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THE EFFECT OF APPLYING ESTABLISHED COLOR THEORY TO PACKAGING WHEN VISIBLE PRODUCT AND EXTERNAL LABELS EXIST SIMULTANEOUSLY

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THE EFFECT OF APPLYING ESTABLISHED COLOR THEORY TO PACKAGING WHEN VISIBLE PRODUCT AND EXTERNAL LABELS EXIST SIMULTANEOUSLY

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ABSTRACT

Color is affected by what is around it. A color doesn't necessarily look the same when its placed against two different colored backgrounds (Ryan, William, and Theodore Conover, 2004) Oftentimes, designers are given a blank package and given the task of creating a label or package for the product. What is missing is the product, which can be an integral part of this design process. What is not yet to be determined by current packaging research is how colors work together through the product and package. One way to determine this would be through transparent bottled packages that contain external labels. Using various color harmonies, with the base color determined by the product color, this can be evaluated.

Transparent packages with visible products containing colored labels were evaluated using established color theory. This research sought to understand the following questions:

[RQ1]: Can established color theory be applied to packaging when visible product and external labels exist simultaneously?

[RQ2]: Do consumers prefer a particular color harmony when compared to others?

This was assessed using eye tracking metrics and overall preference testing. Eye tracking data yielded quantitative data that was statistically analyzed. This was completed through analysis of variance (ANOVA). A post experiment survey was given to collect participant's demographics and additional data completed through Chi-squared tests for association.

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CHAPTER ONE

INTRODUCTION

Packaging can be broken down into two basic components, where one is graphic and the other is structural. Graphic components include color, typography, graphic shapes, and images. Alternatively, structural components include shape, size, and materials (Ampuero & Vila, 2006). This research explored the relationship of these two facets of packaging through the use of established color theory. Combining labeling, which is a graphic component, along with visible product, which is a structural component, a methodology was established to combine the elements and evaluate with eye tracking technology.

"Color Preference does not exist in a vacuum; rather, color preference for particular objects or settings is developed by the situation and the underlying associations people may have developed" (Grossman & Wisenblit, 1999). This research seeks to understand color within packaging and its effect on consumers purchasing. Additionally, it looks to establish how the color of a label design is viewed with a visible product color. This work evaluated five color harmonies within three product categories and explores trends within 107 participants. Within this research, quantitative preference and eye tracking metric data were evaluated to seek developments between existing color harmonies and labeling

Statistical analysis was used to compare eye tracking and preference data among the participants. Specifically, ANOVA and Chi-Squared tests evaluated this data that was collect through survey data and eye tracking software. Post-hoc, demographic data collected during the study was compared to analyze any additional trends. The goal of this research is to determine guidelines for designers, as the history and theories on color and color harmonies are vast.

CHAPTER TWO

REVIEW OF LITERATURE

Packaging Design

Primary use of a package is to protect its contents while designing an easy to open and ship container. Additional goals for packaging include attracting consumers' attention as well as become a component of a product's brand guidelines. Each of these items are the consequence of package design. The packaging is what attracts you to a product when you first view an aisle. Attractive packaging at the point of sale will help consumers to quickly make decisions in the store (Silayoi & Speece, 2004). The designers' responsibility also includes the thought and consideration of a safe arrival in store. Successful use of these components result in consumer demand and increased shelf space, which is vital in the competitive market of today (Drew & Meyer, 2008).

Packaging can be divided into two basic categories: logistics or marketing. Logistical is in regards to protection while marketing is in regards to attractively conveying a message at the point of sale (Prendergast & Pitt, 1996).

Color and graphics are part of the "marketing in the retail outlet" segment of the supply chain. These challenges include attractive design, which can be considered the "silent salesman" (Rundh, 2009). In simple terms, packaging is the primary contact that contains the product itself which holds, protects, preserves, and identifies (Ampuero & Vila, 2006).

Since only one third of women shoppers and slightly fewer men buy food products that they are familiar with or have habitually purchased (Groves, 2002). The opportunity to have a consumer make a decision based on appearance at shelf is great.

Packaging Design and the Influence on Consumers

In general, visual elements of the package influence choice of the product to a great extent, and graphics and color are frequently the major influence. Attractive packaging generated consumer attention by breaking through the competitive color (Silayoi & Speece, 2004).

Figure 1 below illustrates the various influences of packaging elements that are taken into consideration during a purchase decision. These include the combination of visual elements and informational elements. Visual elements are described as various graphics, as well as the shape and size of the package. On the other hand, informational elements are described as product information and various technologies that are included within the package design. Time pressure and the involvement level of the consumer compound each of these considerations.

The consumer dictating the length of time to make a purchase decision establishes time pressure. When consumers are under time pressure, decisions are easier when they have simpler, straightforward information (Gofton, 1995). This is valuable for designers when establishing graphic and color guidelines. Involvement level is how invested the consumer is in the purchase. This can also be viewed as whether the purchase is a low or high risk for the consumer. For example, a low risk/ low involvement item may be a new type of cereal, while a high risk/ high involvement item may be new toothpaste. However, evaluating this risk and involvement varies based on many external factors. FMCG's (Fast Moving Consumer Goods) are now known as low risk. The consumer does not spend much time searching or deciding on which brand to buy. Oftentimes, it is easier and less time consuming for the buyer to choose what they are familiar with, in which brand loyalty comes into play (Chaudhuri, 2000). Consumer use of packages is important with low-involvement products that have a low level of concern for purchasing because it is low risk (Silayoi & Speece, 2004). Visuals evoke more of an emotional response.

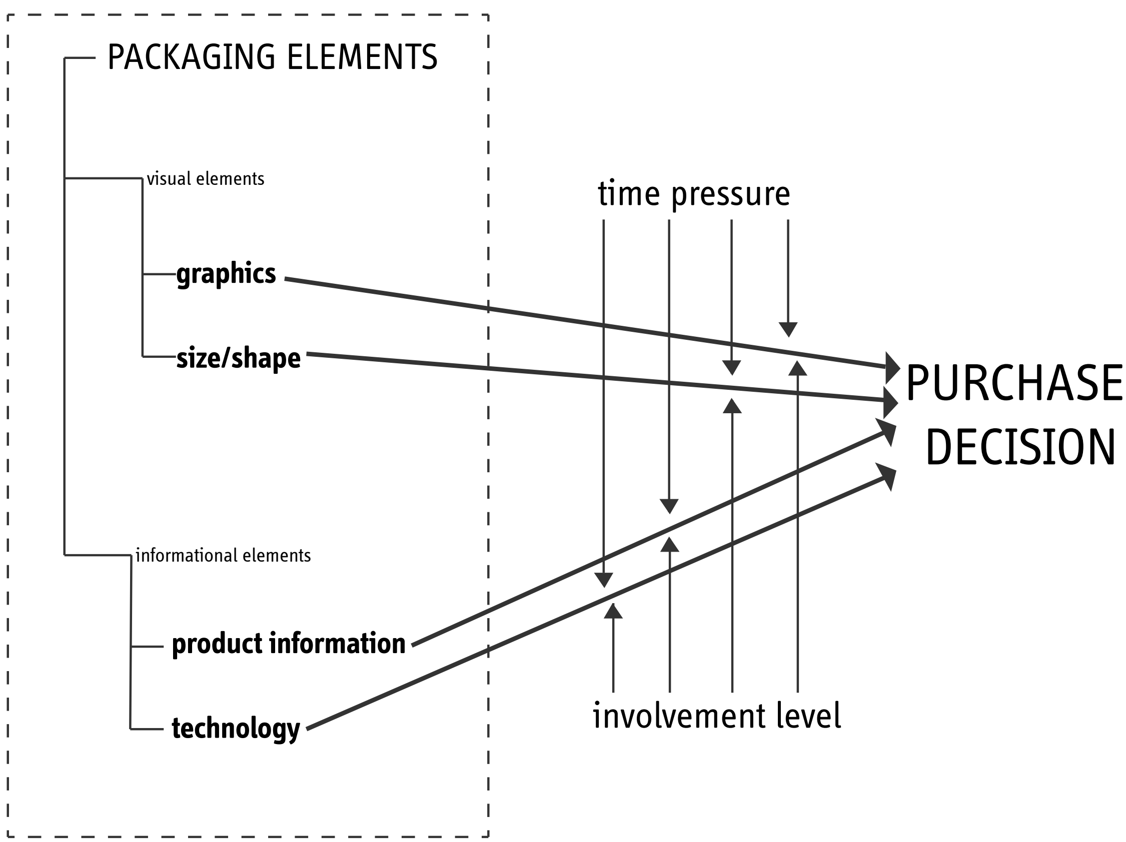


Figure 1: Purchase Decision flow chart devised from Silayoi & Speece

Graphic and packaging design can also be employed to increase awareness of certain claims. Mufano, et al devised a cigarette packaging study comparing existing packaging to that with standardized shape, color, and method of opening with all branding removed was compared to existing cigarette packaging. On the plain packages, the brand name remains with a standard typeface. On both packages, the health warnings were added. The hypothesis was that the plain packages would make the warnings more prominent, with measurement being the time of viewing on the two packages. Ten plain packs versus ten branded packs were used for this study. Plain cigarette packaging increased visual attention towards health warning information for non-smokers and non-established smokers. For regular smokers, no significance was found (Munafò, Roberts, Bauld, & Leonards, 2011). This study establishes an opportunity for exploring how packaging and graphics are shaped by their surroundings in regard to consumer preference and attention.

The aspects of a packaging design are very important to the successful marketing and sales of a product. A study conducted in the UK with fifty participants explored twenty-seven package design combination. This included various label fonts, medallions, pictures, and taglines. The consumers were asked to rate the packages based on purchase intent as well as an emotional attachment to the package, which was completed using a scale. The results suggested that consumers preferred larger fonts, while overall simple medallions were chosen most frequently. Additionally, the study found that females were far more responsive to visual elements than males.

The importance of packaging design as a whole has been studied in many capacities. However, it is important to regard each aspect being evaluated as its own component. In many cases, research has shown that color has a very high influence on consumers purchase decisions. Color as a whole is a very broad ranging topic and must be considered as such.

Color Theory

"The color literature is vast and highly fragmented. No underlying theory of color in marketing has yet been advanced" (Grossman & Wisenblit, 1999). Color is a phenomenon with much historical context and background. Its complexity is explored through many environments such as art, design, nature, and many more. Color theory, as a topic in general, is broad and wide ranging. For the scope of this research and experimental design, an abbreviated basic color theory history and applications were objectively explored, with a focus on color harmonies and their practical applications.

Color has been explored historically for many centuries. Spanning across multitudes of disciplines beyond art, Plato and Aristotle's views on color were known throughout the Renaissance. The late eighteenth centuries and into the twentieth centuries gave birth to a new philosophy of color regarding the pursuit of a color-order system as well as a set of rules concerning harmony of colors. During this time period, the knowledge and investigation of color expanded greatly. Today, we regard this collection of works and studies as Color Theory (Holtzschue, 2012). It can also be noted that no work regarding color and theory can be viewed as unbiased, and it is best to explore each contribution as a piece of a larger set of theories.

Isaac Newton was first to hypothesize the nature of light and the origins of color (or how color is perceived). This conclusion that light alone generates color is widely accepted and is known as a basis of modern physics today (Newton, 1704). From this knowledge, a seven-hued color wheel was established, which was widely accepted and is still used today.

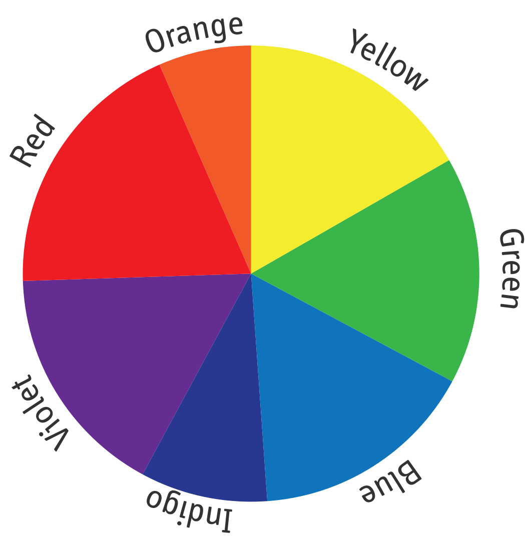


Figure 2: Abstracted re-creation of Newton's seven-hue color wheel

Alternatively, Joann von Wolfgang Goethe viewed colors in a less mathematical sense. His opinions were wide-ranging with many implications. In a less concentrated sense than Newton, Goethe views were more like open dialogue and treatises than one particular theory. His most fundamental and possibly most widely used contribution to color theory is the six-hue spectrum that is also known as the artists' spectrum. This includes red, orange, yellow, green, blue and violet (Goethe, 2006).

Figure 3: Abstracted re-creation of Goethe's six-hued spectrum

This six-hue spectrum of Goethe remains the standard for artists. It is viewed as simple and familiar for artists. Newton's seven-hue model established the scientific spectrum (Holtzschue, 2012). These theories were later expanded- most notably by Alber Munsell (Munsell Book of Color, 1915) and Wilhelm Ostwald (Color Atlas, 1919); all followed by German Bauhaus contributors Johannes Itten and Faber Birren. Combinations of these theories are what have given us a variety of color spectrums. Today, many terms are used when communicating about color and its attributes. Ryan and Canover describe the following vocabulary:

Hue- derived from ancient gothic work kiwi, which means, “to show.” This term is interchangeable with color. Typically, the name we use to describe a color is its hue.

Tone/value- variation or relative lightness or darkness of a hue

Shade –addition of black ink to a hue creates a darker shade

Tint- addition of white into a hue creates a lighter tint

Chroma- indicates the intensity of a color and is determined by the amount of pigment saturation in the ink that produces the color. Increasing a color’s Chroma boosts its intensity. (Ryan & Conover, 2003)

Color Harmony

Stimulus color contrast as an aspect of visual perception states that colors that are viewed are not seen in isolation, but affected by what is seen around them. More specifically, that a color’s hue, value, and intensity appears on an adjacent color and vice-versa. Among complementary colors, this relationship is more evident. This theory was first explored by Michel Eugène Chevreul (Chevreul, 1855). This theory establishes ground for the exploration of combining colors and their effects.

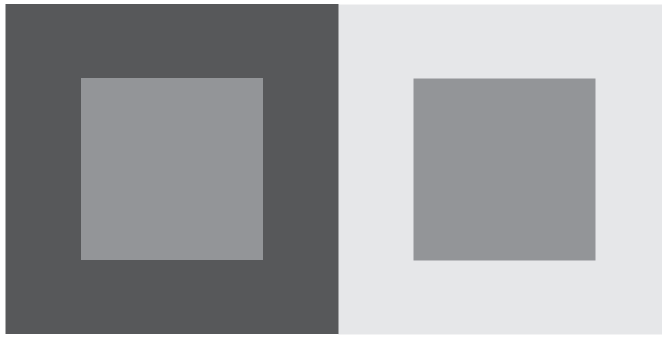


Figure 4: Example of Simultaneous Color Contrast where the interior grey squares are the same color, but appear dissimilar when surrounded by two unlike colors

Within color theory exists a facet of research and principles regarding color harmonies. Burchett defines color harmonies as two or more colors brought together to produce a satisfying affective response (Burchett, 2002). Many definitions and meanings surround this term, leaving some aspects up to interpretation depending on situation and context of experimentation.

According to Ryan and Canover, there are five basic color combinations that have been devised to maintain color harmony. This text also outlines the characteristics of each harmony. These five also correspond to ColorMunki ColorPicker (X-Rite Grand Rapids, MI) software guidelines.

Monochromatic- the simplest color harmony which is constructed from different vales of the same color.

Analogous- two colors that are immediately adjacent to one another on the color wheel, such as blue and green

Complementary- two colors that are positioned directly across the color wheel from one another are used, such as red and green. Complementary can also be called contrasting

Split Complementary- Similar to complementary, with the exception of using the color next to the complement for the second color rather than the color itself. An example of the split complement for red would be blue-green or yellow-green.

Triad- combination of three colors, each of which is at the point of an equilateral triangle superimposed on the color wheel (Ryan & Conover, 2003).

The nature of this experiment sought to use established color theory to determine a set of color harmonies that could be simulated and reproduced. This was completed in order to gain insight into the preference of consumers viewing these harmonies. Understanding of basic color theory and harmonies along the software at hand drove a method (see *Materials and Methods),* which created a system of harmonious color generation. Although other types of color harmony theory and generation could be applied, it is important that regardless of the theory behind the method of simulation of color harmonies, that it remain constant throughout experimentation.

Product Visibility

Primary, secondary, and tertiary levels can categorize the majority of packaging (Ampuero & Vila, 2006). Primary packaging is in direct contact with the product, while secondary contains this primary package. An example of this is a bottle of lotion (primary) that is placed inside a paperboard box (secondary) on the shelf set. Tertiary is an additional level beyond this which may include shippers and boxes for many products.

