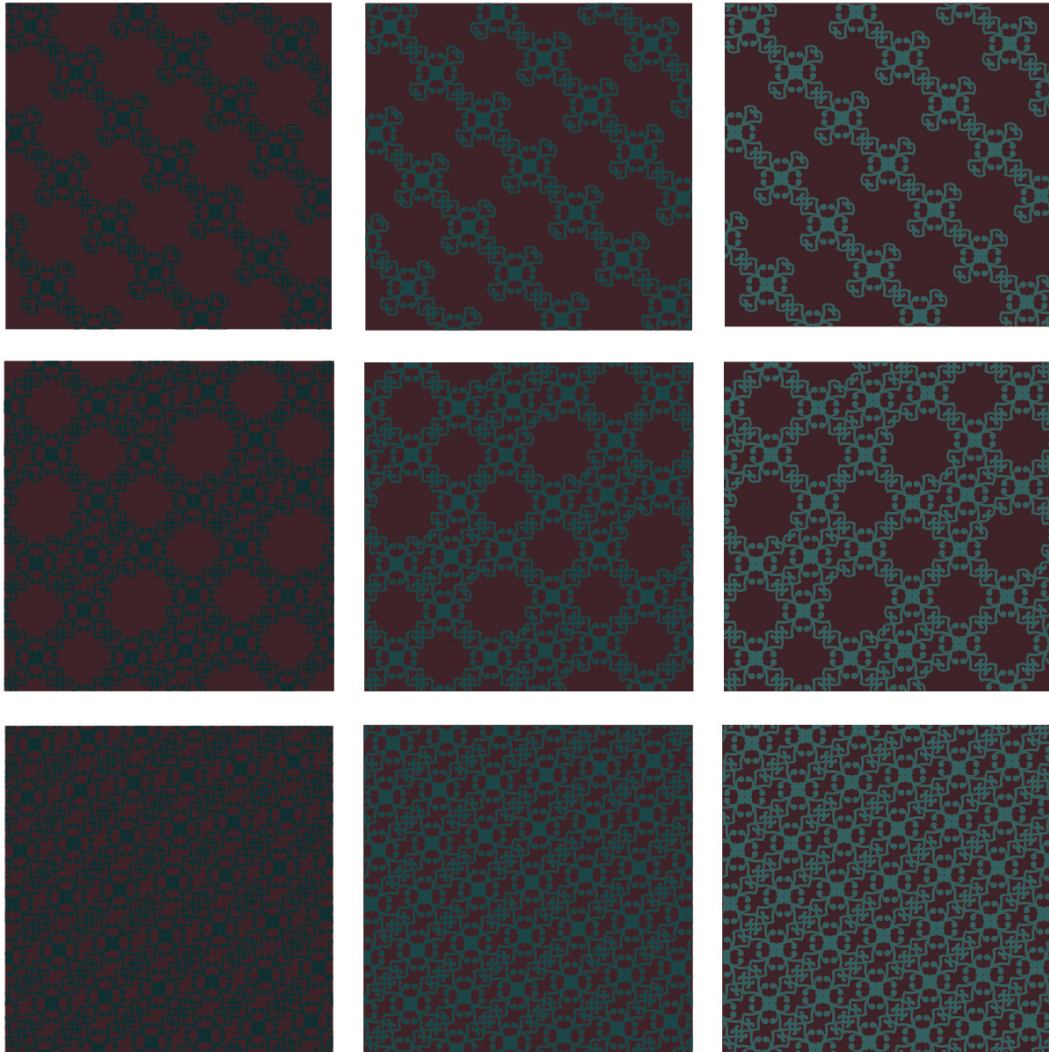
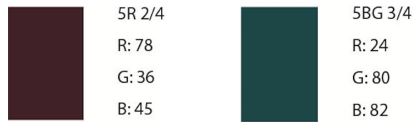


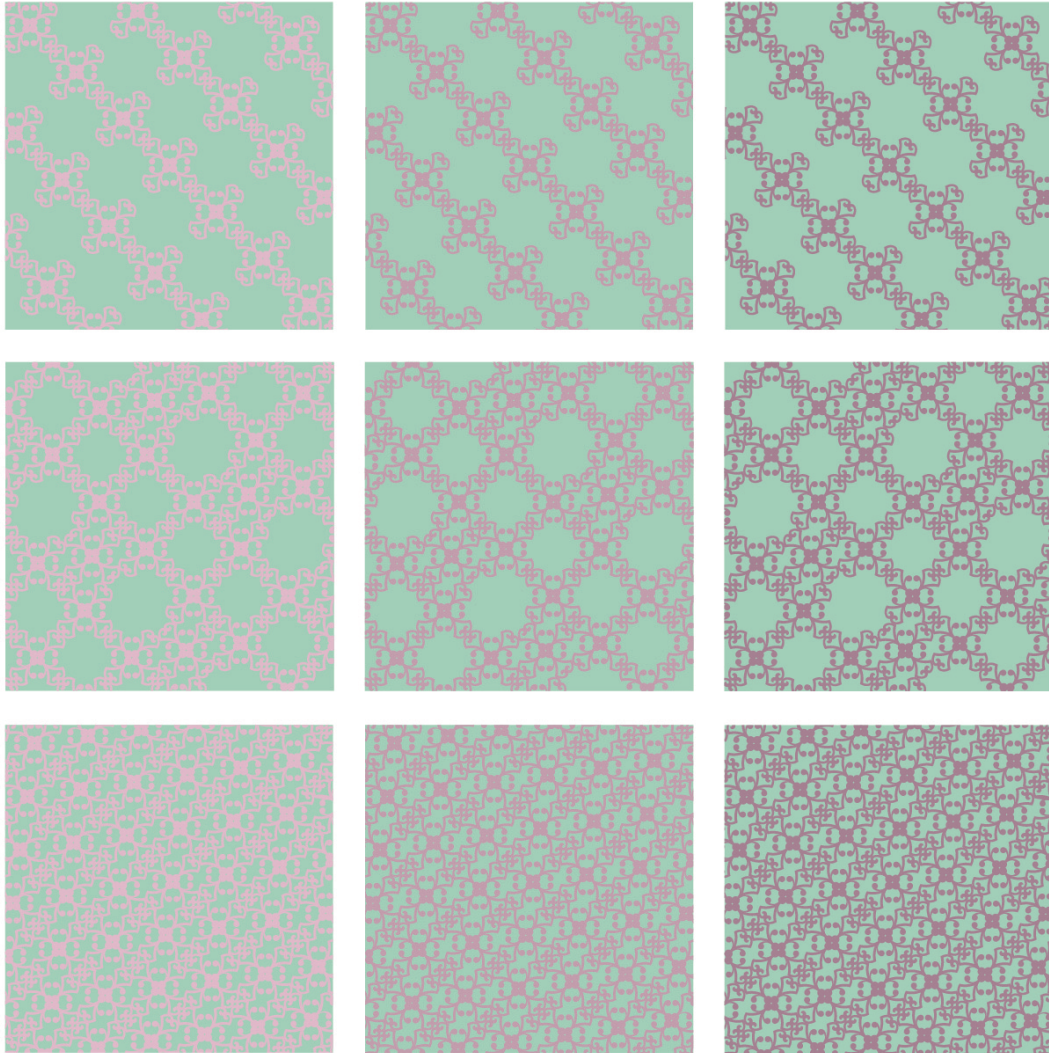
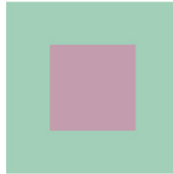
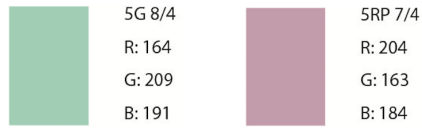


