Journal of
APPLIED PACKAGING RESEARCH

RESEARCH ARTICLE

Ensuring Packaging Accessibility for those with Red-Green Colorblindness: A Case Study

Perian Reese*
Clemson University

R. Andrew Hurley
Clemson University

George Cavender
Clemson University

INTRODUCTION

Red-green colorblindness is widespread, affecting up to 8% of men and 0.5% of women, primarily among those of Northern European descent [1]. This color vision deficiency often results in profound difficulty distinguishing between red and green. Medically speaking, the condition is most commonly caused by one of two conditions- protanopia or deuteranopia. Protanopia is the lack of red photoreceptors in the retina, while deuteranopia is the lack of green photoreceptors [1]. For people suffering from this condition, there are certain graphics and images that they may have difficulty understanding or seeing as intended. Given the large number of people affected (at least 300 million people, using current estimates) some research has been conducted to determine ways to improve package designs to ensure they can be more inclusive for those with a color vision deficiency [1]. The first reported method for improving upon these designs was a minor switch in colors, such as substituting magenta for red or turquoise for green [1]. These slight changes make the colors easier to identify as they rely on more than one type of cone or have different luminance/reflections. Additional methods such as strategic use of contrasting colors for emphasis have also been explored to achieve these goals, where these concepts have shown promise in studies attempting to make signs and web pages more accessible [2, 3].

KEY WORDS

Package design, color blind, accessibility.

***Perian Reese**
Corresponding Author
perianr@g.clemson.edu

These studies utilized online simulations to model colorblindness and ensure accessibility for the colorblind, but the Variantor Dichromatic Spectacles (VDS) can also be used to show designers how these individuals would see a design in real time. VDS are a wearable simulator relying on special lenses that allow a person with normal color vision to see as though they had red-green colorblindness [4]. VDS could be especially beneficial in designing the marketing used on physical objects, such as product packages, in-store signage, and point of purchase displays. Further, in terms of accessible packaging, there is a paucity of available literature on formatting packages for those with red-green colorblindness, despite the relatively high percentage of consumers with color vision deficiency (up to 4% of the global population) [1], there is substantial potential for increased marketability of specific products should they be re-designed to meet the needs of this consumer population.

This study includes a small retail sample using VDS to simulate how people with red-green colorblindness would see packages. From that retail sampling, one item, a premium toothcare product (Colgate Optic White Pro Series),was chosen to be the basis of a case study for a redesign. The researchers sought to redesign the product without changing or abandoning the signature red color, as that is a vital component of the branding and identity of the product. The process utilized commercial software (Adobe Photoshop and Adobe Illustrator) to create implementations concepts intended to improve accessibility, such as contrasting colors and usage of outlines. The resulting designs were then evaluated using VDS to help select the most promising candidates for commercialization. The goal of the study was to create a more universally designed package that would maintain brand identity, while being more accessible for those with red-green colorblindness.

LITERATURE REVIEW

Background information and methods for improving design for colorblind individuals

There are different types of red-green colorblindness, and Bang Wong [1] outlines how these types of red-green colorblindness are caused by lack of either red or green photoreceptors. Of course, color confusion can also be caused by other colors besides red and green, which is often overlooked in design due to misconceptions about the causes and physiology of color impairment. The most commonly proposed solution to address red-green confusion involves replacing red with magenta and green with turquoise [1]. While this provides a good background on the general concepts behind current suggested re-design norms for those with colorblindness, it does not provide solutions and merely points readers in the direction of online tools such as Adobe Photoshop and the DanKam app [1]. While many choose to avoid these challenges entirely by removing all red and green colors in their advertising, this can be limiting to the design team, particularly if red and/or green are vital to the product's established branding, and as such further solutions are needed.

Hamieh [5] looked at the importance of the meaning behind red and green as colors, explaining how the color red is often linked to passion, strong emotions, and warnings while green is associated with peace, nature, and wealth [5]. Since most designs attempting to accommodate red-green colorblindness change red and green to other colors, Hamieh investigated these associations with red and green to determine if

individuals who see them differently still associate the same cues with those colors. He interviewed participants with colorblindness about their associations with red and green and found that participants with colorblindness still understand the color symbolism associated with red and green despite seeing them differently [5]. Therefore, when making designs more accessible for colorblindness, changing the red and green may appear to be a simple solution, but it could cause one to lose other important factors that are key to the intended messages of the product's advertising and branding cues. If the goal is to maintain the symbolic messages and themes, it is clear that other solutions are necessary in order to be able to still use the full range of colors while improving accessibility.

