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THE EFFECT OF COLOR IN PRODUCE PACKAGING ON CONSUMERS' ATTENTIVE BEHAVIORS AND PERCEIVED FRESHNESS

By

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ABSTRACT

THE EFFECT OF COLOR IN PRODUCE PACKAGING ON CONSUMERS' ATTENTIVE BEHAVIORS AND PERCEIVED FRESHNESS

By

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Varied produce is available in the marketplace, to which consumers can devote attention using their senses: sight, sound, smell, taste, and touch. Attention is requisite to perception, of both the produce and packaging attributes; perception is mediated with consumer experience and prior knowledge. It has been indicated that consumers pay more their attention to positive attributes, which ultimately influence purchase decisions.

The objective of this research was to investigate consumer's attentive behavior and quality as it related to the color effect that results when produce is packaged in mesh bags. Four color combinations were studied (1. mono-chromatic (same), 2. complementary, 3. complementary-analogous, 4. analogous) with six types of produce.

Results suggested that consumers spent significantly more time (α =0.05) viewing the mesh bag in the same color and those that appear in an analogous color than the complementary or the complementary-analogous. This was true for both dependent variables (time in zone and number of hits)

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CHAPTER 1 - INTRODUCTION

The growth of the market for fruits and vegetables has received considerable attention over a long period of time. Consumption of produce has been accelerated by consumer interest in nutrition and personal health. Increasing consumer demands have driven produce market trends which include: the need for more diverse variety, convenience, and safety and quality (Dimitri, Tegene et al. 2003). As a result, the produce market is increasingly growing and segmenting (e.g. markets now exist for organic, fresh-cut, canned/bottled, dried, and frozen produce).

In the produce market, quality is the most important key directly related to sales. Food quality involves all attributes that affect a product's value to the consumer (Food and Agriculture Organization of The United Nations 2002). The quality, or the degree of excellence of a given product, is tested by the human senses. In produce, quality is considered related to the nutritional value, and safety of any chemical components, and influenced by the psychology of the individual, as well as sensory characteristics associated with the produce: its appearance, texture, taste and aroma (Abbott 1999). During perception, quality attributes are gauged against the consumer's previous knowledge, experience and expectations. In short, quality is evaluated by combining these several attributes and gauging satisfaction (Shewfelt 1999). Therefore, a consumer's perception of quality directly impacts their purchasing decision (Shewfelt 1999).

The appearance of produce, including its size, shape, mass, color, and packaging, is a major attribute of quality (Francis 1995). Appearance creates, visually, the perceived quality of the produce to consumers, assisting with consumer acceptance at the point of purchase. However, produce appears differently in the marketplace because it is influenced by optical properties, physical form, and mode of presentation. Hutchings calls the attributes that affect an object's appearance the "total appearance" (Hutchings 1999). The "total appearance" of fresh fruits and vegetables depends on consumers (e.g. their visual abilities, memory and preferences) and design tools (material properties, illumination, and the design itself) at time of purchase consideration (Hutchings 2002). Therefore the "total appearance" of packaged produce in the marketplace is not only influenced by the illumination, packaging and material properties or package design, but it is also subjectively perceived by the consumer's psychological impacts including experience and knowledge, as well as, their physiological / sensory abilities.

Recognizing the new demands of consumers, packaging design for produce has changed dramatically in recent years. Produce packaging is now available in a wider range of sizes to meet consumer demand for smaller units (Boyette, Sanders et al. 1996) and brilliant colors to attract the attention of consumers (VanHurley 2007). Many researchers suggest the importance of packaging that is influential at the point of purchase (Garber 1995; Silayoi and Speece 2004; VanHurley 2007). If consumers cannot find the product on the

shelf, they will purchase another product. For example, Tropicana announced a new packaging design. However, consumer attitude toward the new packaging was unfavorable, and some of Tropicana's most loyal consumers complained that the new packaging made it harder to distinguish the brand among competitors at shelf. The new packaging design was not successful and eventually the packaging was redesigned using the Tropicana brand symbol, meant to evoke fresh taste (Elliott 2009). Learning from the Tropicana experience, as a design tool, packaging is an important cue in marketplace, not only to attract the attention of consumers, but to evoke knowledge in the form of previous experience by enabling product identity, ultimately, stimulating the purchase.

Packaging design also has the potential to influence the consumer's perception of quality. Produce color is an indicator of maturity or ripeness to the consumer at the purchase point. The color of produce, one of the total appearance attributes, is affected by packaging material properties, its design, and opacity or transparency. When looking at produce, consumers are able to perceive the same color of the object in marketplace, despite different sources of lighting, because human vision can adapt to different light sources. As such, packaging attributes have the potential to affect the color of produce more than the illumination at shelf. Thus, the harmonized color of the produce and its packaging have tremendous potential for influencing quality perception and the purchasing behaviors of consumers, and it has been noted that highly visible colors, particularly, have the potential to capture attention at the shelf.

The objective of this research was to identify the impact of color (i.e. the combined effect of package color and produce color) on consumers' attentive behaviors and their perception of freshness. To do so, the study employs a bright pupil eye tracking technique, combined with a brief survey.

CHAPTER 2 - THE PRODUCE MARKET AND PACKAGING

Produce Market Trends

The produce market has enjoyed sustained growth in the United States. The consumption of fruits and vegetables was documented to have increased by 8 percent between the years 1995 and 2000. Increases in international trade have catalyzed the introduction of many new types of produce to consumers in local markets, inspiring increases in produce departments (Dimitri, Tegene et al. 2003).

Estimated retail sales of produce were $63.2 billion in 2007 showing an increase of 24.8% over the reported $50.7 billion in 2002. Foodservice sales estimates for 2007 were $47.2 billion showing an increase of 42.5% from the 2002 estimate of $33.1billion. 57% of total purchases were made at retail stores, and the remaining 43% were purchased by foodservice organization in 2007 (Kristen 2009).

Much of this growth is attributed to growing health concerns that became increasingly important at the turn of the century. According to a 2004 survey conducted by the Food Marketing Institute, 70% of consumers indicated increasing their consumption of fruits and vegetables to achieve a healthier diet (Interantional 2004). This increasing consumer demand has changed market trends so that the produce marketing is becoming more consumer-oriented. Consumption has also increased because producers have recognized the need

to create produce that meets the needs of their customers' demographics and lifestyles. Producers now offer safe, quality produce (as always) that comes in widely varied options (both product and package) that are convenient to use and eat. (Dimitri, Tegene et al. 2003).

Consumer demand is driving both small and large supermarkets to offer fresh produce: whole produce and fresh-cut produce and processed produce: canned/bottled, dried, and frozen produce (Group 2009), with greater diversity than in years previous. Offerings include single and mixed items, such as pre-cut fruits and vegetables. The average number of items handled grows larger every year in the American produce industry. In 1994, an average of 350 produce items were stocked, but this increased to about 550 items handled in 2004. Packaging is also being offered in greater variety with more desirable materials, and broader sizes, improving quality and affecting consumer purchasing (Clemens 2004).

With the growth of the produce market, the safety and quality of produce is becoming increasingly important. During the past decade, foodborne disease outbreaks drove increasing concerns regarding the safety and quality of produce (Johnston, Jaykus et al. 2005). Consumers are demanding greater responsibility of the government, and many food control systems have been revised and strengthened to protect consumers (Food and Agriculture Organization of The United Nations 2002). Increased contamination and the consumption of fresh fruits and vegetables are a continuing concern for the government. As a result, the Food and Drug Administration (FDA) continues to develop guidelines

addressing food-safety hazards and good agricultural practices common to the growing, harvesting, packing, and transportation of the majority of fresh fruits and vegetables.

Another trend, partially borne from safety concerns is the increasing demand for organic fruits and vegetables. Nutrition Business Journal (NBJ) reports suggested that the expected sales of organic fresh produce would be $8.5 billion in 2010, showing an increase of 300% over sales in 2000 (Oberholtzer, Dimitri et al. 2007). According to a report from the Organic Trade Association, estimated sales of organic fruits and vegetables in the US has already reached $9.5 billion (in 2009), showing an increase of 11.4% against 2008 and a 370% from just $2.55 billion in 2000 (McShane 2010).

Convenience has also played an important role in increasing the consumption and selection rates of fruits and vegetables. Pollack (2001) estimated that in the years between 1997 and 1999, 52 percent of vegetable consumption was processed in some fashion, including those that were canned, frozen, or dried (Pollack 2001). In addition, consumption of fresh products like "ready-to-eat" products such as bagged, prewashed lettuce has increased considerably during the past decade (Michael R. Taylor 2009). A major source of the overall growth in the industry is fresh-cut, packaged produce (Misnomer 2005); these products had an estimated sales of $15.9 billion in 2007, increasing 46% in 6 years (Cook 2007).