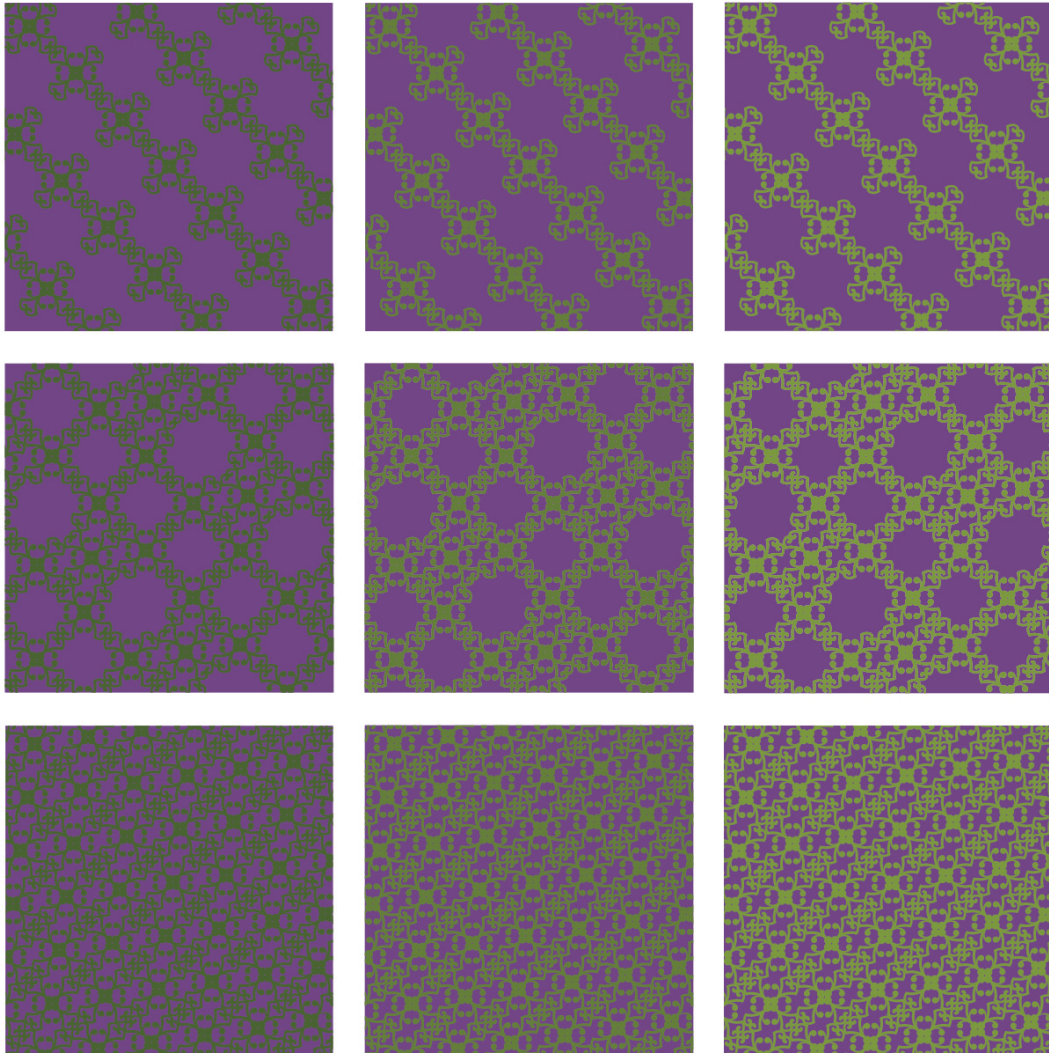


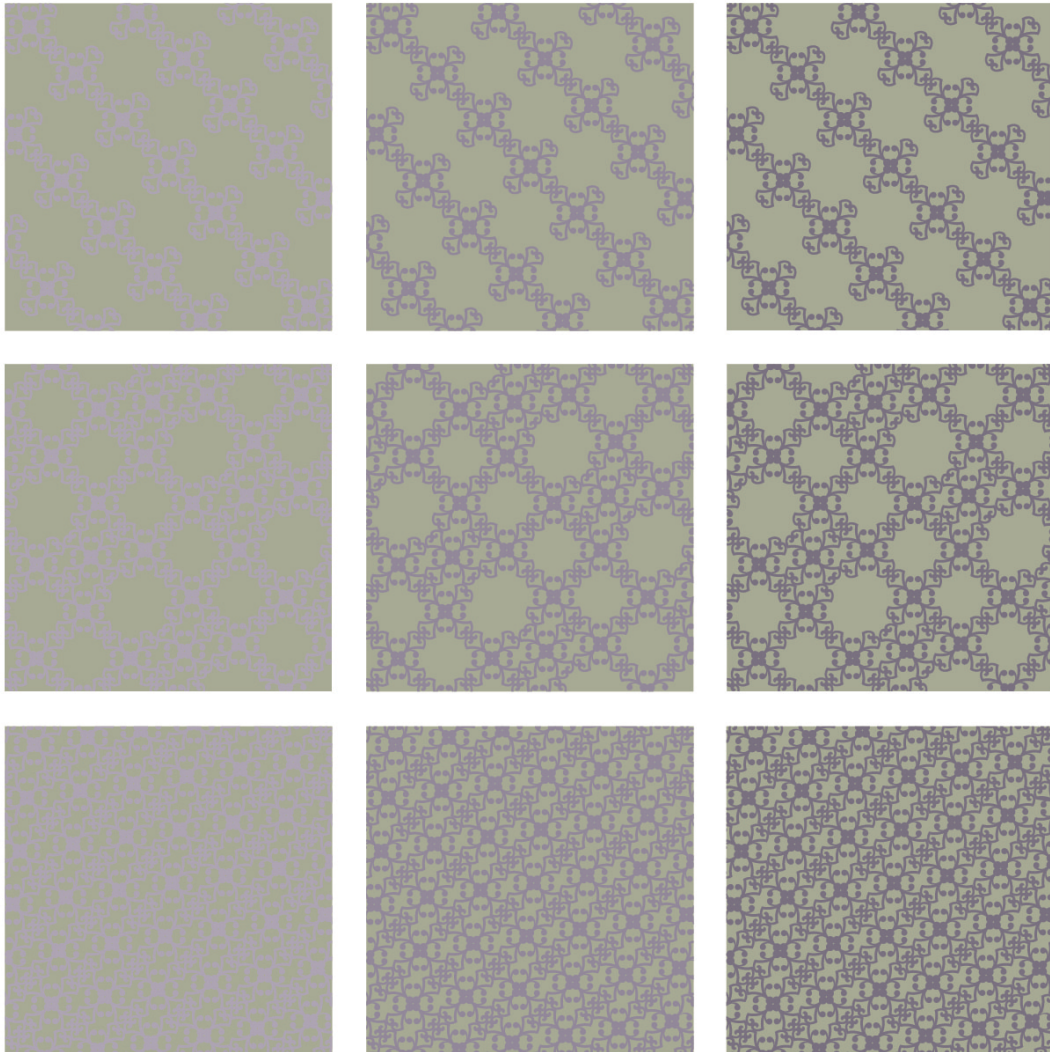


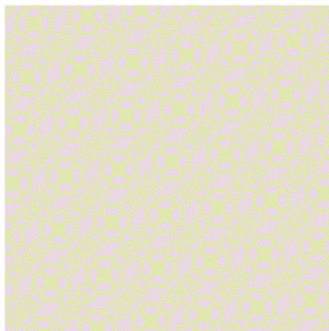
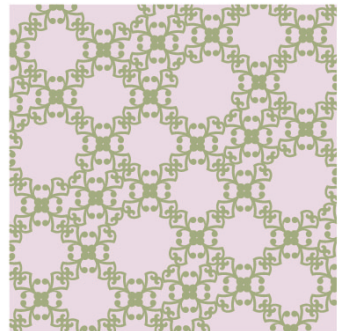
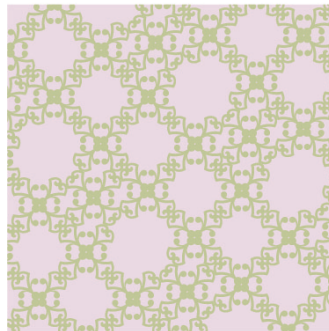
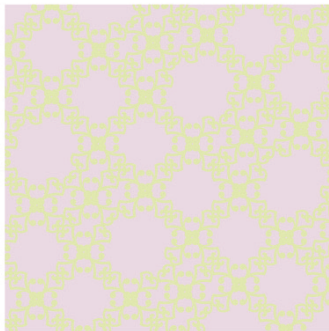
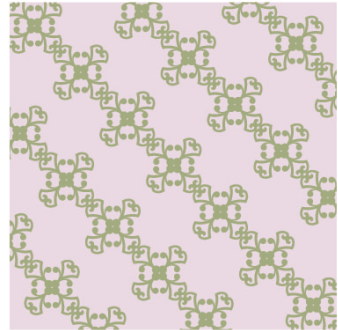
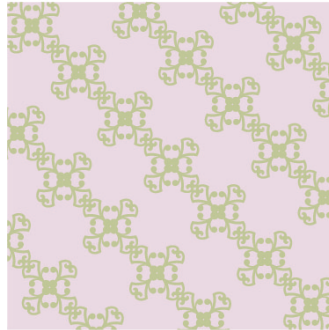
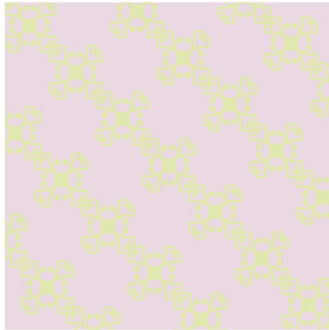
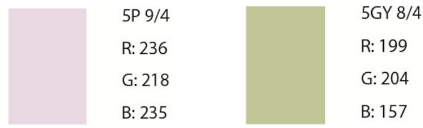


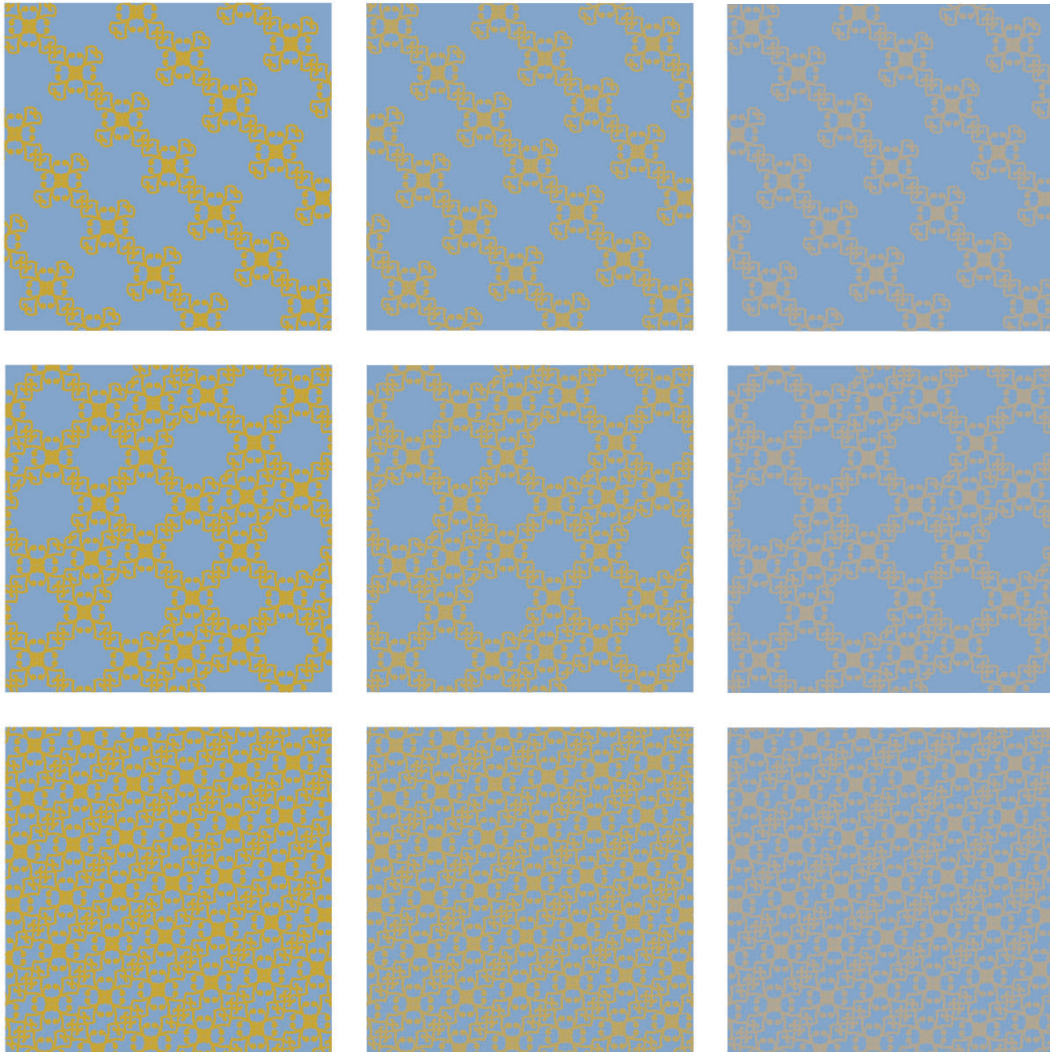
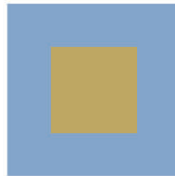