In addition to symbolism, color is often used to communicate other information to consumers and has a strong presence in the marketing world. Kaufman-Scarborough investigated consumer issues experienced by color-deficient shoppers and outlined specific ways color is used to convey information [6]. In her study, she interviewed 62 color-deficient individuals about their vision, problems they encounter when shopping, and suggestions they have to improve product visibility. One recurring theme was that participants complained about packaging that was unreadable due to certain color combinations [6]. Since package designers often rely on color to relay information about its contents, color deficient consumers may be unable to perceive this information properly including having difficulty with bright colors and losing information printed in colors. Combining red and black in particular was an issue among participants when describing packages, warning lights, safety information, and other aspects [6]. With regard to potential solutions, participants primarily suggested using fewer colors and including more contrasting colors such as black and white to help improve the visibility of products and ensure less loss of information.

Daniel Baker wrote about the Food and Drug Administration's (FDA) hearing for the use of color in pharmaceutical packaging and product labels, as the current FDA opinion that there is little evidence to support the application of color to reduce errors. Baker indicates that he generally agrees with that opinion, noting the extremely limited body of scientific work in several well-regarded indexed databases [7]. Historically, companies have used color matching to help with the assembly or understanding of a device and use color branding to differentiate different types of medications from each other. Some sources such as the Institute for Safe Medication Practices [ISMP] indicate that these techniques may actually contribute to the errors instead of preventing them [7]. To limit these types of errors, Baker argues that the FDA color guidelines should take red-green colorblindness into account by considering the problems these individuals may encounter when choosing colors for pharmaceutical packaging [7]. The interest the FDA is showing in the use of colors in packaging confirms that color may be a major contributor to potentially fatal errors and that organizations are noticing this lack of accessibility as well as safety implications. These concerns mean that package designs should be evaluated, and designs must account for this information and strive to design accessible products with a lower risk of error.

Simulations

When making a design accessible for those that are red-green colorblind, simulations have been developed to display how these designs will look and be perceived. These simulations range from digital design methods to wearable simulators that allow for the designers to see how a design would appear to those with red-green

colorblindness. Douglas Keene explored a few of these methods when determining how to accommodate these individuals in terms of microscopy [8]. He specifically used FIJI and Adobe Photoshop to simulate how a design would appear to those with red-green colorblindness. However, Keene notes that colors can appear differently due to differences in lighting and the presence or absence of shadows, as well as color luminosity, and intensities in the final product. Both FIJI and Adobe Photoshop have plugin options that can be used to simulate color blindness and have an option to convert colors. However, this conversion will not work with some images and those must be edited with changes in intensity, which Adobe Photoshop can accomplish with proper manipulation [8]. Overall, computer simulations do have some drawbacks, particularly in terms of image adjustment and the techniques of changing the base colors, both of which may be sub-optimal for certain designs.

Mackie et al. also looked at microscopy-related issues, addressing how colorblind individuals often struggle to differentiate between common stains used in microbiology [9]. Differentiating between red and green is often needed to read stained plates. The common staining colors are fuchsin, violet, green, blue, and safranin [10]. Different staining techniques can also be used to showcase types of cells which may include two of these colors being shown at the same time, such a gram-staining which uses violet and safranin. These colors would be difficult to differentiate if one was red-green colorblind. Complex staining procedures may use more than two colors or have the colors mix [10]. Therefore, complex methods would be even more difficult for those with red-green colorblindness. Mackie et al proposed that researchers should use different stains to be more accessible; however, the study suggested that the simplest and most cost-effective solution would be to simply edit the images taken from the microscope mounted camera. They employed photo editors such as Adobe Photoshop to adjust the hue of the images to enhance the contrast between stains [9]. While this certainly solves the issue of interpreting the stains, it does not address the root cause of the issue and furthermore burdens those that are colorblind with extra measures. If the goal is to make something equally accessible, this solution does not necessarily meet that, but it does show how images themselves can be made more accessible for those with or without normal color vision.