Further enabling the growth is the development of technologies that improve the packaging, handling, shipping, and storing of produce. These technologies improve and prolong their shelf life. This enhances consumer satisfaction and also further increases demand (Pollack 2001).

The Packaging of Fresh Fruits and Vegetables

Packaging must perform varied functions and comes in a variety of types. Packaging is classified into four functional roles: containment, protection, communication, and utility (Abbott 1989). In the case of produce packaging, it protects the produce, reduces costs associated with transportation, maintains quality, and attracts the attention of consumers (Boyette, Sanders et al. 1996). Many packaging types such as paper, plastic, or mesh bags, plastic and paper containers, paper and wood boxes, and bulk bins are used for the processes of harvesting, handling, transporting, and marketing to consumers for sale (Boyette, Sanders et al. 1996).

Packaging is used for containing and transporting large amounts of fruits and vegetables in the produce industry. The industry is generally focused on container standardization to reduce cost. However, packaging has been changed to provide a wider range of sizes in order to meet increasing demand for smaller units by consumers (Boyette, Sanders et al. 1996). Producers and wholesalers want to standardize large sizes in order for shipments be better palletized and handled, saving money and time. Retailers and consumers, on the other hand, want smaller and lighter packaging that is convenient. In addition, smaller

packaging has the potential to reduce spoilage so that there are more saleable fruits and vegetables per packaging unit. This results in more profits for the retailer and more satisfaction for consumers due to the proper volume for consumption (Boyette, Sanders et al. 1996). Other demands of packaging include the need to maintain freshness and quality from harvest to consumption (Connolly 2007).

According to the report, "Produce packaging" by the Freedonia Group, packaging demand in the produce industry may increase 3.6% yearly to reach $4.8 billion in 2014 (Group 2010). Packaging demand will be constantly increasing for display-ready packaging which reduces labor costs and provides a pleasing display in the store, growth will also be driven by value-added packaging, such as zipper bags which offer convenience during transportation, storage and use (Group 2010). In short, produce packaging that provides the consumer choice of size and shape, boosts sales appeal, prolongs shelf life, and reduce wastes is desired.

The mesh bags used in this research have wide application in the packaging of fresh fruits and vegetables. Potatoes, onions, lettuce, citrus, apples, and some specialty items, are all packed in mesh bags. Several aspects of their design drive the appeal of this packaging system for use with produce. Mesh bags are made of low-cost, hydrophobic materials, generally polyethylene and polypropylene. These materials come in various color (e.g. red, orange, yellow, green, blue, violet, white, black).

The mesh bag has the advantage of easier and faster handling for displays, and being lightweight, when compared with other plastic bags and trays. The open nature of mesh bags also provides consumers with the ability to visually identify the produce, and good ventilation for the contents within. These bags have also been noted to attract consumer's attention and stimulate purchases (Boyette, Sanders et al. 1996).

The downside to using this packaging system for fresh produce concerns handling and transportation. These packages do not protect contents from significant physical damage and palletization is challenging, as well.

CHAPTER 3 - CONSUMER PERCEPTION AND BEHAVIOR

The goal of this chapter is to understand how humans sense and respond to objects in the environment. More specifically, this chapter will examine how perception occurs in a sequence of steps, several attributes of fresh produce that have the potential to influence consumer perception and, in turn, how this perception may influence behavior at the purchasing point.

Perception is an essential portion of consciousness to an object. The function of perception depends on the response of humans affected by stimulus in the environment. It can be defined as "the result of processing information of human response to stimulus" (Carterette and Friedman 1974). The perceptual process, shown in Figure 1, is divided into four broad categories: Stimulus, Electricity, Experience and Action, and Knowledge (Goldstein 2009).

People receive stimuli from the environment and devote attention to the stimuli using the senses: sight, sound, smell, taste, and touch. The attended stimulus is transformed into electrical signals in our nervous system and then transmitted to the brain. In this stage, we mentally arrange the stimuli in the brain. During the experience and action step, interpretation occurs. People perceive, recognize and act on the objects in the environment, based on their experience with knowledge which is acquired through learning (Goldstein 2009). The entire process encompasses the perception and behavior of the human on objects within environment.

Therefore, perception and behavior not only relate to the basic senses, but are also affected by experiences and basic knowledge which has been formed.

Perception research was developed in various fields of human behavior such as philosophy, psychology, and cognitive science using two approaches: the psychophysical approach and the physiological approach. The psychophysical approach measures the relationship between stimuli and perception using mostly quantitative methods. The physiological approach measures the relationship between perception and physiological processes by measuring electrical responses in the brain (Goldstein 2009). This study focuses on consumer perception regarding the design of produce packaging using eye tracking, a psychophysical technique.

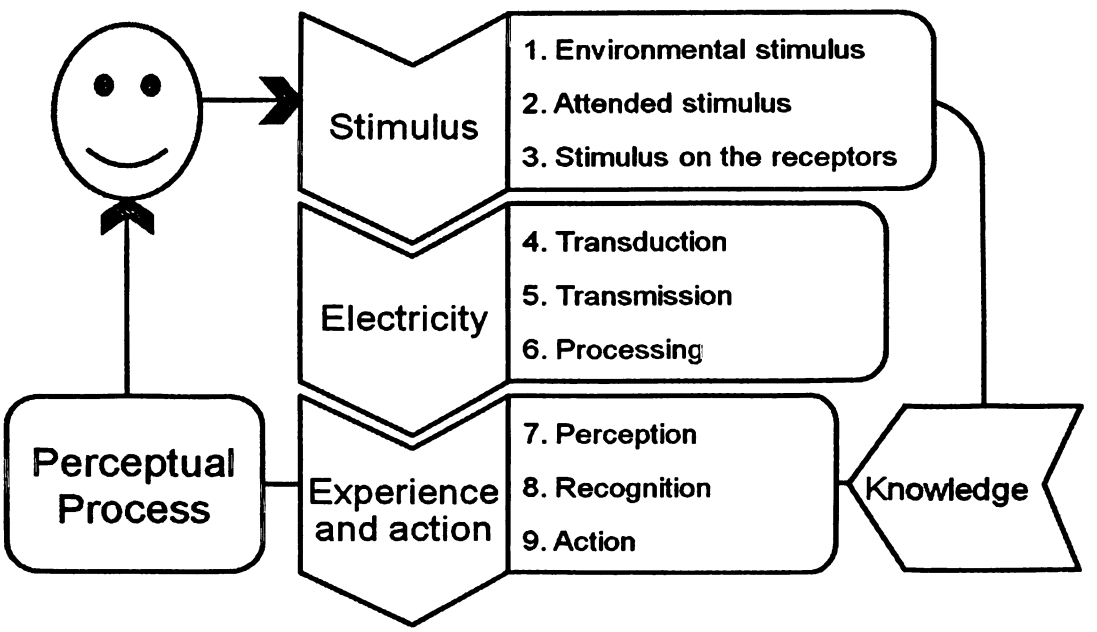


Figure 1- Perceptual Process

Consumer perception is considerably dynamic and complex. However, consumers sometimes experience discord between what they perceive and how they act because they want specific benefits or performance from products when they buy something (Fennell 1978). In the case of produce, they want to buy items that taste great, are safe, nutritive, fresh, and undamaged, and at the same time, many consumers are concerned with cost. These multiple desires create a situation where a range of attributes have the potential to result in consumer satisfaction. Consumers gauge sensory characteristics of products using their senses and then perceive them, based on their experience and knowledge, positively or negatively. They are more likely to pay their attention to positive stimuli when they choose a product (Whaling 2007). In other words, positive outcomes that satisfy a consumer's needs are more likely to lead to a purchasing-decision.

Consumer behavior is defined by Peter and Olson (1990) "as the physical action of the consumer following perception of stimuli through the perceptual process, what they select, prefer and purchase". This includes the study of how consumers act and purchase in the marketplace while shopping (VanHurley 2007). Like perception, the behavior of the consumer is not fixed. It continually changes and is attributable to a confluence of factors including personality, preference and environmental factors. Consumer behavior has been researched in various fields, including Anthropology, Psychology, Sociology, Economics and Statistics. Each field tends to utilize specific methodologies and theories in

conducting research, which is driven by slightly different objectives (See Table 1) (Peter, Olson et al. 1990).