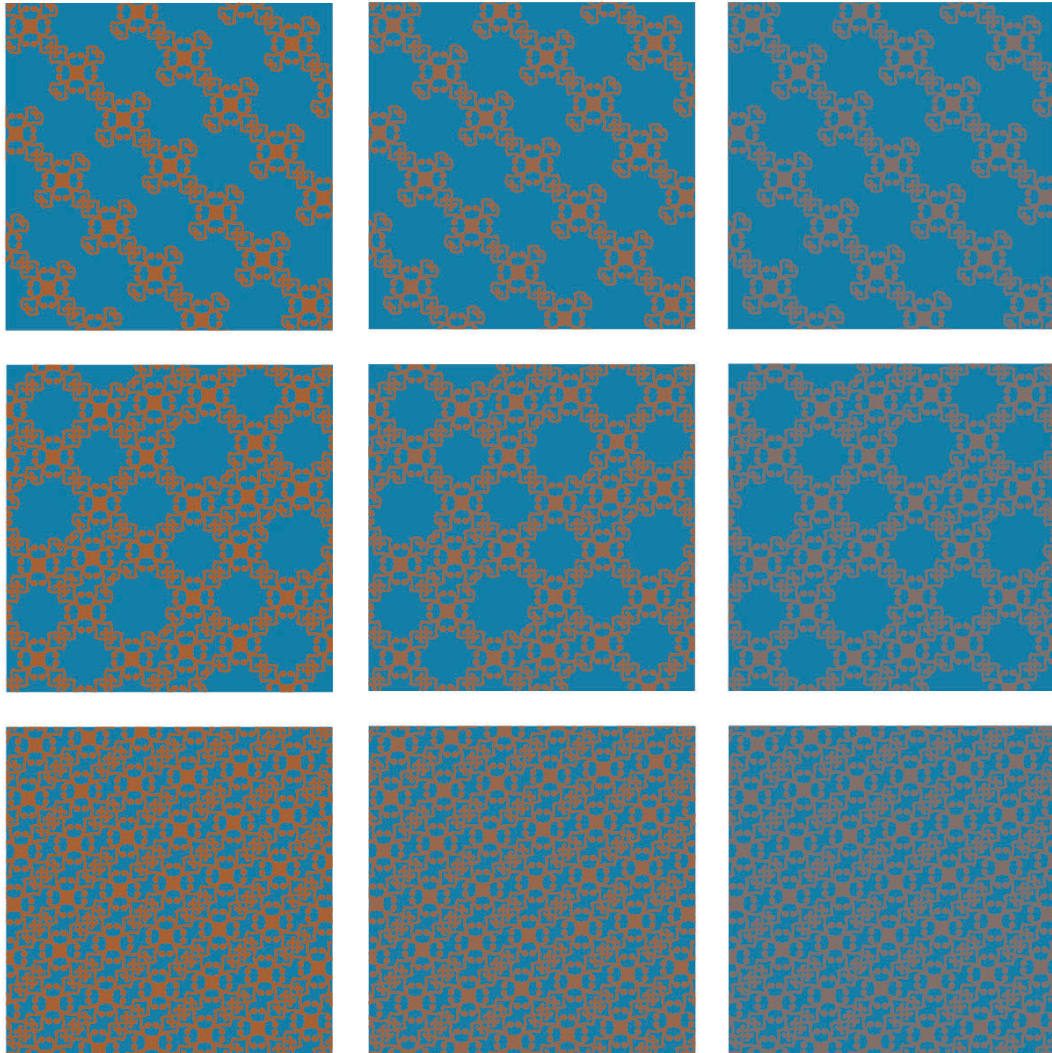
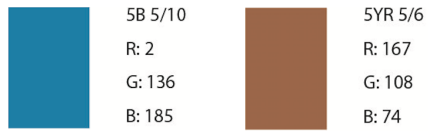


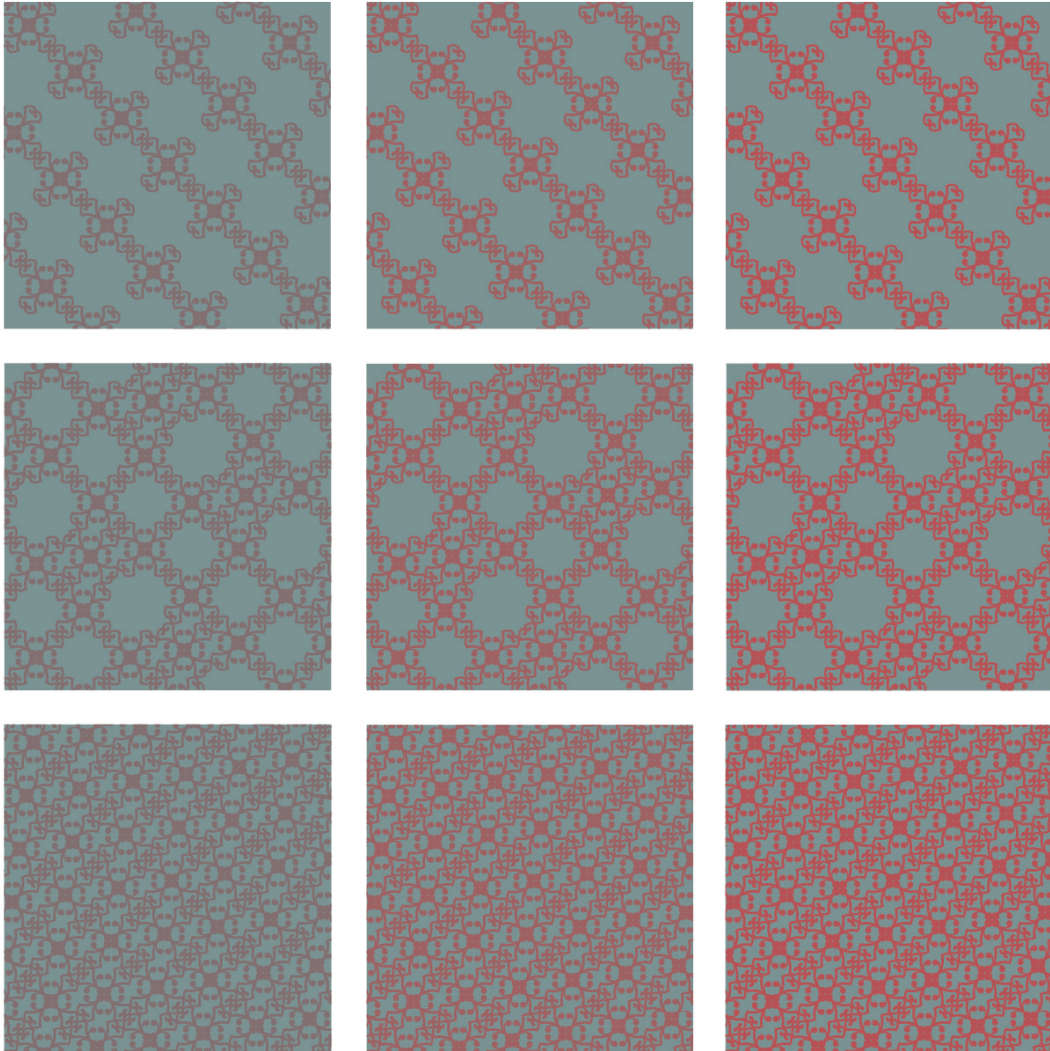


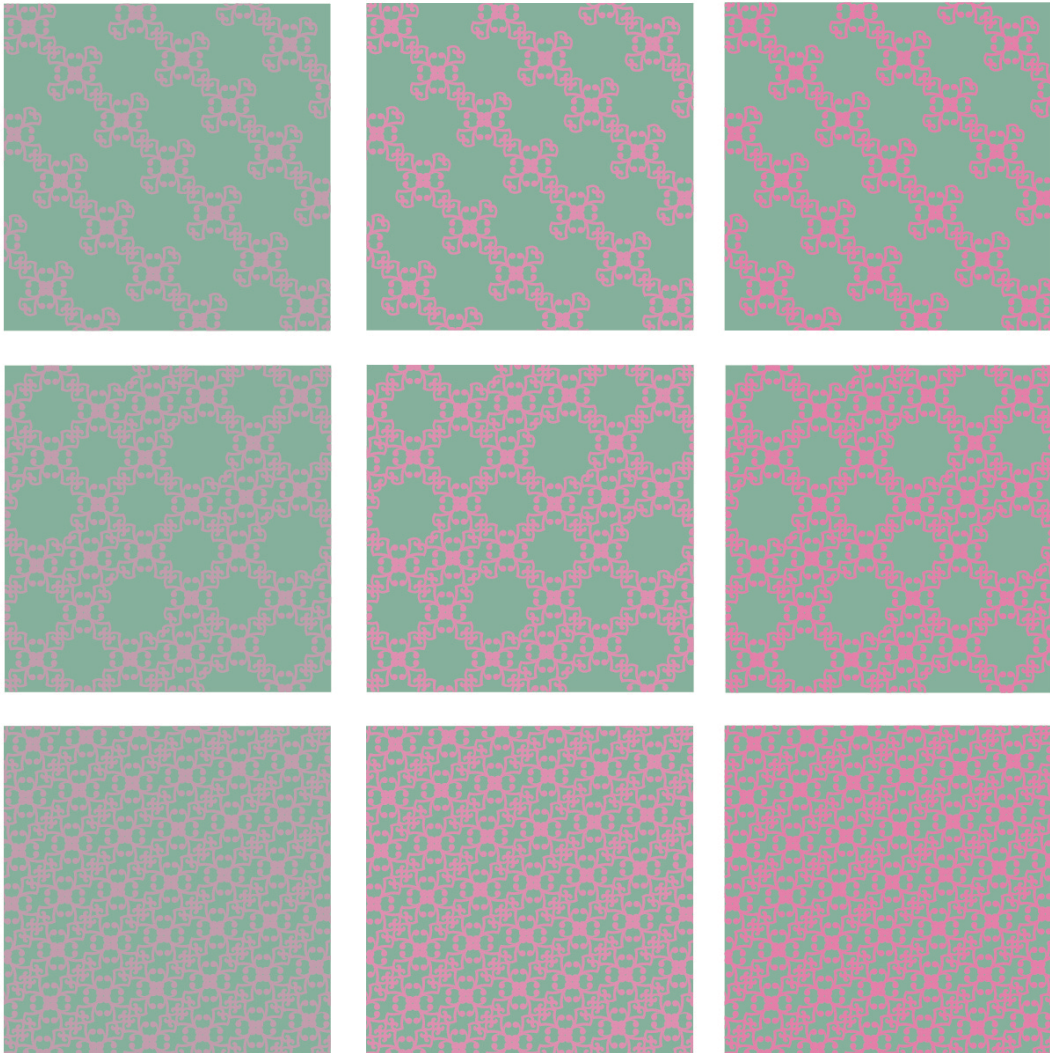
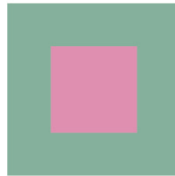
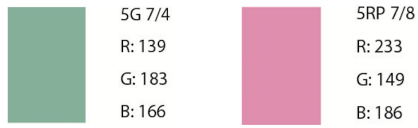


