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Understanding Individual Color Perceptions within Print and Digital Media

Morgan Haskins
Western Michigan University, mhaskins325@gmail.com

UNDERSTANDING INDIVIDUAL COLOR PERCEPTION WITHIN PRINT AND DIGITAL MEDIA

By:
Morgan Haskins
Graphic & Printing Science, Department of Chemical and Paper Engineering

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Thesis Committee:
Paul D. Fleming III, Ph.D., Committee Chair
Department of Chemical and Paper Engineering

Alexandra Pekarovicova, Ph.D.,
Department of Chemical and Paper Engineering

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Morgan S. Haskins
Western Michigan University

Color is a subjective attribute that is seen differently by each individual and this research is intended to build upon the subjective nature of color perceptions. This research aims to determine the effect of subjectivity on print and digital design and of extended gamut printing and effective color management on color perception. The significance of understanding color perception is directly applicable to consumer perception of designs using color. If designers want their brand to be immediately recognized and be positively accepted, they must be able to accurately reproduce their brand colors with little to no color difference and be able to understand the way it will resonate with consumers. In order to better understand color differences and color perception, the studies to be carried out within this research will explore how one's experience leads them identify colors in a certain way, how true colors are identified differently by different people and how extended gamut printing can affect color identification. It is hypothesized that extended gamut printing will help decrease subjectivity gaps between the participants and that each participant's experience will lead them to name colors differently, however, it is likely that a few individuals could name colors in the same way as well.

The outcomes of the research objectives found that prior knowledge, emotional response, and personal experience are factors that had an effect on participant ability to name colors, the use of an extended gamut printer did create a smaller gap within the subjectivity of color identification, and participants did not have any visions deficiencies when tested.

ACKNOWLEDGMENTS

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I would also like to acknowledge and thank Dr. Alexandra Pekarovicova who purchased the Farnsworth D-15 test by XRite so that I could use it in my research. Her support and help allowed me to provide some depth to this project that I wouldn’t have had otherwise.

My final thanks goes to the Lee Honors College, where I was able to find my place and learn so much during my time at Western Michigan University. The assistance and encouragement that I received from several LHC staff members has helped me realize my full potential and has made my undergraduate experience very memorable and valuable.

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CHAPTER 1

INTRODUCTION

Introduction

It is well known that colors are perceived differently by each individual who observes them (Macdonald & Mylonas, 2018). The purpose of this research is to determine if, why, and how those perceptions can be improved through extended gamut printing and effective color management and to understand how experience and prior knowledge influence color identification. Extended gamut printing is a printing method that goes beyond a four color CMYK process in order for a printer to be able to print a wider range of colors (Politis et al., 2015; Pekarovicova, Chovancova-Lovell, & Fleming, 2011). The extended gamut printer that will be used for this project will be the Epson SureColor P5000. It will be used to test the benefits of extended gamut printing and to test if printing with a wider range of colors helps lessen the perceivable color difference on print designs. Aside from the print medium, this project aims to explore color differences within digital designs as well. To do this, explorations in color management will be carried out in order to test color perception within digital design. Color management is a process used to control color conversions between various devices. For this project, proper color management needs to be obtained for a desktop monitor in order to be able to test color perception within digital media (display and printer). Another comparison between color perception within print and digital will be carried out through the implementation of the Farnsworth D-15 Test (provided by XRite) and the XRite Hue Test that will provide a basic understanding of color identification and defects. The ultimate goal of this research will be to understand what factors influence color identification from person to person and to see if using an extended gamut printer and corresponding printer profile help lessen the perceivable color differences within those individuals.

Statement of Problem

Color is a subjective visual attribute as individuals perceive colors differently. Due to inherent variation in physiological responses to visible wavelengths, having a standard nomenclature of color is close to impossible. In turn, designers face a difficulty when trying to communicate through their work with color, be it in print or digital media. By establishing an understanding of the subjectivity of color perception, mitigating steps can be taken to improve the clarity of messaging. This analysis will determine if extended gamut printing and correctly utilized color management are viable solutions for bridging perception gaps within and between print and digital media.

Research Objectives

This study will investigate why certain individuals perceive colors within print and digital designs differently. It is predicted that using an extended gamut printer with a wider range of ink colors for print designs and correct color management for digital designs will provide less color variation for research participants to choose from when identifying colors. Research goals for this project can be broken down into three parts. First, an exploration of the factors that affect color identification will be conducted. These factors include things such as a participant's experience, background knowledge, emotional response, or physical objects that are brought to memory. Second, an extended gamut printer will be used to print samples for identification that will be tested with participants to discover if this can create a smaller gap in the subjectivity of color identification. Finally, color vision and deficiency tests will be carried out to determine if any of the participants suffer from color vision defects.

Significance

Variances in color perception can cause issues for designers attempting to create designs that carry a unified message. However, an understanding of those differences in consumer perception and of prospective methods of reducing this variation can allow for more efficient communication. This efficient communication becomes especially important in colors that are used for marketing campaigns or logos. It is imperative for brands to be universally recognizable and in order for them to be perceived by large and diverse audiences, visual identities must be created in uniformity.

CHAPTER 2

BACKGROUND

Understanding Color and Vision

In order to understand color, first it is important to understand the basic principles of vision. Vision is the sense predominated by the eyes that allows for the perception of the position, qualities, and movements of objects before them (Choudhury & Kumar, 2014). Light is absorbed by light sensitive cells within eyes where those signals are passed on to the brain, and that is where perceptions are formed (Choudhury & Kumar, 2014). Specifically, color vision is a human's ability to correctly characterize lights and objects upon the basis of certain spectral properties. However, there are people who cannot correctly identify light and color because they have a specific type of color blindness. Besides those individuals who are color blind, what causes the identification of colors to be so acutely subjective? Color perception is a psychological phenomenon where each person experiences color differently. For example, one person may see a color as red and other as orange.

Differing color opinions arise because color is an external stimulus encoded within the brain as a visual percept then matched against an extensive library of color percepts in long-term memory (Macdonald & Mylonas, 2018). Therefore, if one person has a larger long-term memory and if for example, (s)he is older than someone else, the longer lived experience allows for a larger library of color terms to pull from. An index within that library then enables a word or phrase to be retrieved from their color lexicon (Macdonald & Mylonas, 2018). Those names act as a label for a region of the CIELAB color space, which causes uncertainty since different people have a different understanding of where color regions and boundaries lie within a color space.

The main reason for the uncertainty within color vision is because there is a genetic variation in the spectral sensitivity of retinal photoreceptors, meaning that no two people have exactly the same physiological response to wavelengths in the visible spectrum (Macdonald & Mylonas, 2018). This creates metamerism between different people because they will never be able to completely agree on a match between a metamer pair of colors, which solidifies the idea that there is no such thing as a true CIE Standard Observer. No two people will ever completely agree on the identification of the appearance of two similar colors that have different spectral composition, so having a standard observer is an incredibly unlikely scenario that will lead to uncertain results.

There are approximately four million colors discernable by the human visual system and in any language only a few thousand words or phrases that can be used to describe them (Macdonald & Mylonas, 2018). The mental process of converting color stimuli into color names is carried out through a many-to-one mapping process, with a thousand-fold reduction in the number of elements that can be named (Macdonald & Mylonas, 2018). That process can also increase or decrease the ability of an individual to identify certain colors depending on the background knowledge of each individual. This categorical structure is how the brain operates when trying to name colors and works as a cognitive architecture (Macdonald & Mylonas, 2018). Therefore, this demonstrates that color identification is influenced by the viewer's experience and through the extent of their archive of color precepts.

The Appearance of Color

Color appearance is fundamentally influenced by the geometry of an object's illumination, shape, and reflectance properties, where color is determined by the parts of the incident white light that is reflected or transmitted without being absorbed (Choudhury &

Kumar, 2014). Color appearance cause individuals to judge whether an object is old, new, worn, fresh, appealing, or ugly and create perception based on first impression. Research has shown that appearance is one of the most important aspect that humans consider when determining the quality of an object (Choudhury & Kumar, 2014).

Understanding Extended Gamut Printing

The appearance and perception of colors can be viewed and studied by using an extended gamut printer. Extended gamut printing is a multi-color printing process that expands the range of colors beyond a standard four-color CMYK process. Typical extended gamut configurations include CMYK + Orange + Green (Hexachrome), or CMYK + Orange + Green + Violet (Heptachrome). This past decade has brought about the emergence of some of the most innovative multicolor processes, such as Pantone's Hexachrome system, HICOS 7800 Huber Intelligent Color Systems, and HIT Highly Improved Technology (Politis et al., 2015). The addition of an extended gamut range beyond CMYK helps printers achieve more colors and produce better results, which is why extended gamut printers are the right tool for measuring color subjectivity. A few reasons as to why printers find it challenging to adequately utilize extended gamut technology is that it is difficult to achieve proper separations for prepress and printing as well as the implementation of color management systems and efficient workflows (Politis et al., 2015).

Color Management

Effective color management systems also help individuals perceive color more accurately. It is of the utmost importance for artists to specify which Working Space was used in their color settings, since correct color reproduction can only be achieved if the Working Space and Color Settings have been adjusted per each device to match the original settings used by the artist (Abildgaard, 2016). When choosing RGB working spaces for example, there is a distinct difference between Adobe RGB and sRGB within the Adobe Creative Suite. Adobe RGB has a 1.2 million color gamut volume and sRGB has an 830 thousand color gamut volume, which represents the number of colors that can be reproduced within a color difference tolerance of $\sqrt{3}$, thus choosing Adobe RGB would provide a wider range of colors that an observer could identify (Chovancova-Lovell, and Fleming 2009) Along with RGB working spaces, artists have the ability to specify the color settings in their document as either CMYK, RGB, HEX, or Pantone values. Each choice would produce different results when printing or publishing in a digital environment. It is paramount to use correct color management within a workflow and to always specify which working space is being used and what color settings are being utilized. Brand color specifications for reproduction are often given for an unknown screen technology on an unknown printer technology using an unknown substrate, and each can create entirely different results if not taken into consideration (Abildgaard, 2016). This makes it important to provide color specifications because not providing them can yield different reproduction results, and individuals would not be able to perceive color correctly since the results would be entirely different colors altogether.

Culture and Color

Color perception varies across entire populations. Communication between members of a community can provide a shared implicit agreement on the meaning of a color name, and individuals also have mental prototypes for particular names (Macdonald & Mylonas, 2018). For example, when asked to picture a blue, that version is likely different than what another individual pictures with this gap widening if the individuals come from different cultures. This phenomenon, as well as with instances where individuals attempt to name a color, can be explained by the Sapir-Whorf Hypothesis (Macdonald & Mylonas, 2018). This hypothesis explains the relationship between linguistic and cultural concepts and how memory and the behavior of culture members has an impact on how those members think and behave.

However, not only does these inherent differences cause variances in color identification and naming, but gender does as well. Girls can also name colors better than boys early on in childhood, and women often use more elaborate vocabulary words to name color than men do (Macdonald & Mylonas, 2018). Learning about color early on allows individuals to relate certain color stimuli to descriptive terms that often change from place to place depending on upbringing (Choudhury & Kumar, 2014). Colors can also curate strong symbolic meanings that have been rooted in a population's tradition. A color like purple can be associated with royalty, dignity, or authority, while a color like green can represent nature, jealousy, or fertility, all dependent upon upbringing. The symbolic nature of color create standard relationships between stimuli and resulting perceptions where neural correlates exist in the brain (Choudhury & Kumar, 2014).

Certain patterns in cognition also suggest that everyday life and environmental cues heavily influence human judgement and decision making. Two societies that share similar values, self-view, and language, but differ in everyday environments can still cultivate significant psychological variations (Jiang et al., 2014). According to research carried out by researchers from the Central University of Finance and Economics, the University of International Business and Economics, and Peking University, individuals from mainland China were found to both implicitly and explicitly associate red with up and green with down, whereas individuals from Hong Kong were found to do the opposite (Jiang et al., 2014). Taken as a whole, an individual's judgement and perception of color cannot be separated from their unique and culturally significant environmental cues.

Understanding Graphic, User Experience, and User Interface Design

Color is used by graphic designers and User Experience/User Interface designers (UX/UI) alike in order to convey meaning and enhance the interactions between a user and a product. Color can be an "effective and universal communication language within different cultures for expressing ideas and delivering messages in the modern user-oriented business context" (Nacheva, 2019). The main goals of a graphic designer are to communicate through visual design, layout, and aesthetics while UX/UI designers study the behaviors and motivations of brand consumers to create meaningful digital experiences. There are also specific color guidelines that designers follow so as to provide consistent color reproduction across brands and platforms. For example, graphic designers follow color management guidelines whereas UX/UI designers follow Web Content Accessibility Guidelines (WCAG) (Jung, 2018)**.** Color is not only a design tool, but a communication mechanism that can elicit different responses if used incorrectly.

Branding and Brand Colors

One of the most important uses of color is to create brand identities or visual identities that are used to represent companies. Brand owners care strongly about the messages being conveyed with their brand colors that are used to symbolize its identity, emotions, and the inner values of the company, while also creating recognizability (Abildgaard, 2016). A challenge designers face is attempting to reproduce brand colors. Brand colors can be found in a style guide or brand guide and their technical specifications are often given as Pantone, CMYK, RGB, or HEX codes. This causes reproduction to be inconsistent, since brand guides do not tend to specify a working space or discuss color management techniques (Abildgaard, 2016). To avoid these divergences, a brand guide needs to include information on a brand color's "master values" in CIELAB as well as any acceptable deviation tolerances and information about reproduction in other industries, technologies, and color systems (Abildgaard, 2016). Consistent color is important because consumers ultimately have a choice between products and tent to buy what looks best as they perceive it to have the highest quality.