Jiawei Wang's dissertation showcased how web design tools can utilize universal design to improve inclusivity [2]. Wang discussed the types of color vision and how green and red are the colors most confused throughout all types of vision. He also found specific hues and combinations of colors that can improve visualization of images, including shades of blue, the use of warm and cool colors alternatively, adding distinct differences in saturation or brightness when using two warm or cool colors, and avoiding all use of low saturation or low brightness colors [2]. Since color can be different for each person with color deficiency, these universal ideas may be applied to all designs to improve accessibility. Universal design can also be used in conjunction with simulators to support designers in creating inclusive designs [2].

However, in addition to web designs and online images, physical items also need to be assessed to improve inclusivity. Lee et al. aimed to improve signage in Seoul by interviewing individuals with colorblindness to determine how they see colors, how friendly current signage is, and opportunities for signage improvement [3]. Lee acknowledges that most studies of colorblindness utilize online simulations which was utilized by this study as well through Adobe

Photoshop. This simulation allowed researchers to determine that yellows appear yellow-red, oranges appear dull, reds appear neutral, purples appear blue, blues appear gray, cyans disappear, greens appear yellow, and chartreuses appear yellow [3]. Once the participants were shown the sample signs, 7 of 50 signs were found to be unfriendly due to low value contrast between the color choices. However, this study is not an extensive list of all color combinations that would be accessible, and the signs were assessed strictly for ability to appropriately convey information and were not assessed for how appealing consumers consider them.

Another simulation option is the Variantor dichromatic spectacles (VDS). Takemata et al. [4] utilized these spectacles to create a colorblind accessible video game. They first utilized these spectacles to evaluate challenges in a retail setting with the black, red, and green aspects of evacuation maps. Using the knowledge they gained from their first experiment, they designed a simple maze game with the choice of colored balls. In testing this game, researchers determined that individuals with color blindness were more likely to select the blue ball and those with normal color vision were more likely to select the red ball. However, this study does have limitations as it included a small sample size of researchers utilizing the spectacles and only evaluated one color combination as opposed to investigating different color combinations, shades, brightness, hues, and saturation.

Jover et al. assessed simulation tools against colorimetric measurements. Simulcheck was used to evaluate color simulation tools, specifically the VDS, coblis-P, and coblis-D [11]. Participants identified which option given was most similar to gray, and if there was no gray, the one with least saturation. Then they identified which background made it most difficult to read the text. The VDS were found to be the most accurate [11]. This validates that the spectacles can be used to simulate colorblindness and can be used in other studies to improve package designs. However, this study only compared the two simulations instead of a comprehensive examination of all simulation tools available.

METHOD

This study utilized VDS to simulate red-green colorblindness in order to determine which products in a retail setting might be difficult for color-blind consumers to read or differentiate. Members of the research team wore these spectacles and walked through the aisles of a local store to determine what, if any, products became difficult to read or differentiate. When a researcher had identified such a product, they asked at least three other members of the team to evaluate the product using the spectacles to determine if they concurred with the identification. After collecting as many packages and products as they found issues with, the research team narrowed the number of products down to six, based on a consensus as to which were the most difficult to interpret while wearing VDS. Documentation of each product included pictures of the image taken normally, and again through the lens of the spectacles. Researchers then performed a ranking of the six least accessible packages and selected the Colgate Optic White Pro Series Toothpaste as the most difficult to interpret while wearing the spectacles, and thus that product's package was selected to undergo a redesign process to improve its accessibility. The goal of this redesign was to improve the package's accessibility for Red-green colorblind consumers while maintaining the color red, which is pivotal to the product's overall branding. The redesigns were first sketched out and then digitally created using commercial image editing

software (Adobe Photoshop and Adobe Illustrator). Throughout the design process, VDS were used to ensure the redesigns achieved the goal of being understandable to those with red-green colorblindness. The new design was ultimately printed and cut to the shape of the original box to effectively model a fully redesigned package.