Each of these levels of packaging provides opportunity for product visibility. This applies to a clear bottle which displays the product, such as shampoo, or a paperboard box displays this bottle through this use of a window. This particular facet of packaging has been studied previously in regards to consumer preference based on exposed product window size (Hurley, Galvarino, Thackston, Ouzts, & Pham, 2012)

Primary display panels (PDP) on packages make up the majority of opportunity for designers to grab consumers' attention. The PDP is the area of a package that the consumer sees while looking at the shelf, as seen in Figure 5. This space becomes very valuable when communicating to the consumer. Ninety percent of shoppers make a purchase after only examining the front of the packaging and without having the product in the hand (Clement, 2007). Knowing this, designers rely on the PDP to be the main communicator to the shopper, therefore it must be straightforward, eye catching, and informative.

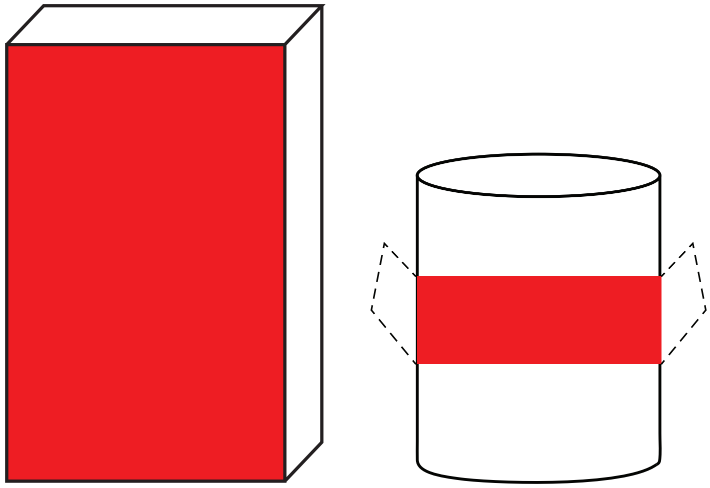


Figure 5: Primary Display Panel shown in red

Many PDPs are decorated with labels; therefore the PDP is defined by the label's size, since this is the area that will be available to communicate to the consumer. In this case, designers have less space to utilize design. However, this leaves an opportunity for more product visibility, depending upon the material of the pack. If the pack is clear and the product is visible, then label is the primary decoration, while the product works as a background for the label. This gives designers an opportunity to use the visible product as a factor when designing the label.

External Labels in Packaging

Products with external labels, meaning labels applied to the primary pack, are the source of information and communication regarding contents and usage. Additionally, these labels serve as the touch point for marketers to encourage sale (Nancarrow, Len Tiu, & Brace, 1998).

The Nutrition Labeling Education Act (NLEA) of 1990 guides food labeling today, after voluntary nutrition labeling regulations in 1973. The result of this act was to control nutrition information on almost all food products. Goals to remove confusion and increase accuracy for consumers, and is regulated by the FDA (Derby & Levy, 2001). Included in this act is per serving information, nutrient reference values, as well as nutrition labeling. Also established are the standard definitions for using the terns "low," "reduced," and "lean." This regulation, along with the advancement in technology and use of bar codes, led to the increase in label use.

For most containers, labels are the main decoration method (Burke & Jones, 2000). Labels have been used since the 19th century to identify drugs. Labels have progressed in many ways since then, mainly due to the increase in literacy. Also, the growth of consumerism and development of new products lead to the need to differentiate for consumers' purchase. In turn, promotional value of products such as beer, wine, matchbooks, food and medicine increased (Hanlon, Kelsey & Forcinio, 1998). Today, label use has increased and in turn, the technologies available have developed to become easier for mas production in the packaging workflow.

The variety of labels available today is vast, while the most common materials are paper and plastic films. Material of labeling dictates many aspects such as print quality, printing adherence, cost, quantity, and printing procedure.

Roll stock labels are large quantity and typically consist of paper or film. Variety of roll stock can include self-adhesive labels, or labels that must be wet glued. The process includes printing the label and then placing onto a rotating bottle in the line. The cutting machine uses an eyespot on the label to signify where the label is to be cut. Most printing processes are available for roll stock labels.

In a study conducted in the UK, six various packs of orange drinks were evaluated by consumers, mainly focusing on the labeling and communication of information. In this setting, a moderator discussed purity of product, interpretation and appeal of verbal and non-verbal pack characteristics, and sources of confusion. Each of these traits was present on the labeling of the packs. Overall, the moderator searched for cues from the consumers regarding good design practice. The findings included color of the pack, along with lettering, and brand, led to judgments of purity (Nancarrow et al., 1998).

According to a Mintel study in 2011, the importance of packaging label characteristics were:

1. Simple, easy to read, without clutter
2. Can identify if the product is "All Natural"
3. Nutritional content
4. Can Identify if the product contains high fructose corn syrup
5. Can identify the products ingredients in regards to allergy information
6. Seal of approval from a legitimate association
7. Environmentally friendly materials

8. Interesting graphics/design (Mintel, 2011)

These characteristics show the significance in labeling for consumers. Consumers desire a label that contains all of the essential information, while portraying an interesting graphic and design.

Color in Packaging

Motion graphics and web design are examples of graphics viewed in a two dimensional digital space. Package design and print based graphics are viewed in three dimensional color spaces, which makes accurate color rendition more complex and often difficult to achieve. Although technology has advanced in this area, it is still valuable for designers to become educated on the new equipment, technology, and standards (Drew & Meyer, 2008).

Marketing professionals use color consultants to determine product colors that appeal to their market. An example of this is Igloo Products who had a fifteen percent sales increase to their new colors (Laney, 1991). According to Tripplet, automobile market changes 30% of their colors each year and think ahead three to four years about trends of colors (Grossman & Wisenblit, 1999).

Color can evoke an emotional response when used purposefully, and can also capture the attention of a viewer as well as increasing the time spent viewing the stimulus. Using color also significantly increases impact and retention. In advertisements, color ads are fifteen times more effective than those utilizing black and white. Use of color is 36% higher impact than black and white. The Newspaper Association of American reported that four-color ads are seen twenty percent more than black and white ads, while seen thirteen percent more frequently than two color advertisements (Berman, 2010). According to this data it can be argued that more color creates more views, and time spent viewing. This theory for advertisements could lead to similar trends in packaging.

Favorite color is not independent of the object, and different color preferences exist for various products (Grossman & Wisenblit, 1999). In packaging, color adds memorability. This can be noted through brand recall, which many consumers are familiar with while in a shopping environment. Faber Birren found that people recalled colors more readily than shapes when testing people with different shapes in various colors (Berman, 2010).

Within a graphic design context, practical and effective use of color is fundamental. Using color creates standout and distinction for packaged products. In packaging design, materials and shapes are essential for success. Color, however, "is a force that holds a package together and acts as a conduit to engage and transfix the buyer." Color is known to communicate well beyond the scope of the product, and even so much to be the main selling feature. The ability for color to transform, translate, and add meaning to messages should not be ignored in the package design context (Drew & Meyer, 2008).

Texture and graphics are other variables aside from structure and form that can be modified and contribute to a package that is successful and, according to Rundh, "graphics are becoming a vital tool in modern marketing activities." Packaging is the last point of sale for the company before the purchase decision is made and the combination of shape and color in graphics aids in evoking the emotional appeal necessary for persuasion of purchase (Rundh, 2009).

Associative learning describes how consumers learn color preferences based on associations. Consumers learn that certain products are from certain color categories, thus always associate that color with that product (Grossman & Wisenblit, 1999). This phenomenon highlights the importance of how product colors are usually stable based on category while the designer has the opportunity to alter the label design or color scheme.

According to marketing researcher Patricia Roderman, color is the single most important factor for people when making purchase decisions. Here we can learn important marketing and packaging lessons.(Ryan & Conover, 2003). Jan White recognizes that the purpose of color is to enlighten, not dazzle the audience. It is noted that designers should use color logically and creatively to simplify the message at hand to the viewer (White, 1997). Additionally, "evaluation of attributes is less important in low involvement decisions, so graphics and color become critical" (Grossman & Wisenblit, 1999) where low involvement decisions are determined by low risk purchases for consumers.

Use of Color

One way to use color is through the use of spot colors. A spot color technique is done through adding a single color to the basic color, which is generally black (Ryan &

Conover, 2003). This is a simple and cost effective way to use color. Typically, using more colors when printing raises the cost of production.

When printing, using one and two color options create budgetary constraints, while limiting the number of hues that can be used. This requires a greater level of creativity from designers. This creativity can stem from other outlets such as three dimensional form and packaging structure, typography, image making, composition, and conceptual development. One and two color package designs are underutilized for high-end design, but can create prominent visual separation on shelf (Drew & Meyer, 2008). Because of this, designers should consider this strategy when new designs and campaigns are developed.

A more rare type of work is three-color package design. Although less expensive than four color processes, the cost-benefit may be negligible. As with two color package designs, this strategy must also work in tandem with shape, imagery, typography, and complete concept. Without considering the relationship between using three color processes and the overall design, an inexpensive appearance may be created. On the other hand, this process can create a high level of hue flexibility (Drew & Meyer, 2008).

Four color package design is rarely used due to the fact that there is typically a flood of varnish, which makes the job five colors. Many times, four color process will be combined with a flood varnish, spot varnish, and one or two spot colors. Four color packaging today has grown tremendously with the globalization and advancements in new technology (Drew & Meyer, 2008).

Color Harmonies in Packaging

It can be deduced that color is an integral part of a branding scheme, and that it is the major factor of attention by consumers when shopping. Noted is also the importance of the effects of colors when used together. Color harmony is an integral aspect of color theory, but its application when used in packaging design is very critical. More critical than the impact and connotation of color is the combination of colors (Berman, 2010).

The effect of color on humans is very complex and powerful, and designers may tailor color to evoke a more meaningful response than the color signifies on its own. However, this is not always possible when designing for the masses (Drew & Meyer, 2008). This implies that the use of color may vary for each individual design for each product, but is not always possible. Thus, it may be beneficial to find trends in use of color that appeal to many consumers. According to Burchett, “Color harmony in the broadest of terms relates to the visual appeal of colors that are used together” (Burchett, 2002).

Color is affected by its surroundings. The same color does not look the same when it is put against two different colors. A smaller space of a warm color will dominate a larger space of a cool hue. This is attributed to the fact that warm colors have more projection and can appear more dominating while the cooler color falls into the background (Ryan & Conover, 2003). Combinations of colors may have different effects than only one color alone (Davidoff, 1991).

When combining colors, it is essential that the designer is aware of the effects of certain color combinations. An example of this is the phenomenon of vibrating type which occurs when colors seem to electrified of moving when viewed. Most commonly, this happens when colors of the same intensity and vibrancy appear adjacent to one another. Some examples are:

Red and orange

Red and neon green

Red and bright blue

Orange and hot pink

Orange and lime green (Berman, 2010)

Color Value Differentiation (CVD) is a theory that the more contrast of colors, the more pleasing the combination, which applies to both men and women. This theory can not be used on its own, as compositional balance is also integral in creating a pleasing CVD. The greater the CVD, the greater the kinetic energy within the composition (Drew & Meyer, 2008).

Originating in 1977 by Hutchings, a term defined as “total appearance” describes the effect that environment has on color perception. More specifically, combining aspects of an object’s shape, size, and environment with the materials appearance (Hutchings, 1995). This theory establishes the idea that every material gains its appearance based on its environment and other external factors. This is important when considering how the consumer in differing environments evaluates package design. For example, the package may look different on a grey shelf versus a white shelf even though the package is identical.

Using color harmonies in packaging design can be beneficial by creating shelf standout and differentiation; however, little research in the packaging design field regards color harmonies within products and packaging.

Research completed by Bix, Seo, and Sundar explored the relationship between color harmonies and product color. This was completed through evaluation of consumer preferences (purchase intentions) as well as visual appeal, this was gauged with the use of a Likert scale by using images on a screen (stimuli) with a head mounted eye tracker. This experiment specifically investigated the relationship between the color of produce and produce mesh bags. Using various colored mesh bags, the colors between the produce and bags were regarded as color harmonies. Same (analogous), complementary, and complementary-analogous schemes were used. These color contrasts were found to have a significant effect on number of visual fixations and time spent on each stimulus. More visual fixations and more time spent occurred with same or analogous colors versus those with complementary or complementary- analogous colors (Bix, Seo, & Sundar, 2012).

Suggesting that simultaneous contrast has significance for many aspects of packaging design, this study has shown that expanding this awareness outside the scope of produce may yield other findings. Product/package color harmonies can be evaluated where there is any type of exposed product or windows. An example of such could be toys, shampoo, snack foods (Bix et al., 2012) and many others where consumer preference and quality could be explored utilizing the above techniques in method.

Eye Tracking for Evaluation

Beginning in the late 1800's, eye tracking has been used by psychologists and physiologists. At its infancy, the process was very intrusive and uncomfortable (Gofman & Moskowitz, 2009). However, new advancements have created a new competitiveness for eye tracking equipment and software.

As the availability of technology has grown, many marketing agencies use eye tracking computer software that follows eye movement of test subjects. This can allow researchers to determine the influence of package design when it is placed on virtual shelf (Drew & Meyer, 2008). This technology is a manner in which to gather quantitative consumer data. Traditionally, many researchers have used surveys, questionnaires, or focus groups to determine consumers' preferences.

Eye tracking research spans across many formats including: television advertisements, billboards, product packaging and web sites. Most simplistically, it is used to determine what "works" for companies (Gofman & Moskowitz, 2009).

When observing the cognitive processes, it is important to remember that these processes cannot be observed directly. Instead, we look towards the gaze pattern behavior to receive insight. It has been noted that people do not randomly view a package, but visually search in a methodical fashion. Within gaze patterns, fixations occur when the eye is stable for an average of 200-300 milliseconds. Without eye tracking, collection of this data would be extremely difficult, considering the average person has over 150,000 different types of eye movements per day (Pannasch, Dornhoefer, Unema, & Velichkovsky, 2001).

Eye Tracking has become important to designers and marketers alike. The technology has grown to become a way to collect quantitative data about consumers shopping behaviors. Using this data, researchers can connect what catches a shoppers attention and how to design using those considerations.

CHAPTER THREE

MATERIALS AND METHODS

Objectives

The purpose of this research is two-fold. Primarily, it seeks to determine if there is a significant difference between participants' preference of color harmonies. This will be completed through assessment of exposed product and external label design. Evaluation of overall preference, as well as evaluation between each harmony will be measured. Secondly, determination of a significant difference between eye-tracking metrics, including total fixation duration and time to first fixation between harmonies, will be assessed. This data will be collected through the use of eye tracking technology. Additionally, demographic and preference data was collect to test for independence. This was completed using Chi-Squared tests for association.

Participants

This study had a total of 118 participants (65 males, 52 females; ages 18-64) who were registered attendees of PMMI (Packaging Machinery Manufacturers Institute) Pack Expo 2013 in Chicago, Illinois, held at the McCormick Place Convention Center. This study ran over a three-day period. Clemson University's booth was staged as a shopping mall environment with various stores. Each store contained a separate, unrelated study.

No incentives were given to participants, as they approached the experiment voluntarily. Each participant was given a unique number for reference purpose so as to remain anonymous. The participants were informed that they were free to exit the study at any time. Also, each participant was required to read over a consent form stating that the study had no known risks.

The study was promoted through various media including magazines, web, and advertisements at the convention center. It was advertised as a study completed by Clemson University's Packaging Science Department.

Materials and Apparatus

A Tobii T60 XL Eye Tracker was used to collect participants' eye movements as well as preferences. This monitor is a high-resolution, 24-inch wide screen, with a 1920 x 1080 pixel display. The eye-tracking processing unit is embedded within the screen, creating an unobtrusive environment for the participant. It is a binocular system with a sampling rate of 60 Hz and a processing latency of <17 ms.

Figure 6: Tobii T60X Monitor

The data was gathered in Tobii Studio, a software program that collects and analyzes eye tracking data. This software was previously installed on a laptop computer, which was connected to the Tobii T60 XL Eye Tracker. This laptop served as extraction and storage of data from the eye tracker.

i1 Display Pro Screen Calibration Software was installed and used on the Tobii Monitor to calibrate the display each day. This was to ensure that each day the colors were accurate and consistent.

ColorMunki ColorPicker Software, a web-based application, was used in stimuli generation to determine color harmonies based on product color. This was extracted and applied through Adobe Illustrator to manipulate the colors of the labels (see *stimuli generation* for more information).

A digital version of the Ishihara Compatible Pseudoisochromatic Plate (PIPIC) Test was used at the close of the Tobii monitor segment to ensure that the participants were not color vision deficient (see *experimental design* for more information).

Lastly, two separate survey computers were used to gather demographic and follow-up information after the study.

Generation of Stimuli

Creating the stimuli was done in a methodical manner so that each six stimuli would be identically produced. Generating the labels involved Adobe Photoshop, Adobe Illustrator, and ColorMunki ColorPicker Software by X-Rite Incorporated (Grand Rapids, MI).

Within the constraints of visible exposed product with an external label, three products were utilized in this study. Visible exposed product is determined by a package that is clear in nature, so that the product is shown. This type of package has another visual layer, where the color of the product then becomes part of the display. Using three products aided in ensuring that color harmony preference was not directly related to the product itself. Shampoo, dishwashing detergent, and a beverage were chosen. Each had various shapes of the package, but had around 50% label coverage.