Table 1 - Consumer Behavior Research Methodology Fields

Core Discipline	Primary Method	Primary Research object
Cultural Anthropology	Long Interviews and Focus Groups	Understand consumption and its meaning
Psychology and Sociology	Experiments and Survey	Examine and explain the decision-making and behavior of the consumer
Economics and Statistics	Math modeling testing and shopping simulation	Predict consumer behavior and consumer choice

Research methods employed to study consumer behavior are generally divided into qualitative methods, such as focus groups and in-depth interviews, and quantitative methods, including: experiments and surveys. In this study, a quantitative experiment (using eye tracking) and survey are used as a measure the psychophysical relationship between stimulus and the consumer's perception and behavior. Specifically, this study investigates: the influence of a mesh bag's color on the consumer's attentive behaviors, their assessment of quality and their purchasing intention for fresh produce. As such, a discussion of food quality and perception continues in this chapter.

Food Quality Perception and Acceptability

Consumer perception of food quality is a complex study which includes food science and technology, nutrition, psychology, physiology, marketing and packaging (Imram 1999). Although many researchers have taken great care in

defining the concept of food quality, it is still difficult to clearly explain what the term of food quality includes, and how it can be measured (Lawless 1995; Bello Acebron and Calvo Dopico 2000). Nevertheless, proposed definitions tend to be related to the consumer as an end-user, a person making the final judgment of the product (Cardello 1995; Ismail, Haffar et al. 2001). There is no doubt that quality is a conclusive attribute for the consumer's choice to purchase a particular fruit or vegetable, but to precisely define quality is a complicated endeavor.

Quality has been defined as a combination of product characteristics, attributes, or properties that contribute value to the buyer or consumer (Shewfelt and Bruckner 2000). Because the quality of fruits and vegetables depends on a long postharvest-life, producers and handlers are encouraged to pay more attention to quality in the procedures of production, distribution, handling, and storing between pre-harvest and preparation (Kader and Lamikanra 2002). High-quality, fresh produce should fulfill sensory characteristics such as: great color, texture, flavor, and smell because many consumers evaluate quality using their sensory dimensions which ultimately lead the consumer to judge the acceptability of a particular item. As a result of the particular importance of these attributes for this product, sensory evaluation is a preferred technique for gauging consumer satisfaction related to quality (Abbott 1999).

The sensory characteristics of fresh produce affect the consumer's perceptual process which, as mentioned, is an integration of physiological, behavioral and cognitive factors gauged by their experience (Imram 1999). The

consumer synthesizes sensory inputs such as appearance, aroma, flavor, touch, mouth-feel and chewing sounds. The sensory characteristics of fresh produce are affected by background factors (e.g. safety and nutrition, heath interest, psychosocial influences), their knowledge, and post-consumption experience with produce. This process, in turn, influences consumer expectation. It can also be influenced by information that accompanies the product (Imram 1999). Therefore, there are many factors that influence quality perception and acceptance.

In conclusion, it is commonly believed that consumers measure produce quality by evaluating the differences in expectation, experience and knowledge, and various factors, this evaluation, in turn, reflects the probability of purchase and consumption of the produce. (See Figure 2)

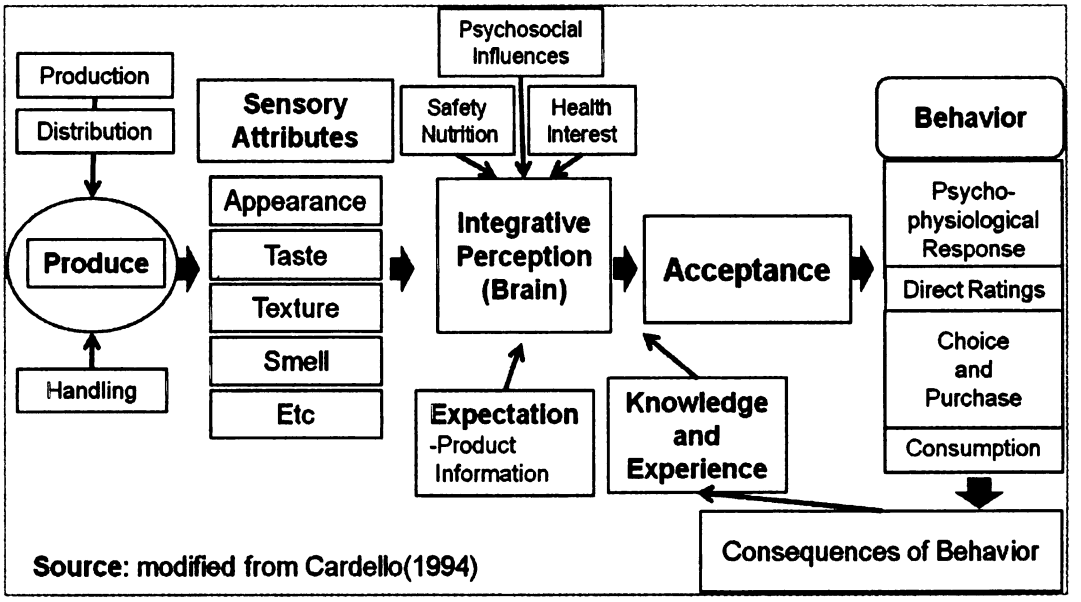


Figure 2 - Produce Perception and Behavior Procedure

Visual Perception of the Appearance of Produce

Visual cues that are evaluated by consumers as they determine freshness in the marketplace include size, shape, color, gloss, and external damage (Kader and Lamikanra 2002). Moreover, appearance is an important key to attracting the consumer's attention; attention to a stimulus in the environment is precursory to the possibility of purchase. For example, a consumer must view products in order to process, select and purchase in the marketplace. Research has indicated that consumers pay more attention to products which provide a visually appealing appearance, and that attention is correlated to selection (Clydesdale 1993).

It has also been noted, however, that consumers often have different views of product appearance in the actual environment because of combined chromatic attributes and geometric attributes of the viewed stimulus (Eugene 2008). This was initially identified by Hutchings (1977), who termed it "total appearance". The concept of "total appearance" consists of three groups of attributes: optical properties, physical form, and mode of presentation (Hutchings 1999). In a subsequent publication, the author indicates, "*The total appearance combines a description of the appearance of each element of a scene... with a personal interpretation of the total scene in term of its recognition and expectation*" (Hutchings 1999).

Visual images are not only controlled by individual, viewer-dependent variables (e.g. their visual properties, memory and preferences), but also scene-

dependent variables which consist of the design tools: material properties, illumination providing light, and the design itself (Hutchings 2002). For example, the total appearance of an orange in the marketplace may communicate that this object is a yellow-orange colored medium-sized orange through yellow illumination, or it may say this is a red-orange colored, medium-sized orange, through red illumination.

Color plays an extremely important role in visual perception, and subsequently, is often used to judge the acceptability of fresh fruits and vegetables (Francis 1995). In particular, the color of fresh fruits and vegetables tell us about the taste qualities: ripe and tempting. If the color of a banana is green, the green color informs us of the banana's condition. The color of fresh produce in marketplace is considerably affected by the design tools because the color of produce, packaging, and lighting are all used as visual cues at the same time (Hutchings 2002). Tools may be manipulated, or harmonized, so that they capture the consumer's attention.

Produce Packaging and Consumer Behavior

Packaging must catch the consumer's eyes in few seconds. It communicates and indicates information about the product and its condition (Rowan 2000). As one of the design tools available for manipulation, packaging attributes including color, text, images, and others are very important because of their role in visual perception. Packaging also assists in point of purchase decision making.

Academic researchers have discussed the relationship between packaging attributes, consumer perception and decision-making behavior. Cichon and Ucherek (2001) and Whaling (2007) conducted consumer studies that explored the relationship of packaging attributes on the perceived quality of fruit juices. VanHurley (2007) concluded that packaging in red and blue colors affected consumers' purchasing behaviors. Dantas et al. (2005) indicated that packaging color and transparency are the attributes with the most impact using a "Focus Group" methodology. Many researchers have suggested that green, in particular, was the most appreciated color for vegetable packaging. (Cichon and Ucherek 2001; Dantas, Minim et al. 2005; VanHurley 2007; Whaling 2007)

Many research papers have estimated the influence of product attributes and packaging factors on consumer perception or behavior. Murray and Delahunty suggest that the visual appearance of packaging influences consumer behavior when making purchase decisions, while the appearance of the product provides conviction about the selection (Murray and Delahunty 2000). The authors concluded that both packaging and product characteristics contributed to evaluated consumer acceptance of the product. Both the sensory characteristics and packaging attributes, greatly constitute the overall visual product entity and affect acceptance of the product as quality cues to the consumer (Oude Ophuis and Van Trijp 1995; Deliza, Macfie et al. 2003). In other words, two important cues, the produce appearance and packaging work simultaneously to aid the consumer in determining whether or not the product is suitable for purchase.