RESULTS

After the retail sampling portion of the study, researchers found six packages [Figures 1-6] that were deemed the most difficult to interpret when wearing the spectacles.

Fig. 1: Indian Healing Clay with and without Spectacles

The Indian Healing Clay had green lettering ("Aztec Secret") on the red background which appeared diminished when wearing the spectacles. Additionally, the black lettering ("Health & Beauty") on the red background was completely lost.

Fig. 2: EOS Lip Balm with and without Spectacles

The EOS Lip Balm relies on the color of the tubes to indicate flavor since the order of written flavors on the package did not match the order of the tubes in the package. This caused confusion when viewed with red-green colorblind glasses.

Fig. 3: Firefly toothbrushes with and without Spectacles

The Firefly Toothbrushes relied on red, blue, and black to differentiate the toothbrushes, but these colors were found to be easily confused when wearing the glasses. The licensed Avengers logo was also hard to see which results in the product losing its added advertising.

Fig. 4: Death at the Dive Bar Board Game with and without Spectacles

Death at the Dive Bar also relied heavily on the use of red and black. The key symbols (time required to play, number of players, and age of players) in the bottom left corner of the front of the game were almost unidentifiable when wearing glasses. The other red elements such as the top tagline and background design were also lost when viewing with the spectacles. These missing elements are highlighted in Figure 4 using blue boxes.

Fig. 5: . Every Man Jack Deodorant with and without Spectacles

Every Man Jack Deodorant also relied heavily on the red and black. The main logo (box around the word “body”) was much harder to identify, but the larger issue was that the scent, cedar-wood, was completely illegible when wearing the spectacles.

Fig. 6: Colgate Optic White Pro Series Toothpaste with and without Spectacles

The Colgate Optic White Pro Series showcased a premium product which relied on the image of a tube to communicate that it is toothpaste. When this red tube was also hard to see on a black background, the only parts of the box to identify it as toothpaste were a small word underneath the brand and brand recognition of Colgate as a toothpaste brand.

Wearing the glasses in the store and looking at these chosen products identified some trends in packaging that can create an issue for color-blind consumers. The first being that red and black are difficult to differentiate- they often blend together, particularly as the red becomes a darker shade. This pattern is seen in five of the six examples found. The next pattern is the confusion between red and green which is expected, given the physiological nature of the disability. The final pattern that presented difficulty involved different shades of a given color, such as light and dark pink. These different shades were easily confused which would likely result in confusion as to the flavor, type, or classification of the product.

Since the majority of the examples identified in the store visit featured designs that were problematic due to the red/ black trend, the research team selected one of those products, the Colgate Optic White Pro Series toothpaste for redesign. The redesign process began with two main goals. First, the package needed to maintain the red color, as it was integral to the established branding of the product, and changing the color entirely could confuse consumers and as such would not be a viable solution. Secondly, the package still needed to utilize the tube imagery in the background to still benefit from the company's marketing strategy as well as showcase how this toothpaste is a higher end offering compared to other Colgate toothpaste products.

The initial idea for improving the product's accessibility for those who are red-green color-blind was to replace the front of the box with a window to see the tube [Figure 7]. The tube inside the box was already printed with the same information as the front of the box, so the window would allow people to see the tube and would also contrast the red tube against the white background of the box interior. Unfortunately, the research team realized that this concept would

have strayed too far from the original packaging structure and might end up requiring expensive equipment changes for the manufacturer.