Figure 7: Products used with blank labels (beverage, deishwashing detergent, shampoo)

Of each three stimuli, three different colors of visible product were used. A number of studies suggest preference depends on product (Mundell, 1993). For this reason, each product used two different colors. Additionally, the stimuli slides only used one product color per slide. These products were then repeated, using different visible product colors. (For example: the red beverage was then repeated with an orange beverage) This was done to ensure that all primary and secondary colors were represented as a visible product color. Controlling this aspect of the stimuli was required in order to be certain that the color itself was not a factor in the study. The colors of the products were simulated using Adobe Photoshop.

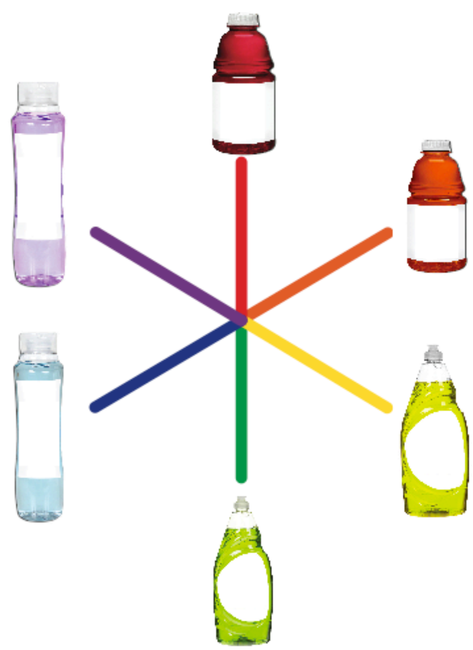


Figure 8: Six visible product colors shown on color wheel

These products with blank labels were then imported into Adobe Illustrator and duplicated five times on a 1920 x 1080 pixel art board. The additional five products were centered and spaced in an identical manner to create consistency. Duplicating them with blank labels was necessary to then add the label art, which contained five various labels, corresponding with each color harmony. The following outlines the process for one set of images label generation, and was repeated identically for the other five products.

Using the Eyedropper tool in Adobe Illustrator, the base color of each product was extracted. The L*a*b* value for this color was noted, and then used in ColorMunki to generate the color harmonies. In ColorMunki, the base color of the product was found in the preset library. Using the harmony function, the color harmonies were determined by the software. The five color harmonies were:

1. Monochromatic
2. Analogous
3. Complementary
4. Split complementary
5. Triadic

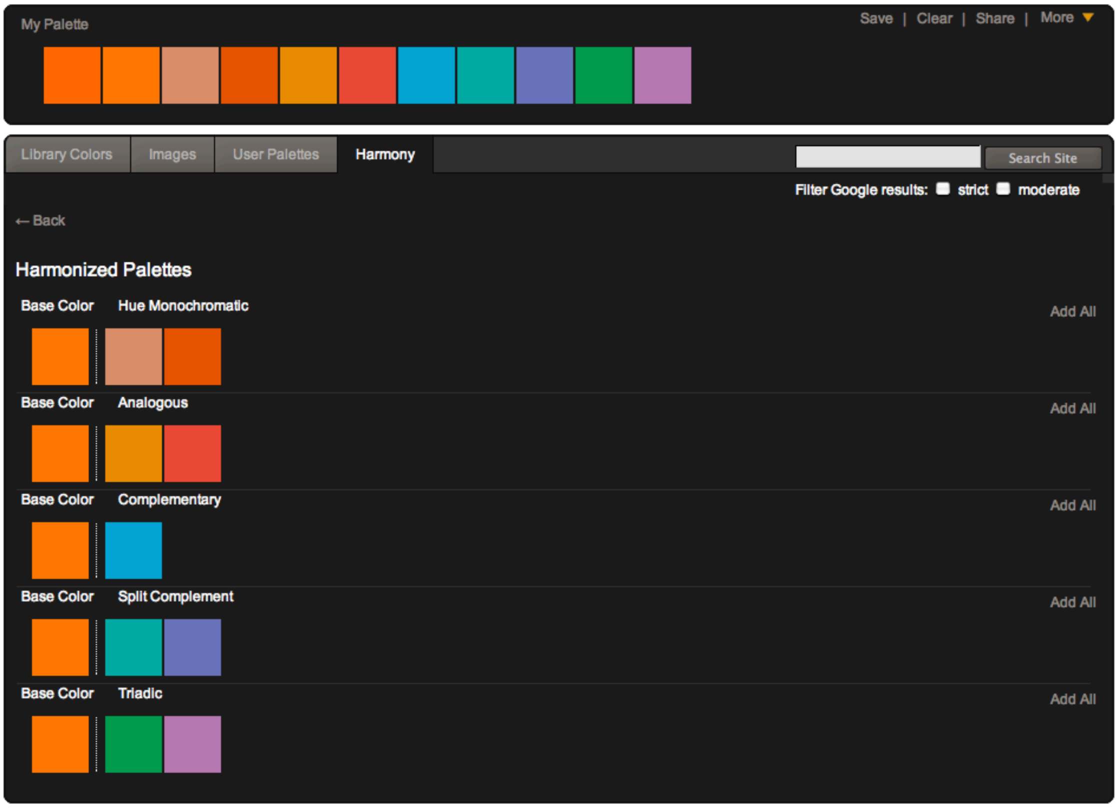


Figure 9: ColorMunki interface determining harmonies through mathematical values

Next, the palette (named "My Pallete") was saved to the software. Using the "more" function, the L*a*b* values were exported into an Excel file. Color swatches were generated in Adobe Illustrator for each of the L*a*b* values. Once all of the swatches were created and saved, the labels could be generated using these colors precisely.

	A	B	C	D
1	Sample Name	L*	a*	b*
2	PANTONE 23-5-1 C	48.9	61.82	47.9
3	7.5R 5/8	50.48	34.47	22.32
4	7.5R 3/12	29.65	52.49	33.35
5	10R 5/14	49.73	53.43	57.17
6	5R 5/14	50.21	57.26	29.81
7	7.5BG 5/10	55.19	-55.76	-9.02
8	2.5G 5/12	51.42	-58.11	33.19
9	10B 5/12	55.41	-27.3	-40.22
10	7.5GY 6/12	60.39	-33.98	68.34
11	7.5PB 4/12	43.87	7.29	-44.63

Figure 10: L*a*b* Values exported from ColorMunki

Employing the Color Munki software to determine the color harmonies ensured a repeatable, unbiased selection of the color schemes employed in the study. Rather than arbitrarily choosing red, blue, etc., as this can be very biased and non-mathematical, using the values creates assurance of accuracy. Replicating this factor for the remaining five colors then becomes identical, regardless of color.

Next, the content of the label was created. In order to exclude brand influence on the participant’s preference, an abstracted, fictional “brand” was created using only shapes. In place of a logo and text, silhouettes were used. Within these shapes, it was determined that the base color would stay constant throughout the five color harmonies (this would change depending on base color of the six products). Color 1 (see figure 11) would then change to one of the secondary colors within the harmony. Color 2 would also change according to harmony. For the harmonies that only have two colors (base + color 1), and color 2 would be treated as color 1, with the base color still remaining constant.

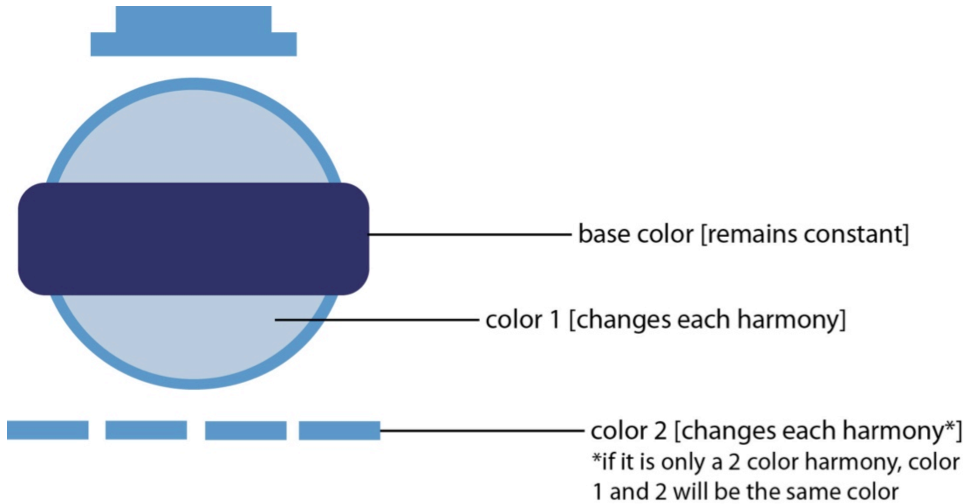


Figure 11: Abstracted label created in Adobe Illustrator for external labels

The procedure for label creation would be repeated for the five other products, using the L*a*b* values from ColorMunki, and altering the colors in Adobe Illustrator on the 1920 x 1080 artboard. Each of the harmonies (monochromatic, analogous, complementary, split complementary, and triadic) would all be shown on the same artboard. This was done for all six products with differing base colors.

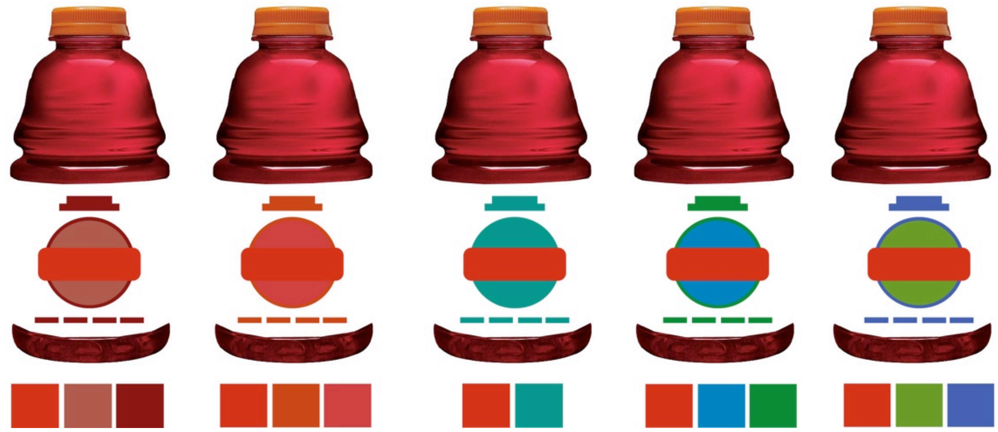


Figure 12: One of six products with labels added through Adobe Illustrator

Final steps in Adobe Illustrator included rotating the stimuli in a Latin Square manner so that the location on the artboard did not influence preference choice for the participants. This step insures counterbalancing of the stimulus, which avoids the participants having learning effects. Since there were six products with five color harmonies each, 30 different scenarios were generated. Special care was taken to ensure that the products, although rotated, remained in the exact coordinates on the artboard when rotated. This was done with the use of the guideline features in Adobe Illustrator. This created a total of 30 stimuli (five products, six Latin square combinations).

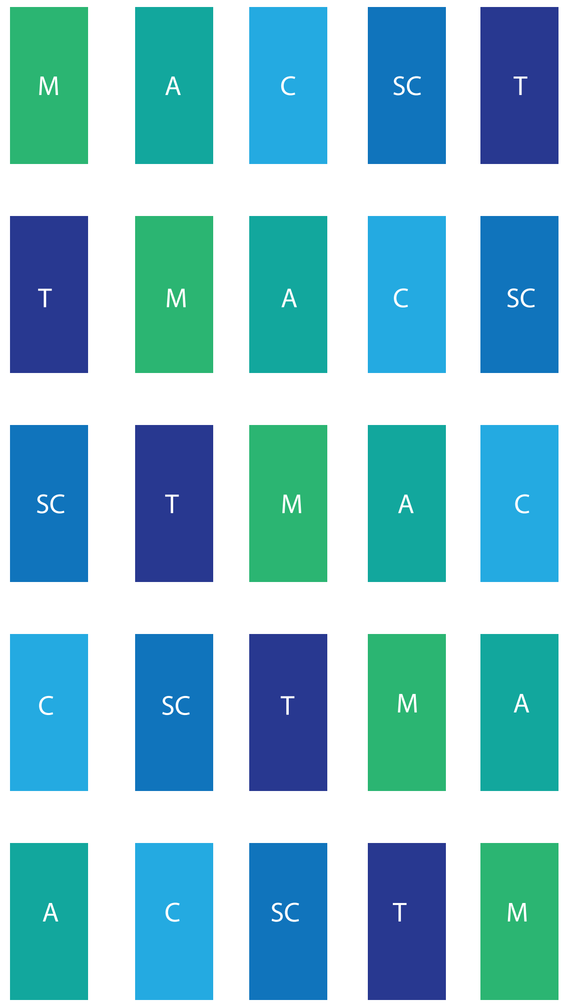


Figure 13: Latin square rotation of stimuli (M= monochromatic; A=analogous; C=complementary; SC= split complementary; T=triadic)

Using the aforementioned procedure for stimuli generation, the stimuli colors were completed on each artboard. Product Images were exported from Adobe Illustrator as .jpg files and saved as a new file. This jpeg was then opened in Adobe Photoshop where final editing was done (aside from color). This included removing any stray marks from the products, as well as creating a three-dimensional look using the “burn tool”. The setting for this tool was noted and kept consistent through all editing.

Once editing was complete, the stimuli were exported as .jpg files. Thirty files total were exported and stored (six products with five variations in rotation of color harmonies). No images were labeled to indicate their color scheme during the study, as this was completed only through file naming. Only the labeled products with white backgrounds were shown to participants.

Figure 14: One of five variations of all six products

CUMart

Within the McCormick Center, Clemson University had a 5,800 square foot exhibition space called "The Packaging Test Track." Here, five various "rooms" were delegated to different, unrelated types of studies. CUMart was a one of these rooms where this study took place.

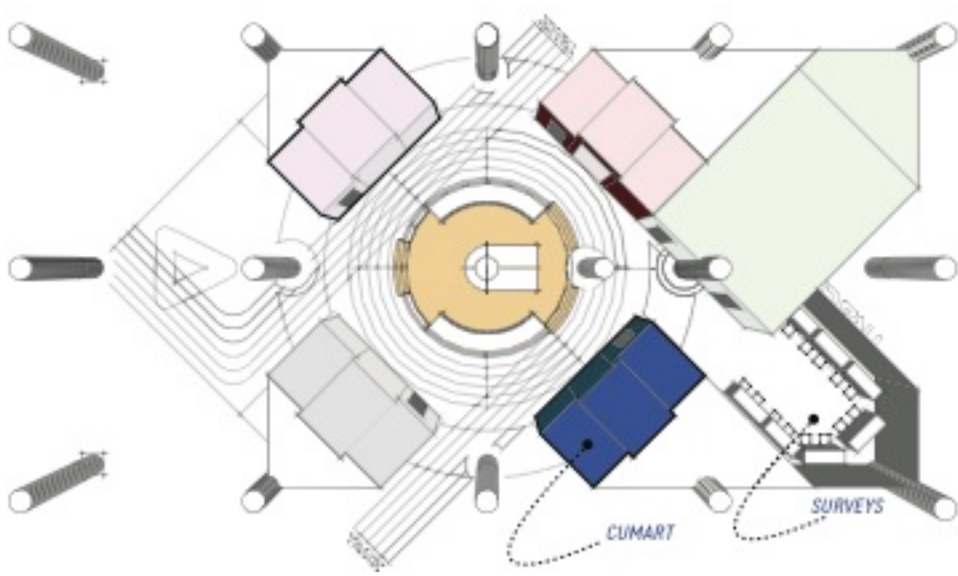


Figure 15: Packaging Test Track planogram, CUMart noted in blue

CUMart was branded as an extension of CUshop ™, a realistic eye tracking laboratory in Clemson, SC (This laboratory is part of the Sonoco Institute of Packaging Design and Graphics). Given the nature and stimuli of the experiment, the store was set up as a general convenience/pharmacy store. The design of the CUMart was immersive for consumers with graphics of shelving upon entry. However, during the study, participants had only white, undecorated walls in their line of sight in order give a sterile environment during actual testing.

Figure 16: Exterior view of CUMart

Experimental Method

Primarily, five color harmonies were evaluated. This were completed over six base colors (primary and secondary colors) and rotated in five Latin Square variations. Within this study, there was a 5 (color harmony) x 6 (visible products color) experimental design. To minimize variability, stimuli generation was extremely important. To increase randomization, the color harmonies within each visible product color were rotated within the stimuli generation. Within the eye tracking Tobii software, the order in which the six stimuli slides were shown was randomized.

Although the study took place over three days, the conditions of the experiment did not change day to day. Each participant saw six slides of stimuli, one of each visible product color. The order in which they saw the harmonies within these products was randomized for each participant.