Many researchers concluded that packaging is able to influence perception of the product and consumer purchasing behavior at the point of purchase (Garber 1995; Silayoi and Speece 2004; VanHurley 2007). It delivers a positive or negative image to the consumer, ultimately affecting the decision-making process. In addition, color, as conveyed both in the appearance of the product and through packaging, plays a considerably important role in quality perception and purchasing decisions of the consumers of produce. In this research, harmony of produce color and packaging color is examined as a dependent variable that has the potential to impact the attentive behaviors of individuals, their perception of quality.

CHAPTER 4 - COLOR

Color perception is the result of the interaction between light, materials, and our visual apparatus (Kaszubowski 2004). It results when waves of light from the visible portion of the electromagnetic spectrum are reflected from objects and into our eyes (Figure 3).

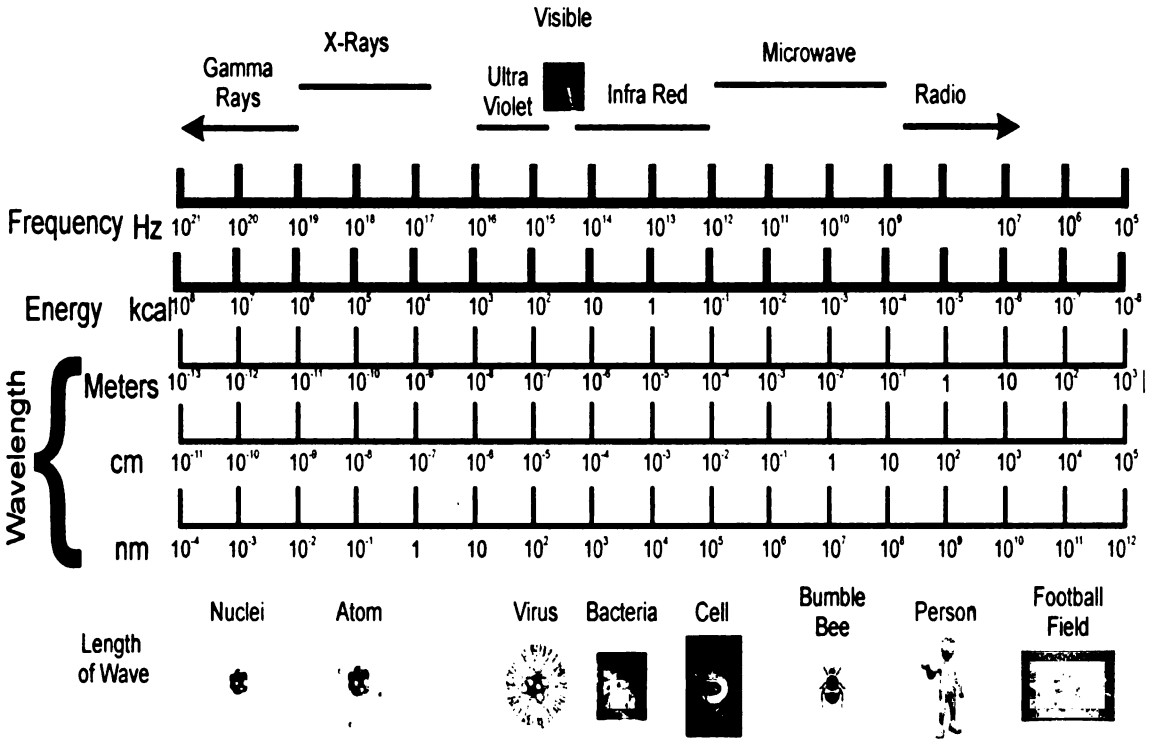


Figure 3 - The Electromagnetic Spectrum

The physical aspects of color, waves with varying amplitudes and distances between troughs, were recognized as a perceptual function of light in distant history by Newton (1670). These theories can be tested fairly simply by using a prism, which will refract different wavelengths of the visible spectrum

differently. When the light is separated through the prism, each wavelength is refracted at a different angle, producing a continuum commonly called "ROYGBIV" (Red, Orange, Yellow, Green, Blue, Indigo, and Violet). The human eye is capable of sensing only a portion of the electromagnetic spectrum, specifically those wavelengths from approximately 400 to 700 nanometers (Cheskin 1954; Holtzschue 2006) (see Figure 3).

However, although color is measureable in physics, it is still difficult to clearly define because of various factors. Physiologically, color is related to the ability of the eye to sense reflections of the visible spectrum when reflected off of objects. The retina detects the light entering the eye and transmits signals to the brain, resulting in color perception (Hutchings 2002). Color perception involves the perception of three independent properties of color: hue, saturation/ chroma and lightness/value (Kuehni 2004).

Hue is the most obvious characteristic of a color, what we normally understand as blue, red, yellow, etc. The saturation / chroma represent the dominance of hue in the color the saturation of the color. Low saturation / chroma colors are "dull" and high saturation / chroma colors are "deep." Lightness / value are the degree of darkness or lightness of the color relative to the overall intensity of strength of the light. These are a neutral scale that extends from pure black to pure white (Gorn, Chattopadhyay et al. 1997).

Beyond the physical (e.g. wave length, etc.) and physiological aspects are the emotional. Color invokes feeling, sensation, and emotion. Color also

influences psychological responses in people: e.g. red is warm and blue is cool (Cheskin 1954). Therefore, during the perceptual process, color is affected by the interaction of three variable factors: the light source, the object and the viewer (Holtzschue 2006).

Impact Factors to Color Perception

Vision is the most important among the traditional five senses (vision, hearing, taste, smell, and touch) perceived by sensation. Visual perception encompasses more than 80% of our sensory experiences (Holtzschue 2006). Color perception can be influenced by neighboring color and also by the light source which illuminates it.

One isolated phenomenon of an object's color that is not directly related to neighboring color is the light which it reflects. This phenomenon is encompassed by the fact that lights, themselves, have brightness, hue, and saturation (Kuehni 2004). For example, when looking at an orange under certain lighting, the surface of the orange appears to have different brightness of value. In other words, some area are highlighted (lighter by adding white) and shadowed (darker by adding black). The orange may also appear to have a different hue under different light sources such as red orange or dull brownish orange.

During this isolated phenomenon, the vision of color is most controlled by the physiological aspects of the human eye. The human visual system is capable of adapting itself to different light sources (both in quality or quantity). This

phenomenon is referred to as adaptation (Holtzschue 2006). Adaptation of human vision allows humans to perceive the same color under varied light sources.

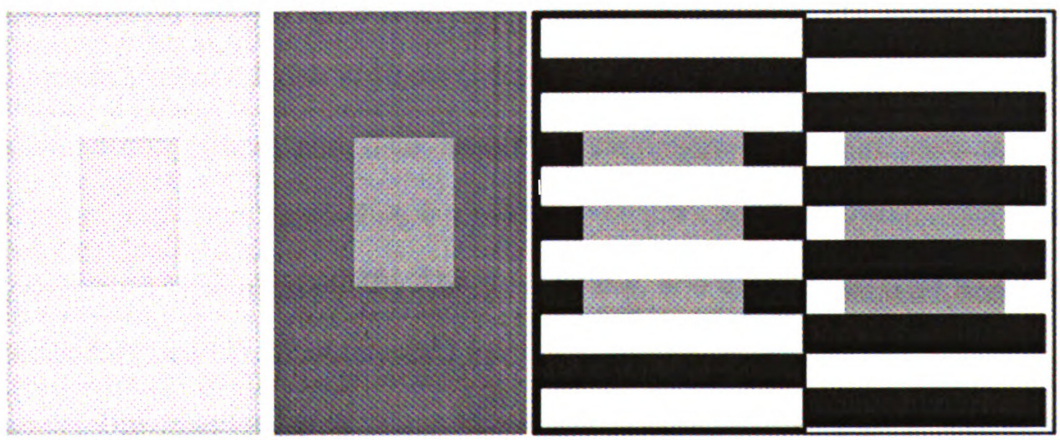
As mentioned, color perception is also affected psychological influences, one of which is color memory. The color of an object is assumed or remembered through an individual's experience such as the "red" of an apple or the "orange" of an orange. Color memory subjectively influences the color perception of the brain. Therefore, the human color perception system is able to perceive the same color under different light conditions. This is called color constancy (Holtzschue 2006). For example, although different colored surfaces of an orange exists under varied light sources, color constancy enables us to expect it to be orange (Edwards 2005).

In this way, the physiological system allows the color to be viewed consistently through the phenomenon referred to as light adaptation, and this ability is further enhanced by the psychological phenomenon of color constancy, or color memory.

Related phenomena are caused by colors surrounding the color of interest. In short, visual sensation is generated when viewing an object in the presence of other objects, under the same illumination. Both unrelated and related phenomena can influence color sensation, but the majority of our color experiences comes from related color (Kuehni 2004).

This effect is known as "color contrast" (Kuehni 2004). Consider, for example, Figure 4(a). Rectangles appear in a shade of grey against two different background color rectangles. One, however, appears to be a lighter than the other as a result of the difference in the background. This is called as simultaneous contrast (Holtzschue 2006).