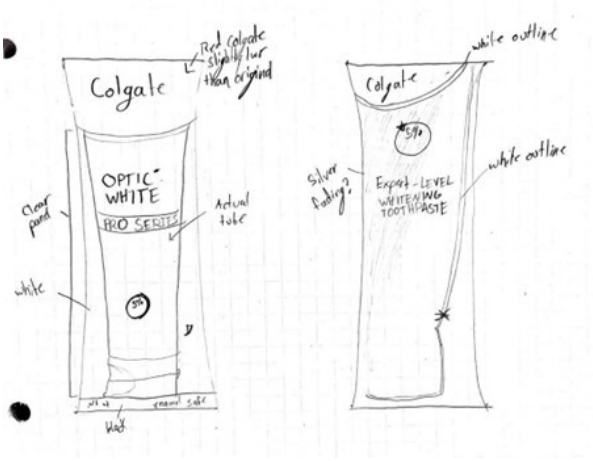

Fig. 7: Initial Sketch of Redesign

Therefore, researchers focused on finding a graphical solution to the problem instead. Several potential designs were completed using Adobe Lightroom, Adobe Photoshop, and Adobe Illustrator. Researchers would wear the spectacles while designing the new box to ensure what they were designing would be understandable. In order to highlight the shift from the red to black, a white and gray outline around the image of the tube seemed like a natural choice [Figure 8]. However, the positioning of the tube made it such that the outline would run into the printed text, and in order to maintain perspective, the farther side of the tube could not be outlined. The team also found a promotional image of this toothpaste which showed the tube from a slightly different perspective, which could then be used on the new box [Figure 9]. This change allowed for both sides of the tube to be outlined while maintaining both perspective and sheen. The redesign also allowed the tube to be centered on the box in order for the outline to not intersect the lettering on the box as well. This design was then printed to ensure it was clearly visible with the spectacles even in hard copy [Figure 10]. Compared to the original box, this design was much clearer and the tube could be easily discerned while wearing the spectacles [Figure 10], effectively meeting the goals of the redesign. A small sizing change was required between the first printing and the second in order to accommodate the graphic and properly fit it on the cut and shaped box, but the rescaled design was still able to achieve the goal [Figure 11].

Fig. 8: First Redesign Using Adobe Photoshop

Fig. 9: Promotional Image of Product [12]

Fig. 10: Printed Design 3 with and without Variantor Dichromatic Spectacles

Fig. 11: Final Printed Design with and without Variantor Dichromatic Spectacles

DISCUSSION

The use of red and black as alternating colors in marketing is quite prevalent among packaging designs, as evidenced by the fact that it was used in the majority of samples found in the retail portion of the study. When looking at other products on

the market, a trend can be found with this combination being used to market towards men such as the Every Man Jack and Death at the Dive Bar examples in this research. These are often used to differentiate products made for men from those made from women that often use lighter colors or pinks. Razors can be an example of this where pink and purple razors are made for women others that use blacks, grays, and reds are for men [13]. These choices may be due to color preferences found between men and women, where red and black both score highly for men [14]. Men's favorite colors include blue, black, red, and green, but these can be difficult for those with red-green colorblindness to decipher [15]. The fact that the red-black combination is well known to be problematic for people with color vision deficiencies yet is still used highlights a blind spot in the packaging and marketing industries involving accessibility for those consumers. While the other observed patterns also pose accessibility issues, they do not appear to be nearly as prevalent in the industry according to this study. In terms of designing anything to be accessible for those with red-green colorblindness, the method most commonly proposed is to reduce the use of red and green or to replace these colors with other colors such as magenta and turquoise [1]. However, during this redesign it became obvious that for this product (and many others) the color red is important to the brand itself which means changing the shade or color would not be an ideal solution, and this predicament shows a need for a different approach.

The design of the Colgate Optic White Pro Series exemplifies the red and black confusion particularly well, especially because it features red elements fading into black and even uses darker shades of red in several areas. While the first redesign, which included a window to directly show the primary packaging, eliminated most of the accessibility issues, it had another flaw- While the purpose of the window was to utilize the already present white color of the inside of the box to provide contrast with the red of the tube, but this would be too drastic of a change for the package and would require changes to machinery and be difficult to implement. Eliminating the tube graphic might have worked as well, however, that feature appears to be designed to showcase the premium nature of the toothpaste and distinguish it from other offerings. Therefore, the next step was to increase the contrast on the original graphic, and this was accomplished by increasing the saturation, lightness, and adding a light gray outline. This solution was explored because these features are well-known to improve image visibility and solve issues involving red-green colorblindness [6]. While adopting this technique did make the image slightly easier to differentiate with the red-green glasses, showing how contrasting colors can be utilized, the graphic could still be improved. However, the changing of brightness and the contrasting outline did not help with the fading which by definition is the opposite of contrast. Therefore, the best approach would be to change or alter the tube graphic so that it does not fade into the background and has an increased contrast. The new image was not subjected to the fading colors and was able to have a thin contrasting white outline on both sides of the tube. This was the final solution presented for this specific package because of the good use of outlining.