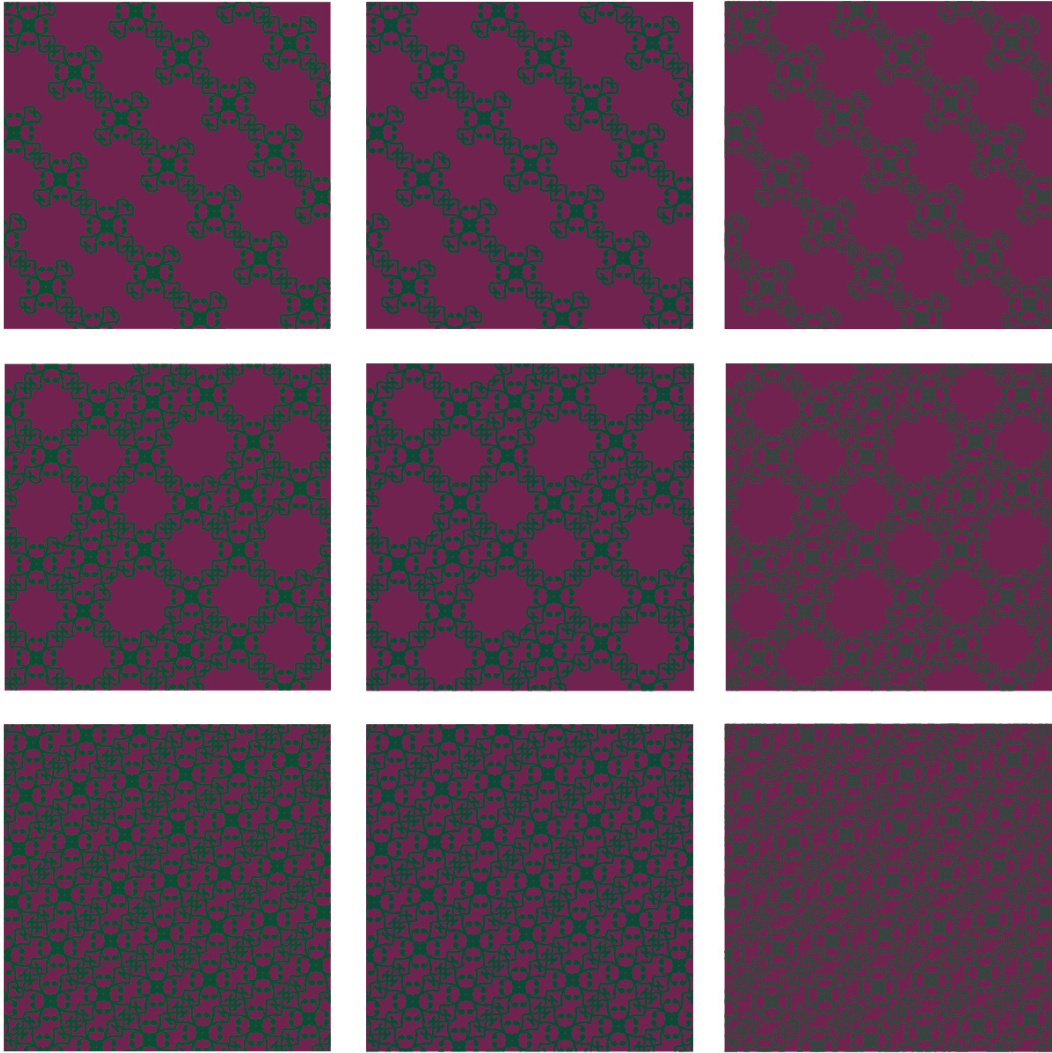
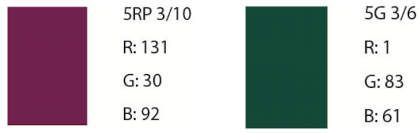


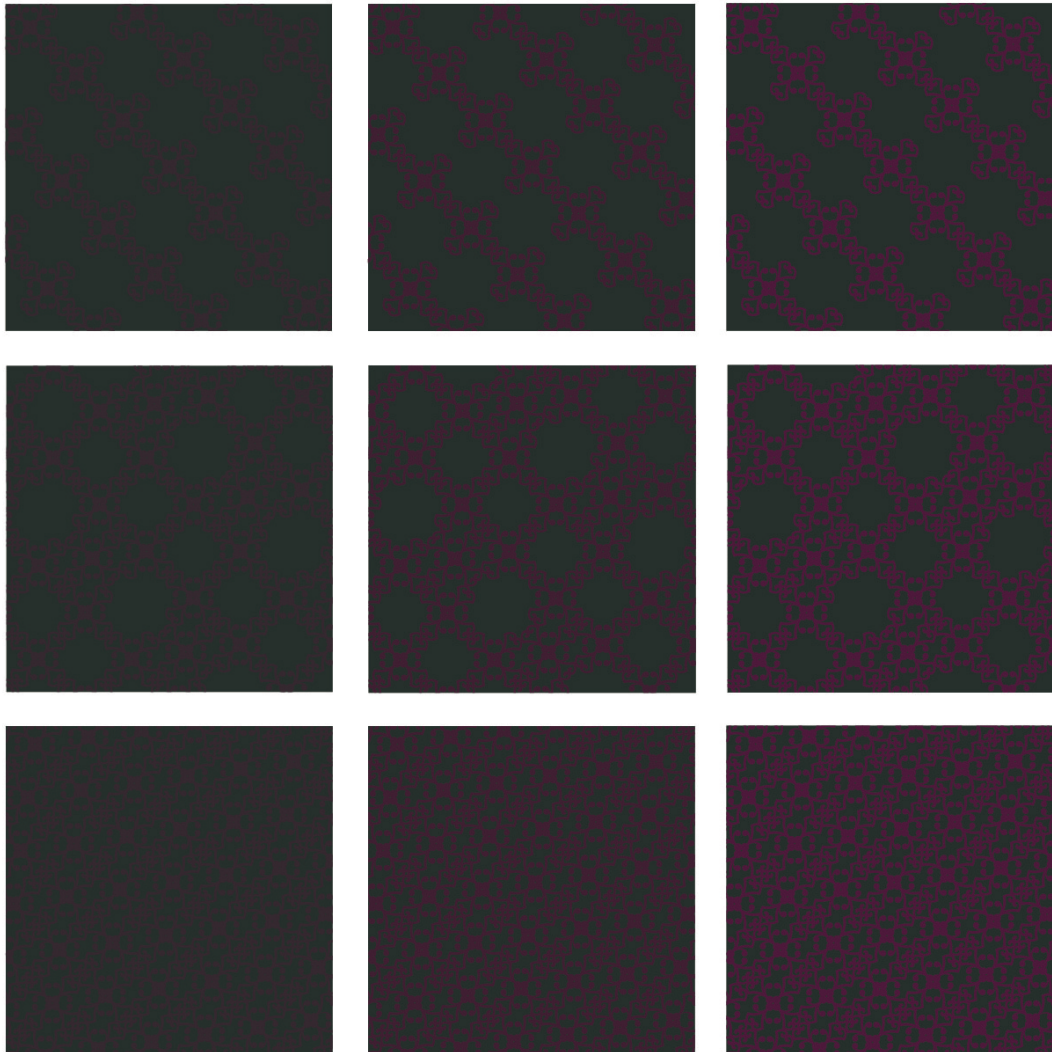
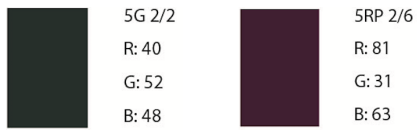


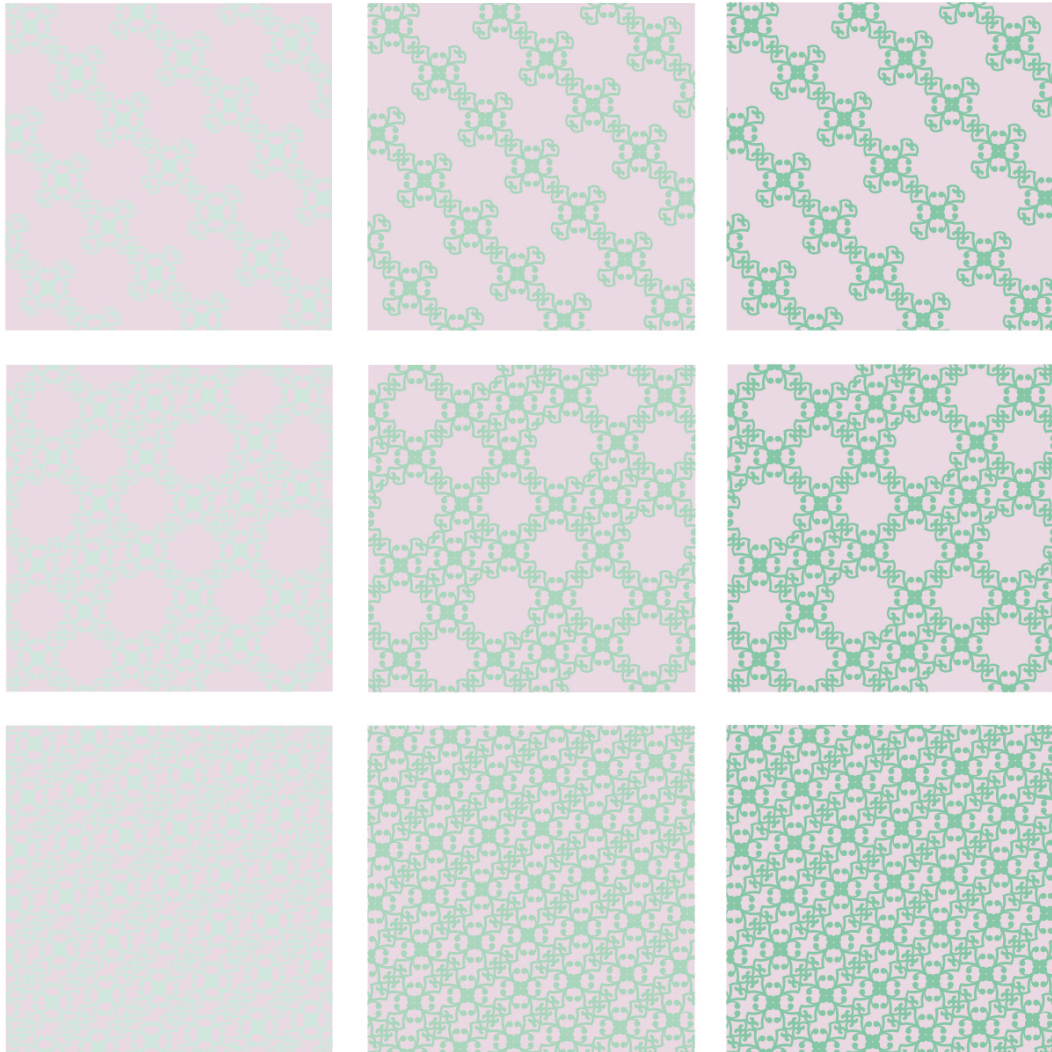
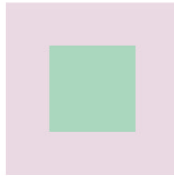
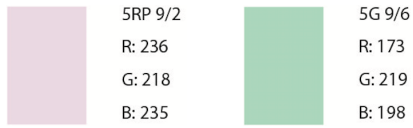




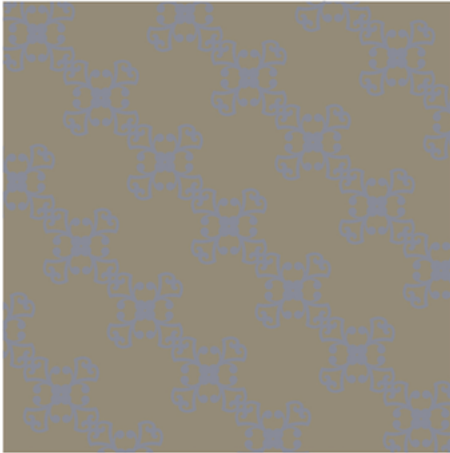








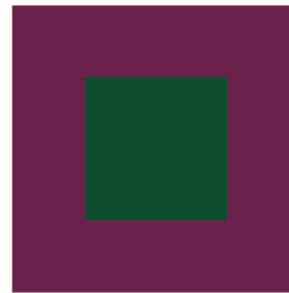
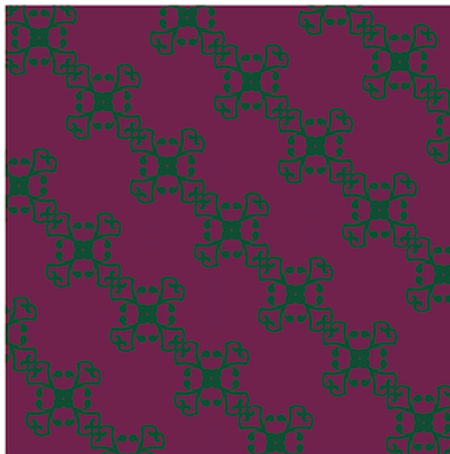
APPENDIX C
COLORED PATTERN SWATCHES (QUALITATIVE)