The proctor for the study had control over which set of images the participant viewed, and kept track of this on a separate spreadsheet. Each of the five scenarios of slides (changing color harmony order) was rotated after five participants. For example, participants 1-5 were given scenario A, 6-10 scenario B, 11-15 scenario C, etc. Preferences and eye tracking data were collected through Tobii Studio software and exported after the close of the three-day experiment. Participants selected their preferred product on each screen by clicking with a mouse pointer on the product. These click locations were also recorded in Tobii Studio, and corresponded with each color harmony.

After the stimuli were shown, participants were given an abbreviated basic color vision deficiency test. The Ishihara Compatible Pseudoisochromatic Plate (PIPIC) Color Vision Test was used for its relatively quick distribution to participants. This test could also be completed on the screen without the moderator re-entering the room, which helped with the flow of the study. Participants were asked to identify one- or two-digit numbers formed of colored circles embedded in various red-green backgrounds. The standard for "normal" color vision indicated in the manual is around 70 percent or more correct responses (Buckalew, & Ross, 1989).

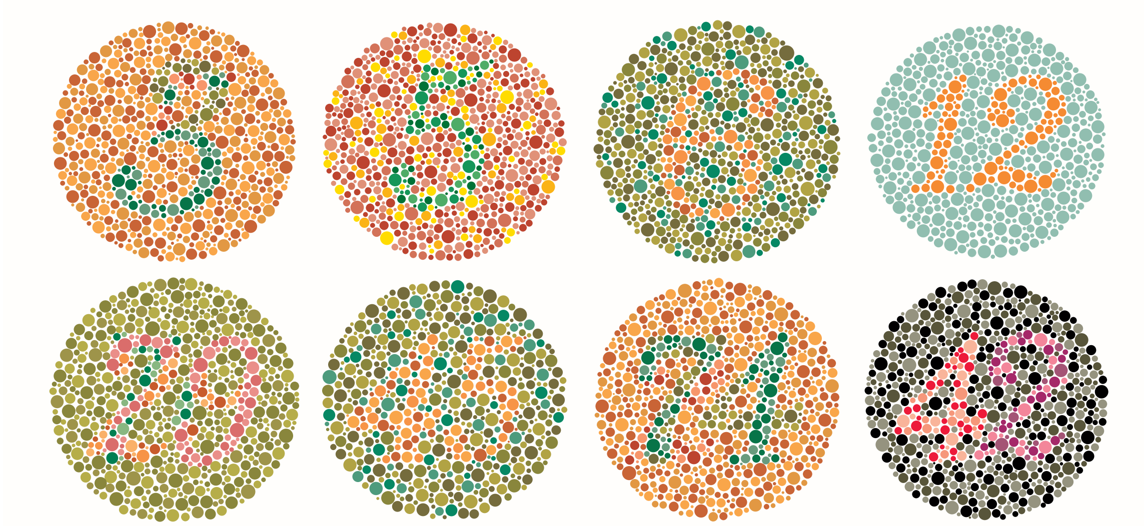


Figure 17: PIPIC Color Vision Slides

This color vision test was also completed through Tobii Studio on the monitor, and the participants were required to write down the numbers that they saw on the screen onto a premade form. Each of these eight slides was shown for three seconds before the screen was forwarded automatically. Between each color vision deficiency slide, a grey screen with instruction to "click to continue" was shown. This gave participants an opportunity to write down the corresponding number.

Part 2 Questionnaire

Participant ___________

1. __________
2. __________
3. __________
4. __________
5. __________
6. __________
7. __________
8. __________

Figure 18: Questionnaire to correspond with PIPIC Color Vision Test

Additionally, a survey was given to each participant to collect basic demographic data as well as a few questions regarding packaging and shopping habits. This was completed on separate computers following the study, outside of CUMart.

Set Up

Within the CUMart space, a desk with a Tobii T60X and a laptop were placed against blank white walls in the room. This provided a clear visual field for participants free from distraction.

The Tobii monitor was connected to the laptop, and set to mirror the laptop screen. This laptop was set up with the Tobii Studio software and the participant spreadsheet (Excel document) to keep track of which participants viewed the various stimuli sets. Within the Tobbi Studio software, the various stimuli sets could be chosen for the participants to view. Once the stimuli sets were chosen, the sets were displayed on the Tobii monitor for the participants' view

Figure 19: Set up of experiment with laptop and monitor

Prior to each study day, the Tobii monitor was calibrated to ensure accurate color display. Although the lighting and conditions did not change from day to day in the experiment space, it was necessary to be certain through calibration software. i1 display Pro Screen Calibration Software (X-Rite, Grand Rapids, MI) was used for this purpose. The software was loaded onto the laptop, and the monitor was calibrated and profiled using this software with the aid of a colorimeter rests on the monitor to gauge color and light on the screen. Only minimal adjustments were made on the first day, and no adjustments to the monitor were required the following days.

Procedure

Participants who willingly volunteered to participate were informed of the nature of the study as a consumer-packaging, eye-tracking study. Additionally, they were informed that the study, including the post-experiment survey, would last approximately fifteen minutes. They were also informed that they could leave the study at any time without penalty.

Each participant was required to read over an informational consent form notifying that there were no known risks involved with the study. Following this, they were able to start the study.

To begin the study, the participant was shown into CUMart with a moderator. Here, the participant was asked to sit in a chair in front of the Tobii monitor, while the moderator sat in front of a laptop next to them. Next, the participant was calibrated on the monitor through the Tobii software on the connected laptop. Calibration involves the participant following a moving red circle around the screen. They were instructed not to move their head while doing so to determine accurate vision calibration. This software utilizes a nine-point calibration system in which the participant must successfully fixate upon all nine zones.

A nine-point calibration was performed while the participants followed marks on the screen with their eyes. This calibration process was initiated through the Tobii Studio software when the moderator prompted it to begin. Once the calibration procedure was complete, the stimuli were shown.

Figure 20: Participant selecting preferred product

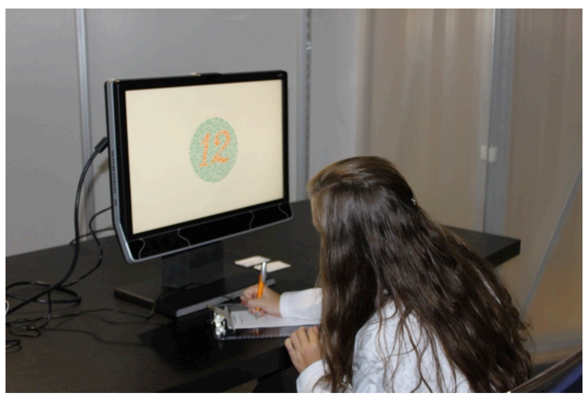


Figure 21: Participant completing color vision deficiency portion of the experiment

Through Tobii Studio, the recording of eye movements and mouse clicks began when the moderator clicked “start recording” on the laptop interface. The proctor then informed the participant that they would leave the room and if there were any questions, to step outside and let the moderator know. All instructions for the study were then shown on the screen to the participant. The participant forwarded the study by clicking on the screen. This portion of the study included selecting stimuli preferences, as well as completing the color vision deficiency portion.

Once this portion was completed, the participant was prompted to exit the room. Here, they were met with the proctor who led them to a survey computer. Each participant then answered basic demographic questions along with a few questions regarding their opinion of packaging design and color's influence on purchase decisions. During this process, the participants did not use their own names, but a unique participant number to identify themselves. In this way, all information gathered was kept confidential.

While participants completed this survey, the proctor went back into CUMart, collected the Color Vision Deficiency Test, and restarted the next stimuli set in Tobii Studio, and set the room up for the next participant to be calibrated for the experiment.

Data Collection and Eye Tracking Metrics

Within Tobii Studio, Areas of Interest, or AOI's, were determined. AOI's were then used to determine the location of eye movement, as well as location of mouse clicks by the participants. Once the stimuli were created and uploaded into Tobii Studio, the AOIs were drawn. See Figure below. For this study, the AOI's corresponded with each harmony. This was completed for each of the 30 stimuli slides. Doing this allowed Tobii Studio to export data according to color harmonies.

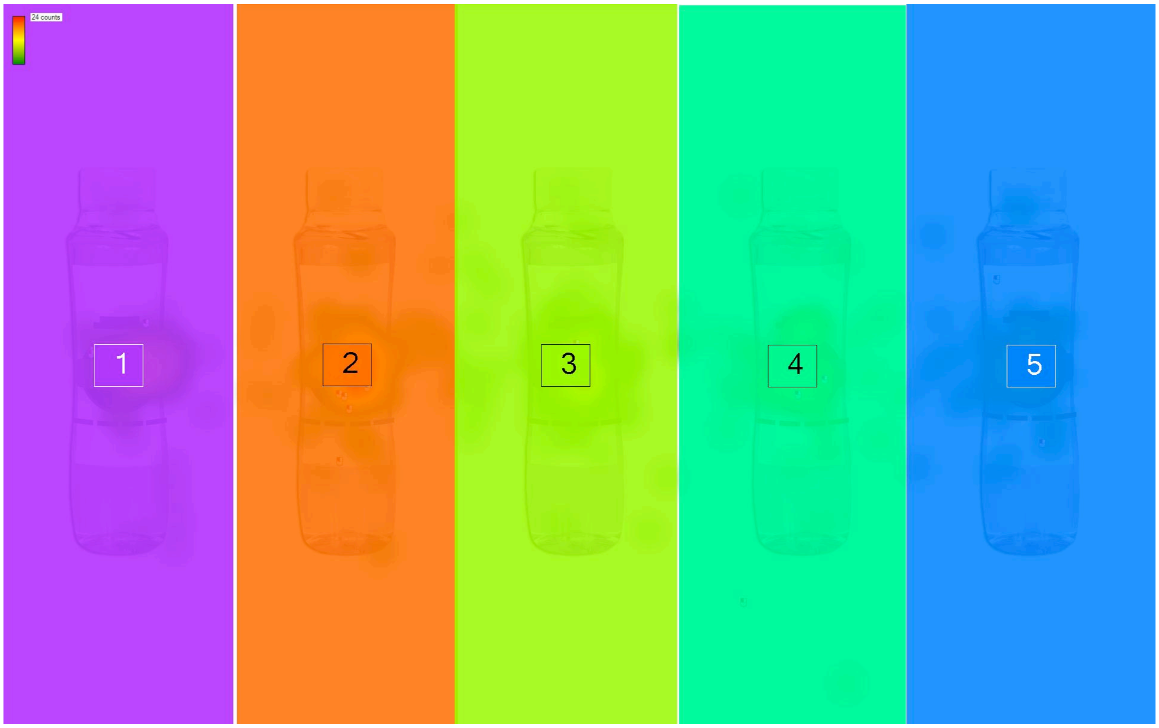


Figure 22: Example of AOI's in Tobii Studio

AOI groups can also be created through the software. This is useful to group AOIs that are on different stimuli, but will be analyzed in the same way. For example, each of the five color harmonies had its own AOI group containing each instance of that harmony throughout the stimuli. Also, all of the Monochromatic schemes were placed in an AOI group, regardless of where they appeard on the screen. This helped manage the data when rotating it Latin square and randomizing it for participants.

Preference data for each color harmony was collected through Tobii Software. By collecting the coordinates of the mouse clicks (participants clicked on their preferred product), the number of mouse clicks for each AOI was compiled. This data directly reflects which product was preferred according to color harmony.

Two eye-tracking metrics were studied to determine which harmonies participants preferred using the same AOIs as for preference tests. One metric collected was time to first fixation (TTFF). This is defined as the time it took a participant to fixate on an AOI. Secondly, total fixation duration (TFD) was the total time that a participant looked at a particular AOI.

A fixation is predetermined through Tobii Studio settings. This eye tracker gathers data every 16.6 ms, and this data is aggregated into fixations to aid in data collection. This is done through the use of gaze points which are simply the location of the eye within the stimuli. Algorithms within the software determine that if two gaze points are close enough together, they will be considered fixations. The software determines that the gazes are so close and that the participant did not move their eyes enough, it is not considered another gaze point (Tobii, 2010). For the purpose of this experiment, the predetermined settings were used through the software.

Data for the color vision deficiency test was collected on survey sheets at the close of each participants experiment. The participants marked these with one or two digit numbers. At the close of the study, each answer was later marked correct or incorrect. Those who did not pass this portion were removed from the final data set.

Demographic survey data was collected through survey computers and was run through SurveyMonkey.com. Stored online, this data was exported in Excel format after the close of the three-day experiment. The same participants whose eye tracking data was removed due to failing the color vision deficiency test were also removed from the survey data set.

Statistical Analysis

The raw eye tracking data will be collected using Tobbi Studio software and reformatted in Excel to run statistical analysis. This will then be put into excel for ANOVA/correlation analysis. Upon finding significance, pairwise T-tests will be used to evaluate where the significance lies. This will be completed for the following:

- to determine significance between the five color harmonies
- to determine significance between demographic data and preference results

This analysis will be completed for each category above for preference data, time to first fixation, as well as total fixation duration.

CHAPTER FOUR

RESULTS AND DISCUSSION

This study included 118 participants over the three-day period. Five of those were deleted due to poor eye tracking calibration. Of those remaining, six additional participants were removed for color vision deficiency. Therefore, the following analysis was completed for 107 participants. This data included preference selection, eye tracking metrics, and survey data.

Eye movement metrics and preference data were collected through Tobii software and reformatted in Microsoft Excel. Eye tracking metrics included Time to First Fixation (TTFF) and Total Fixation Duration (TFD). Mouse click coordinates on pre-determined Areas of Interest noted preference (see *Materials and Methods)*. This data was exported through Tobii Studio and reformatted in Microsoft Excel.

Survey data was collected through Survey Monkey and exported into Microsoft Excel. Combined eye tracking data and preference data can be viewed in Appendix A.

After reformatting all of the data in a single Microsoft Excel document, it was analyzed for further statistical analysis. StatPlus (AnalystSoft) was used to generate Analysis of Variance (ANOVA) tests for eye tracking and preference data as well as Chi-Square tests for independence. Using the F distribution, a 95% confidence level to determine significance was used for all analysis.

Survey Results

Each participant was given a survey following the eye-tracking portion of the study. This was completed through Survey Monkey. Each participant used a unique participant number to ensure confidentiality. Questions included basic demographics as well as questions regarding the previous experiment. The following outlines the results of these questions:

- Regarding gender, the sample was 50% (or 53 participants) male. One participant chose not to answer this question. In turn, 49.1% (52 participants) were female. This nearly split sample size lends it self for further analysis regarding association with color harmony preferences (see *Analysis of Demographic Results and Preference*).
- Sixty-four percent of participants self reported as the primary shopper for their household, while 28% were sometimes the primary shopper, and 8% were not the primary shopper. Additionally, 58% of participants shopped once a week or more, 30% once every two weeks, 11% once a month and 1% less than once a month.
- Participant age (Figure below) ranged from 18-64 years old. The majority of participants (34%) were between the ages of 21-29. The age range 40-49 included 28% of participants.

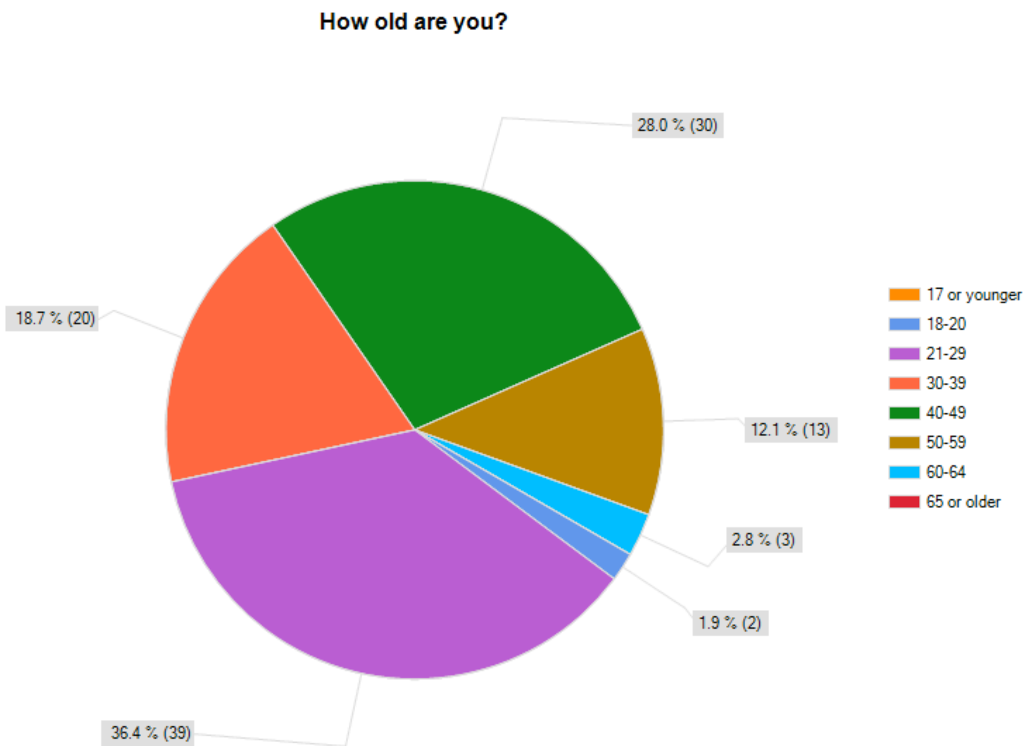


Figure 23: Survey Responses, Participants' Age

As this study required participants to view stimuli on a screen, it was necessary to gather data regarding corrective vision. Of the participants, 55.7% self-reported wearing either contacts or glasses, while 23.6% were wearing contacts and 20.8% were wearing glasses at the time of the study. Neither glasses nor contacts were intrusive to the study, and participants who did not calibrate correctly were removed from the study data as well as survey data. Figure 2 shows the response data for corrective vision of the participants.