The Farnsworth D-15 Test & Color Vision Defects

XRite Pantone has created the Farnsworth D-15 Test in order to implement a quick vision screening process. This test is not intended to generate an in-depth study of color vision defects; however it can be used as a benchmark. Individuals who are successful with this test will have little difficulty in differentiating color differences within an everyday environment. Normal color vision is dependent on the existence of three types of nerve cells within the retina of the eye, which are the red, green, and blue receptors (XRite). When the receptors mix together, colors are seen. If any of the receptors are “missing, partly missing, non-functioning or partly non-functioning, the individual’s color vision will not be normal” (The Farnsworth D-15 Test). Color vision where one receptor is missing creates lines of colors that all look the same to an individual with non-functioning receptors. Vision defects can be categorized as protanopia, deuteranopia, tritanopia, and anomalous trichromatism. Protanopia is a defect where red receptors are missing/non-functioning and the individual sees colors as a mixture of blue and greens only. Deuteranopia is a defect where the green receptors are missing/non-functioning and the individual confuses blue-green, gray, and red-purple. Tritanopia is a defect where the blue receptor is missing/non-functioning and the individual confuses blue and green. These three defects are together called dichromatisms, meaning only two types of receptors are used (XRite). Anomalous trichromatism is a defect where a receptor group is only partly missing or partly non-functioning and “there are three types of receptors in use, but they occur in abnormal proportions and the resulting color visions is not, therefore, normal" (The Farnsworth D-15 Test). All of these types of color defects are inherited and are more common in men than in women, caused by a sex-linked, recessive gene (XRite). According to XRite, "about 1 in 12 males and 1 in 250 females have some form of color defectiveness" (The Farnsworth D-15 Test).

Color Perception & Light

Light has one of the biggest influences on how humans see colors. Since objects themselves do not actually have color, the mixture of "reflected light that enters our eyes" is what is perceived as color, and different lighting conditions cause the same color to appear altered (XRite Color). Our brains have also learned how certain objects should look. An example of this is identifying the color white in everyday objects. Pages of magazines, newspapers, and printer paper are all white, but when laid next to each other, each white is different. The newspaper will probably be yellower than the others and the printer paper will appear the brightest. This is because "our eyes tend to capture the brightest part of the scene, call it white, and judge all other colors relative to this "bright-level" (XRite Color).

CHAPTER 3

EXPERIMENTAL

This experimental setup was modified in order for it to be completed in a purely remote environment, since there was restricted access to Parkview Campus during this time period. Remote interviews were carried out through Google Hangouts and screen sharing techniques were implemented in order to allow for proper color identification within parts 1 and 2 of the experiment. Prior to interviews, time was spent creating a printer profile for the Epson SureColor P5000 which was applied before printing the extended gamut sample shown to participants. The printer profile was also applied within the Adobe Illustrator and Photoshop files where color patches were created and saved before showing to participants. A Research Plan & Discussion Guide was created and followed in order to optimize time and have a consistent procedure that is outlined as follows:

Research Plan and Discussion Guide *(Step-by-step guide followed during remote interviews)*

Methodology:

The focus was on research participants who sign up to participate in this study and who were recruited to participate. Interviews took place from 3/19/20-4/3/20 and a total of fifteen research participants signed up to partake. Participants were asked to answer questions about color identification as well as demographic questions about themselves. Each participant was asked to sign a consent form agreeing to the terms of the study and each form will be collected prior to the completion of the interview. Each session lasted about 30 minutes or less.

Discussion Guide

Introduction:

Thank you for taking the time to participate in this study. Before we get started, I ask that you take a look over this consent form and let me know if you have any questions about it or the study in general. If after reading it you no longer want to participate, that's completely fine. Or if there are no questions and you still wish to proceed, go ahead and sign your name on the last page. If you have the ability to electronically sign it, please do. If not, print out the last page, sign it, and email it back. To provide you with some background before we get started – this study is going to help further the understanding of how colors are perceived differently by different people with different experiences and backgrounds. What may seem like a specific color to you could be completely different in the eyes of another observer. Color printing can also be improved by the use of an extended gamut printer, which prints using colors beyond the 4-color process CMYK and expands the range of colors that observers can see. Since color is such a subjective medium, this research is going to help decipher some of those gray areas. Any questions at this point? Keep in mind that there are no wrong answers. Answer each question as honestly as you can and focus on your first impression or instinct if you feel stuck.

Discovery

Part 1: First, take a look at this color patch on the screen (Pantone 208C is shown). Look at it for as long as you need to in order to answer these questions, however, I encourage you to provide answers based on your first impression or instinct, since that will be the most helpful. After each question, enter your responses into the questionnaire I've sent to you.

1. What is the name of the color patch in front of you? Please provide the first answer that comes to mind.

2. Why did you choose to name the color in the way that you did?
3. What does this color make you think of?
4. On a scale of 1-5, with 1 being definitely not and 5 being definitely yes, is it likely that you chose to identify that color in that way because it makes you think of a particular object?
5. If so, what object do you associate this color with?
6. On a scale of 1-5, with 1 being definitely not and 5 being definitely yes, is it likely that you chose to identify that color in that way because you link this color to a particular experience/memory/emotion?
7. If so, and if you feel comfortable disclosing, what experience/memory/emotion did you link to this particular color?

Now please answer these three demographic questions.

1. What ethnicity do you identify with?
2. What gender do you identify as?
3. What region of the United States did you grow up in? (Midwest, West Coast, etc.)

Part 2a: Now take a look at this grid of color patches consisting of 25 different Pantone shades of blue. Take a look at it for as long as you need to, but again, your first instinct will prove to be the most important answer and there are no wrong answers.

1. Out of all the blues on this grid, which is the truest blue to you (i.e. which blue would you pick if someone asked you "what is blue?") Type in which Pantone you pick.

Part 2b: Next, shown before you is the same grid of color patches, but this time I've printed them out (High resolution images taken inside of a light booth were shown to participants since these prints could not be shown in person). Again, look at them for as long as you need to.

Participants were not told which was the four-color sample and which was the extended gamut sample.

1. For this sample (four-color sample), which is the truest and best looking blue to you? Type in which Pantone you pick.
2. For this sample (extended gamut sample), which is the truest and best looking blue to you? Type in which Pantone you pick.

Part 3a: Next, complete a simple color vision test called the Farnsworth D-15 Test. This test is designed to be carried out in-person but was completed by participants over Google Hangouts. Video quality, vision perceptions, and errors will be discussed in Results and Conclusions. The procedure is as follows:

1. First, find the pilot cap. This is the only cap that won't move from its place and should be on the left-hand side of the test instrument.
2. Next, select the cap that is the closest possible match to the pilot cap. Place your choice to the right of the pilot.
3. Then find the closest color match to that cap and so on.
4. Continue to choose caps in this way until a sequence of colors has been built up.
5. Take your time, but ideally this test should be completed within a couple of minutes.

Part 3b: Finally, complete a digital version of the Farnsworth Test so that informal comparisons can be made.

1. Visit https://www.xrite.com/hue-test
2. On this screen, there are 4 color tests, where each end has a fixed color patch.
3. Drag and drop the colors to arrange them by hue.
4. Score your test to obtain your results.

Facilities & Equipment Needed

The following list includes the facilities and equipment necessary to complete the outlined experimental procedures from above:

Facilities

- WMU College of Engineering and Applied Sciences Computer Lab (C-220)
- If lab access is restricted, any location with adequate WiFi will suffice

Laboratory Equipment

- iMac desktop computer or MacBook Pro Laptop
- i1 Profiler and i1iO software
- X-Rite eXact Spectrodensitometer (CIELAB measurements)
- Epson SureColor P5000 printer
- Adobe Illustrator/Adobe Photoshop (Free to use with departmental license)
- Qualtrics survey software (Free for WMU student use)
- Paper/Ink
- Farnsworth D-15 Test

CHAPTER 4

RESULTS AND DISCUSSION

Part 1

The data collected from this part of the research confirmed the validity of the Sapir-Whorf Hypothesis, which explains how experience and culture have an effect on the linguistics one uses to identify certain objects. Despite a homogenous study population, it was found that each participant relied on background knowledge and their own experience to serve as the basis for color identification. Each of the 15 participants were asked to name the color patch shown in Figure 2 and the distribution in Figure 1 shows how frequently each color identification term was used. The general consensus for five out of the fifteen participants was that Pantone 208 C is burgundy, however, each person had a different reason for why they chose to identify it as such. Reasons varying from "this is the color of a shirt that my roommate owns" or the color experiences "[a] strong presence of red with subtleties of brown" or even "it reminds me of the richness of wine". No two responses were the same. For the rest of the participants, knowledge and experience led them to identify Pantone 208 C as maroon, purple, grapeberry, magenta, cranberry, and wine.

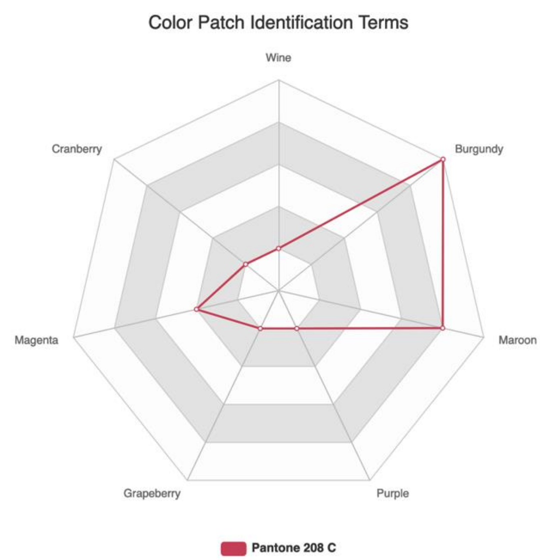

Figure 1: Frequency of Color Identification Terms

Identification in this sense had everything to do with experience and prior knowledge. If some of the participants knew nothing about wine or haven't seen the color of cranberries very often in their lifetime, then they don't have that knowledge base or exposure to those particular colors in order to identify Pantone 208 C that specifically. In response to a question asking participants if they chose to identify Pantone 208 C in these specific ways because they associated it with a particular object, 53.3% of them said "definitely yes". When asked if they chose to identify Pantone 208 C because they linked it to a particular experience, memory, or emotion, 33.3% of them said "probably yes". Gender also has an effect on the identification of colors as well, which was proven within the data collected. Typically, women tend to be more descriptive in their use of identification terms and reasoning for identifying color in a specific way. For example, one female participant had a lengthy explanation as to why she identified Pantone 208 C as burgundy. She stated that "I chose this name because the color does not look solely red or purple to me but somewhere in between. I also really like the color burgundy so any color that I see that is close to the actual color burgundy I tend to consider as burgundy as well." Whereas a response from a male participant was short and to the point, and he chose to use less descriptive language to identify Pantone 208 C, naming it purple, and when asked why he chose to name it that way stated, "because it looks purple." To him, he didn't need a reason to explain why it looked purple~~ but based on~~, rather his prior knowledge, experiences, and exposure to colors that resemble something close to Pantone 208 C led him to see it and immediately identify it as purple.

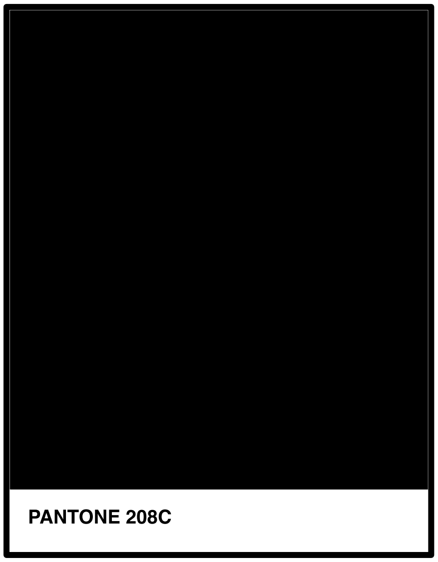

Figure 2: Research Pt. 1 Color Patch

Part 2a

During this part of the research, participants were presented with a grid of 25 different shades of blue as shown in Figure 4 and were asked to identify the truest blue (often phrased by a follow up question in the research as, if someone were to ask you simply "what is blue?" which of these would you pick?). The results from this are shown in the distribution in Figure 3 where there were four patches that participants gravitated towards, 2935 C, 293 C, 299 C, and 7460 C, however, there was not one "true" blue. This is also an instance of confirming the Sapir-Whorf Hypothesis, where exposure and experience to specific shades of blue can alter the way they are perceived once placed in front of a participant. The fact that there was not one blue that was chosen by all participants as the "truest" blue, proves the subjective nature of this type of color identification.