Another effect that can occur is known as assimilation. The example of assimilation is referred to as White's effect (White, 1979). Again, in Figure 4(b), the grey images appear different, despite the fact that they are the same color. The grey portion of the image on the left, which borders horizontal bars in white, appear lighter than the same color bars on the right, which are bordered by black horizontal bars (Ripamonti and Gerbino 2001). Therefore, the presence of multiple colors in images or objects has the potential to influence color perception.



(a) Simultaneous contrast (b) White's effect

Figure 4 - Color Effects

Color Theory

Primary and secondary colors

As with all color, primary colors, which cannot be made by mixing any other colors, are perceived differently depending on the lighting, the object being viewed, and the viewer. The primary colors of light are Red, Green, and Blue. When added together, they form White in same amount and create all other colors of spectrum as a result of a combination of wavelengths. This is called an "additive color mixture." When all wave lengths of light are present, the result is a white light.

By contrast, the pigments of objects have the primary colors: Cyan, Magenta, and Yellow and use the subtractive color mixture. The subtractive color mixture shows the complementary relationship between the primary colors of light (Cheskin 1954; Holtzschue 2006). When all pigments are mixed, in the subtractive model, black is formed. However, viewers tend to use a model of colors: Red, Yellow, and Blue based on their experience with paint mixing (Gossett and Chen 2004). This is a fundamental color model of vision which was investigated by Goethe (1810). The Red, Yellow, and Blue (RYB) color model is traditionally used in art and design.

The relationship of the additive and subtractive mixtures is shown in Figure 5. The primary colors of light, or pigments, are used for computer monitors (additive displays) or color printers (subtractive media), respectively.

For the purpose of this study, the RYB color model is used as the primary color scheme. Figure 6 depicts the position of the hues in artists' color wheel. Secondary colors, which are made by mixing two primary colors, are located at the midpoints between two primary colors in the color wheel. The secondary colors of the RYB color model are Orange, Green, and Violet. The tertiary colors, which are made by mixing one primary color and one secondary color together, are located between primary color and secondary colors.

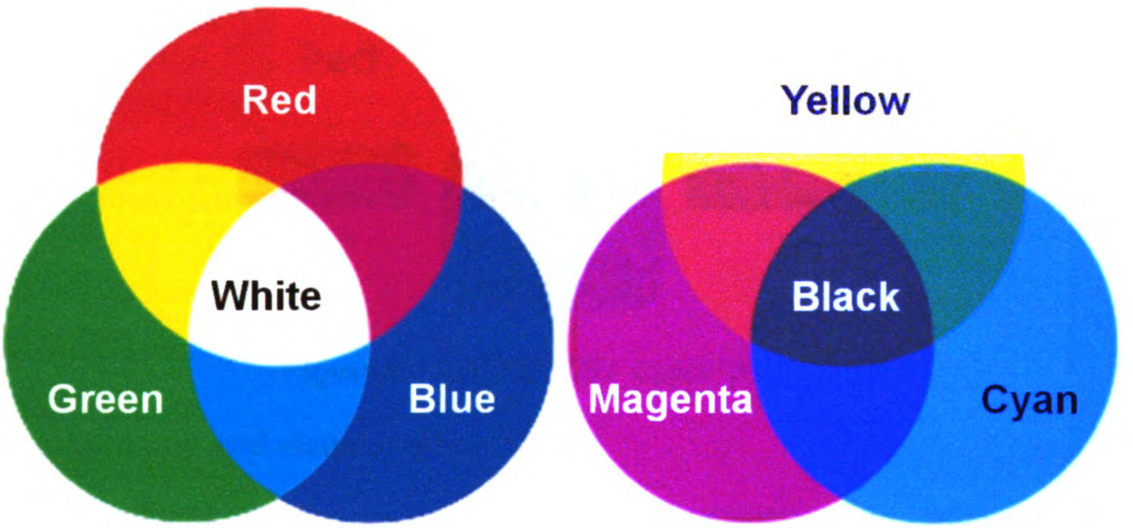


Figure 5 - Additive and Subtractive Color Mixtures

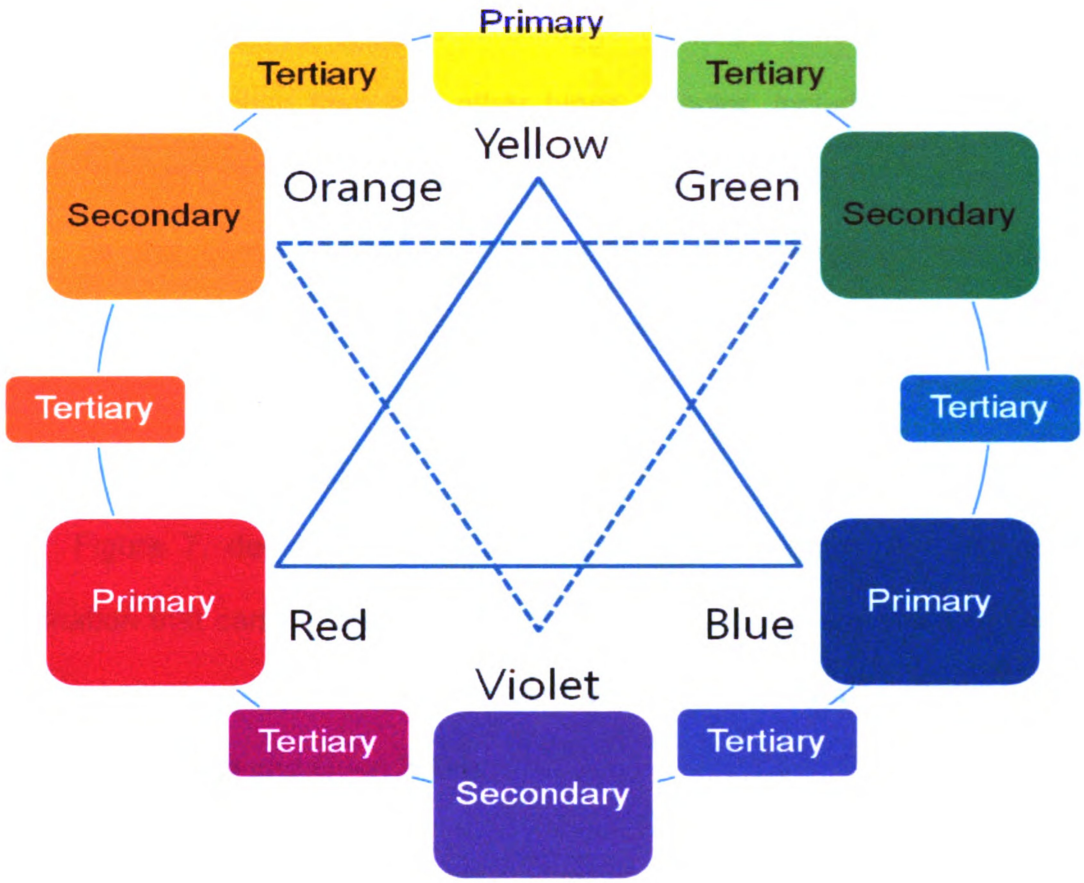


Figure 6 - Artists' RBY Color Wheel

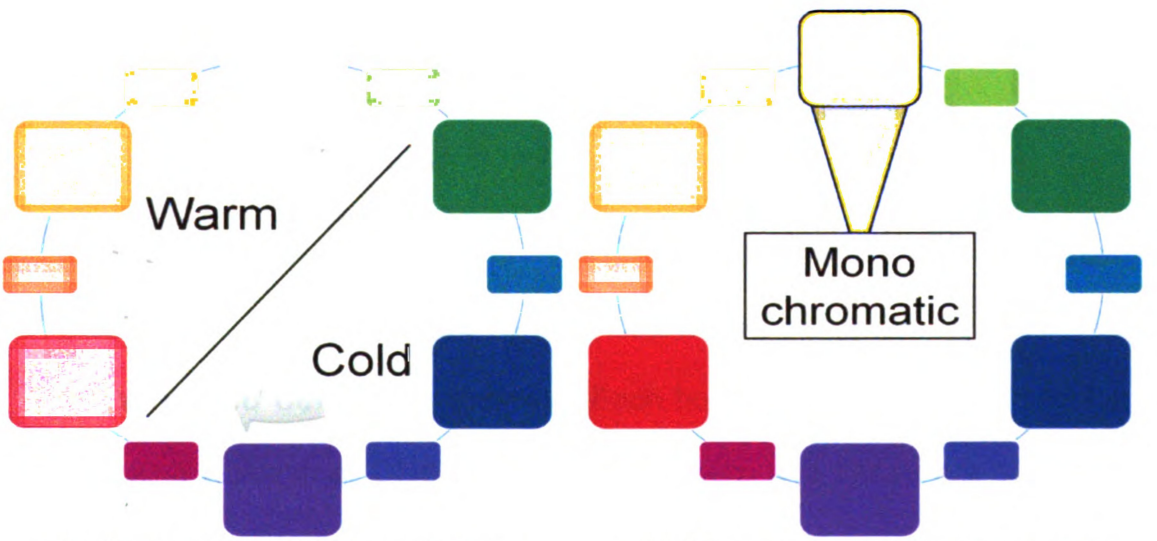
Color harmony and visual impact

Johannes Itten devised seven methodologies for studying the combination of color harmony. He defined color harmony as, "the joint effect of two or more colors" (Itten 1969).