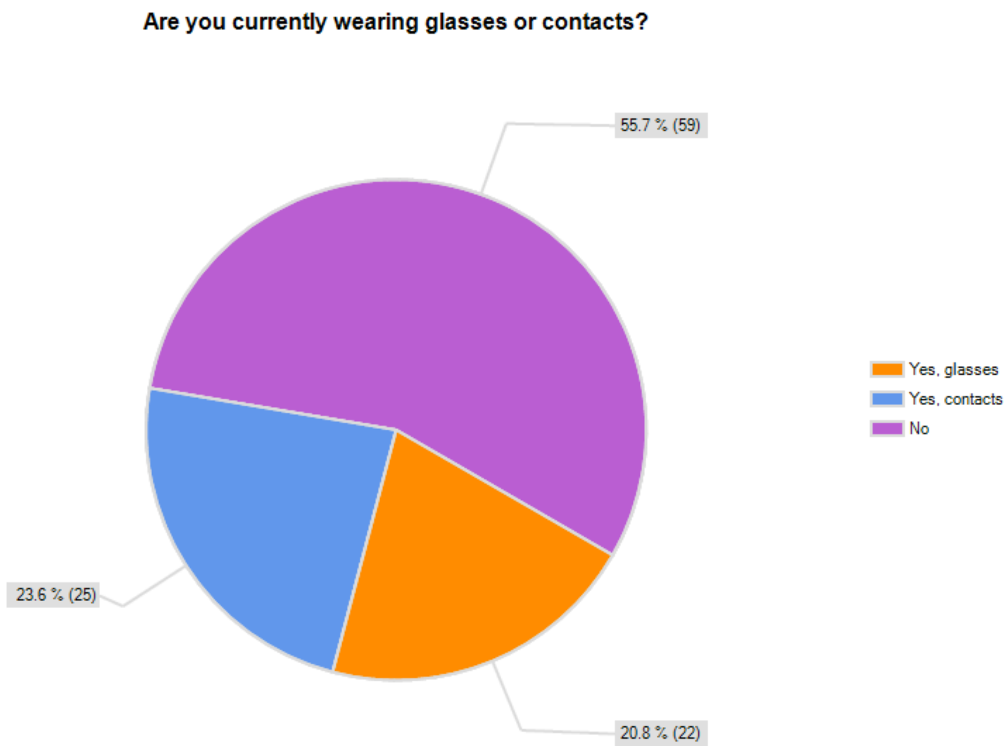


Figure 24: Survey Responses: Corrective Vision

A simple rating scale was used for four additional questions on the survey. This type of scale was chosen based on its straightforwardness (Wimmer & Dominick, 2006, p. 56).

Figure 25 represents the response data to the question, "How well did you understand the task of the study with (1) being very unclear and (10) being very clear." The average result for this question was 8.75 with 58.5% of participants rating the test as (10) ten, or very clear.

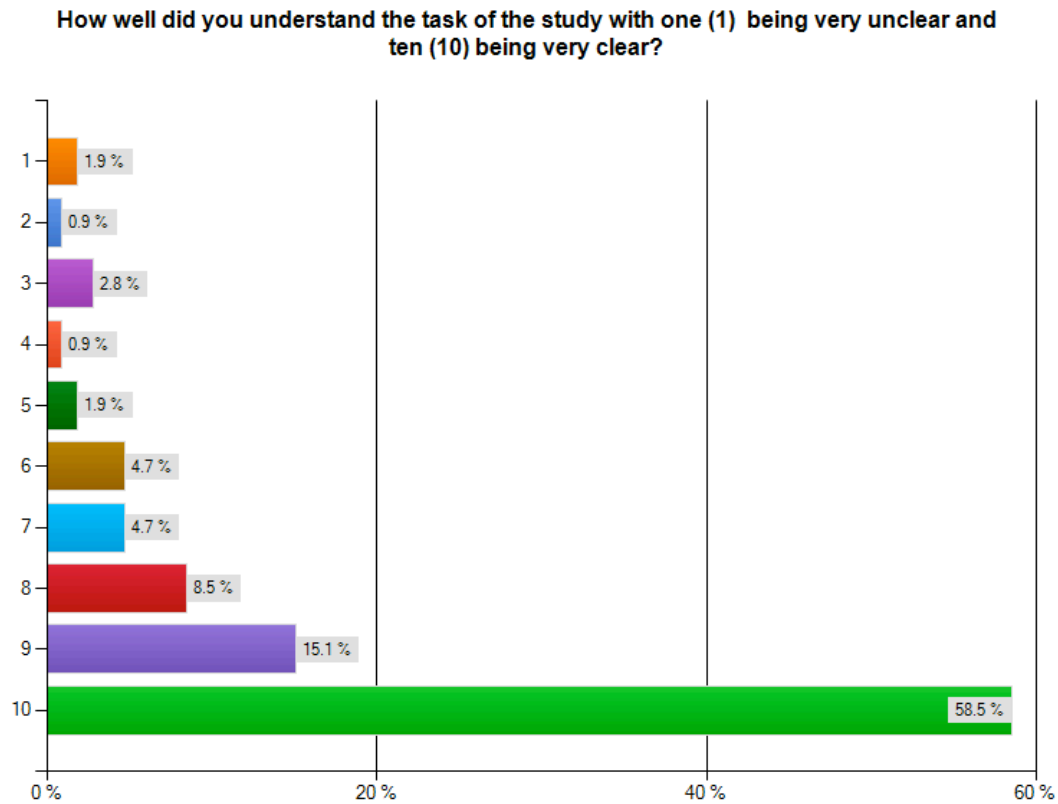


Figure 25: Survey Responses, Understanding of Study Task

Figure 26 represents the response data to the question, "Do you feel that packaging design is an important part of your purchasing decisions? Please rate using the following scale with (1) one as least important and ten (10) as most important." The average result for this question was 8.10 with 37.7% of participants selecting (8) eight as the most selected option.

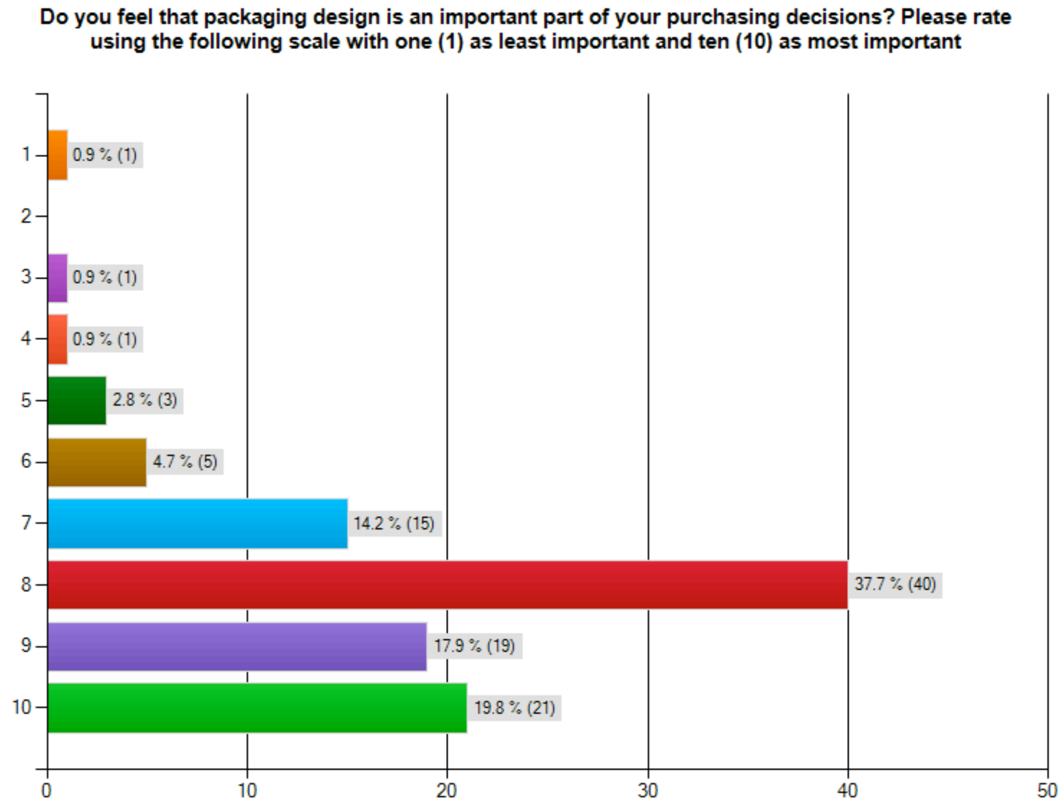


Figure 26: Survey Response, Package Design Importance

Figure represents the response data to the question, “Do you feel that the colors of a package are an important part of your purchasing decision? Please rate using the following scale with (1) one as least important and ten (10) as most important.” The average result for this question was 7.60 with 26.4% of participants selecting (8) eight as the most selected option.

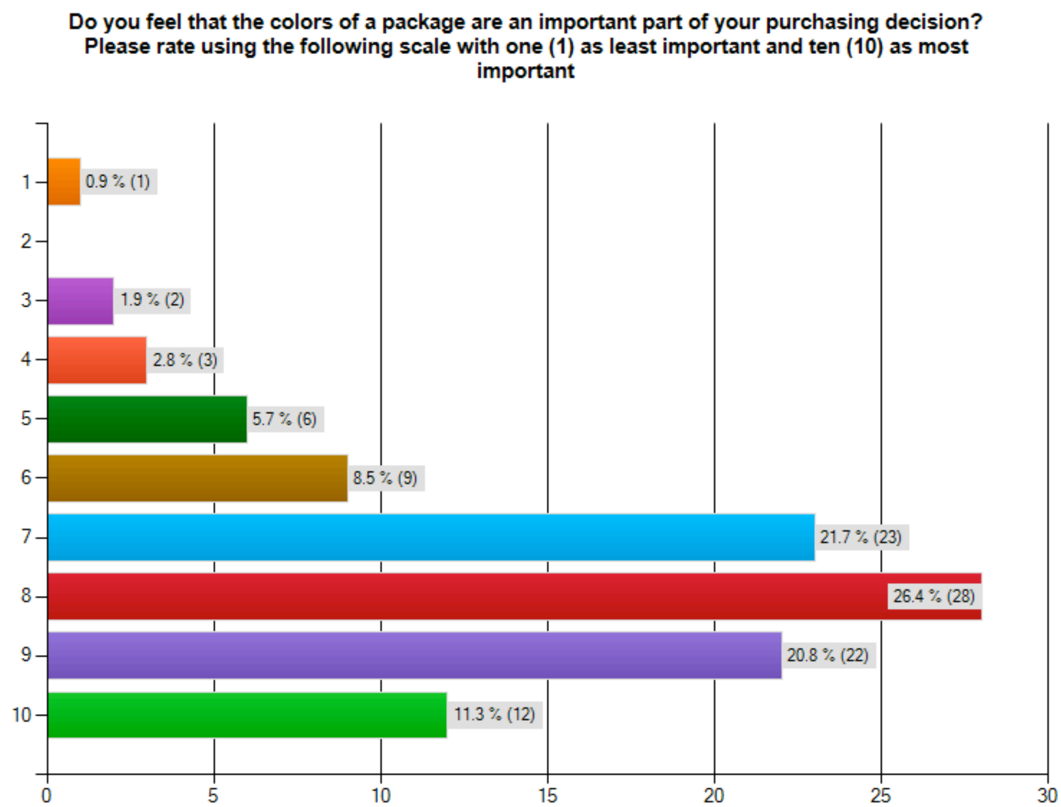


Figure 27: Survey Response, Color of Package Importance

Figure 28 represents the response data to the question, “Do you feel that the colors of a product are an important part of your purchasing decision? Please rate using the following scale with (1) one as least important and ten (10) as most important.” The average result for this question was 7.75 with 30.2% of participants selecting (8) eight as the most selected option.

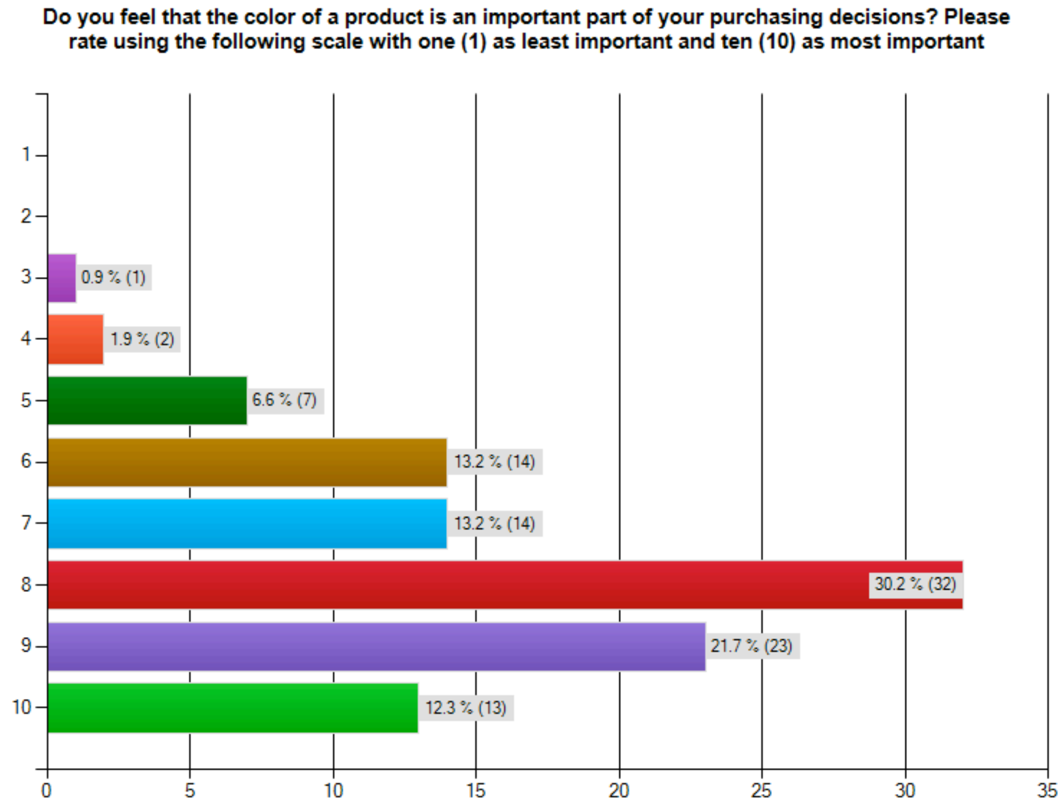


Figure 28: Survey Response, Color of Product Importance

Preference Results and Statistical Analysis

A within subjects, repeated measures Analysis of Variance (ANOVA) was conducted to determine whether or not there were statistically significant differences in the five conditions of color harmonies based on preference.

H_o: All means are equal between color harmonies

H_a: At least one mean is different between color harmonies

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Monochromatic	107	115	1.074766355	0.900017634
Analogous	107	129	1.205607477	1.429024863
Complementary	107	128	1.196261682	1.442250044
Split Complementary	107	148	1.38317757	1.86122377
Triadic	107	103	0.962616822	1.017457239

Table 1: Summary Data for Color Harmony Preference

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	10.628037	4	2.6570093	1.9977593	0.0935642	2.388753 4
Within Groups	704.89719	0	1.3299947			
Total	715.52523	4				

Table 2: ANOVA Color Harmony Preference

No significance was found between color harmonies and participant preference. Color harmony was used as the treatment-based, independent variable, while the dependent variable was the number of selections per harmony.

The color harmony did not elicit statistically significant changes in overall preference, $p = .0936$, ($p > 0.05$) with the average preference per color harmony ranging as follows: monochromatic (M= 1.05), analogous (M= 1.21), complementary (M=1.19), split complementary (M= 1.38), and triadic (M=0.96).