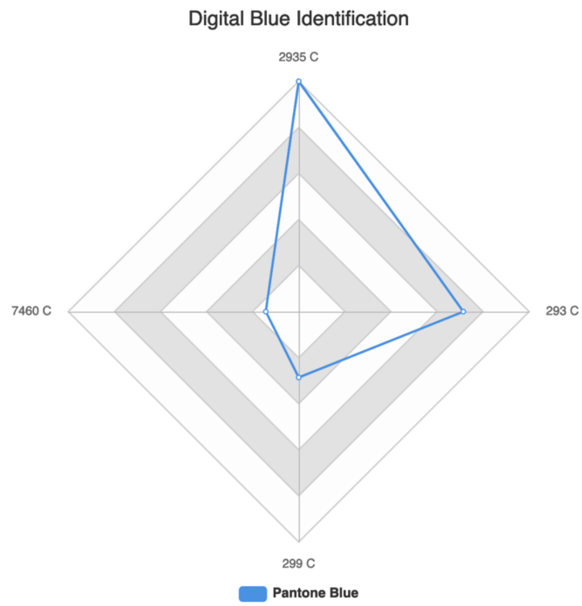

Figure 3: Frequency of Truest Blue Identification

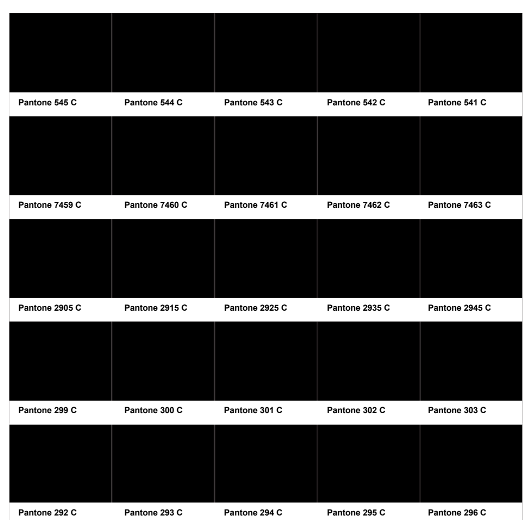

Figure 4: Pantone Grid of Blues

Part 2b

This part of the research had to be adapted in order to comply with the completely remote interview structure. Participants were presented with two printed out samples of the same color patches from Figure 4, however, one was printed using a four-color printer and one was printed using an extended gamut printer. Participants were not told which print corresponded to which printer and were asked to identify the "truest and best looking" blue on each print. The purpose of this question was to discover if using an extended gamut printer would decrease the number of choices that participants would identify as the "truest" blue, thus decreasing overall subjectivity. Results of the identification for the four-color print are shown in Figure 5 and the results of the extended gamut print are shown in Figure 6. The consensus between participants was that the "truest" blue on the four-color print was either 2935 C, 299 C, 7460 C, 2925 C, 300 C, or 7461 C and the choices narrowed once participants were shown the extended gamut print, since participants identified the "truest" blue as 2935 C, 293 C, 300 C, or 7461 C. Thus, proving that using an extended gamut printer decreases a participant's subjectivity gap, since this type of printer produces more accurate color results.

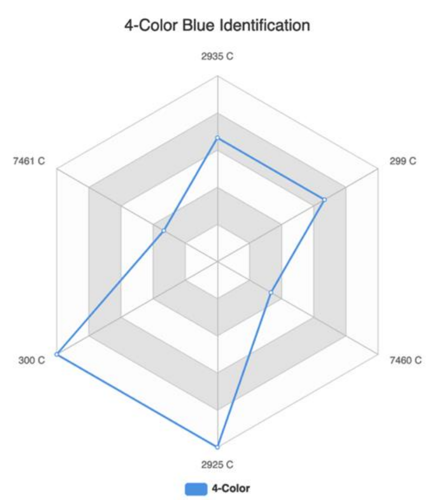

Figure 5: Frequency of 4-Color Blue Identification

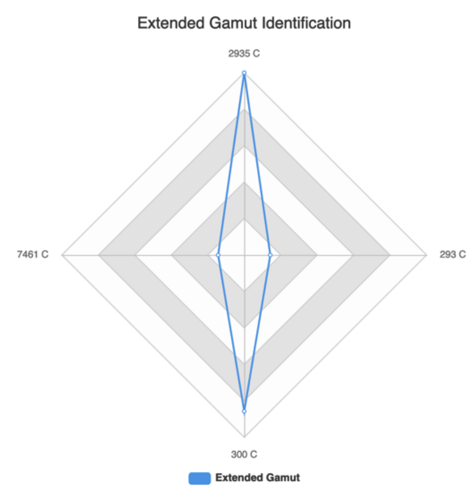

Figure 6: Frequency of Extended Gamut Identification

Figure 7: 4-Color Print

Figure 8: Extended Gamut Print

Figures 7 and 8 are photos of the four-color and extended gamut prints respectively and were taken with a DSLR camera within a controlled light box setup shown below in Figure 9. This environment was created in order to compensate for the lack of access to lab equipment and to provide participants with high resolution images in order to perform adequate color identification within a purely remote atmosphere.

Figure 9: Lightbox Set-Up

Part 3a

This part of the research asked participants to complete the XRite Farnsworth D-15 test. This test is meant to be a color vision screening test that looks for color defects. Results and raw data can be found in Appendix A in Figures 1A-15A. A complication that arose was trying to complete this within a remote interview setting and relying on looking through a webcam to move the color caps around. Each participant encountered their own issues ranging from a blurry digital picture, incorrect lighting affecting the appearance of the caps, and a smaller image if using a phone instead of a computer. Despite these challenges, 11 out of the 15 participants achieved a perfect score, which can be interpreted as not experiencing any color vision defects. XRite lays out in their procedure for the Farnsworth D-15 test that a re-test should be performed if the participant does not get a perfect score the first time, however, the unique circumstances and slight variations within the 4 out of the 15 participants that did not achieve a perfect score can be attributed to a difference in computer screen profiles and blurry images that altered the direct appearance of the color caps. This test was meant to be carried out in a face-to-face environment but was completed within remote interviews to compensate for the lack of access to University labs.

Part 3b

This part of the research asked participants to take the XRite Hue Test, which is a digital version of the Farnsworth test that can be found on the XRite website. Results are shown below in Table 1 with 11 out of the 15 participants achieving a perfect score of zero which can be interpreted as having no color vision deficiencies. To interpret the accuracy of these results, it is also important to keep in mind that this test was meant to be administered in a controlled environment on a profiled monitor in C-220 but was modified in this remote interview to be taken on each participant's personal laptop. Administering the test in this fashion could lead to unexpected results since not every laptop is profiled the same way and each participant's environment around them, including how tired they were at the time of the test, also has an effect on the accuracy of this test.

XRite Hue Test	
Participant	Score
1	0
2	2
3	0
4	4
5	2
6	4
7	0
8	0
9	0
10	0
11	0
12	0
13	0
14	0
15	0

Table 1: XRite Hue Test Results

Four-Color Printing vs. Extended Gamut Printing

Prior to performing remote interviews with participants, a printer profile was created using the Epson SureColor P5000 and the prints in Figure 7 and 8 were tested for color differences (ΔE). The gamut plot for the printer profile is shown below in Figure 10 and Figure 11 shows the RGB chart used to build the profile. It was applied to the extended gamut patches before printing. The color differences between the four-color print and the extended gamut print can be found in Table 2A in Appendix A and the CIELAB values were found using an XRite i1iO Spectrodensitometer. These ΔE's range from 5.12-32.95, with a mean of 12.62 and a standard deviation of 6.36, which means that the differences in color are perceptible with the human eye and become very apparent once these two prints are placed side by side.

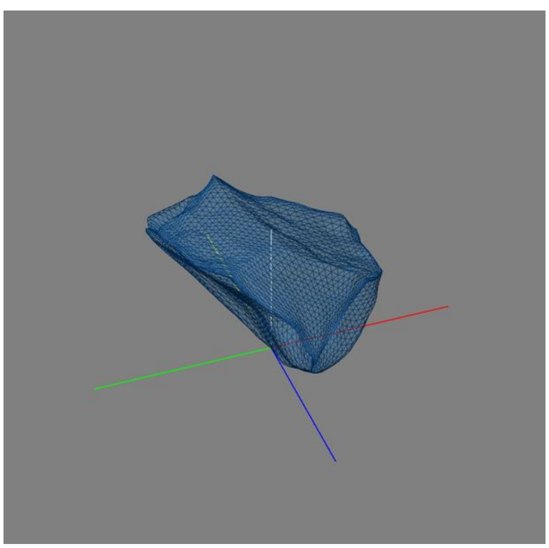

Figure 10: RGB Gamut Plot

The CIELAB values of the blue patches were also taken digitally from within Photoshop and

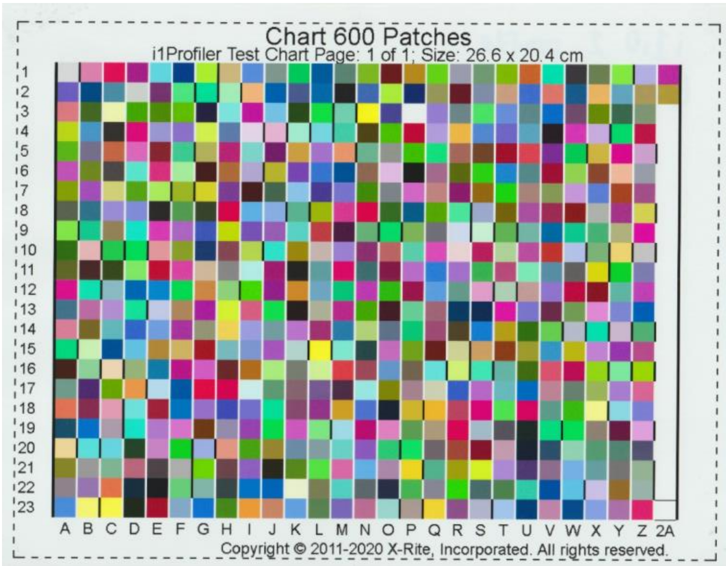

Figure 11: 600 Patch Printer Profile Chart

these values can be found in Table 3A in Appendix A. By gathering these values, this made it possible to calculate ΔE's between the digital patches and the 4-color print as well as between the digital patches and the extended gamut print. These values can be found in Table 4A and Table 5A in Appendix A respectively. The ΔE's between the digital patches and the 4-color print range from 1.11-27.11 with a mean of 10.78 and a standard deviation of 7.32 and the ΔE's between the digital patches and the extended gamut print range from 3.94-21.81 with a mean of 13.93 and a standard deviation of 4.03. Visually, the color differences between the digital patches and both prints are perceptible by the human eye, however, there is less of a deviation from the mean for the ΔE between the digital patches and the extended gamut print, which means that implementing a printer profile and printing with an extended gamut printer in fact does lessen the perceptible color difference.

CHAPTER 5

CONCLUSION

Final Conclusions and Implications

Factors that Effect Color Identification

Prior knowledge, emotional response, and personal experience are factors that had an effect on participant ability to name colors. Several participants named the provided color patch with terms they took from their own life experience, relating it to an object or memory. Certain implications can be made regarding participant identification results and the principles of vision and color perception. Since color opinions are based off of external stimuli within the brain, each participant experienced this differently, which allowed them to pull a color phrase from their long-term memory. This resulted in a variety of nomenclature used to describe Pantone 208 C. Color perception is also based on lighting conditions, which were varied for each participant as they used personal laptops and inconsistent lighting within their own homes.

Benefits of Extended Gamut Printing

The use of an extended gamut printer did create a smaller gap within the subjectivity of color identification. When presented with two prints, one from a four-color printer and one from the extended gamut printer, the list of patches used by participants to describe the "truest blue" decreased from 6 to 4. Extended gamut printers have a wider range of colors than standard four-color printers, which is a factor that contributed to a better quality print and more accurate color representation on the patches that were put in front of participants. Color management techniques were also utilized when the extended gamut printer was used to create a printer profile that was applied to the Pantone blue grid file before printing. Creating printer profiles helps to decrease the perceivable color difference by the human eye (ΔE), and this is a factor that contributed to participant identification of the “truest blue”. Using an extended gamut printer and color management are steps that brand managers and owners should be implementing within their art departments. Correctly carrying out these steps helps to lessen perceivable color differences that consumers see and also help to accurately reproduce brand colors. This creates unity within the brand and makes sure there is consistent communication of the brand’s message.

Color Deficiencies

Participants did not have any color vision deficiencies after being tested with the Farnsworth D-15 Test and the XRite Hue Test. If participants were successful with these tests, this means that they have little to no difficulty distinguishing color differences on a day-to-day basis.

Industry Applications

These findings do agree with the findings of other researchers within this field. Work done by Lindsay Macdonald and Dimitris Mylonas at the University College London was carried out to understand how color naming is linked to vision and speech. Part 1 of this study was carried out to understand these concepts as well. The following parts of this study that try to understand extended gamut printing and color deficiencies are directly related to the print industry as a whole and were put in place to understand how this equipment relates to color subjectivity. This research was not consistent with the accepted practices within the print industry simple because it had to be carried out remotely. Limitations with color profiles and lighting conditions are discussed below. It is suggested that the printing industry take the information that comes out of this study and improve upon it to better understand the deeper implications that come with print and the subjectivity of color identification.

Limitations

Two of the biggest limitations are the small number of participants and the lack of participant diversity. These two factors limit the data from being extrapolated to a larger population. There are also a few experimental limitations that can be addressed. The first limitation being the restriction of lab access and not being able to hold participant interviews at Parkview, which was difficult since these interviews had to be modified so that they could be carried out completely remotely. Two of the biggest challenges regarding the experimental setup in a remote environment come from having to show printed samples on a digital screen and carrying out the Farnsworth D-15 test on a webcam. These tests were obviously supposed to be carried out in the lab within a controlled environment, so these factors could have had an effect on the results. Another issue comes from the fact that during each interview, each participant was using their own personal laptop, and in one case a smartphone, in order to answer interview questions. Each person was relying on the default color profile that their computer was using as opposed to being in the lab and using a correctly calibrated monitor. There were also some broader technological issues ranging from blurry webcam quality to poor Internet connection to different lighting conditions that could also have had an effect on the participant's ability to identify colors.