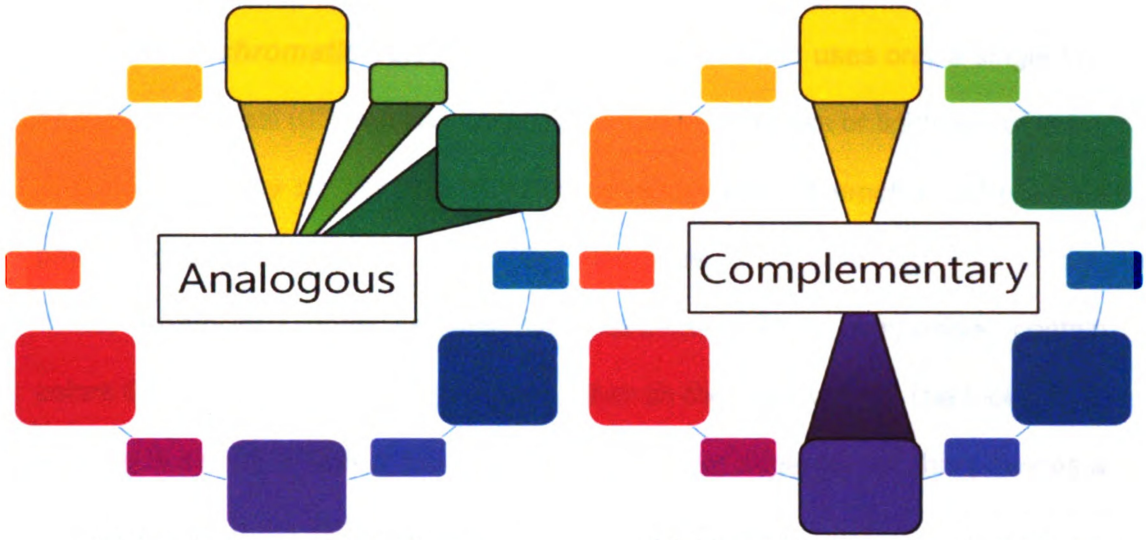
Successful color combinations contribute to the goal of color effect, (Holtzschue 2006) and are frequently manipulated to garner visual impact in advertising, promotion marketing and packaging. Researchers have arrived at multiple conclusions regarding the best way to garner attention. VanHurley

indicates that warm color seems to improve visibility, garnering attention, while cool colors seem less visible. Others suggest that pure hues provide greater visibility and attraction than any other types of color, including tints, tones or shades (Cheskin 1954), particularly pure hues placed next to their complements, known as the complementary contrast effect, can strengthen visibility and attention when compared with others. For example, a yellow-orange against a dark blue-violet background has better visibility than one against an orange background (VanHurley 2007)

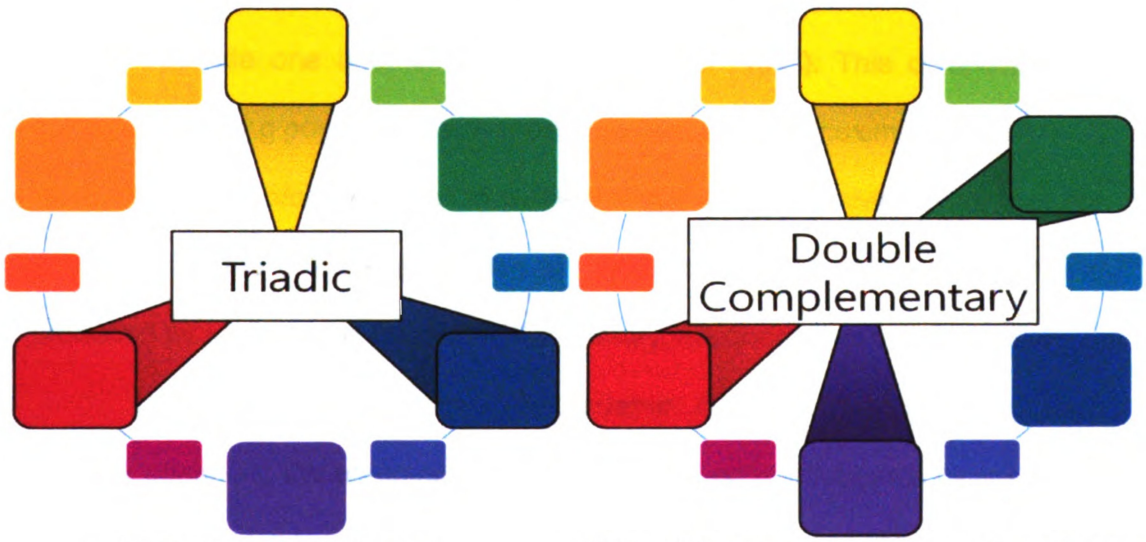
Figure 7, depicting an artist's color wheel, indicates the varied color combination that can be used: e.g. warm-cold, analogous, and, complementary. These color schemes are often described as principles to gain with the effort of color harmony (Lay and Guan 2004).



(a) Warm and Cold color scheme (b) Monochromatic color scheme



(c) Analogous color scheme (d) Complementary color scheme



(e) Triadic color scheme (f) Double complementary color scheme

Figure 7 - Color Schemes

Warm and Cold color scheme: Each hue of the color wheel is thought of as evoking a Warm or Cold feeling. Red, orange, and yellow are considered warm; while blue, green, and violet are considered cool. These colors are divided to describe two characteristics of hue as the warmth or coolness.

Monochromatic color scheme: This composition uses only a single hue on the color wheel (0°), but can consist of different darkness or lightness of color. This scheme may be considered to evoke some kind of emotion with certain psychological intensity associated with varied hues.

Analogous color scheme: Color schemes of this composition contain colors that are located adjacent to each other on the color wheel. The look of this scheme is similar to that of the monochromatic color scheme, but this provides a wider range of hues that can be combined.

Complementary color scheme: Complementary colors are located directly opposite one another on the color wheel (180°). This composition of colors of opposing position creates maximum contrast and maximum stability.

Triadic color scheme: In a triadic color scheme, three colors that are separated on the color wheel (120°) are used to create a composition. This is produced by using one color among the primary, secondary, and tertiary colors.

Double complementary color scheme: A double complementary color scheme combines the analogous and the complementary schemes by using two colors that are next to each other on the color wheel as well as the compliment of each.

The Power of Color in Marketing

The visible effects of color have been widely studied with physiological and psychological impact in marketing that focuses on branding, advertising, design and packaging (Bellizzi, Crowley et al. 1983). Color is one of essential

facts in marketing communications. It affects moods and emotions, perceptions and behavior (Aslam 2006). Some research indicates that color is an extremely important factor in suggesting a product's attributes and appeal at considerable distance (Cheskin 1954; Garber 1995; Rex, Wai et al. 2004). VanHurley (2007) concluded that red and blue packages were perceived more positively in terms of product quality and shelf visibility than yellow, orange, green, and purple packaged products with yellow packaging having the poorest quality and shelf visibility.

The use of color in branding has also been studied. The strongest brand identities possess great color retention (VanHurley 2007). As a result, color conveys to consumers the identity of products and their position in the market place. For example, in the carbonated beverage category: red conjures images of Coca-cola®, while blue indicates Pepsi cola®, and green 7-up® or Sprite®.

Colors also evoke opinions on quality (Kerfoot, Davies et al. 2003). Darker colors tend to indicate richness and value. For instance, dark grey is used in high tech-products to communicate high value (Stanton, Etzel et al. 1994). With regard to food, color is used to improve the perception of food quality, and to predict a distinctive flavor we will taste (Downham and Collins 2000). Consumers have been found to be capable of judging a grade of a ripening fruit based on color. Color aids consumers in identifying flavors correctly and perceiving a sense of the flavor (Garber, Hyatt et al. 2000).