5Y 6/2
R: 159
G: 146
B: 128



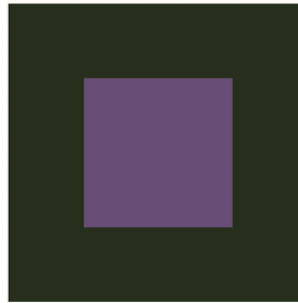
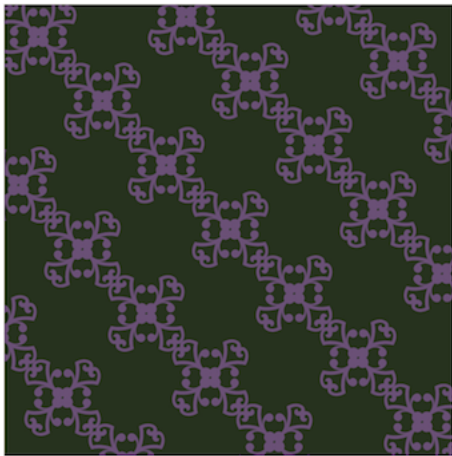
5PB 6/2
R: 145
G: 147
B: 167





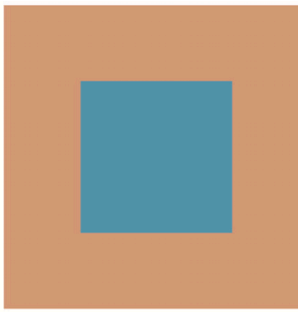
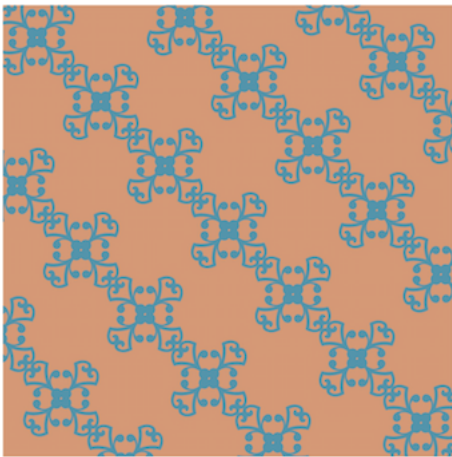
5RP 3/10
R: 131
G: 30
B: 92





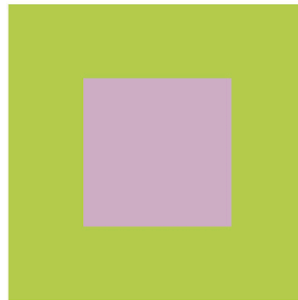
5G 3/10
R: 0
G: 89
B: 55





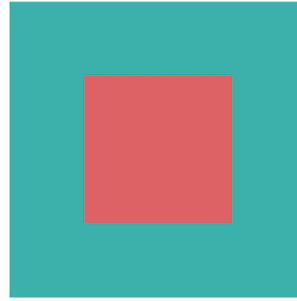
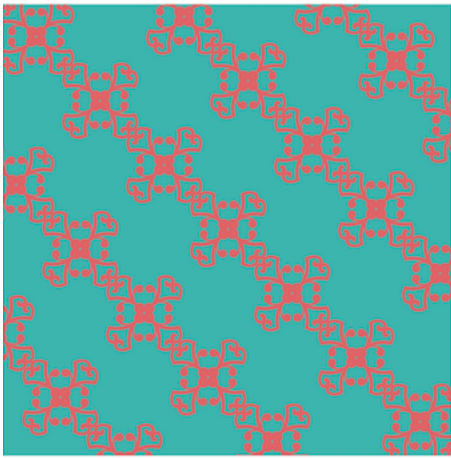
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	5P 4/6 R: 115 G: 86 B: 134



	5YR 7/6 R: 224 G: 160 B: 125
	5B 6/6 R: 82 G: 157 B: 188

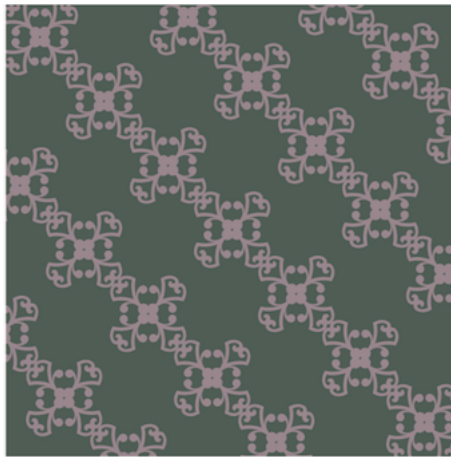


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	5P 8/10 R: 213 G: 181 B: 214



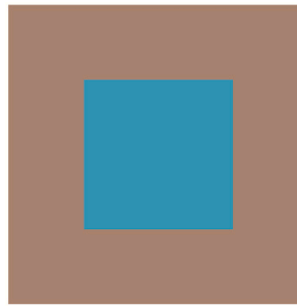
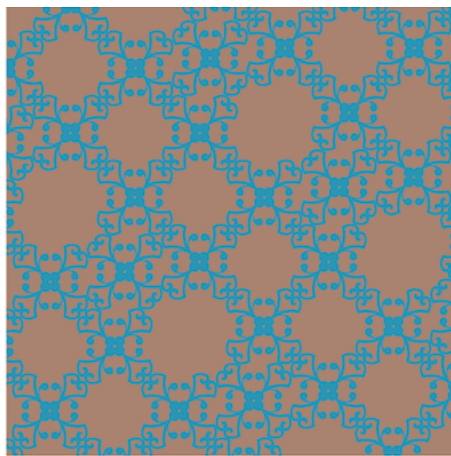
5BG 7/12
R: 48
G: 190
B: 188

5R 6/12
R: 238
G: 105
B: 111



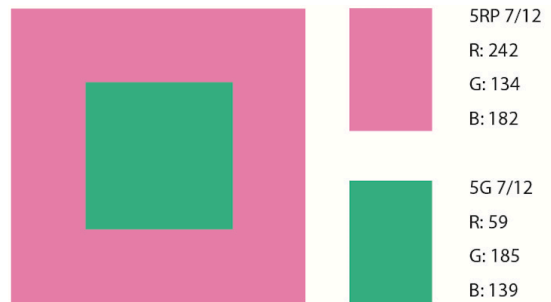
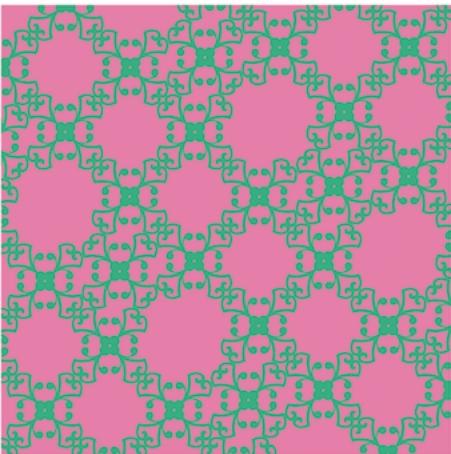
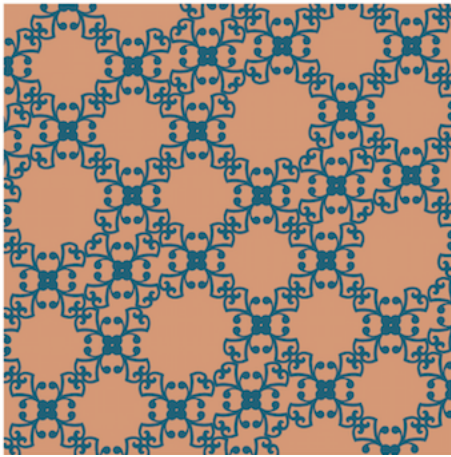
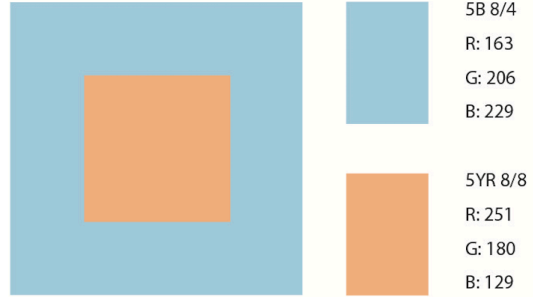
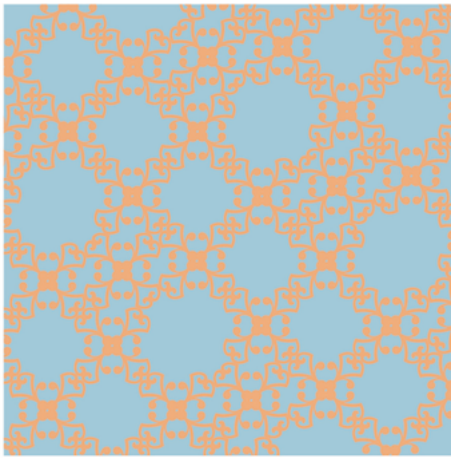
5G 4/2
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B: 96

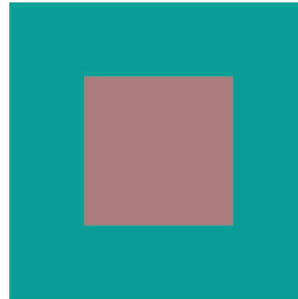
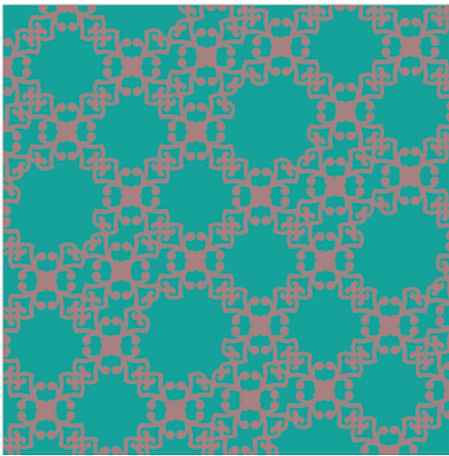
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R: 164
G: 142
B: 155



5YR 6/4
R: 182
G: 138
B: 119

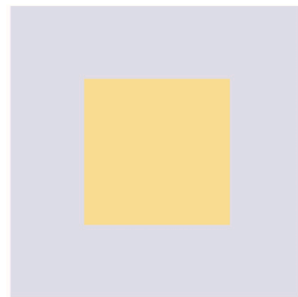
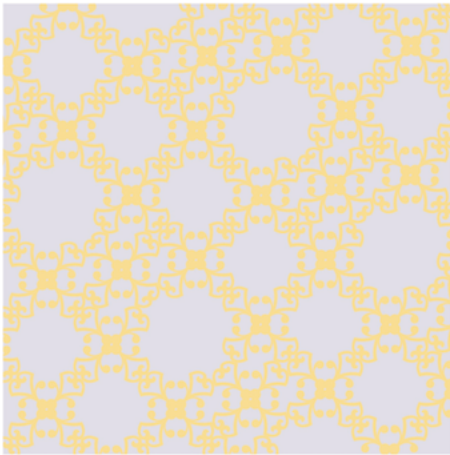
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G: 160
B: 200