Recommendations

A few recommendations for future considerations of this research would be to carry out the experimental procedure within a controlled environment where the monitor can be profiled, and the lighting is consistent. Even though accurate results and conclusions can be derived from the data that were collected, having a controlled environment would contribute to more dependable results. Another suggestion would be to recruit a larger number of participants and to have a greater diversity of participants; more men and more participants from different backgrounds and ethnicities.

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APPENDIX A

Pt. 1 Pantone 208 C				
Sample	**L**	**A**	**B**	
208 C	32.00	47.00	8.00	
	R	**G**	**B**	
	138.00	30.00	65.00	
	C	**M**	**Y**	**K**
	33.00	98.00	60.00	27.00
	#			
	8a1e41			

Table 1A: Color data collected from Pantone 208 C

Print EGP CIELAB Values				Print 4 Color Print CIELAB Values				
Sample	**L**	**A**	**B**	**Sample**	**L**	**A**	**B**	**ΔE**
545 C	77.99	-5.32	-8.73	545 C	82.74	-7.12	-9.36	5.12
544 C	76.56	-5.30	-11.63	544 C	81.33	-7.54	-11.93	5.28
543 C	70.90	-8.24	-17.53	543 C	75.79	-11.59	-19.59	6.28
542 C	60.89	-9.52	-23.96	542 C	64.51	-14.12	-24.34	5.87
541 C	19.83	-6.63	-34.77	541 C	30.85	-10.99	-31.53	12.29
7459 C	52.26	-16.17	-22.36	7459 C	52.96	-22.50	-15.69	9.22
7460 C	41.89	-12.26	-34.70	7460 C	45.39	-19.80	-49.77	17.21
7461 C	41.66	-12.27	-39.81	7461 C	44.11	-18.75	-48.94	11.46
7462 C	29.07	-7.09	-36.64	7462 C	37.15	-14.51	-40.11	11.51
7463 C	14.85	-4.92	-20.62	7463 C	24.77	-9.40	-20.79	10.89
2905 C	68.92	-12.46	-21.56	2905 C	74.08	-14.29	-18.23	6.41
2915 C	62.52	-15.49	-31.51	2915 C	63.79	-20.25	-28.96	5.55
2925 C	52.81	-12.79	-40.99	2925 C	48.87	-22.95	-52.83	16.09
2935 C	30.18	-1.44	-61.03	2935 C	41.27	-13.23	-46.89	21.49
2945 C	25.19	-5.35	-48.98	2945 C	37.10	-12.90	-41.15	16.13
299 C	54.52	-13.52	-38.60	299 C	49.30	-23.02	-52.13	17.34
300 C	32.16	-5.90	-58.66	300 C	42.02	-12.92	-47.12	16.72
301 C	24.09	-7.54	-40.31	301 C	35.21	-11.57	-37.30	12.20
302 C	19.08	-7.81	-23.69	302 C	29.16	-12.77	-26.58	11.60
303 C	14.88	-6.45	-12.07	303 C	22.81	-10.16	-13.41	8.86
292 C	62.10	-13.23	-33.59	292 C	65.44	-17.71	-28.80	7.36
293 C	23.51	11.21	-60.45	293 C	36.45	-10.95	-39.78	32.95
294 C	16.91	2.67	-38.72	294 C	30.90	-7.48	-31.00	18.93
295 C	13.61	-2.74	-30.38	295 C	27.58	-8.05	-25.93	15.59
296 C	10.59	-3.56	-12.08	296 C	23.34	-6.36	-9.88	13.24

Table 2A: LAB/Delta E between 4-color and extended gamut prints

Digital Values in Photoshop (Post-Profile)											
Sample	**L**	**A**	**B**	**R**	**G**	**B**	**C**	**M**	**Y**	**K**	**#**
545 C	93	-5	-7	196	217	230	13	2	1	0	B1CCDE
544 C	90	-4	-9	189	211	230	16	4	1	0	A8C7E0
543 C	83	-6	-13	161	198	226	26	8	3	0	84B7DD
542 C	75	-8	-18	121	173	211	39	15	6	0	559ACF
541 C	31	-10	-32	9	60	113	100	71	30	12	O62769
7459 C	64	-16	-16	56	150	180	60	22	22	0	0684AE
7460 C	59	-16	-33	0	131	194	73	27	8	0	0162A4
7461 C	57	-16	-33	1	124	186	75	31	10	0	005FAD
7462 C	42	-12	-33	10	84	139	91	55	20	3	0D3E82
7463 C	22	-7	-21	11	42	74	99	75	43	36	O51E47
2905 C	83	-11	-17	138	198	232	32	5	2	0	65B4E2
2915 C	75	-15	-25	86	179	228	47	8	2	0	27A1E5
2925 C	66	-16	-33	29	154	221	62	17	2	0	027DD4
2935 C	44	-12	-52	0	86	184	97	51	0	0	1431AD
2945 C	38	-10	-44	0	74	152	100	62	11	1	062D8D
299 C	67	-19	-32	0	160	224	63	14	3	0	0084D6
300 C	47	-13	-49	0	92	185	93	47	0	0	003CB1
301 C	37	-11	-36	0	74	135	98	63	20	4	00307C
302 C	29	-12	-24	0	58	93	98	68	39	23	002A55
303 C	20	-9	-13	10	42	59	92	68	52	49	O52238
292 C	75	-14	-26	89	178	231	46	9	1	0	339CE6
293 C	35	-7	-57	0	60	166	100	66	8	1	25089A
294 C	26	-8	-38	6	47	110	100	76	31	17	181267
295 C	22	-9	-30	0	40	87	100	77	37	29	0A1457
296 C	13	-4	-9	14	28	44	86	71	56	66	O71530

Table 3A: Blue color patch data taken from Photoshop

Digital Values in Photoshop (Post-Profile)				Print 4 Color Print CIELAB Values				
Sample	L	A	B	Sample	L	A	B	ΔE
545 C	93	-5	-7	545 C	82.74	-7.12	-9.36	10.74
544 C	90	-4	-9	544 C	81.33	-7.54	-11.93	9.81
543 C	83	-6	-13	543 C	75.79	-11.59	-19.59	11.25
542 C	75	-8	-18	542 C	64.51	-14.12	-24.34	13.70
541 C	31	-10	-32	541 C	30.85	-10.99	-31.53	1.11
7459 C	64	-16	-16	7459 C	52.96	-22.50	-15.69	12.82
7460 C	59	-16	-33	7460 C	45.39	-19.80	-49.77	21.93
7461 C	57	-16	-33	7461 C	44.11	-18.75	-48.94	20.68
7462 C	42	-12	-33	7462 C	37.15	-14.51	-40.11	8.97
7463 C	22	-7	-21	7463 C	24.77	-9.40	-20.79	3.67
2905 C	83	-11	-17	2905 C	74.08	-14.29	-18.23	9.59
2915 C	75	-15	-25	2915 C	63.79	-20.25	-28.96	13.00
2925 C	66	-16	-33	2925 C	48.87	-22.95	-52.83	27.11
2935 C	44	-12	-52	2935 C	41.27	-13.23	-46.89	5.92
2945 C	38	-10	-44	2945 C	37.10	-12.90	-41.15	4.16
299 C	67	-19	-32	299 C	49.30	-23.02	-52.13	27.10
300 C	47	-13	-49	300 C	42.02	-12.92	-47.12	5.32
301 C	37	-11	-36	301 C	35.21	-11.57	-37.30	2.28
302 C	29	-12	-24	302 C	29.16	-12.77	-26.58	2.70
303 C	20	-9	-13	303 C	22.81	-10.16	-13.41	3.07
292 C	75	-14	-26	292 C	65.44	-17.71	-28.80	10.63
293 C	35	-7	-57	293 C	36.45	-10.95	-39.78	17.73
294 C	26	-8	-38	294 C	30.90	-7.48	-31.00	8.56
295 C	22	-9	-30	295 C	27.58	-8.05	-25.93	6.97
296 C	13	-4	-9	296 C	23.34	-6.36	-9.88	10.64

Table 4A: LAB/Delta E between digital patches and 4-color print

Digital Values in Photoshop (Post-Profile)				Print EGP CIELAB Values				
Sample	**L**	**A**	**B**	**Sample**	**L**	**A**	**B**	**ΔE**
545 C	93	-5	-7	545 C	77.99	-5.32	-8.73	15.11
544 C	90	-4	-9	544 C	76.56	-5.30	-11.63	13.76
543 C	83	-6	-13	543 C	70.90	-8.24	-17.53	13.11
542 C	75	-8	-18	542 C	60.89	-9.52	-23.96	15.39
541 C	31	-10	-32	541 C	19.83	-6.63	-34.77	11.99
7459 C	64	-16	-16	7459 C	52.26	-16.17	-22.36	13.35
7460 C	59	-16	-33	7460 C	41.89	-12.26	-34.70	17.60
7461 C	57	-16	-33	7461 C	41.66	-12.27	-39.81	17.19
7462 C	42	-12	-33	7462 C	29.07	-7.09	-36.64	14.30
7463 C	22	-7	-21	7463 C	14.85	-4.92	-20.62	7.46
2905 C	83	-11	-17	2905 C	68.92	-12.46	-21.56	14.87
2915 C	75	-15	-25	2915 C	62.52	-15.49	-31.51	14.08
2925 C	66	-16	-33	2925 C	52.81	-12.79	-40.99	15.75
2935 C	44	-12	-52	2935 C	30.18	-1.44	-61.03	19.60
2945 C	38	-10	-44	2945 C	25.19	-5.35	-48.98	14.51
299 C	67	-19	-32	299 C	54.52	-13.52	-38.60	15.14
300 C	47	-13	-49	300 C	32.16	-5.90	-58.66	19.08
301 C	37	-11	-36	301 C	24.09	-7.54	-40.31	14.04
302 C	29	-12	-24	302 C	19.08	-7.81	-23.69	10.77
303 C	20	-9	-13	303 C	14.88	-6.45	-12.07	5.79
292 C	75	-14	-26	292 C	62.10	-13.23	-33.59	14.99
293 C	35	-7	-57	293 C	23.51	11.21	-60.45	21.81
294 C	26	-8	-38	294 C	16.91	2.67	-38.72	14.04
295 C	22	-9	-30	295 C	13.61	-2.74	-30.38	10.47
296 C	13	-4	-9	296 C	10.59	-3.56	-12.08	3.94