When looking at the final solution used for the toothpaste, its feasibility is strengthened by the similarities to other research findings. Since it is assumed that red and green would be the color combination of the most difficulty for this type of colorblindness, the red and black combination is often overlooked, but Kaufman-Scarborough et al. noted that multiple interviewees with red-green colorblindness stated that red on

black and black on red were hard to read or understand [6]. This case study then tried to follow the guidelines found by other researchers, such as the work of Wong, which found that colors are "easier to distinguish when they vary in lightness and saturation" [1]. This trend was also shown in the current study, particularly given that the first redesign, while offering an improvement, ended up not being the best answer for the package. While there is little available information on designing packages that are friendly for those with a color vision deficiency, information from other accessible formats such as website design can be applied and provide possible solutions. For example, Wang outlined different goals for designing websites using universal or inclusive design which included using colors with high contrast [2]. This technique was ultimately implemented in this study because the contrast between the black background and the slim white outlines of the tubes is the largest possible contrast that can be made. While these previous studies do support the validity of this case study's solutions and also show why these concepts would make a product more visible to those with a color vision deficiency, they do not look at the effect this inclusive design has on packaging. If researchers are suggesting that the methods used to design signs and websites better are universal for all designs, these ideas and solutions for increased accessibility need to be able to extend to packaging. In particular, the difficulty of using "broad stroke" solutions in packaging is that a package will be displayed in multiple different environments with different levels, colors and geometries of lighting. Therefore, the design will almost certainly need to utilize multiple methods in order for it to become the most visible to people in all scenarios. As Jenny and Kelso put it succinctly "It is important to balance the needs of the 8% of people with colorblindness against the 92% of people without it. Both groups have the right to information" [16].

Despite the overall success in improving accessibility in our redesign, the current case-study does have limitations, and the first of which is that it was only done with a small number of researchers using the Variantor Dichromatic Spectacles. This case study sets up a theory framework, but still needs to be quantified through a full human subjects study with a control and comparison. While some may say that these packages must be tested with people that are red-green colorblind, previous research has shown that these spectacles and other simulation methods are accurate enough to base studies and findings off of them [11]. The other potential issue is that this solution was not tested using equipment that would actually produce these packages. However, the simplicity of the design suggests that this might not necessarily be an issue. It is likely that these colors can be replicated at the manufacturing level when testing reaches the point of using industrial equipment. Regardless of these limitations, the findings of this study showcase that the findings in studies related to improving accessibility for those with red-green colorblindness for non-packaging applications can be applied to packaging and also highlights how making packages for those with a color vision deficiency is a key step towards inclusive and accessible packaging.

CONCLUSION

Red-green colorblind individuals make up about 8% of the population, but their particular needs have not been taken into consideration during packaging design [1]. This was supported by the retail sampling done in this study since multiple products were found to be an issue. Variantor Dichromatic Spectacles can be used

to model or simulate the issues those with color blindness may encounter, and by using VDS, it became readily apparent that red and black combinations were the most prevalent problem in packaging affecting their accessibility for color-blind individuals. This fact had also been found in other (non-packaging) studies, so it was a supported finding in this study [6]. The redesign process relied upon combining different previously identified strategies in order to improve a product. Utilizing the methods of outlining, increasing lightness and saturation, and improving contrast, a final design was achieved and tested with the spectacles. This redesign showed how these known methods for improving products or websites for those with color vision deficiencies can be applied to packaging and helps bridge the gap between the known solutions and the medium of packaging. However, due to the limitations of the study the design needs to be tested in other ways in order for these results to fully be trusted. More work in this space needs to be done to fully develop this case study into a fleshed-out theory.

If these results are recreated and others have studied ways to improve packaging for those with color vision deficiencies, there will be an opportunity for important future work. Additional methods could be designed and existing programs such as Adobe Photoshop and Adobe Illustrator can be utilized to implement these methods. The Variantor Dichromatic Spectacles can also be used to show designers the issues their current designs may pose and allow them to have more insight into their red-green colorblind consumers. Companies can then improve their current designs and ensure future designs are more inclusive. When more people can understand and comprehend the package design, more people will likely purchase the product. This expands their market to include additional potential customers and provides consumers with more options and information thus benefiting the company. These studies can then pave the way for improvements in other fields such as product development and building design, thereby furthering the goal of universal consumer packaged goods accessibility.