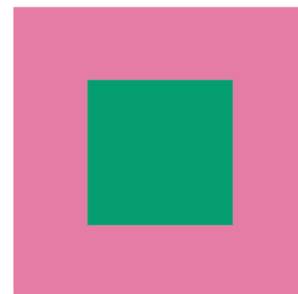
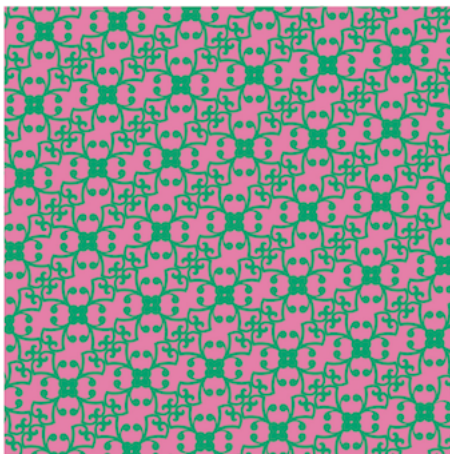
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G: 172
B: 169

5R 6/4
R: 184
G: 135
B: 140



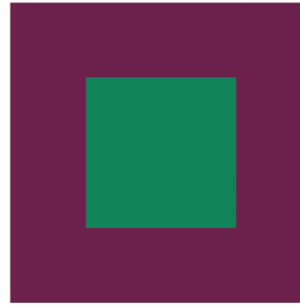
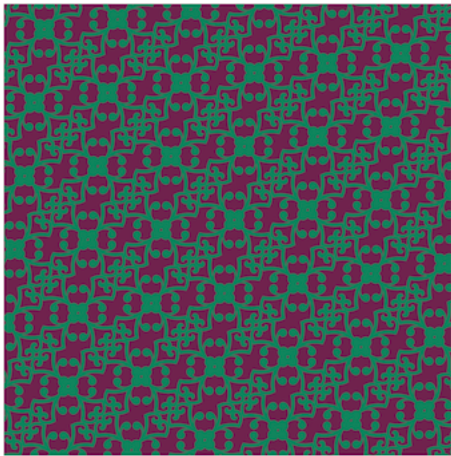
5PB 9/2
R: 227
G: 224
B: 240



5Y 9/6
R: 252
G: 224
B: 149

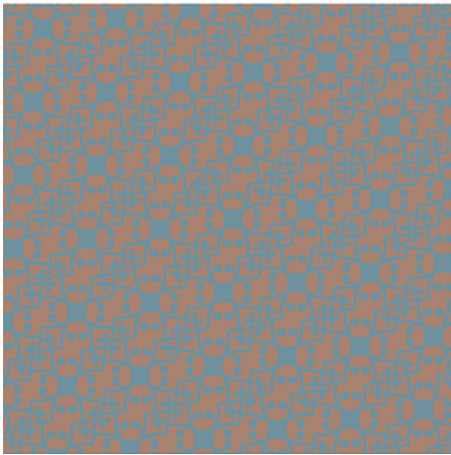




5RP 7/12
R: 242
G: 134
B: 182

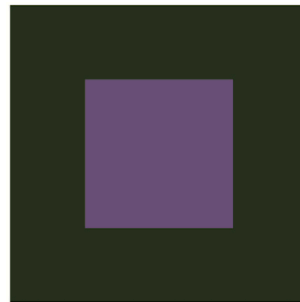
5G 6/12
R: 0
G: 172
B: 119



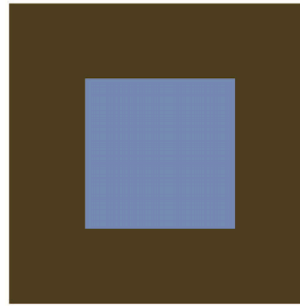
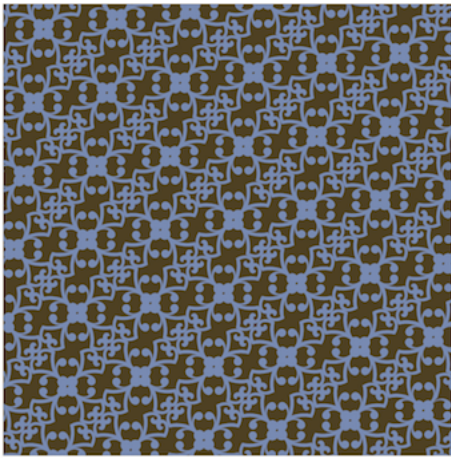
	5RP 3/10 R: 131 G: 30 B: 92
	5G 5/10 R: 0 G: 142 B: 100



	5YR 6/4 R: 182 G: 138 B: 119
	5B 6/4 R: 112 G: 154 B: 175

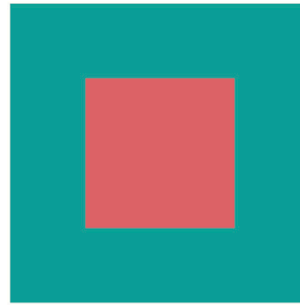
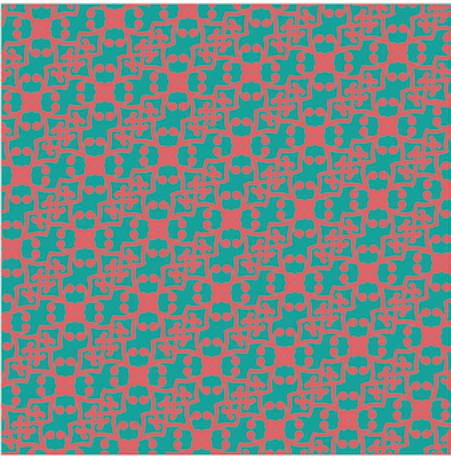


	5GY 2/6 R: 42 G: 55 B: 25
	5P 4/6 R: 115 G: 86 B: 134



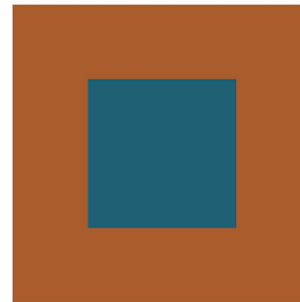
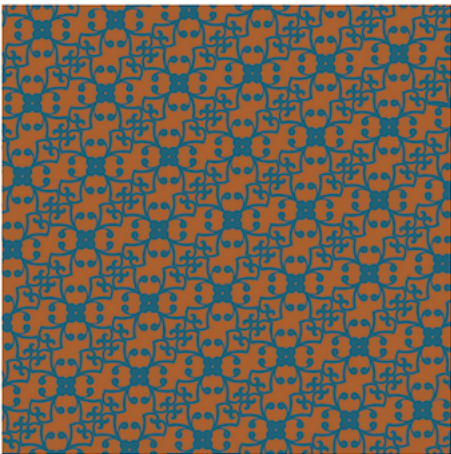
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R: 90
G: 71
B: 27

5PB 6/6
R: 101
G: 122
B: 169



5BG 6/12
R: 0
G: 172
B: 169

5R 6/12
R: 238
G: 105
B: 111



5YR 4/10
R: 184
G: 101
B: 40

5B 4/6
R: 10
G: 106
B: 136

APPENDIX D
DATA COLLECTION FORM

Data Collection Form

Participant #

Age: Gender: Major: Color Vision:

Quantitative Data

Stage 1|

Solid Swatches #			
------------------	--	--	--

Stage 2|

Pattern Swatch #			
Object 1			
Object 2			

Qualitative Data

Pattern Swatch #		
Object 1		
Object 2		

Why did you pick this specific swatch for these objects? Explain

1|

.....

2|

.....

Additional Comments:

.....

.....

.....

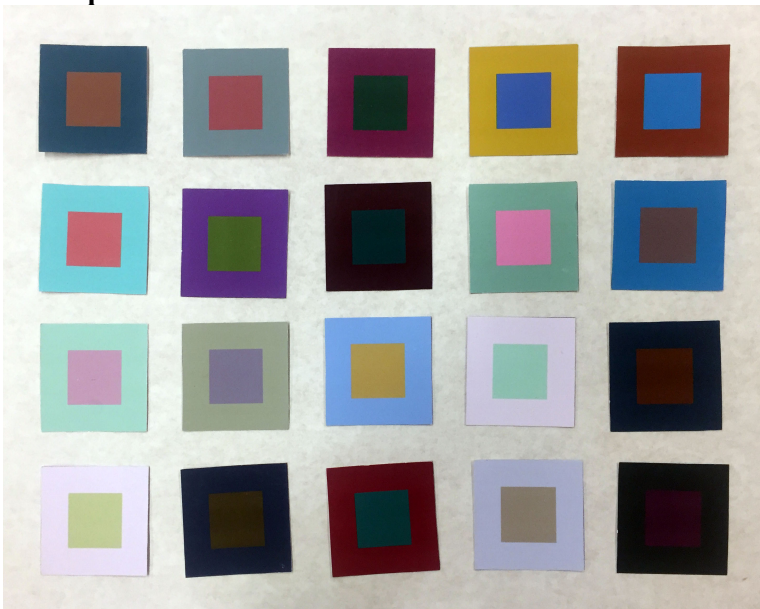
APPENDIX E
EXPERIMENT SET-UP (FIRST STAGE)