Table 5A: LAB/Delta E between digital patches and extended gamut print

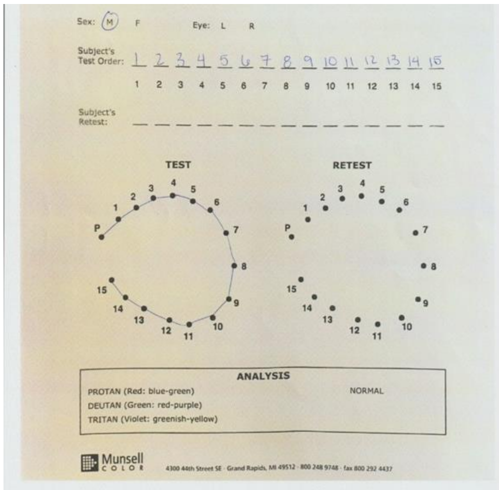


Figure 1A: Participant 1 Farnsworth data

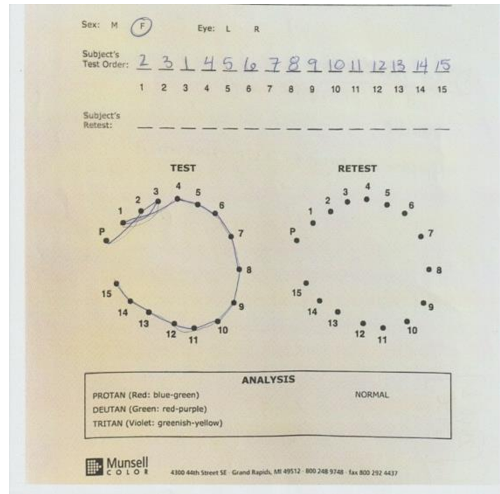


Figure 2A: Participant 2 Farnsworth data

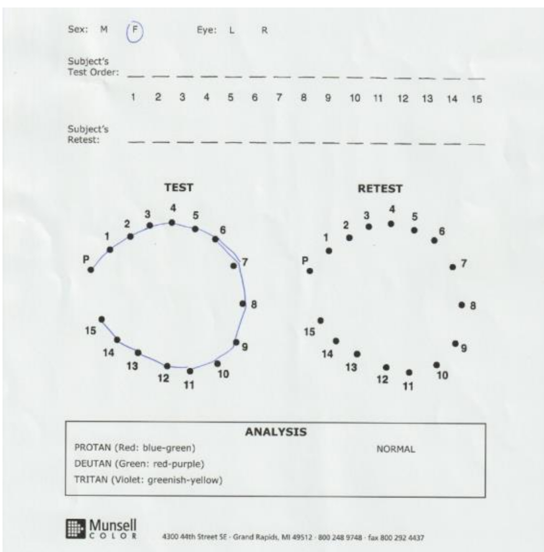


Figure 3A: Participant 3 Farnsworth data

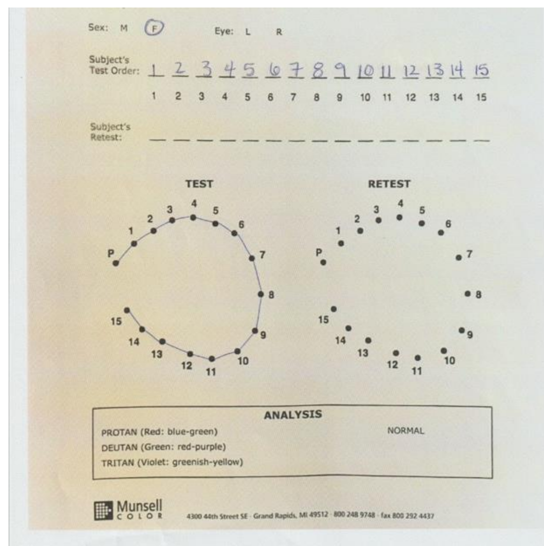


Figure 4A: Participant 4 Farnsworth data

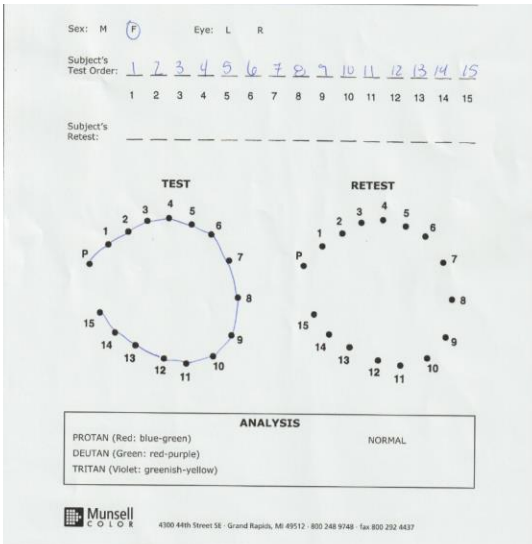


Figure 5A: Participant 5 Farnsworth data

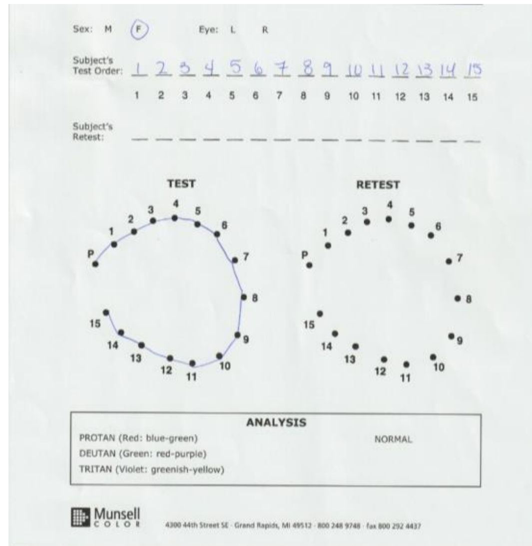


Figure 6A: Participant 6 Farnsworth data

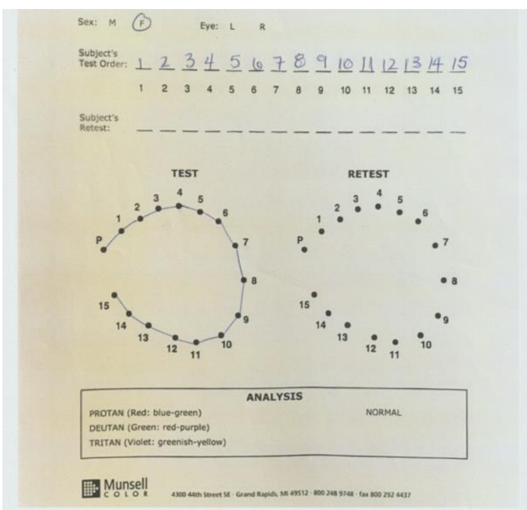


Figure 7A: Participant 7 Farnsworth data

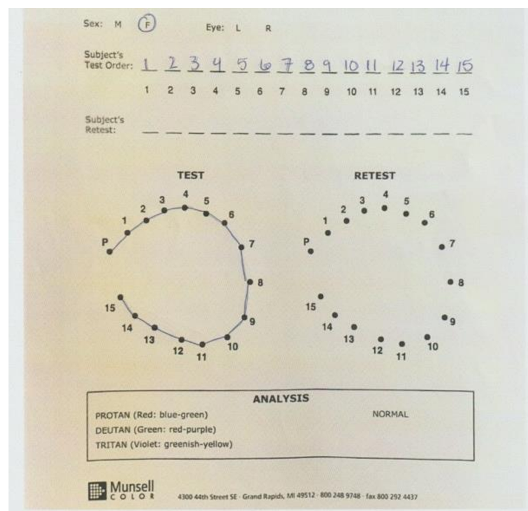


Figure 8A: Participant 8 Farnsworth data

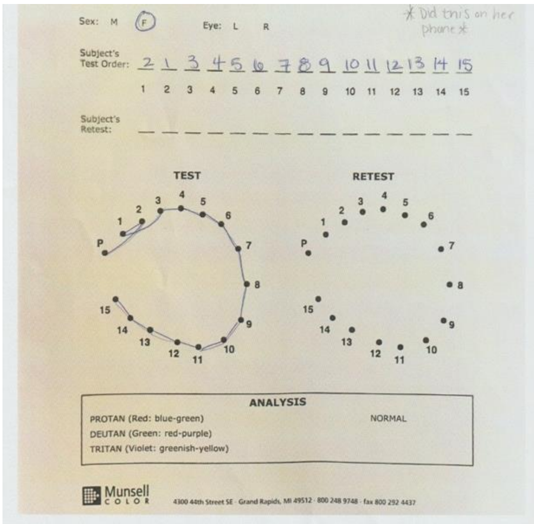


Figure 9A: Participant 9 Farnsworth data

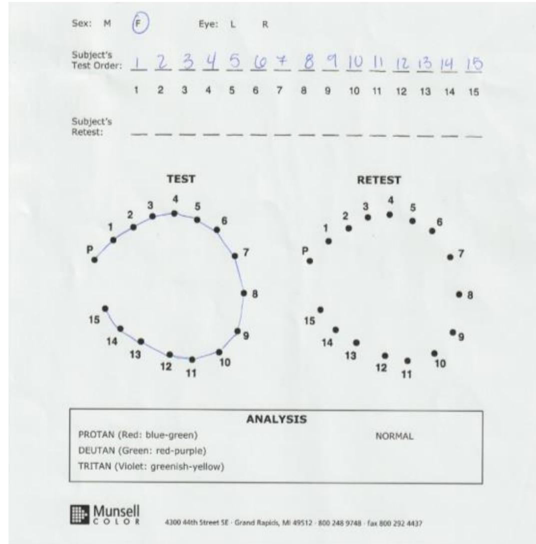


Figure 10A: Participant 10 Farnsworth data

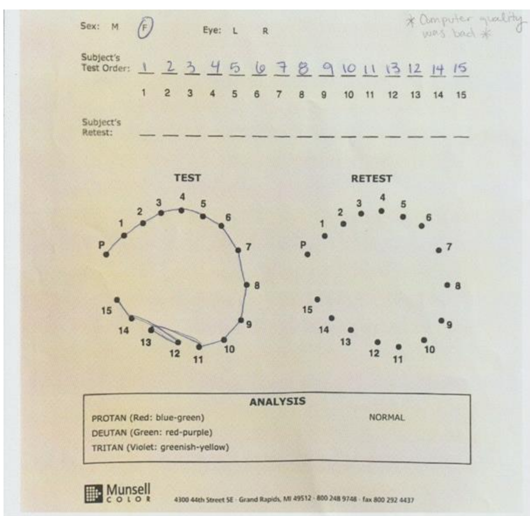


Figure 11A: Participant 11 Farnsworth data

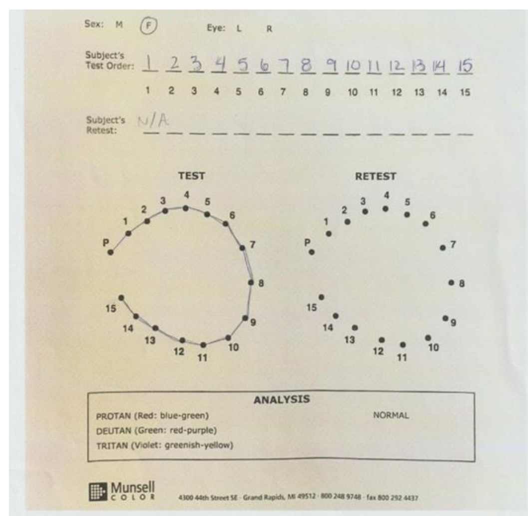


Figure 12A: Participant 12 Farnsworth data

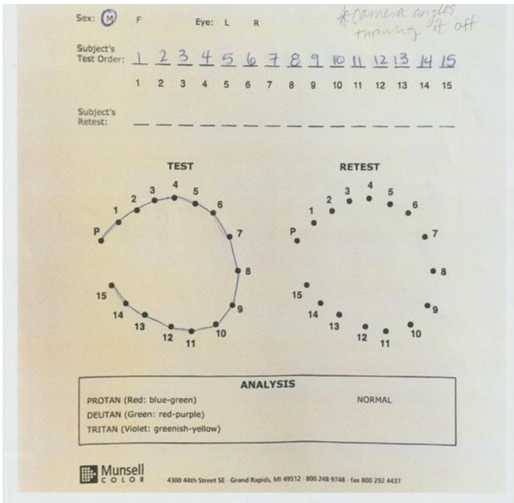


Figure 13A: Participant 13 Farnsworth data

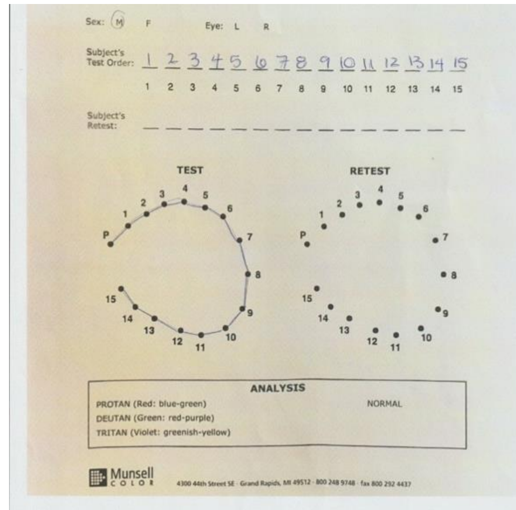


Figure 14A: Participant 14 Farnsworth data

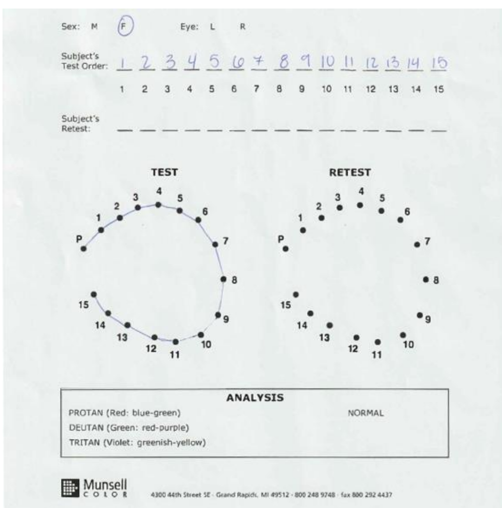


Figure 15A: Participant 15 Farnsworth data

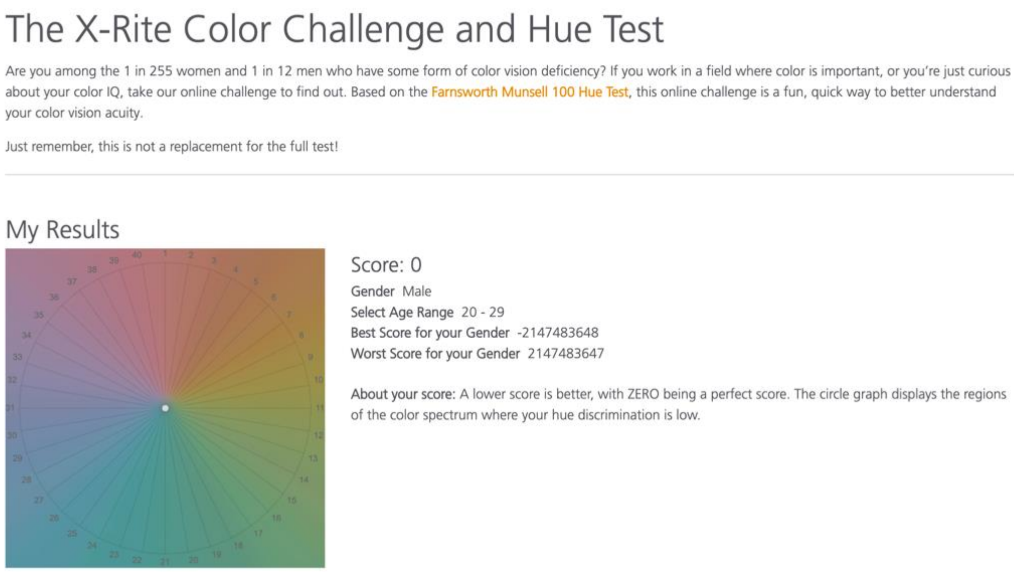


Figure 16A: Participant 1 Hue Test results

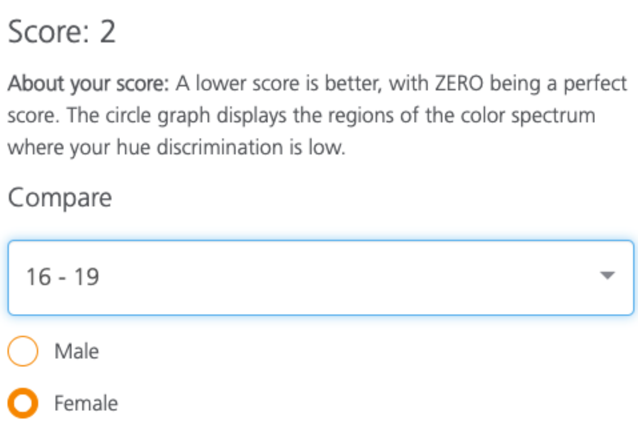


Figure 17A: Participant 2 Hue Test results

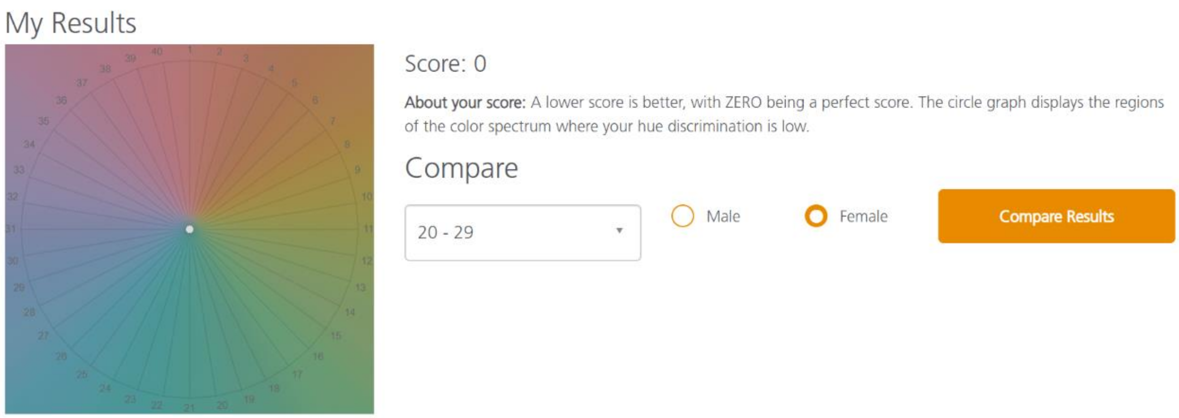


Figure 18A: Participant 3 Hue Test results

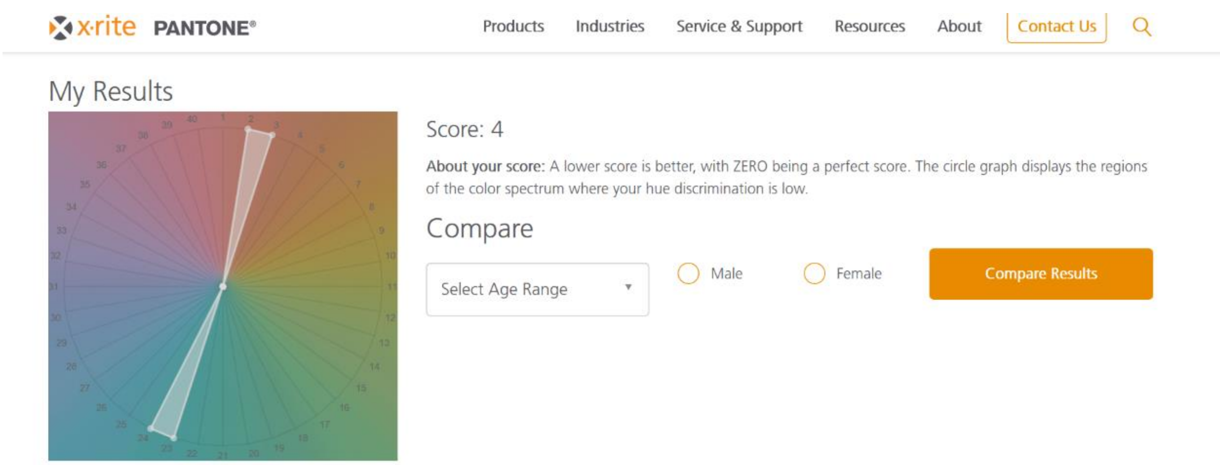


Figure 19A: Participant 4 Hue Test results

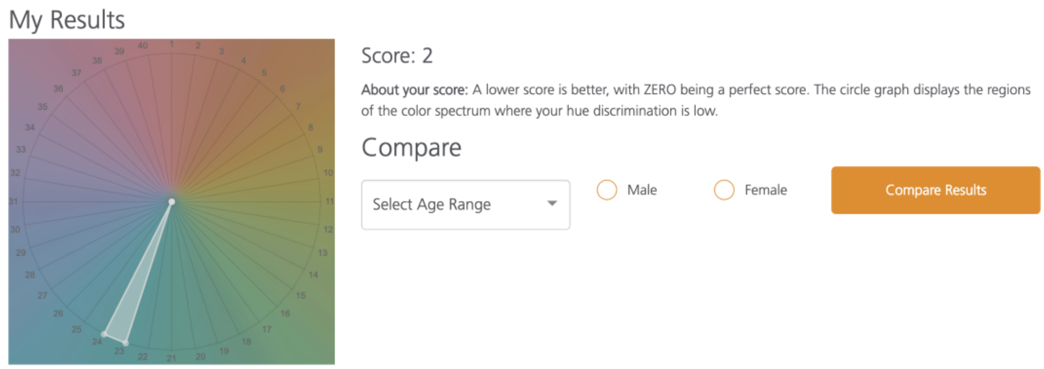


Figure 20A: Participant 5 Hue Test results