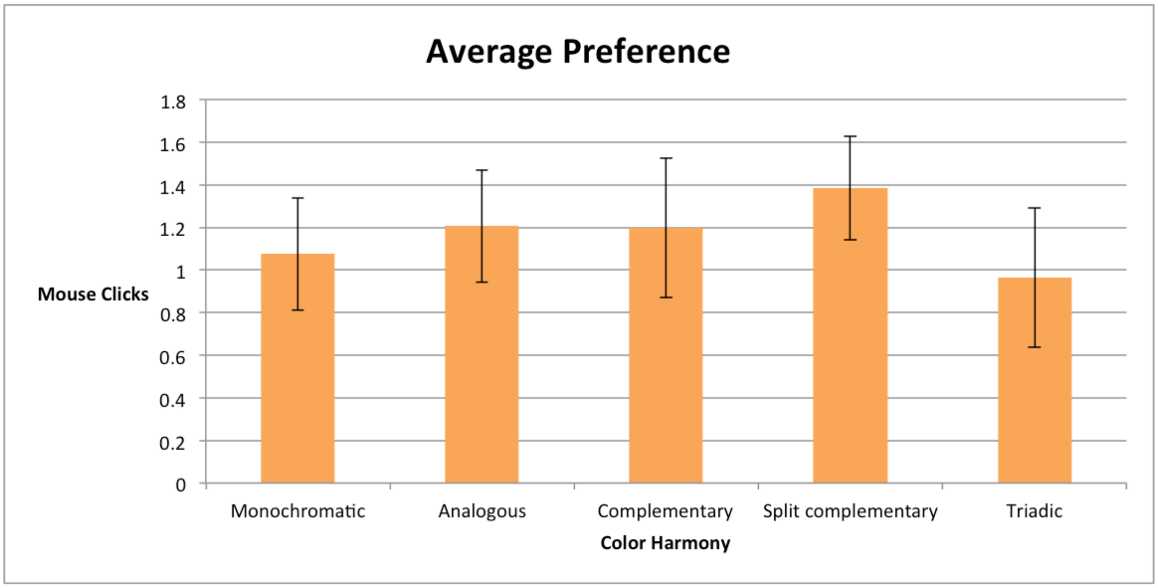


Figure 29: Average Preference per Color Harmony

There was no statistically significant difference between means and, therefore, we fail to reject the null hypothesis.

Eye Tracking Metrics and Statistical Analysis

Time to First Fixation (TTFF) is measured in seconds, and represents the time from when the stimulus appears until a fixation appears on the AIO.

A within subjects, repeated measures Analysis of Variance (ANOVA) was conducted to determine whether or not there were statistically significant differences in the five conditions of color harmonies based on TTFF.

H_o: All means are equal between color harmonies' TTFF

H_a: At least one mean is different between color harmonies' TTFF

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Monochromatic	107	251.75	2.352803738	7.403773197
Analogous	107	244.54	2.285420561	7.385774114
Complementary	107	238.62	2.230093458	11.47036886
Split Complementary	107	207.86	1.942616822	6.301538371
Triad	107	235.6	2.201869158	11.47007194

Table 3: Summary Data for TTFF for each Color Harmony

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	10.46118	4	2.6152960	0.2969799	0.8799347	2.3887534
Within Groups	4667.3418	530	8.8063052			
Total	4677.8029	534				

Table 4: ANOVA Average TTFF for each Color Harmony

No significance was found between color harmonies and TTFF. Color harmony was used as the treatment-based, independent variable, while the dependent variable was the time, in seconds.

The color harmony did not elicit statistically significant changes in overall preference, p = .879, (p >0.05) with the average preference per color harmony TTF ranging as follows: monochromatic (M= 2.35), analogous (M= 2.28), complementary (M=2.23), split complementary (M= 1.94), and triadic (M=2.20).

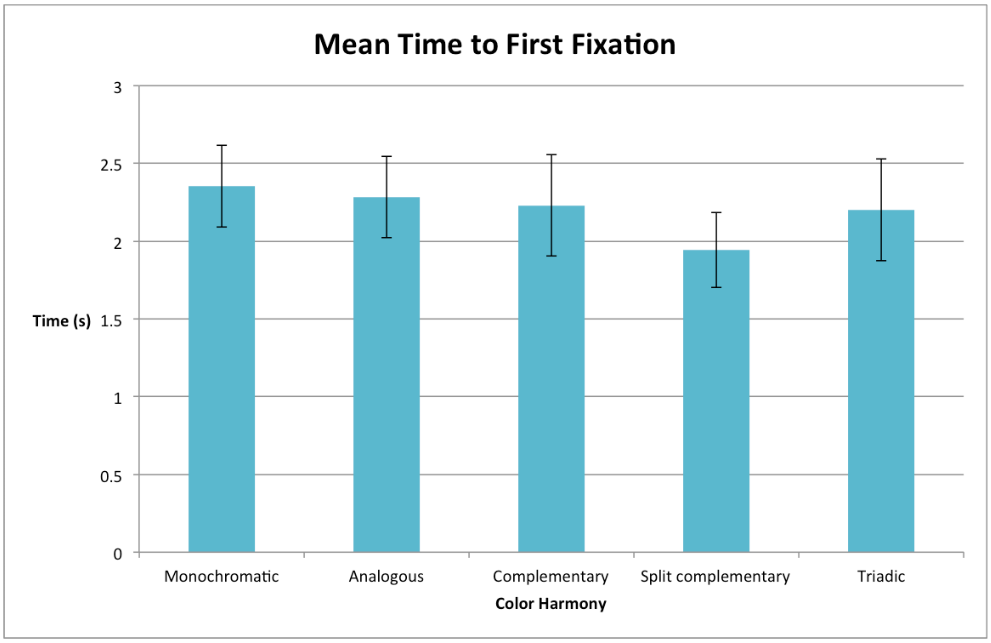


Figure 30: Mean TTFF per Color Harmony

Total Fixation Duration (TFD), measured in seconds, is the summation of all fixation durations in a particular AOI.

A between subjects, repeated measures Analysis of Variance (ANOVA) was conducted to determine whether or not there were statistically significant differences in the five conditions of color harmonies based on TFD.

H_o: All means are equal between color harmonies' TFD

H_a: At least one mean is different between color harmonies' TFD

SUMMARY

Groups	Count	Sum	Average	Variance
Monochromatic	107	476.65	4.454672897	9.154268524
Analogous	107	481.17	4.496915888	6.529306436
Complementary	107	458.12	4.281495327	7.110486422
Split Complementary	107	514.89	4.812056075	12.2842146
Triadic	107	480.2	4.487850467	11.09569062

Table 5: Summary Data for TFD for each Color Harmony

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	15.741548	4	3.9353871	0.4261478	0.789797	2.3887534
Within Groups	4894.440	530	9.234793			
Total	4910.1820	534				

Table 6: ANOVA Average TFD for each Color Harmony

No significance was found between color harmonies and TFD. Color harmony was used as the treatment based independent variable, while the dependent variable was the time, in seconds.

The color harmony did not elicit statistically significant changes in overall preference, p = .789, (p >0.05) with the average preference per color harmony TFD ranging as follows: monochromatic (M= 4.28), analogous (M= 4.49), complementary (M=4.28), split complementary (M= 4.81), and triadic (M=4.49).

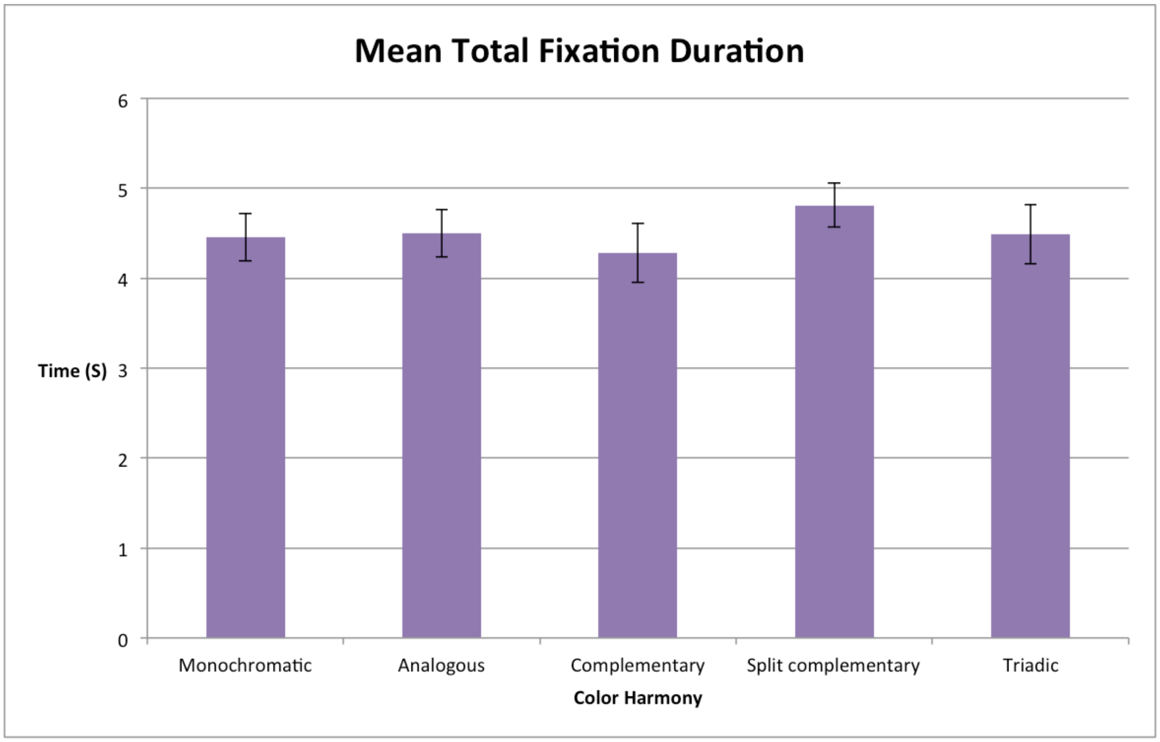


Figure 31: Mean TFD per Color Harmony

There was no statistically significant difference between mean TFD and therefore, we fail to reject the null hypothesis.

Within Tobii Studio, fixation data was collected and superimposed upon the stimuli images. This heat map data represented fixations upon each stimulus. The red areas represent areas with the most fixations. The majority of fixations appeared to be concentrated on the label. Figure 32 represents an aggregate heat map of all 107 participants fixations on one of the stimulus. Small red dots on these images represent the mouse clicks, or preference, for each participant who view this stimulus. Additional Examples can be found in Appendix B.

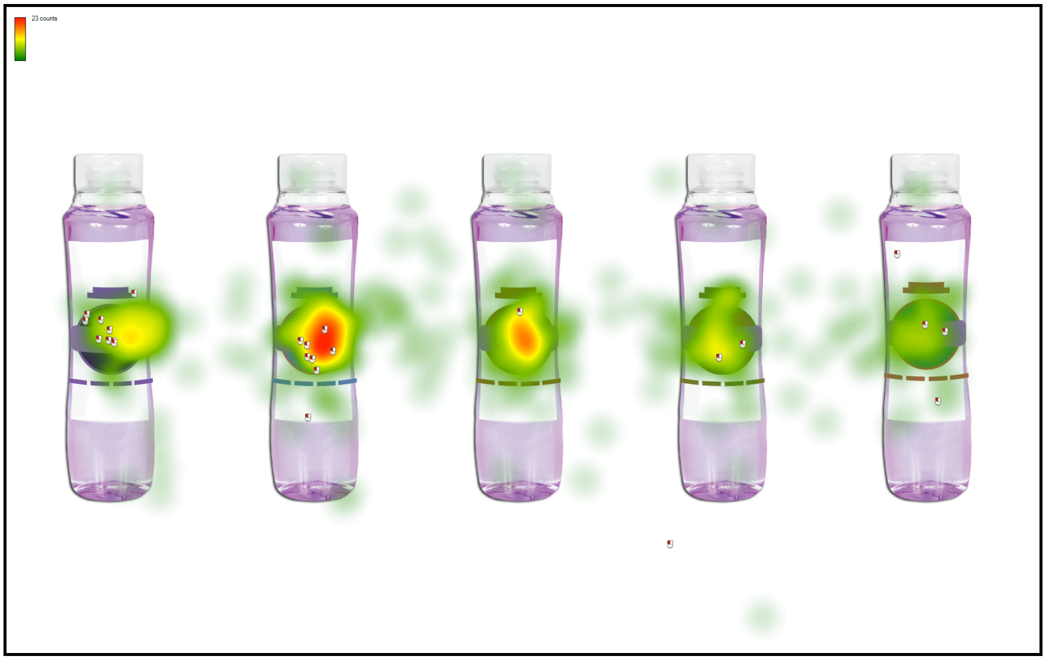


Figure 32: Aggregate Heat Map for 107 Participants

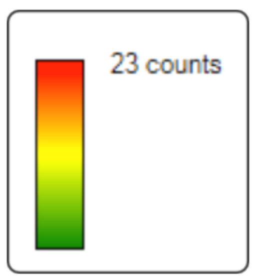


Figure 33: Fixation Count for Heat Map in Figure Above

Another data visualization is the ability to view the order and position of fixations, or scanpaths. Each participant's scanpath data can be exported on the stimuli through Tobii Studio. This helps gain insight on the order and viewing process of each participant.

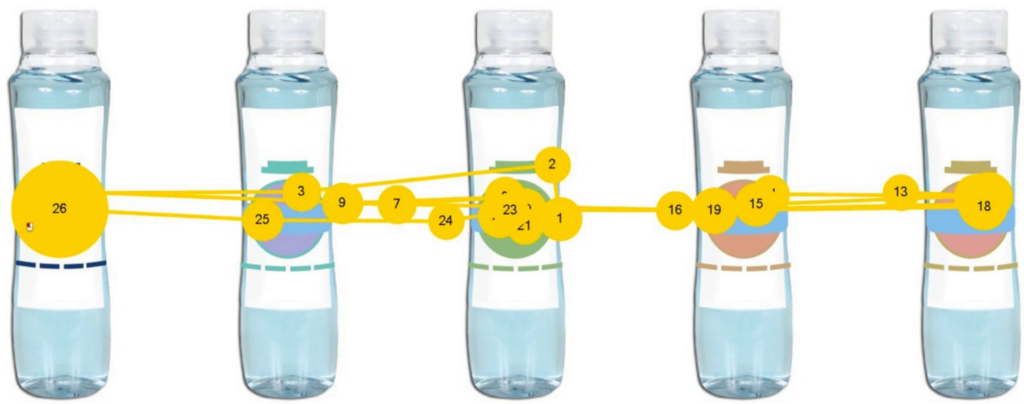


Figure 34: Scanpath of one Participant

Analysis of Demographic Results and Preference

Association between various demographics versus preference data was conducted using Chi-Squared tests for independence. This type of test determines whether two categorical sets of data are independent of one another. For Table 7, Table 8, Table 9, and Table 10, each color harmony is abbreviated. M= Monochromatic, A= Analogous, C= Complementary, SC= Split Complementary, T= Triadic.

A Chi-square test for association was conducted between age and preference for color harmony. There was not a statistically significant association between gender and color harmony preference, p = .749 (p>05).

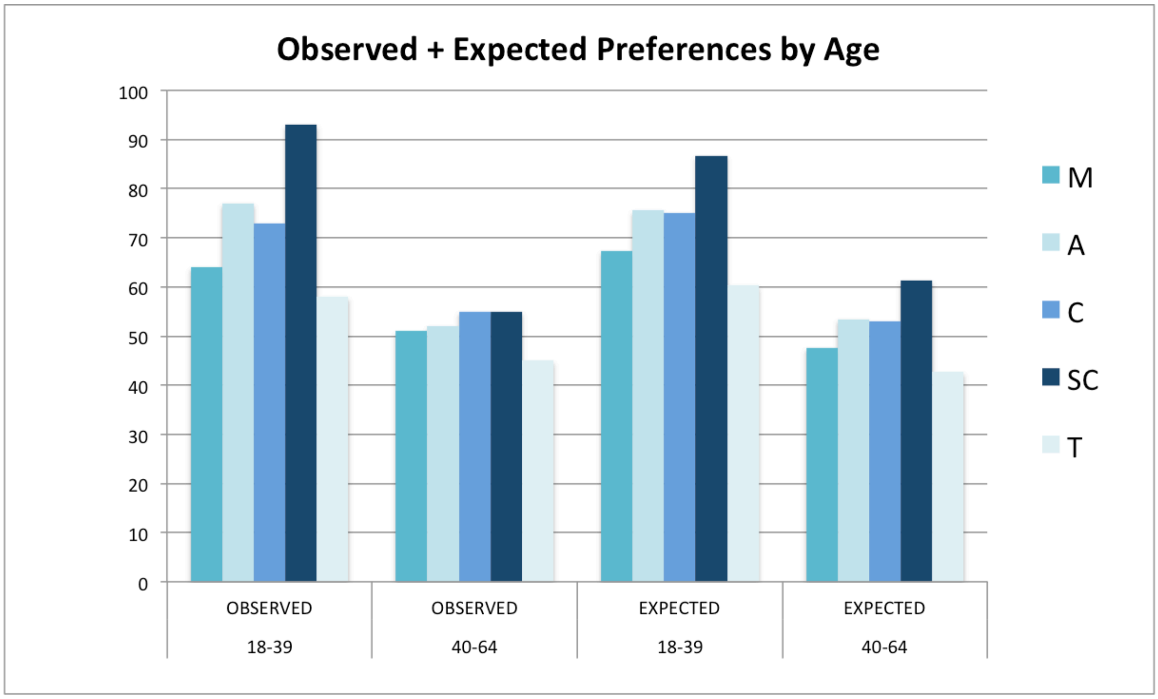


Figure 35: Observed and Expected Preferences by Age

AGE*PREFERENCE

		M	A	C	SC	T	TOTAL
18-39	***OBSERVED***	***64***	***77***	***73***	***93***	***58***	***365***
40-64	***OBSERVED***	***51***	***52***	***55***	***55***	***45***	***258***
18-39	EXPECTED	67	76	75	87	60	365
40-64	EXPECTED	48	53	53	61	43	258
	TOTAL	115	129	128	148	103	623

p 0.749951369

Table 7: Chi-Squared Test for Association, Age and Preference

A Chi-square test for association was conducted between gender and preference for color harmony. There was not a statistically significant association between gender and color harmony preference, p = .897 (p>05). This notes that that age does not have a significant influence on preference of color harmony.