Examples for four participants

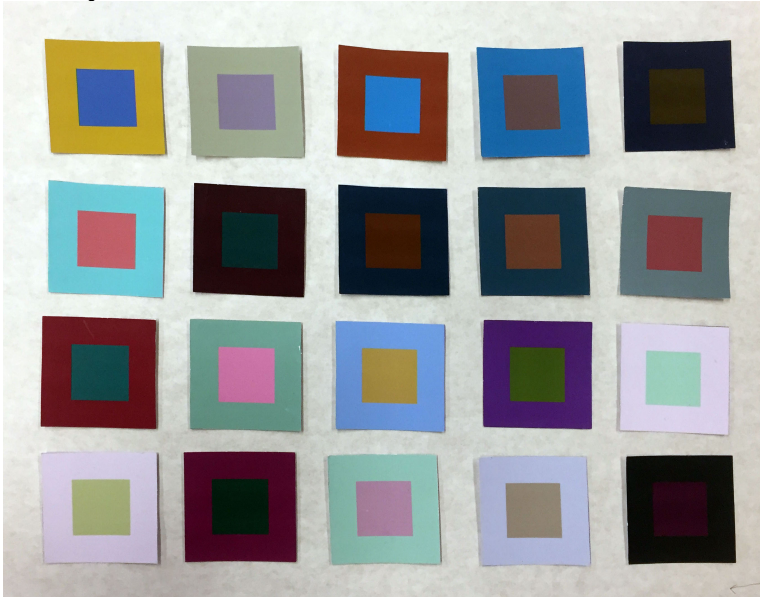
Participant- 1



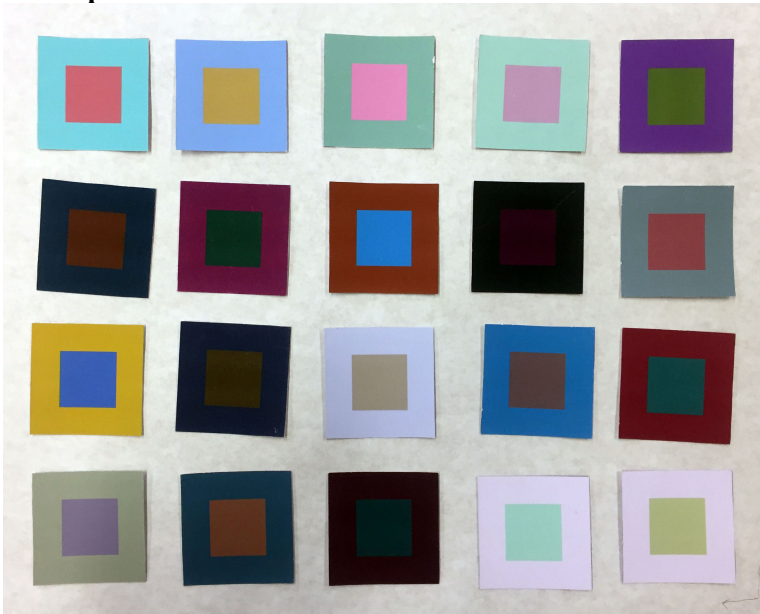
Participant- 2



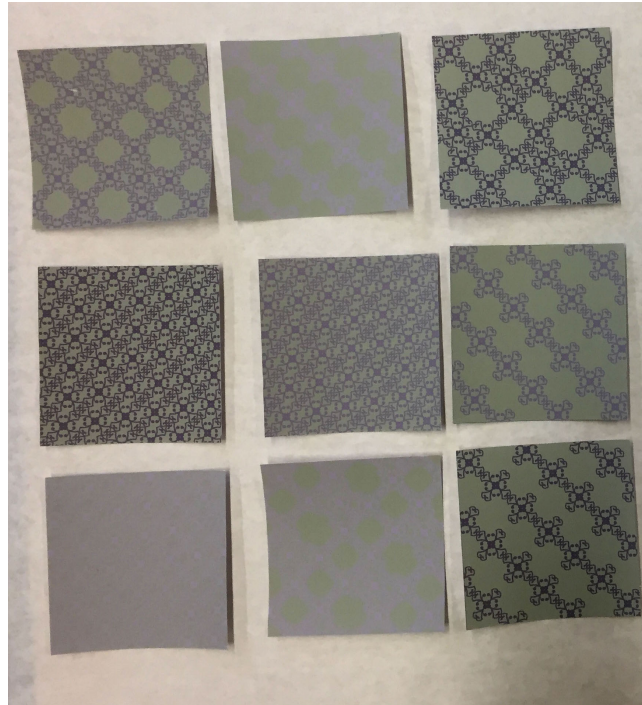
Participant- 3



Participant- 4



APPENDIX F
EXPERIMENT SET-UP (SECOND STAGE)



Participant # 9

Pattern Swatch1

Notbook	Sofa	Chair	Pillow	Apparet
Wallpaper	Wall Art	Tiles	Mug	Bag
Blanket	Tie	Greeting Cards	Wrapping Paper	Carpets

Pattern Swatch2

Notbook	Sofa	Chair	Pillow	Apparet
Wallpaper	Wall Art	Tiles	Mug	Bag
Blanket	Tie	Greeting Cards	Wrapping Paper	Carpets

Pattern Swatch3

Notbook	Sofa	Chair	Pillow	Apparet
Wallpaper	Wall Art	Tiles	Mug	Bag
Blanket	Tie	Greeting Cards	Wrapping Paper	Carpets



APPENDIX G
INTERVIEW SET-UP

Examples for four participants

Participant- 1



Participant- 2



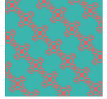

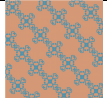

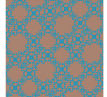
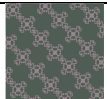
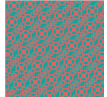
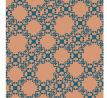
Participant- 3

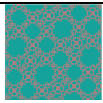
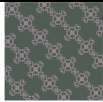
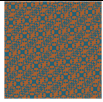
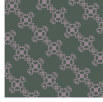
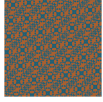
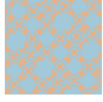
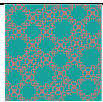
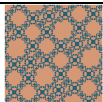


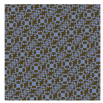


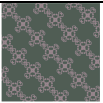

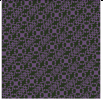

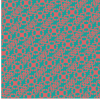
Participant- 4

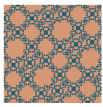

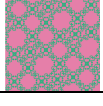


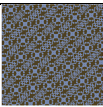
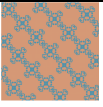
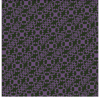



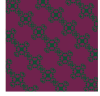
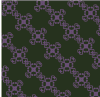
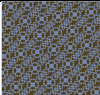
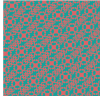
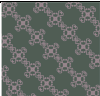
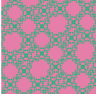
APPENDIX H
QUALITATIVE TRANSCRIPTS




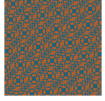
#	Participant's characteristic	Swatch	Munsell Code	Density Level	Contrast Level	Objects	Reasons
1	20 Male Graphic Design		5BG 7/12 5R 6/12	low	low	blanket, sheet	Work well in bedding. I Like the contrast. Like bright colors. Both colors are bright and exciting. Not overwhelmed with pattern like the other one. Super-high contrast. Simple pattern with one stripe.
			5GY 8/10 5P 8/10	low	low	shoes, t-shirts	Like bright colors, low-contrast in terms of saturation, like the shades of greens with purple that worked really well without. Bright green with muted purple. Like simple pattern and bright colors.
2	26 Female Graphic Design		5YR 7/6 5B 6/6	low	mid	pencil bag, tote bag	Like the color combinations and the layout of the design. The contrast. Love this one more.
			5PB 9/2 5Y 9/6	mid	mid	wall art, wallpaper, water or metal bottle	Contrast is hurting the eye. Something not dominant. Like the yellow color. love to see in bigger objects in less contrast colors.
3	20 Male Graphic Design		5YR 6/4 5B 6/8	mid	mid	card, cover, notebook, wrapping paper	Colors vibrate together, and the pattern has good open space. Like the mix of saturated color blue and dull orange that works really well together.
			5G 4/2 5RP 6/2	low	high	pillow, tie, scarf, interior fabric	Like the darker background and lighter pattern, which help to see it easily. High-contrast. It could work with big or small objects either way. Pattern are structured and organized unlike others that everywhere.
4	20 Female Graphic Design		5BG 6/12 5R 6/12	high	low	Children's clothing, dishware	Looks fun reminds of watermelon. Small scale patterns work well with children's clothing. Dishware. Like the highly saturated colors that very intense. Like the distribution of two colors which are even so no one is dominant. Figure-ground ambiguity.
			5YR 7/6 5B 4/6	mid	high	wallpaper for old style home in kitchen, scarf	High-contrast colors bring out the negative and positive spaces. So, it can be recognized from faraway.

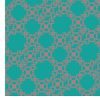

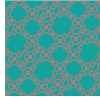
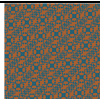

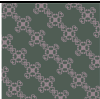
#	Participant's characteristic	Swatch	Munsell Code	Density Level	Contrast Level	Objects	Reasons
5	21 Female Graphic Design		5BG 6/12 5R 6/4	mid	high	notebook, shirt, scarf	Bright but like the color combinations and pattern. Something apparel. Like pink that looks really nice with pattern, but I don't like pink that much.
			5G 4/2 5RP 6/2	low	high	notebook, mug	Like the complement color combinations. Like that pattern more. Contrast is better with this one, its subdued. Not popped out very much.
6	20 Female Graphic Design		5YR 4/10 5B 4/6	high	mid	wallpaper, wrapping paper	From distance its two busy but close you can see the details. Not hurting the eyes like some vibrate colors. Like the complementary colors. Nice to look at.
			5G 4/2 5RP 6/2	low	high	apparel, mug	Interesting colors and work well together and contrasting without vibration. The pattern is simple and no overwhelming.
7	20 Female Graphic Design		5YR 4/10 5B 4/6	high	mid	pillow, chair	Has deep orange a good neutral to match with other furniture. Blue is a fun color. The value contrast is nice. Blue is more saturated, so the colors work together well.
			5B 8/4 5YR 8/8	mid	mid	notebook, greeting cards	The colors are strange and vibrating. less value contrast. I see white line. Look glowing. Fun and happy colors. Not too dark. Light enough feels welcoming. See other colors (pink and green) when staring at it. Color preference pick the same colors but in different value.
8	20 Female Graphic Design		5BG 6/12 5R 6/4	mid	high	pillow, blanket	Like blue and pink palette. Usually drone to. Colors see in an apartment. Use it at my home. Pattern not linear. Soft color not highly contrast. Colors not super intense or over stimulating.
			5YR 7/6 5B 4/6	mid	high	tote bag, pillow	Complementary and soft colors. Intricate pattern not for wallpaper, but visually interesting.



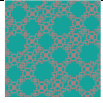
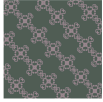
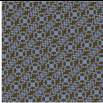
#	Participant's characteristic	Swatch	Munsell Code	Density Level	Contrast Level	Objects	Reasons
9	21 Female Graphic Design		5Y 3/6 5PB 6/6	high	high	notebook, pillow	More personal preference, not bright colors. Contrast well. Like gloomy past out colors. Its fill up the space. Nice for decorations. Not good for wall-paper because its busy.
			5G 4/2 5RP 6/2	low	high	wallpaper, blanket	Strong colors of light pink and dark gray. Like the layout. Each layout and designs suit different objects based on the purpose of the object. Mostly is personal preference.
10	20 Female Graphic Design		5PB 9/2 5Y 9/6	mid	mid	blanket, notebook	Subdued colors not super contrasting or vibrant because I would have a bigger blanket. pretty and I would like to bring them to classes.
			5G 4/2 5RP 6/2	low	high	wallpaper, tie	Looks classy in some rooms even a bathroom. Men don't like crazy colors and dark color makes it not feminine colors. Not crazy and overwhelming goes with a nice suit.
11	21 Female Graphic Design		5PB 9/2 5Y 9/6	mid	mid	wallpaper in the kitchen, decorative pillow	Reminds me of my kitchen. Like it because its bright and the colors are warm. My mom picks my pillows and looks like this. White and yellow gives life to it and remind me of sun shine that we don't see these days in winter. Has a lot of breathing room.
			5GY 2/6 5P 4/6	high	high	folder, notebook for elementary school	Like this one a lot. Like the darkness for this one. Some parts remind me of faces.
12	35 Female Graphic Design		5Y 6/2 5PB 6/2	low	low	pillow, tie	I can see it as a whole sheet set. It would look really cool. Catch people attention, not loud but its subtle catch. Looks classic, conservative. Fits for people who have professional job. The colors affect for that I picked the simple pattern.
			5BG 6/12 5R 6/12	high	low	notebook, apparel	In class everybody zones out and it would be a perfect to zone out of it. Catch attention and vibrant.