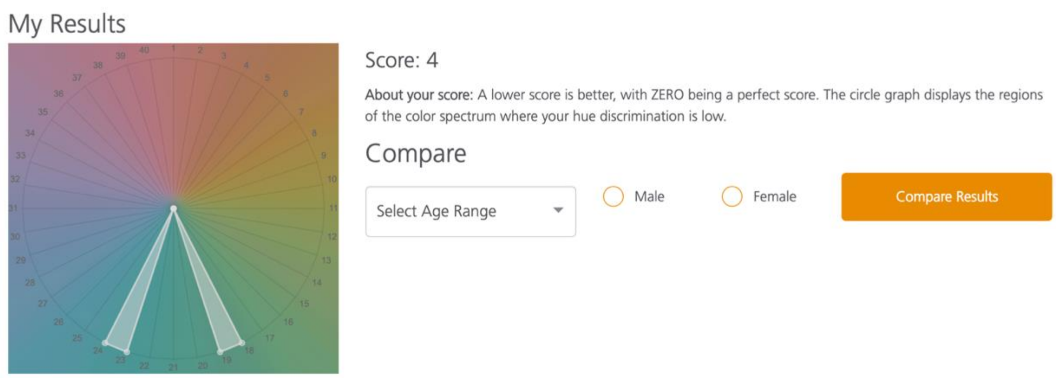


Figure 21A: Participant 6 Hue Test results

Figure 22A: Participant 7 Hue Test results

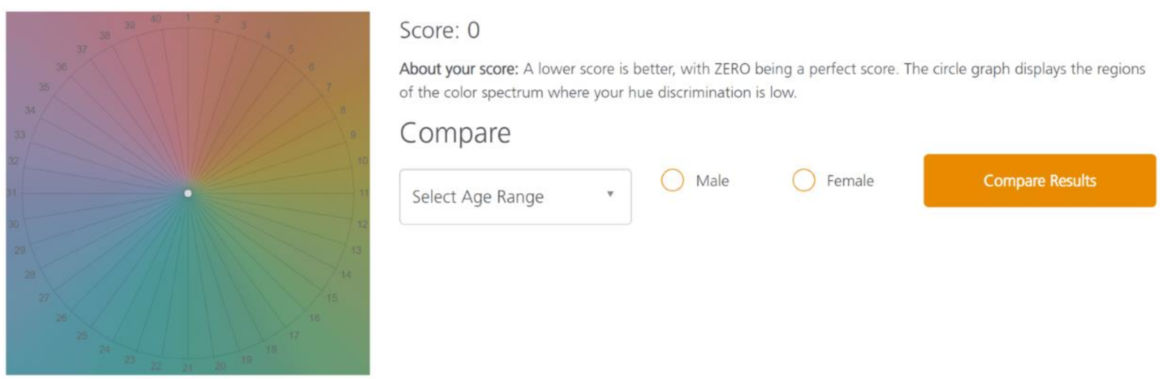


Figure 23A: Participant 8 Hue Test results

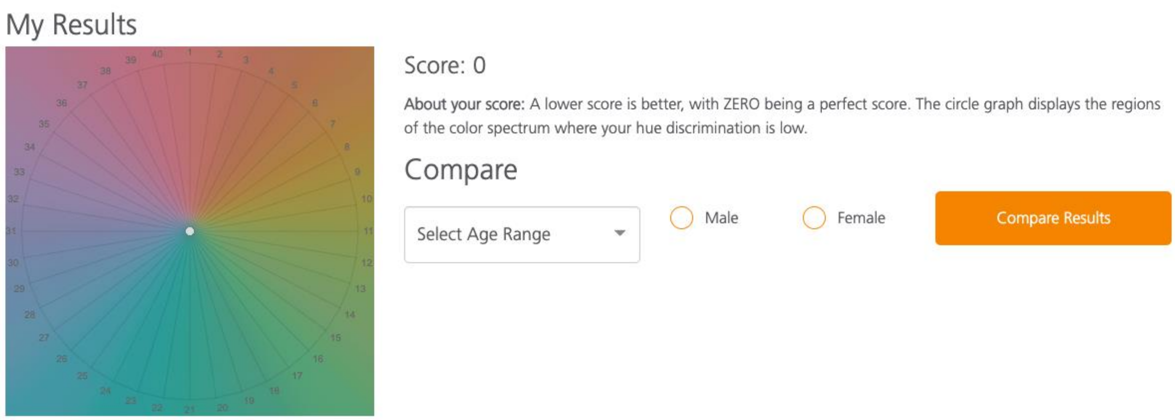


Figure 24A: Participant 9 Hue Test results

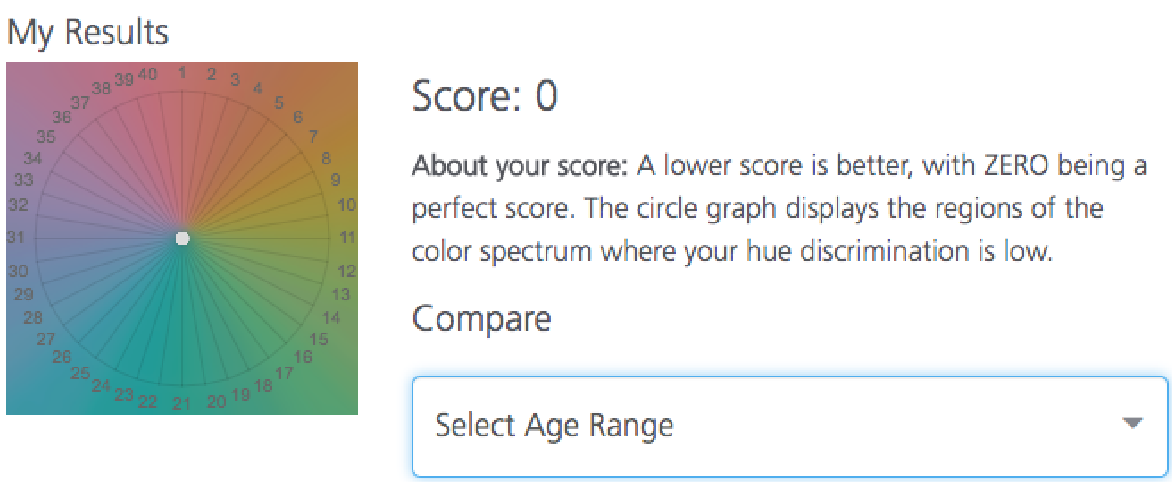


Figure 25A: Participant 10 Hue Test results

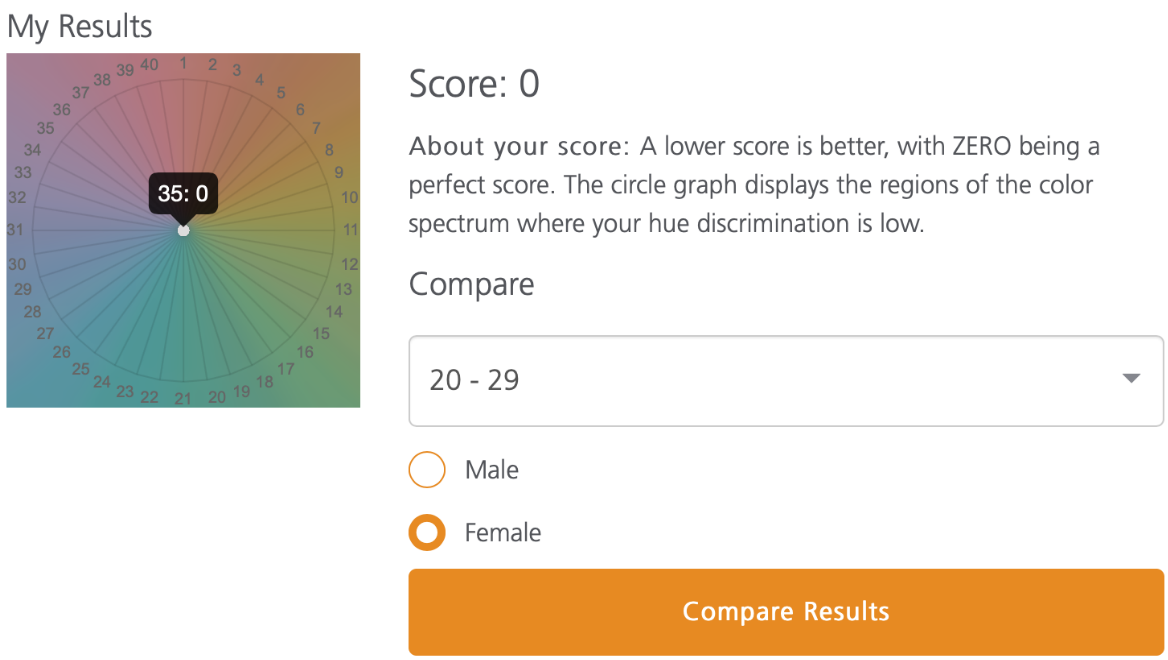


Figure 26A: Participant 11 Hue Test results

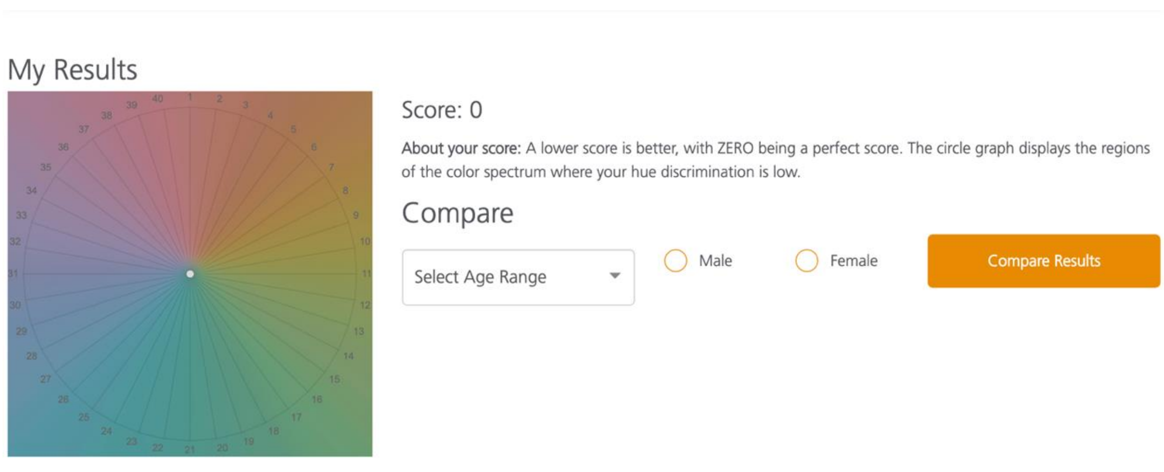


Figure 27A: Participant 12 Hue Test results

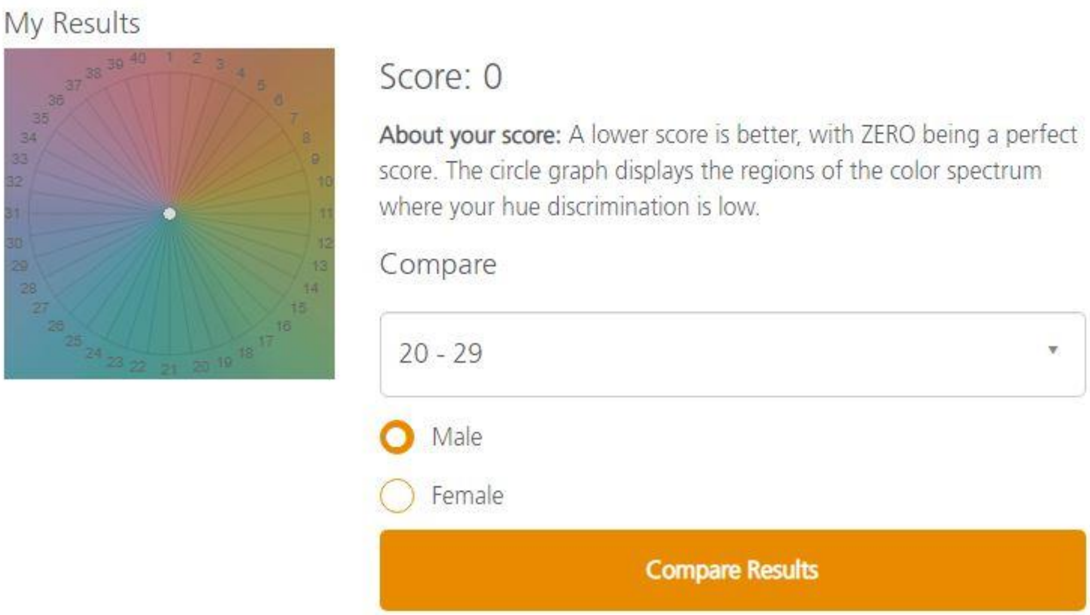


Figure 28A: Participant 13 Hue Test results

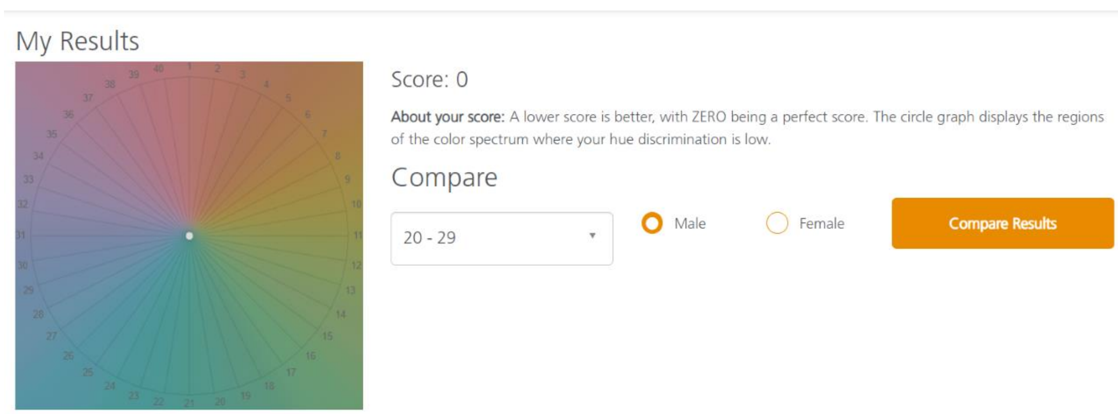


Figure 29A: Participant 14 Hue Test results

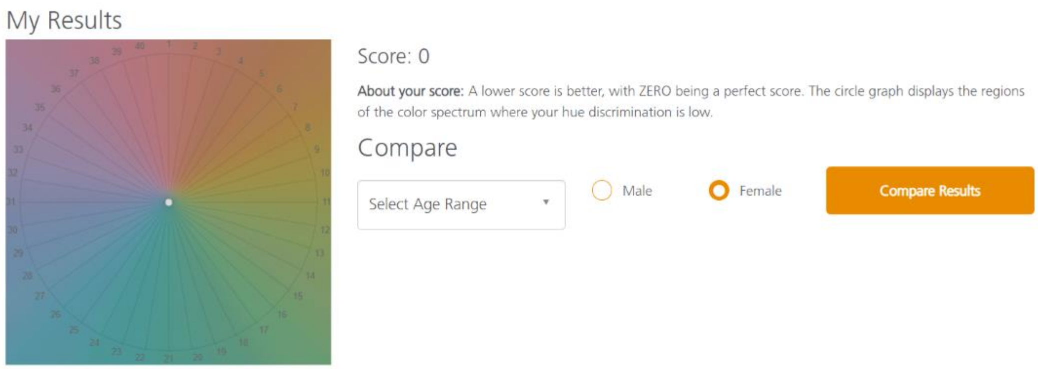


Figure 30A: Participant 15 Hue Test results

APPENDIX B

Interview Raw Data

Q1 - What is the name of the color patch in front of you? Please provide the first answer that comes to mind.

What is the name of the color patch in front of you? Please provide the first answer that comes to mind.
wine
burgundy
maroon
Maroon
Burgundy
Purple
burgundy
Burgundy
Grapeberry
Magenta
Cranberry
Maroon
Magenta
Burgundy
Maroon

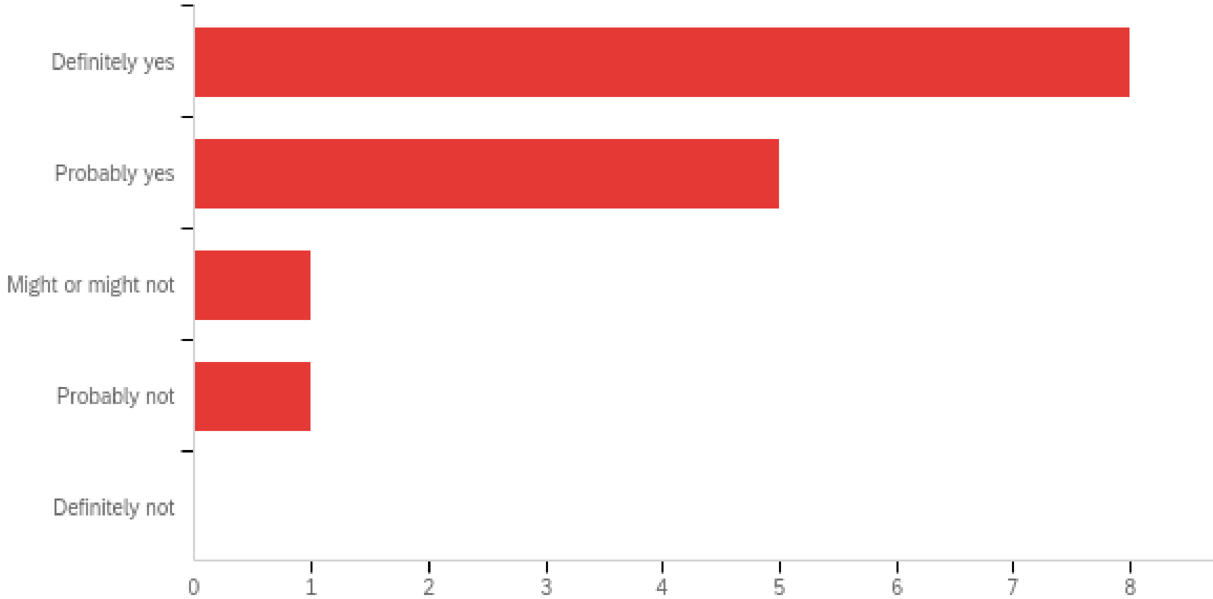
Q9 - Why did you choose to name the color in the way that you did?

Why did you choose to name the color in the way that you did?
This is the color of a shirt that my roommate owns, it has always been a color that reminds me of the richness of wine, but her shirt (this color) refers to wine and so that association has become concrete in my mind.
-brother's favorite color, -accent color in living room growing up
I have seen similar colors referred to as maroon, and see that it is dark red with a bit of pink, making it not burgundy.
Because I do not know any other shades of that color.