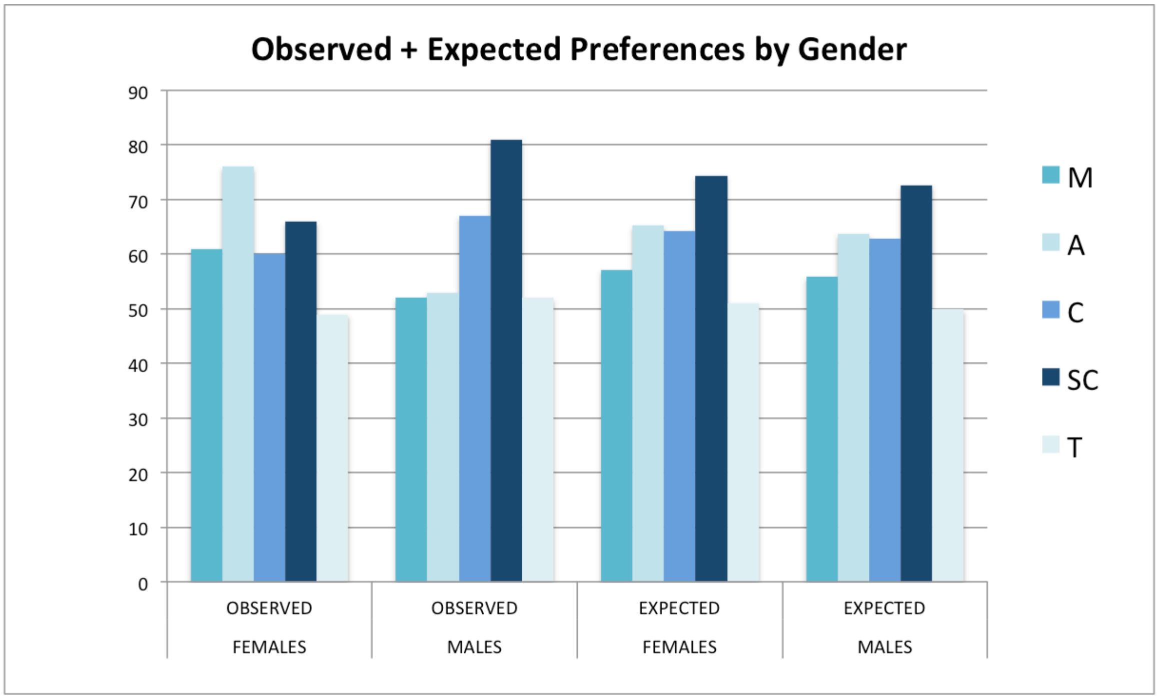


Figure 36: Observed and Expected Preferences by Gender

GENDER*PREFERENCE

		M	A	C	SC	T	TOTAL
FEMALES	***OBSERVED***	***61***	***76***	***60***	***66***	***49***	***312***
MALES	***OBSERVED***	***52***	***53***	***67***	***81***	***52***	***305***
FEMALES	EXPECTED	59	70	62	70	50	312
MALES	EXPECTED	56	63	63	73	50	305
	TOTAL	113	129	127	147	101	617

P	0.15001702

Table 8: Chi-Squared Test for Association, Gender and Preference

Corrective vision during this study was viewed as those participants wearing glasses or contacts at the time of the experiment. This question was asked in the post experiment survey. It should be noted that this corrective vision is not related to the color vision deficiency test given during the study (see *Materials and Methods).* A Chi-square test for association was conducted between corrective vision and preference for color harmony. There was not a statistically significant association between corrective vision and color harmony preference, p = .051 (p>05). This specific metric trends towards significance, which may lead to future work in this specific category regarding corrective vision

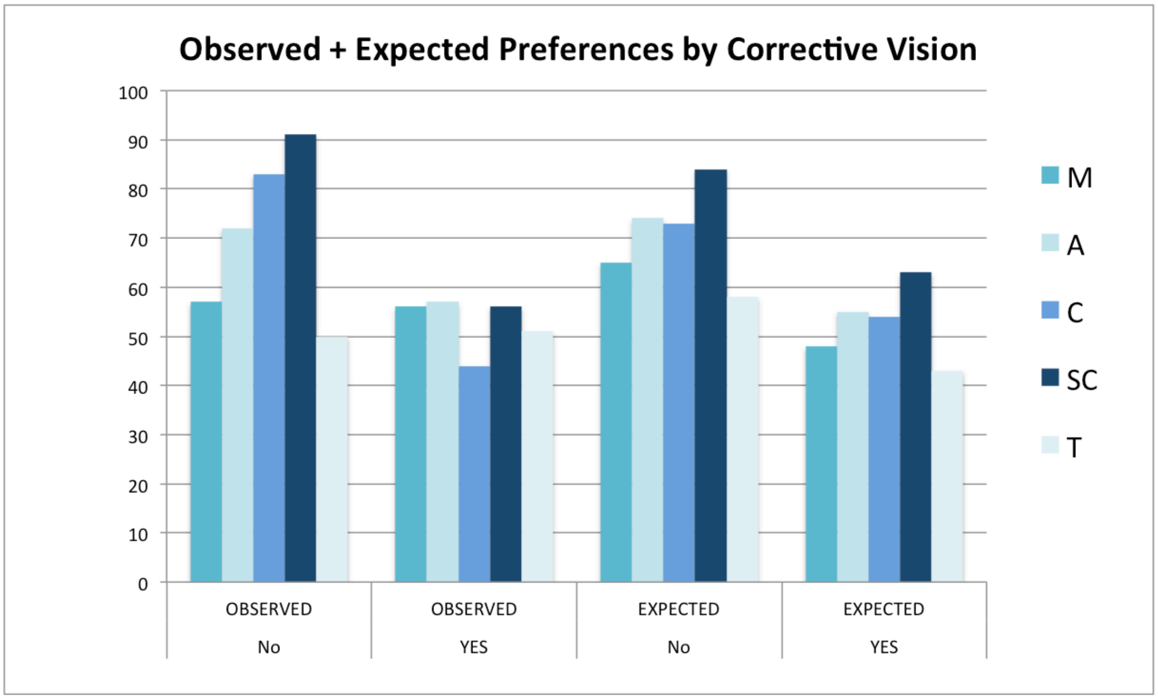


Figure 37: Observed and Expected Preferences by Corrective Vision

CORRECTIVE VISION*PREFERENCE

		M	A	C	SC	T	TOTAL
No	***OBSERVED***	***57***	***72***	***83***	***91***	***50***	***353***
YES	***OBSERVED***	***56***	***57***	***44***	***56***	***51***	***264***
No	EXPECTED	65	74	73	84	58	353
YES	EXPECTED	48	55	54	63	43	264
	TOTAL	113	129	127	147	101	617

P	0.051185522

Table 9: Chi-Squared Test for Association, Corrective Vision and Preference

Each participant was asked in a post experiment study how important he or she felt color of a package was in his or her purchase decision, one being not important, and ten being very important. For the purpose of this Chi-Squared test for association, the responses were divided into responses one through seven (1-7) and eight through ten (8-10). The purpose of this was to more evenly distribute the selections, since most of the data fell in the higher range (see *Survey Results*).

A Chi-square test for association was conducted between corrective vision and preference for color harmony. There was not a statistically significant association between corrective vision and color harmony preference, $p = .118$ (p>05).

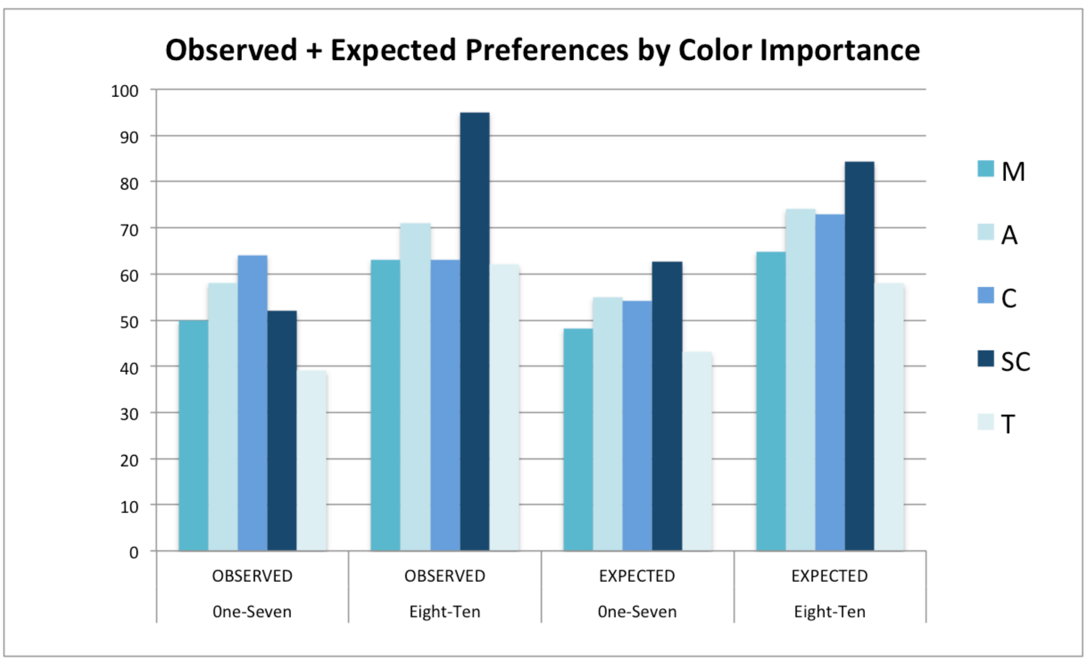


Figure 38: Observed and Expected Preferences by Color Importance

COLORIMPORTANCE*PREFERENCE

		M	A	C	SC	T	TOTAL
1-7	OBSERVED	50	58	64	52	39	263
8-10	OBSERVED	63	71	63	95	62	354
1-7	EXPECTED	48	55	54	63	43	263
8-10	EXPECTED	65	74	73	84	58	354
	TOTAL	113	129	127	147	101	617

0.117660406

Table 10: Chi-Squared Test for Association, Color Importance and Preference

CHAPTER FIVE

CONCLUSION

Concluding Remarks

Utilizing data from 107 participants' data, an eye tracking and preference study was completed. This was conducted using a Tobii T60 XL monitor to collect eye tracking metrics (Time to First Fixation, TTFF; and Total Fixation Duration, TFD) and preference data (mouse coordinates). Five color harmonies were tested, using three household products. Using the color of the visible product as a guide for generation, labels were created using abstracted graphic shapes.

The goal of this research was to determine if there was a difference between consumer preferences for color harmonies for products which external labels and visible product existed simultaneously. Much research has been conducted on color preferences for various products, but little has been contributed to color harmonies in the field of packaging in regards to labeling and visible product.

As packaging designers are faced with material considerations, graphical standards, protection criteria and other regulations, no guide is given for where to begin for label color choices. This study sought to create a guide for designers to use for creating label color choices, using the product color as a starting point.

Analyzing preference and eye tracking metrics through repeated measures ANOVA tests, no significance ($p<.05$) was found between preference, TTFF, or TFD. Chi-Squared tests for association were completed for color harmony preference and age, color harmony preference and gender, color harmony preference and corrective vision, and color harmony preference and understanding of task. No significance was found in any of these tests. This leads to the conclusion that gender, age, corrective vision, and understanding of task were independent of color harmony preference.

As no clear preference was found with this study utilizing color harmonies, designers now have the opportunity to use other design guidelines to create aesthetically pleasing labels for products with visible product color. Employing branding color schemes, trend colors, promotional colors, and others, was demonstrated not to hinder the preference of consumers. These results recognize the freedom for designers in consumer packaging fields to use their talents and judgment regarding this specific category, and remove the prospect of implementing a guide.

Limitations

Although this research reached its aims, limitations were unavoidable within the scope and method. As the color harmonies were derived, they were driven by existing technology. This was done in order to keep consistency in samples and color variation. To do so, ColorMunki software was used. This limited the types of color harmonies that were explored. Since ColorMunki's method of color harmony generation is proprietary, the study could only use the harmonies included in the software. Although these five harmonies were sufficient for the nature of this study, various other color combinations are regarded as harmonious that could not be explored in this research.

The number of products that exist with visible product color and external labels is extensive. A sampling of product types spanning across categories was selected

(Beverage, Dishwashing Soap, and Shampoo). A vast number of other products could have also been selected and replicated in the same fashion, however; for this investigation selecting three was a sufficient, manageable amount of data. On the same note, adding additional colors could yield interesting findings.

A further limitation was discovered post-hoc, while viewing the aggregate heat maps. Exclusion of blank slides between each stimulus may have created unintended fixations to certain stimuli. In turn, fixations may have been carried over from one slide to another. Within the experimental design, rotating the stimulus in a Latin square design could have alleviated this concern, but the effects of this limitation cannot be examined.

CHAPTER SIX

RECOMMENDATIONS

Within the scope of preferences in consumer testing based on established color theory, there is much room for expansion in research. Many additions and modifications could be made to this methodology to increase findings in this particular subject, or related topics.

Although three common household products were used, using other categories such as spirits packaging, cosmetics packaging, pastas, spices, or many more could enhance the study and its level of applicability.

While keeping the label artwork constant, with exception of color, removed this as a factor of preference, it may not be viewed as the most realistic form of a brand. Exploring more ways of keeping an existing brand consistent while removing brand loyalty and association may be viewed, if successful, as an improvement. Using trademarked brand colors with this type of testing method could be beneficial to companies with existing brand standards.

Correlating consumer color harmony preferences with memory of the color schemes could yield noteworthy findings.

This study focused on eye tracking of products as a two-dimensional static method. Replication of this study in a realistic, immersive environment may lead to varying results. It would be difficult to replicate the colors precisely with printed labels, and it would be vital to control the color values as accurately as possible.