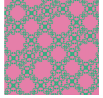

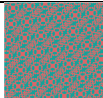
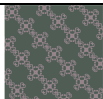

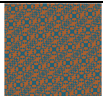
#	Participant's characteristic	Swatch	Munsell Code	Density Level	Contrast Level	Objects	Reasons
13	20 Female Graphic Design		5YR 7/6 5B 4/6	mid	high	wrapping paper, wallpaper	Doesn't have as many vibrating colors that hurt my eyes. As the green one. Like the contrasting between warmer color with cooler blue, which makes it a balanced pattern and harmonious.
			5B 8/4 5YR 8/8	mid	mid	chair, sofa	Has vibrating colors. More balanced in terms of both colors are light. I like the color combination, reminds me of a real classic French furniture.
14	21 Female Apparel		5RP 7/12 5G 7/12	mid	low	wall art, good card	Hard to look at because is so much contrast. Cool to see on a bigger area.
			5GY 8/10 5P 8/10	low	low	pillow, notebook	Have book that a similar color. Color combination reminds me of my mom. Nice color works with a lot of neutral in my house. When I was seven my room was two colors.
15	22 Male Graphic Design		5PB 9/2 5Y 9/6	mid	mid	pillow, notebook	It is vibrant. Looks white or off-white, a pale blue or purple. Complementary colors. Interesting patterns. Not high-contrast, hurt my eyes when I look at it for a while.
			5Y 3/6 5PB 6/6	high	high	quilt, tile	Like the contrast of two colors, appealing contrast. Reminds me of floral patterns. I see a lot of hearts on it. Works well for interior because of the high-contrast.
16	20 Female Graphic Design		5YR 7/6 5B 6/6	low	mid	wallpaper, dress	Don't hurt my eyes, appealing colors. I picked these two objects because, very light, just enough contrast but bright colors that I would like to put in my room or wear it for fun.
			5GY 2/6 5P 4/6	high	high	carpet, scarf	Don't hurt my eyes, appealing colors. Detailed enough for a carpet when you look close to it. Heavily patterned scarf.
17	21 Male Graphic Design		5BG 7/12 5R 6/12	low	low	blanket, towel, scarf	Accessory, something not primary, a bag or tie. It pops reminds me of beach and sun, something you would like to bring to the beach. The simple patterns make it pop but if the pattern was complex it would hurt my eyes when I look at it too much.

#	Participant's characteristic	Swatch	Munsell Code	Density Level	Contrast Level	Objects	Reasons
17	21 Male Graphic Design		5RP 3/10 5G 3/10	low	low	classic sitting, carpet, rug in a restaurant, wallpaper of a tile, back of a chair.	The colors fit together really well with the pattern. Add: different contrast for different settings and purpose. Think of multiple things in different settings.
18	20 Female Graphic Design		5GY 2/6 5P 4/6	low	high	carpet, cup, mug	The color so bright. Like dark background. For the carpet, Heavy. The carpet on the ground for that I picked simple patterns and dark color.
			5Y 3/6 5PB 6/6	high	high	notebook, curtain	Like dark background. For the notebook, sometimes it hard to find different subject. I want my note to be special and easy to look for. This pattern catches the eye. For the curtain, cover the space.
19	19 Female Graphic Design		5BG 6/12 5R 6/12	high	low	wallpaper, pillow	Immediately stand out to me. like the color combination. More drone to the orange color. When I look at it almost blends together but still separate it.
			5G 4/2 5RP 6/2	low	high	notebook, tile	Like the contrast between the light and dark colors. Like the simple more. The other one is interesting but only work with some colors. So, you picked two different density one simple and the other one is very busy. I like the simple one more is easier to read. The other one is interesting but only works with certain colors. So, if there is light color and dark color is going together.
20	20 Female Apparel		5RP 7/12 5G 7/12	mid	low	picture frame, blanket	It has a high-contrast, which will help the picture to stand out, frame the picture really well. As a blanket, high enough contrast and all the negative space it creates a nice pattern but not busy because the blanket is a big object.

#	Participant's characteristic	Swatch	Munsell Code	Density Level	Contrast Level	Objects	Reasons
20	20 Female Apparel		5PB 9/2 5Y 9/6	mid	mid	mug, pillow	Less contrast doesn't bother me maybe because the yellow makes it really bright. And I would like to use it every day. And I don't want to use in bigger object because the contrast is very low, and it would hurt my eye.
21	24 Female Apparel		5YR 6/4 5B 6/4	high	low	chair, apparel	I like the two colors together. Like how the blue is more saturated and how the other color is less saturated. the colors are complementing each other really well. Like how is kind of because the colors are so contrasting from one another, so it is hard to tell what is the pattern until you look at it close. Really cool pattern as an accent chair if you have other object to complement it in a room. For the apparel, if you put this pattern on a shirt but not the entire pattern with the background color that would be really cool. Really busy pattern. For small pieces. If it was on a tile it would be too busy.
			5G 4/2 5RP 6/2	low	high	tile on a bathroom, flooring tiles	Like a bathroom tiles on the wall but not all the wall or flooring tiles. I think this work well on tile because the pattern is simple, and it is easy to find.
22	20 Female Graphic Design		5YR 4/10 5B 4/6	high	mid	shower curtain, sofa	Like busy patterns on large spaces, then you can have simpler minimalistic style in the rest of the room. It is not dizzying any way it is clearly orange and blue it is easy to imagine these darker hues with white surroundings.

#	Participant's characteristic	Swatch	Munsell Code	Density Level	Contrast Level	Objects	Reasons
22	20 Female Graphic Design		5BG 6/12 5R 6/4	mid	high	blanket, notebook	The colors are fun and feminine, so a lot of women will use it as a throw over blanket on a sofa or something. And use it like a stationary with a pretty pattern. If it was different colors the patterns would look cool on a bathroom tile. Pick two different one busy and one medium, like busy for larger object the other with more open space and open hues for smaller object.
23	19 Female Graphic Design		5G 4/2 5RP 6/2	low	high	quilt, wallpaper	Like how the colors work together, which are muted colors. Simple pattern makes the soft color look interesting.
			5BG 6/12 5R 6/4	mid	high	wallpaper Tile in a kitchen	Colorful. the color caught my eye. Bright color and interact pattern make the color and pattern complement each other really well.
24	20 Female Graphic Design		5YR 4/10 5B 4/6	high	mid	sofa, apparel	Like the way that color that pop out of each other but not hurting your eyes but a pleasing amount. The color is more subtle, the pattern more intense. But it still looks nice because of the color choices.
			5BG 7/12 5R 6/12	low	low	notebook, tile	The contrast between the red and blue makes each one pop but not too much for the eyes. Brighter hue is good to have simple pattern.
25	22 Female Graphic Design		5G 4/2 5RP 6/2	low	high	tile, wall art	Like muted tones a lot. Like the patterns because they look that just enough but the other ones are too busy to me, but this have more space to breath. A really cool sofa.

#	Participant's characteristic	Swatch	Munsell Code	Density Level	Contrast Level	Objects	Reasons
25	22 Female Graphic Design		5GY 2/6 5P 4/6	low	high	pillow, interior fabric	Like green and the two colors complement each other really well. Either one could be a cool fabric. Picked the same colors? Yes, but I think it has a lot to do with the pattern. Like the first one better but if the second one will be the reverse it would be much better. Like the darker tones. The high-density would work with big objects much better. The colors are work together but not blend. So, the bigger object would not be very dense. Also, the scale of pattern.
26	34 Female Graphic Design		5GY 8/10 5P 8/10	low	low	accent pillow, notebook	Because it is bright and cheery. And the pattern is soothing to me. Like the high-contrast the green in particular.
			5BG 6/12 5R 6/4	mid	high	pillow, tie, blanket	My two favorite colors. Also, men tie even if the colors are feminine. Anything in my house. Like the contrasting colors and the shape in particular. The negative spaces are very nice. For both of them I thought first about the colors.
27	22 Male Art		5G 4/2 5RP 6/2	low	high	wallpaper, notebook, blanket, carpet	It can be incorporate in any kind of form this specific color. Color contrast dark greenish with purple pink attracted me. Like the simple pattern, easy to see. First, I attracted to the colors.
			5Y 3/6 5PB 6/6	high	high	notebook, wall art	Complicated but interesting and unique with these colors. Like purplish color, seem unique and I liked the texture. If this was on a carpet or blanket or any big object, this would be too much.

#	Participant's characteristic	Swatch	Munsell Code	Density Level	Contrast Level	Objects	Reasons
28	18 Female Interior Design		5RP 7/12 5G 7/12	mid	low	pillow, notebook	Like the green and pink together, bright colors that catches my eyes. Like the pattern, geometric, diamond, floral patterns. For small scale objects, busy pattern with bright colors makes it really exciting.
			5G 4/2 5RP 6/2	low	high	wallpaper, blanket	Gray on the background with pink bringing out give depth. Like the simple diagonal patterns. Which make it looks different than the other one. For big scale objects, calm colors with very simple pattern makes you look calm in the room.
29	20 Female Graphic Design		5BG 6/12 5R 6/12	high	low	mug, notebook	High-contrast, very bright and pop out to my eyes. And like colors as well. Goes with smaller scale because the colors are overwhelming. Instead of the entire coach.
			5G 4/2 5RP 6/2	low	high	sofa, tile	Like soft colors, both pretty gray, see in bigger scale. More spread out than the other one, which helps to focus on the pattern. Look more repeated line. The line helps to move the eye, so it is good for bigger pieces.
30	27 Male Graphic Design		5BG 7/12 5R 6/12	low	low	surfboard, Christmas gift	Beach resort kind of color or any type of advertising like surfing purpose like surfboard, or Christmas gift wrap because of the blue that almost looks like green. Valentine day stuff. Very beautiful.
			5YR 4/10 5B 4/6	high	mid	carpet, sofa, notebook	Busy pattern for big object. Like the color palate. Dark orange and blue.

APPENDIX I CONSENT FORM

Consent Form

Title of Research Study: The Influence of Pattern density and Color Contrast in Color Preference

Researcher: Shuruq Nahhas

Supported By: This research is supported by University of Minnesota.

Background Information

You are invited to participate in a research study that focuses on examining the influence of two variables that related to color and pattern in color preference, which are contrast and density. These two variables interact together differently based on their levels and change the appearance of colored patterns as seen on a square swatch or an object.

Participation and Procedures

You were selected as a possible participant because you are a design student at University of Minnesota who is taking a class that related to either pattern or color. We are expecting 30 students to take a part of this study. If you are interested in this study you will take a part of an experiment of two stages and an interview. The researcher will explain verbally the tasks of each stage prior the experiment. Then, you will be asked two questions for the interview. You will spend 5-10 min to do the tasks and answer the interview questions. The researcher will collect your responses and record your thoughts.

Compensation

If you agree to take a part of this study, we will deposit \$5 in your Gopher Gold account for your time and effort.

Confidentiality

Your answers and opinions will be kept confidential. No individual will be named on the evaluation or interview sheets, as well as any reports or presentations. Final reports and presentations will not include any information that would identify a participant. Written permission will be secure before any records or photographs are taken. I would not take photographs of the people, only of the swatches if needed.

Consent Form

My signature below documents that the information in the consent document and assent process and any other written and verbal information was accurately explained to, and apparently understood by, the participant, and that consent was freely given by the participant.

Signature of participant

Date

Printed name of participant

Signature of person obtaining consent/assent

Date

Printed name of person obtaining consent/assent