Color also plays a powerful role in increasing sales. It has the potential to create a different value in the marketplace. Consumers pay more attention to packaged products that use bright colors, as opposed to dull (Quester, Neal et al. 2007). Highly visible colors can easily catch consumer's eye in the market place. Attentive behaviors have been correlated with higher sales when packaged product were the stimulus (Cheskin 1954).

Therefore, color is a very important key in differentiating a product from its competition in the marketplace, communicating information about the product to the consumer, and promoting sales growth. In produce marketing, particularly, the role of color is meaningful when evaluating a product's quality at the purchasing point.

CHAPTER 5 - METHODOLOGY

This study employed eye tracking to quantify the attentive behaviors associated with varied color combinations employed in produce packaging. Eye tracking data helps us understand where consumers invest attention, and in what they perceive before making a selection. In this research, the stimuli for the eye tracking test are reproduced by photography. This chapter is divided into stimuli and methods. The first part of this chapter explains the materials and stimulus reproduction procedure related to the photography. The second part includes descriptions of methods utilized this research. Images in this thesis are presented in color.

Stimuli

Materials

Produce choice: The produce selected for study were: red apples, oranges, lemons, green apples, purple onions, and white onions. All produce was obtained from a local supermarket. Produce was selected to represent varied positions on the color wheel, and by the availability of a mesh bag in all four of the required color schemes (1. same, 2. complementary, 3. complementary - analogous, 4. analogous). As such, produce were selected using two requirements; the color of produce was included in the primary or secondary colors in the traditional color wheel (Figure 8). Six different types of produce were

selected using these requirements. Eight pieces of the selected produce were arranged under fluorescent lights in order to create the test stimulus.

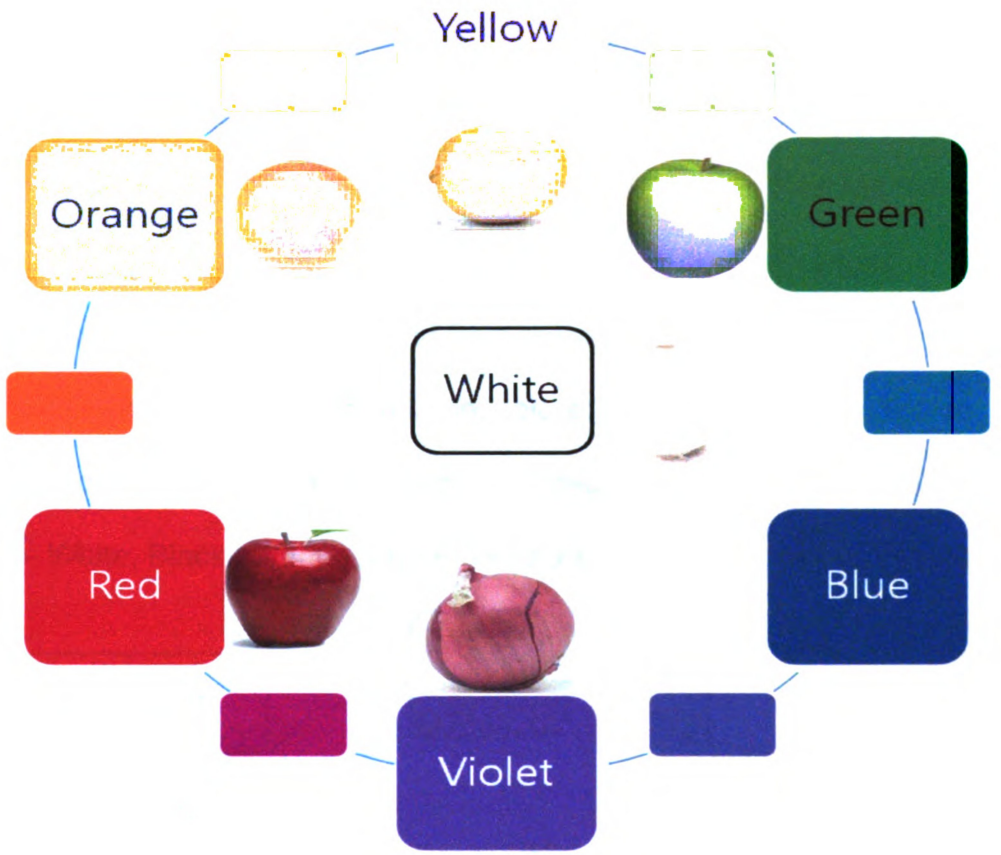


Figure 8 - Produce Choice

Mesh bags: Vexar® produce bags manufactured by Conwed Plastics (Minneapolis, Minnesota) were used in this study. These mesh bags made from soft, flexible, diamond mesh and offered in a variety of colors. In this study, eight colors: red, orange, yellow, green, blue, violet, white, black of mesh bags were used to induce the required color combination (mesh + produce) for photography.

Produce and packaging combination: Four color treatments were tested. These included: mesh bags that were the same color as the produce, mesh bas in an analogous color to the produce, mesh bags in a complementary color, and a complementary-analogous color (Figure 9) (detailed Appendix 1). This corresponded to the following bags for the selected produce.

- Red, Green, Orange, and Blue colored meshes on Red Apples.
- Orange, Blue, Red, and Green colored meshes on Oranges.
- Yellow, Violet, Orange, and Blue colored meshes on Lemons.
- Green, Red, Yellow, and Violet colored meshes on Green Apples.
- Violet, Yellow, Red, and Green colored meshes on Purple Onions.
- White, Black, Orange, and Blue colored meshes on White Onions.

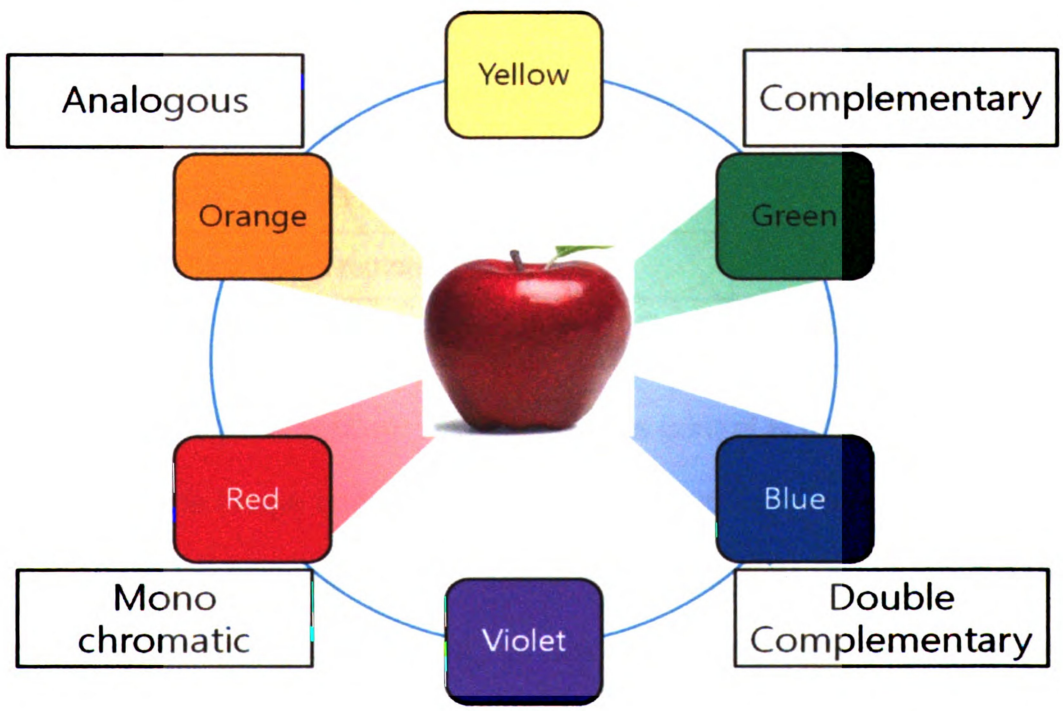


Figure 9 - Example of Red Apple Packaging Choice

Stimulus image reproduction

Digital camera choosing: The goal of produce photography is to make produce look as attractive and fresh as possible. To take a great image, the choice of a digital camera plays a very important role. Many functions go into the selection of an appropriate camera. General requirements are shown in Table 3 (Stevens, PARraga et al. 2007). Based on these features, a Canon EOS D40 digital camera was selected for this research.

Table 2 - Requirements of Digital Camera Choice for Use in This Research

Attributes	Relative importance for photographing produce
Manual white balance control	High
Manual setting for exposure control and shutter speed	High
Macro lens	Medium
High resolution	Medium
Ability to save TIFF/RAW file formats	High
Ability to use a remote controller	Medium
Optical zoom	Medium

White balance setting: A white balance control is needed to make color corrections of the image under differing lighting conditions because light sources have a different color temperatures, called Kelvin (K). This influences the image to appear either more red (under higher color temperature) or more blue (under lower color temperature) (Weston and Coe 2009). White balance function

presents the correct color under different light conditions as a function of color constancy of human eyes (Chikane and Fuh 2006). The images in Figure 10 show different Red, Green, and Blue color values in the form of a histogram, depending on the different white balance mode.