APPENDICES

Appendix A: Survey

***1. What is your participant number?**

2. Are you the primary shopper for your household?

- ☐ Yes
- ☐ No
- ☐ Sometimes

3. How often do you shop for household items?

- ☐ Once a week or more
- ☐ Once every two weeks
- ☐ Once a month
- ☐ Less than once a month

Other (please specify)

4. How old are you?

- ☐ 17 or younger
- ☐ 18-20
- ☐ 21-29
- ☐ 30-39
- ☐ 40-49
- ☐ 50-59
- ☐ 60-64
- ☐ 65 or older

5. What is your gender?

- ○ Male
- ○ Female
- ○ Both male and female

6. What is the highest level of school you have completed? (Check all that apply)

- ☐ Less than high school degree
- ☐ High school degree or equivalent (e.g., GED)
- ☐ Some college but no degree
- ☐ Associate degree
- ☐ Bachelor degree
- ☐ Graduate degree
- ☐ Higher than a graduate degree

7. Which of the following categories best describes your employment status? (Check all that apply)

- ☐ Employed, working 1-39 hours per week
- ☐ Employed, working 40 or more hours per week
- ☐ Not employed, looking for work
- ☐ Not employed, NOT looking for work
- ☐ Retired
- ☐ Disabled, not able to work

8. What is your annual household income? (Check all that apply)

- ☐ Less than $20,000
- ☐ $20,000 to $34,999
- ☐ $35,000 to $49,999
- ☐ $50,000 to $74,999
- ☐ $75,000 to $99,999
- ☐ $100,000 to $149,999
- ☐ $150,000 to $199,999
- ☐ $200,000 or more

9. Do you have children, or not?

- ◯ Yes, I do
- ◯ No, I do not

10. How well did you understand the task of the study with one (1) being very unclear and ten (10) being very clear?

1	2	3	4	5	6	7	8	9	10
◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

11. Do you wear glasses or contacts?

- [ ] Yes, glasses
- [ ] Yes, contacts
- [ ] Yes, both
- [ ] No

12. Are you currently wearing glasses or contacts?

- [ ] Yes, glasses
- [ ] Yes, contacts
- [ ] No

13. Do you feel that packaging design is an important part of your purchasing decisions? Please rate using the following scale with one (1) as least important and ten (10) as most important

1	2	3	4	5	6	7	8	9	10
○	○	○	○	○	○	○	○	○	○

14. Do you feel that the colors of a package are an important part of your purchasing decision? Please rate using the following scale with one (1) as least important and ten (10) as most important

1	2	3	4	5	6	7	8	9	10
○	○	○	○	○	○	○	○	○	○

15. Do you feel that the color of a product is an important part of your purchasing decisions? Please rate using the following scale with one (1) as least important and ten (10) as most important

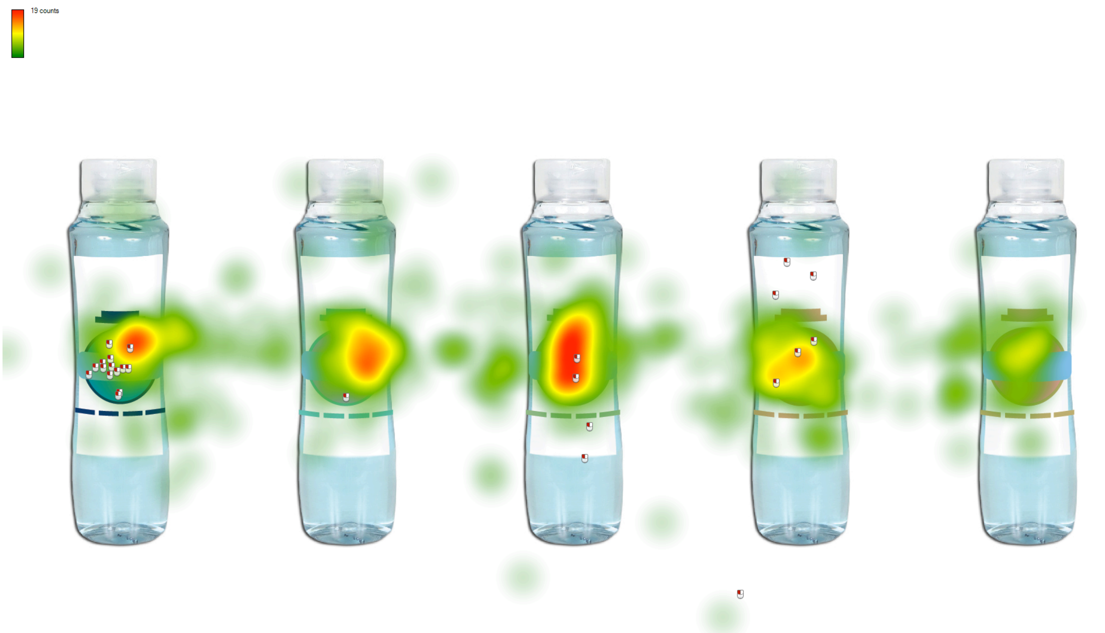
1	2	3	4	5	6	7	8	9	10
○	○	○	○	○	○	○	○	○	○

Appendix B: All Stimuli Sets Shown to Participants

Appendix C: Heat Maps for Each Stimuli Set


21 counts


29 counts


19 counts

Appendix D: Aggregate Data for all Participants

	Time to First Fixation (TTFF) in seconds					Total Fixation Duration (TFD) in seconds					Preference in Mouse Clicks				
Particpant #	Monochromatic	Analogous	Complementary	Split Complementary	Triadic	Monochromatic	Analogous	Complementary	Split Complementary	Triadic	Monochromatic	Analogous	Complementary	Split Complementary	Triadic
1	6.92	1.36	0.17	2.25	3.27	5.67	3.53	8.94	4.96	2.16	1	0	4	1	0
2	1.51	1.7	0.41	3.68	10.5	2.65	4.67	3.96	5.99	2.85	0	1	3	2	0
3	5.76	4.62	0.26	1.46	2.5	1.68	2.48	3.35	2.9	4.49	0	0	2	2	2
4	1.96	0.88	0	0.33	1.61	9.07	4.93	4.97	6.15	8.94	2	0	1	1	2
5	1.71	8.33	1.58	1.33	1.13	2.45	2.03	1.61	2.14	3.33	2	0	0	2	2
6	2.47	0.98	0.68	0.3	0.03	3.17	3.05	3.31	3.99	4.32	0	1	1	1	3
8	2.29	1.32	0.79	0.38	2.46	4.19	6.26	4.41	4.49	4.44	2	1	1	2	0
9	2.65	2.17	3.63	0.62	0.43	7.56	5.36	2.2	4.74	8.29	3	1	0	0	2
10	0	2.57	6.45	0.82	0.39	18.19	11.05	5.3	4.04	8.67	4	1	1	0	0
12	0.07	3.04	11.56	0.44	0.32	3.87	1.99	1.79	0.97	5.01	1	2	1	0	2
13	0.33	3.26	1.96	0.88	0.47	1.76	1.63	2.85	0.97	2.33	0	1	3	2	0
14	0.42	0	0.07	1.8	0.62	1.51	1.48	0.85	1.05	1.8	0	0	0	0	0
15	0.95	0	2.69	2.04	1.46	5.61	4.67	2.46	5.23	6.9	2	1	0	1	2
17	2.08	0.48	1.01	1.19	6.43	0.67	1.25	0.82	1.2	0.45	2	1	1	2	0
18	1.52	0.24	0	7.18	10.91	4.41	7.86	4.89	0.97	0.42	3	3	0	0	0
19	4.16	0.62	0.27	0	2.45	6.27	7.26	9.87	4.21	4.21	2	1	3	0	0
20	2.4	0.7	0.27	0	1.22	2.76	6.52	2.51	3.19	2.91	2	4	0	0	0
20	6.94	3.37	2.58	2.4	5.14	4.21	1.66	1.7	1.73	2.51	3	1	1	0	1
22	11.66	9.5	0.31	0.09	4.42	0.25	0.52	5.15	1.73	2.24	0	0	3	1	2
22	1.48	5.14	2.68	0.68	0.07	7.51	6.13	3.69	5.62	9.89	0	0	0	0	0
25	1.36	2.41	3.3	0.63	0	3.05	2.15	2.86	3.11	1.5	1	0	3	1	1
26	1.51	11.66	21.65	4.25	1.26	0.17	0.2	0.52	0.73	0.35	0	0	0	0	0
27	0	2.11	2.91	1.1	0.86	2.91	4.33	1.46	6.28	3.1	2	2	0	2	0
28	0.73	1.23	1.83	2.6	0.37	6.24	5.42	3.78	2.9	6.13	2	2	1	0	1
29	0	0.27	2.1	2.33	0.68	4.21	7.3	2.05	2.4	1.91	1	3	0	1	1
30	0.99	6.62	2.03	10.45	9.04	2.11	1.41	1.45	0.17	0.82	1	2	1	1	1
31	0.36	0	1.08	3.17	3.64	3.51	6.64	7.18	3.01	4.19	0	1	4	1	0
32	5.98	2.91	0.73	1.01	0.46	1.8	3.21	3.58	4.17	2.51	0	0	2	4	0
33	0.67	0.33	0.06	1.67	2.27	5.71	5.41	5.67	7.97	6.16	2	0	0	2	2
34	2.34	0.31	0.16	1.13	5.49	5.39	4.86	5.08	4.24	2.27	1	1	3	1	0
35	1.11	0	0.21	1.89	2.39	4.38	7.22	5.73	13.68	18.28	1	0	0	2	3
36	4.02	2.31	0.34	0	1.59	4.39	9.4	6.84	15.98	10.24	0	0	0	6	0
37	3.24	2.09	0	0.54	0.76	0.9	0.83	4.03	4.91	2.52	0	0	2	3	1
38	2.82	0.57	0.84	3.78	2.62	2.96	2.88	4.83	3.94	4.4	1	0	2	1	2
39	2.13	7.26	1.01	0.58	0	11.1	2.45	5.68	13.99	20.1	0	0	0	1	5
40	1.21	3.78	0.35	0.03	0.9	3.89	3.23	3.5	5.99	4.45	1	1	1	2	1
41	1.48	2.13	0.65	0.37	0.24	6	1.87	3.06	3.45	5.49	2	1	1	1	1
42	0.01	1.76	9.11	0.88	0.38	4.73	8.54	3.26	9.9	7.67	0	4	0	2	0
43	1.37	1.84	4.25	0.83	0.04	5.49	4.9	2.36	2.78	8.74	1	2	0	0	3
44	0.25	1.5	4.41	0.55	0.98	6.43	9.66	6.2	8.02	5.55	0	2	2	2	0
45	1.63	0	2.32	2.88	3.38	2.37	4.21	4.98	0.67	2.57	1	0	4	0	1
46	0.3	0	1.6	2.9	0.87	2.16	2.25	1.3	1.07	1.24	1	2	0	2	1
47	0.42	0	1.33	2.33	3.47	4.34	4.49	5.59	1.03	1.28	2	1	2	0	1
48	7.85	0.26	0.01	1.21	3.36	2.13	4.79	6.09	4.49	1.6	1	2	1	2	0
49	5.93	0.31	0.04	0.94	4.41	1.56	7.97	2.36	2.51	1.48	0	6	0	0	0
50	3.18	0.3	0	0.64	0.9	4.13	5.09	6.05	5.98	6.73	1	1	1	1	2
52	1.66	3.29	0.34	0.19	1.43	10.79	8.41	11.39	15.44	7.07	0	0	0	6	0
53	2.61	2.03	0.5	0.03	2.3	1.75	6.14	5.48	10.1	3.17	0	2	1	2	1
55	10.27	7.71	9.04	0.31	0	0.15	0.14	0.4	0.57	0.21	1	2	1	1	1
56	0.56	1.81	1.21	1.36	0.33	8.05	5.23	3.63	6.81	7.45	3	1	0	0	2
57	0.99	1.19	1.76	0.59	0.13	3.04	2.1	1.41	1.27	3.27	1	1	1	1	2
58	0.27	0.84	6.43	4.77	0.47	9.27	5.9	4.06	7.52	6.3	3	2	0	0	1
60	3.84	3.32	5.05	5.4	4.04	2.55	7.03	1.18	2.96	1.75	0	2	0	3	1
61	0	0.05	2.37	4.41	1.62	6.15	11.19	3.83	3.41	2.43	0	0	5	0	0
62	2.67	0	1.4	3.67	3.04	0.75	2.95	1.81	1.6	1.41	0	2	3	1	0
64	1.2	0.5	0	1.68	4.36	3.77	5.72	10.1	4.43	4.06	2	1	1	1	1
65	0.61	0.01	1.03	1.39	5.02	3.65	3.55	8.5	2.36	2.12	2	0	4	0	0
66	1.81	0.48	1.15	1.4	1.58	3.85	4.73	7.92	8	5.71	0	1	2	2	1
67	1.6	0.88	0.7	0	1.22	6.07	3.36	2.92	5.87	3.76	2	3	0	0	1
68	1.65	4.64	0.32	0.52	0.73	3.23	4.83	3.66	5.46	3.18	1	2	0	2	1
71	2.44	2.17	3.82	0.74	0.11	3.59	2.25	2.28	4.63	7.71	1	0	0	1	4
72	0.22	1.45	2.02	0	0.34	6.16	2.62	2.79	7.14	3.55	2	0	2	2	0
73	0.26	3.13	6.75	1.03	0	7.87	5.64	2.41	5.34	7.54	2	0	0	3	1
74	0	2.96	3.31	1.15	0.38	5.28	5.77	2.3	5.76	6.21	1	3	0	0	2
75	3.31	3.85	6.7	0.44	0	3.5	4.92	0.87	2.35	2.44	1	3	1	1	0
76	0.3	0	1.51	1.79	0.66	9.19	5.39	4.08	11.56	6.17	1	0	0	4	1
77	1.41	0.22	0	6.47	1.08	12.66	7.41	8.04	10.83	8.54	2	0	0	3	1
78	0.75	0	1.2	3.19	2.41	5.59	7.76	6.06	7.43	4.59	1	2	1	2	0
79	13.23	0.37	0	0.9	2.87	0.28	2.47	6.7	4.69	3.42	0	1	3	1	1
80	2.29	0.26	0	0.86	1.21	3.95	6.86	8.15	4.34	6.51	1	3	1	0	1
81	1.79	0.69	0.29	2.44	5.2	2.13	6.46	5.55	3.63	0.52	0	0	0	6	0
82	3.7	4.59	0.54	1.35	1.67	1.65	1.35	0.96	1.63	1.66	2	1	0	1	2

83	3.66	9.47	0.18	0.02	7.34	4.06	4.28	9.71	9.02	7.7	0	0	1	5	0
84	2.31	11.99	0.53	0	1.53	3.59	0.28	1.77	3.92	3.6	2	0	1	1	2
85	1.88	2.06	0.83	3.21	7.1	1.88	2.91	3.3	4.37	3.14	0	1	1	2	2
86	0.95	1.36	2.5	0.08	0	4.59	4.13	7.72	6.08	3.33	1	1	4	0	0
87	0.93	2.06	2.64	0.36	0.63	2.86	2.81	1.6	4.43	1.88	0	2	1	3	0
88	1.17	2.15	2.63	1.52	1.72	3.66	1.77	1.36	0.84	4.56	0	1	1	1	3
89	1.15	0.74	1.9	1.57	0.22	8.11	7.28	9.57	4.61	7.15	1	1	2	1	1
91	0	0.27	2.4	1.77	4.26	8.51	8.49	8.14	6.84	6.01	1	1	1	2	1
92	0.38	0.22	0	1.82	0.57	2.84	5.43	4.01	1.13	3.5	0	3	1	0	2
93	1.49	2.34	2.79	5.6	0.28	6.91	4.11	5.47	5.41	4.47	1	1	1	2	1
94	1.45	0.1	3.83	5.83	2.86	1.8	0.5	0.5	0.85	0.7	2	0	3	0	1
95	1.37	0	0.23	0.56	0.76	4.19	7.79	7.67	4.16	4.45	0	3	2	0	1
96	1.51	1.11	0.11	13.1	7.64	5.43	7.55	10.66	4.92	5.28	2	0	1	2	1
97	1.86	0.94	0.32	0.57	1.67	5.66	6.01	3.34	4.23	3.94	2	2	1	0	1
98	1.28	4.56	0	0.55	0.85	7.78	2.75	4.28	8.1	5.99	2	0	0	3	1
99	1.86	1.2	0.95	0	1.63	4.97	8.15	4.6	4.22	4.9	0	4	1	0	1
100	2.17	6.46	1.14	0.07	0	13.19	7.82	9.14	14.55	12.92	2	0	0	2	2
101	7.33	1.55	2.87	0.2	0.5	1.57	3.81	2.05	1.12	1.47	1	3	0	1	1
102	5.07	2.22	2.85	7.99	0.11	3.74	6.42	4.18	4.92	2.35	0	3	1	2	0
103	0	1.29	19.45	2.44	0.49	3.48	2.02	1.12	1.2	2.01	2	3	1	0	0
104	10.85	12.4	9.49	14.13	10	4.56	2.31	2.64	1.12	3.73	1	1	1	0	3
105	0.11	1.71	1.31	2.47	0	7.4	4.63	5.28	3.06	7.34	2	1	1	1	1
106	6.32	3.91	4.48	5.73	26.88	0.08	0.94	0.87	0.3	0.08	0	2	3	1	0
107	12.35	9.09	4.69	1.1	0.93	0.17	0.25	0.43	0.53	0.17	2	1	2	1	0
108	0.91	0.45	0	2.63	3.01	7.81	7.64	9.77	6.72	5.51	2	0	2	1	1
109	1.05	2.28	1.88	0	0.81	4.53	2.41	6.86	8.79	4.23	1	0	2	2	1
110	3.12	0.44	0	1.36	1.79	2.21	4.39	5.26	5.05	2.55	1	2	2	1	0
111	1.74	2.29	1.07	0.02	0.41	2.51	3.16	2.01	6.74	4.34	0	1	2	2	1
112	4.51	0.92	0.6	0	1.47	0.8	1.07	4.42	4.15	1.86	1	1	2	2	0
113	1.85	2.16	0.76	0.33	0.2	4.64	2.83	3.28	14.02	5.62	0	0	0	5	1
114	0.56	0.86	1.46	1.32	0.07	7.24	8.31	7.99	9.64	9.66	1	1	1	2	1
115	0.62	2.5	1.49	0	0.4	7.78	2.51	2.98	4.83	9.35	2	0	0	1	3
116	0	0.95	1.62	2.75	0.72	1.74	2.58	1.53	0.2	0.8	2	1	3	0	0
117	2.3	1.53	1.75	0.73	0.08	2.9	4.38	3.32	5.35	3.16	0	2	1	3	0
118	0.03	2.28	2.74	5.39	0.28	3.02	4.23	4.69	4.7	4.26	1	3	1	1	0
MEANS	2.352803738	2.285420561	2.230093458	1.942616822	2.201869159	4.454672897	4.496915888	4.281495327	4.812056075	4.487850467	1.074766355	1.205607477	1.196261682	1.38317757	0.962616822
STD DEV	2.720987541	2.717678074	3.3867933	2.510286512	3.386749466	3.025602175	2.555250758	2.666549535	3.504884392	3.331019456	0.948692592	1.19541828	1.200937152	1.364266752	1.008690854
STD ERR	0.263047794	0.262727856	0.327413666	0.242678557	0.327409429	0.292496002	0.247025415	0.257785074	0.338829963	0.322021805	0.091713575	0.115565447	0.116098977	0.131888645	0.097513825

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