REFERENCES

[1] B. Wong, "Points of view: Color blindness," Nat Methods, vol. 8, no. 6, pp. 441–441, Jun. 2011, doi: 10.1038/nmeth.1618.

[2] J. Wang, "Dissertation: colour blindness oriented universal web design," DesignForColourBlind. Accessed: Feb. 20, 2023. [Online]. Available: https://designforcolourblind.wordpress.com/2016/08/25/dissertation-colour-blindness-oriented-universal-web-design/

[3] H. Lee, E. Lee, and G. Choi, "Wayfinding signage for people with color blindness," Journal of Interior Design, vol. 45, no. 2, pp. 35–54, Jun. 2020, doi: 10.1111/joid.12169.

[4] K. Takemata, T. Takeda, M. Tanaka, and A. Minamide, "Development of game software based on color universal design," in 2016 IEEE 16th International Conference on Advanced Learning Technologies [ICALT], Austin, TX, USA: IEEE, Jul. 2016, pp. 123–124. doi: 10.1109/ICALT.2016.43.

[5] B. Hamieh, "The meaning of red and green in user interfaces for the color deficient," Portland State University, 2020. doi: 10.15760/honors.946.

[6] C. Kaufman-Scarborough, "Seeing through the eyes of the color-deficient shopper: consumer issues for public policy," Journal of Consumer Policy, vol. 23, no. 4, pp. 461–492, Dec. 2000, doi: 10.1023/A:1007253306383.

[7] D. E. Baker, "Use of color on pharmaceutical labels and packaging," Hosp Pharm, vol. 40, no. 4, pp. 296–297, Apr. 2005, doi: 10.1177/001857870504000401.

[8] D. R. Keene, "A review of color blindness for microscopists: guidelines and tools for accommodating and coping with color vision deficiency," Microsc Microanal, vol. 21, no. 2, pp. 279–289, Apr. 2015, doi: 10.1017/S1431927615000173.

[9] I. Mackie, M. Bisson, C. Linge, and R. Sanders, "A simple solution to a 'blinding' problem," J Histochem Cytochem., vol. 50, no. 8, pp. 1139–1139, Aug. 2002, doi: 10.1177/002215540205000816.

[10] "Staining microscopic specimens | microbiology." Accessed: Apr. 09, 2024. [Online]. Available: https://courses.lumenlearning.com/suny-microbiology/chapter/staining-microscopic-specimens/

[11] J. A. Lillo Jover, L. Álvaro Llorente, and H. Moreira Villegas, "Do dichromats see colours in this way? Assessing simulation tools without colorimetric measurements," Psicothema, no. 28.4, pp. 435–441, Nov. 2016, doi: 10.7334/psicothema2016.201.

[12] Colgate, "Colgate Optic White Pro Series Whitening Toothpaste with 5% Hydrogen Peroxide, Enamel Strength, 3 oz Tube," Amazon. [Online]. Available: https://www.amazon.com/Colgate-Whitening-Toothpaste-Hydrogen-Peroxide/dp/B09R2LSSPM

[13] Old spice men's electric foil shaver / electric razor, red/black," CamelCamelCamel.com.

[14] S. Singh, "Impact of color on marketing," Management Decision, vol. 44, no. 6, pp. 783–789, Jul. 2006, doi: 10.1108/00251740610673332.

[15] [15] A. Zbooker, "Gender based marketing: How brands use the power of colors to persuade you.," Medium. Accessed: Feb. 23, 2024. [Online]. Available: https://namegenderpro.medium.com/gender-based-marketing-how-brands-use-the-power-of-colors-to-persuade-you-5f47bfa2b7e3

[16] [16] B. Jenny and N. V. Kelso, "Color design for the color vision impaired," CP, no. 58, pp. 61–67, Sep. 2007, doi: 10.14714/CP58.270.