This was the first thing to come to mind. This is most common color name that's used to describe colors like this. It's kind of red and brown toned.
It looks purple
I chose this name because the color does not look solely red or purple to me but somewhere in between. I also really like the color burgundy so any color that I see that is close to the actual color burgundy I tend to consider as burgundy as well.
It reminds we of the suit in Anchorman
It seemed in between a purple and a mulberry so that's the first thing that came to mind
I had a sweatshirt once this color that was magenta.
That's the first thing that came to my mind
it appears as a darker/saturated red
Because it looks like magenta colors I have seen before.
The strong presence of red with subtleties of brown
It reminds me of a dress that I wore to my cousin's wedding. It has a color I associate with marroon

Q8 - What does this color make you think of?

What does this color make you think of?
wine, but also shakespearean costuming and the maroon and gold of my university.
my brother kevin, wine, my living room
a sweater that I own, and griffyndor
Autumn
Red wine
Paint colors
It makes me think of the season of Fall. It also makes me think of prom and my relationship with my boyfriend because we both really like this color and it was my accent color to my prom dress.
Anchorman. the first one
Opulence and wine and expensive lipstick
Grapes, my magenta sweatshirt
Cranberries and my grandma's house. She has this color throughout her house.
private school polo shirts
My backpack! It is the same color
The burgundy furniture at my childhood home
It makes me think of fall.

Q2 - Is it likely that you chose to identify that color in that way because it makes you think of a particular object?



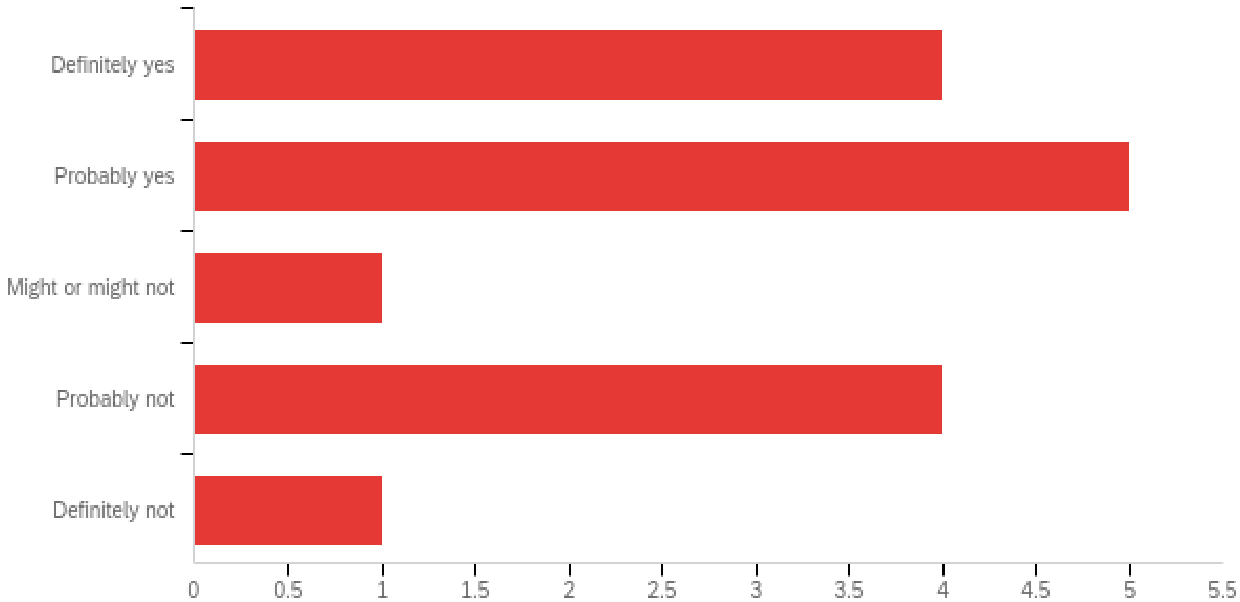
#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Is it likely that you chose to identify that color in that way because it makes you think of a particular object?	1.00	4.00	1.67	0.87	0.76	15

#	Answer	%	Count
1	Definitely yes	53.33%	8
2	Probably yes	33.33%	5
3	Might or might not	6.67%	1
4	Probably not	6.67%	1
5	Definitely not	0.00%	0
	Total	100%	15

Q3 - If so, what object do you associate this color with?

If so, what object do you associate this color with?
A t-shirt owned by my roommate
rug in my dining room
sweater
leaves
Red wine, or the autumnal colors
N/A
I feel like the color makes me think more about memories and feelings, but there are things in my memories that were this color such as my prom earrings and a shirt I bought for my boyfriend.
A suit
lipstick or wine
My magenta sweatshirt
Cranberries
polo shirts
My backpack
The burgundy furniture from my childhood home
A bridesmaid dress, and a maroon sweater that I have

Q4 - Is it likely that you chose to identify that color in that way because you link this color to a particular experience/memory/emotion?



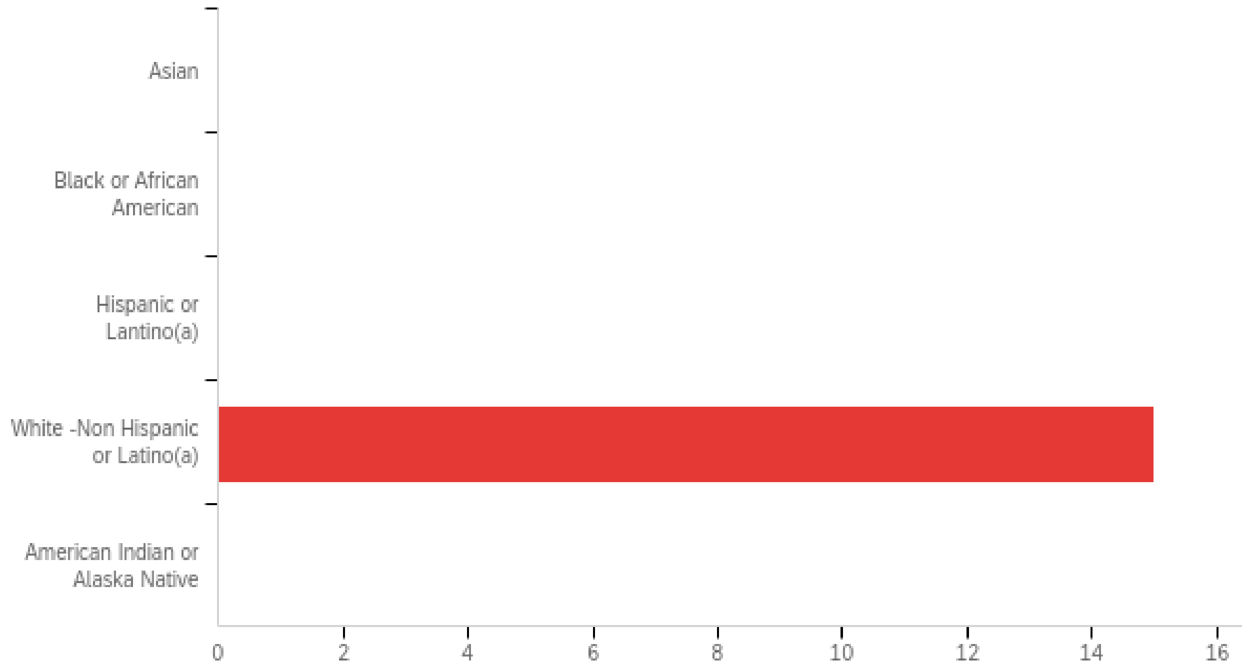
#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Is it likely that you chose to identify that color in that way because you link this color to a particular experience/memory/emotion?	1.00	5.00	2.53	1.31	1.72	15

#	Answer	%	Count
1	Definitely yes	26.67%	4
2	Probably yes	33.33%	5
3	Might or might not	6.67%	1
4	Probably not	26.67%	4
5	Definitely not	6.67%	1
	Total	100%	15

Q10 - If you feel comfortable disclosing, what experience/memory/emotion did you link to this particular color?

If you feel comfortable disclosing, what experience/memory/emotion did you link to this particular color?
I don't associate this color with an experience, memory, or emotion.
not applicable
memories it makes me think of reading/watching Harry Potter
NA
This reminds me of elementary school when you're first introduced to colors that aren't just the primary or secondary colors. This was one of the first colors I learned about, so the name has stuck with me.
N/A
I link happiness and I feel like myself with this color because I feel that it represents me and I love this color. I link it to fond memories of when my boyfriend and I started dating as well as many happy Fall memories with my family ans friends.
Watching Anchorman with my best friend growing up like once a month.
The powerful feeling I had when wearing a bold color like this. (I legitimately bought a lipstick like this 3+ weeks ago)
Seeing other people wear the magenta sweatshirt.
I painted my grandma's back of her counter and her fan blades in the living room this color.
going to a catholic school for six years
I am not sure on a particular one, I would think that it is more in my subconscious
The burgundy furniture from my childhood home
My cousin's wedding.

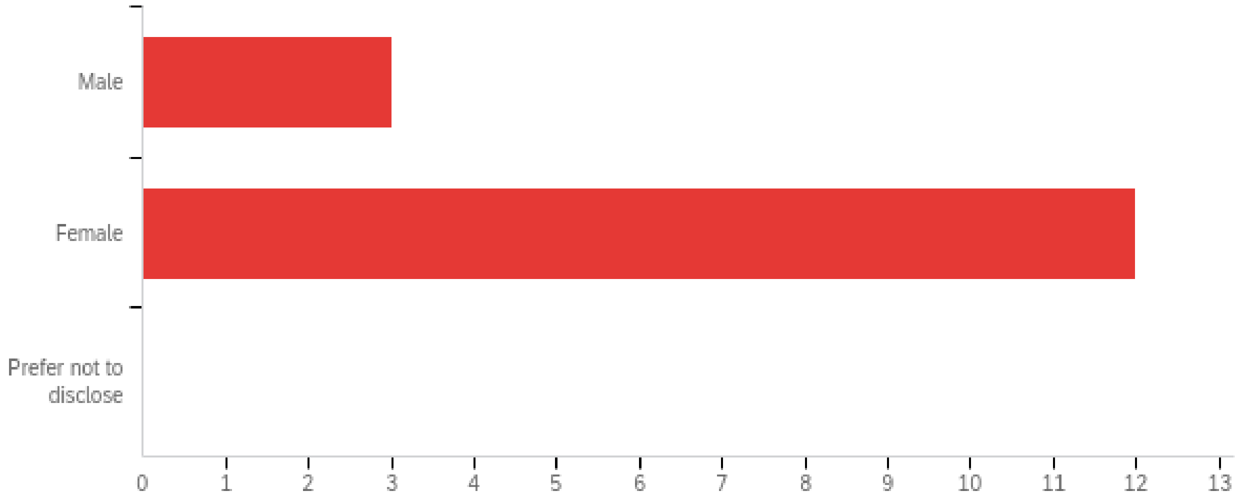
Q6 - Which ethnicity do you identify with?



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Which ethnicity do you identify with?	4.00	4.00	4.00	0.00	0.00	15

#	Answer	%	Count
1	Asian	0.00%	0
2	Black or African American	0.00%	0
3	Hispanic or Lantino(a)	0.00%	0
4	White -Non Hispanic or Latino(a)	100.00%	15
5	American Indian or Alaska Native	0.00%	0
	Total	100%	15

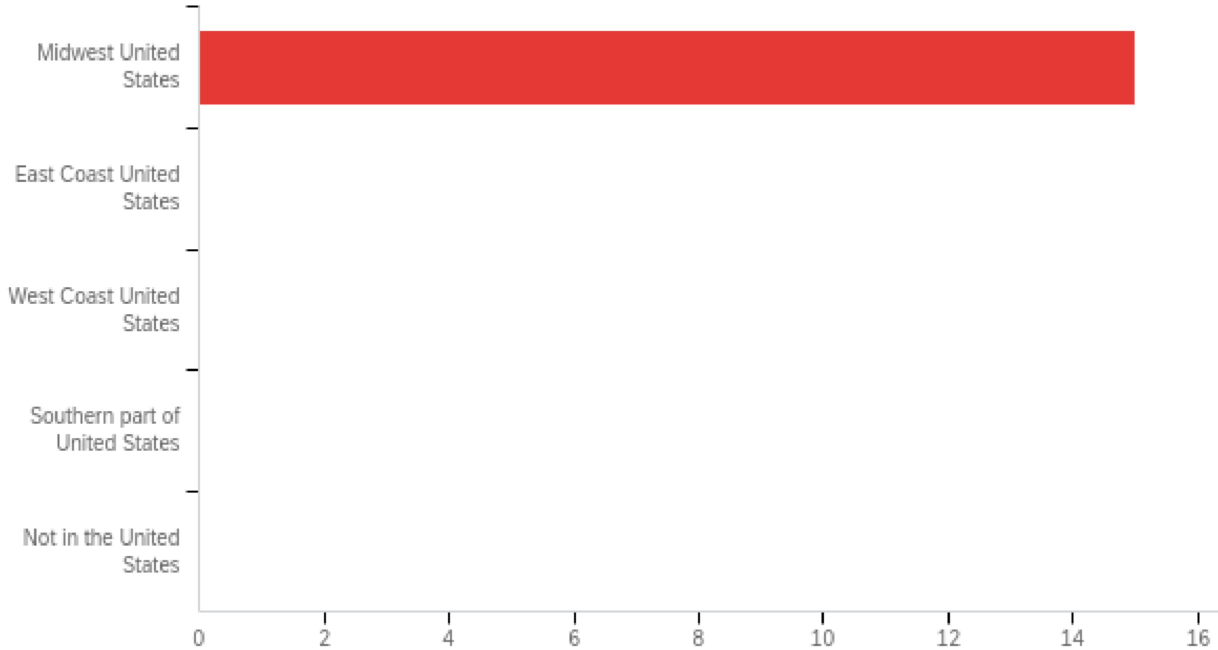
Q7 - Which gender do you identify as?



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Which gender do you identify as?	1.00	2.00	1.80	0.40	0.16	15

#	Answer	%	Count
1	Male	20.00%	3
2	Female	80.00%	12
3	Prefer not to disclose	0.00%	0
	Total	100%	15

Q11 - What region did you grow up in?



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	What region did you grow up in?	1.00	1.00	1.00	0.00	0.00	15

#	Answer	%	Count
1	Midwest United States	100.00%	15
2	East Coast United States	0.00%	0
3	West Coast United States	0.00%	0
4	Southern part of United States	0.00%	0
5	Not in the United States	0.00%	0
	Total	100%	15

Q13 - Out of all the blues on this grid, which is the truest blue to you?

Out of all the blues on this grid, which is the truest blue to you?
Pantone 2935 C
2935 C
293 C
2935
Pantone 293 C
293C
Pantone 293 C
299
7460 C
Pantone 2935 C
pantone 299 c
2935C
Pantone 2935 C
Pantone 2935 C

Q14 - For this first sample, which is the truest and best looking blue to you?

For this first sample, which is the truest and best looking blue to you?
Pantone 2925 C
300 C
300 C
7460
Pantone 7461 C
299C
Pantone 300 C
2935
2935C
2935 C
Pantone 299 C
pantone 2925 c
2925C
Pantone 299 C
Pantone 2925 C

Q15 - For this second sample, which is the truest and best looking blue to you?

For this second sample, which is the truest and best looking blue to you?
Pantone 300 C
2935 C
300 C
300
Pantone 2935 C
293C
Pantone 2935 C
300
300C
7461 C
Pantone 2935 C
pantone 2935 c
300C
Pantone 2935 C
Pantone 2935 C