Custom white balance mode was set to create identical images for the produce photography used in this study. A grey card that reflects 18% of the light was used to measure white balance in which the image presented to equal R, G, and B color value with no color cast (Weston and Coe 2009). The histogram of the image in Figure 10(d) which was taken using the custom white balance mode shows approximately the same RGB value.

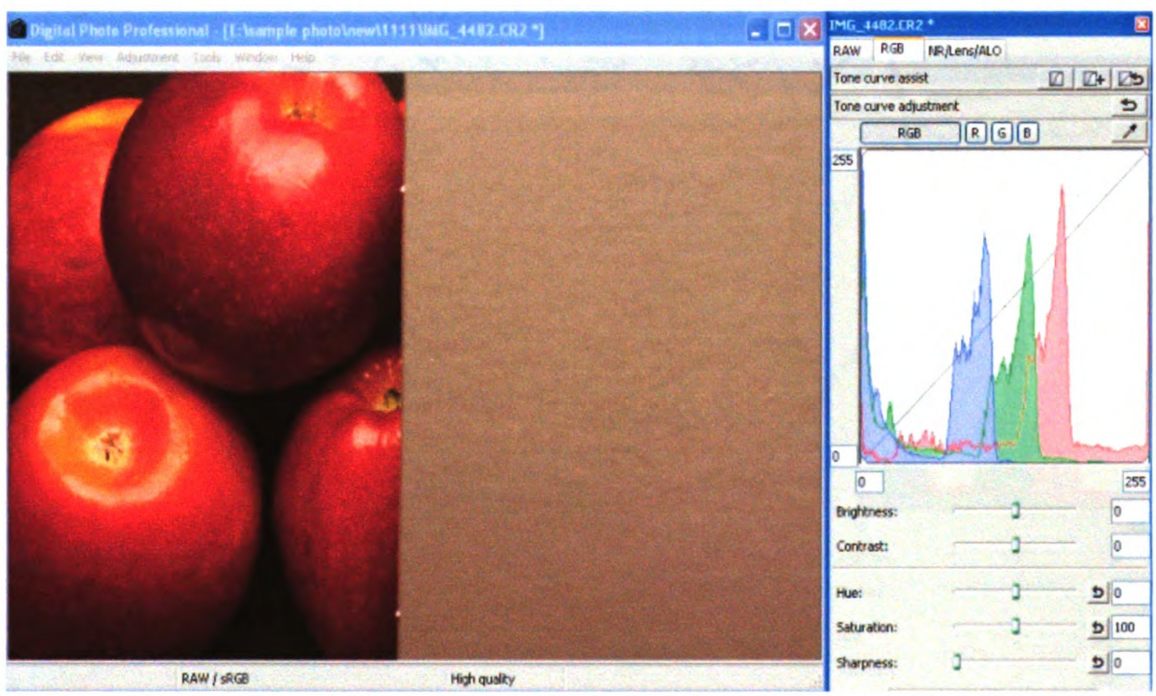


Figure 10 - The Influence of White Balance Mode on RGB Color Values
Figure cont'd of figure 10 (a) Auto white balance mode

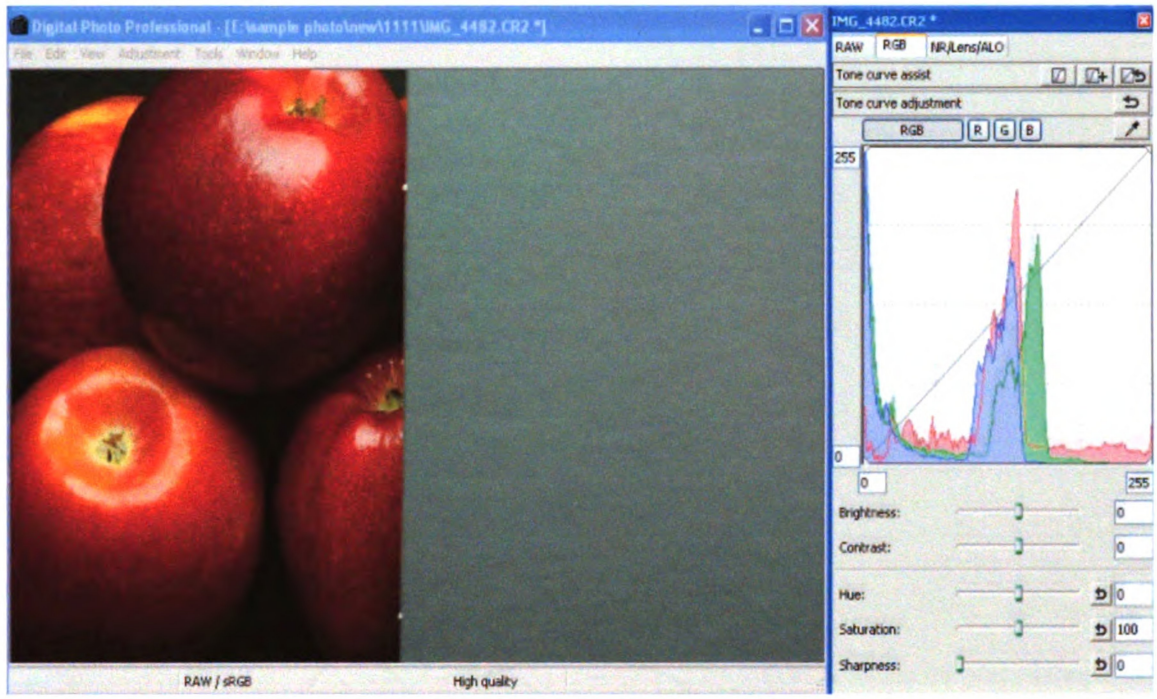


Figure cont'd of figure 10 (b) Color temperature 2700K white balance mode

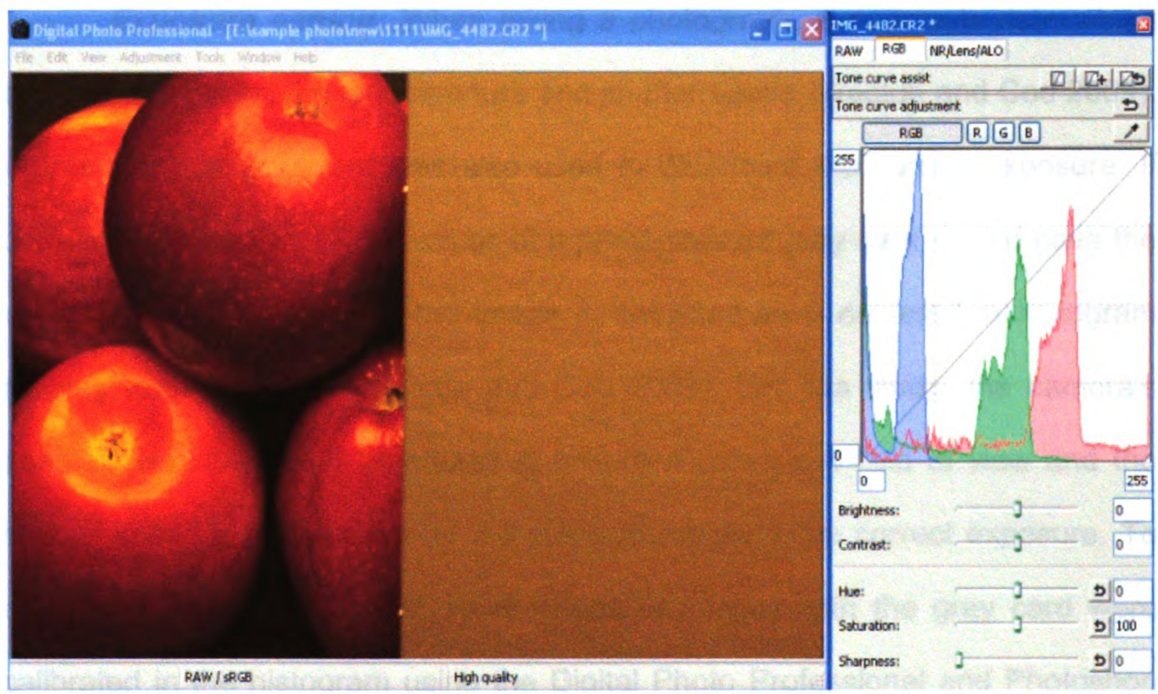


Figure cont'd of figure 10 (c) Color temperature 5200K white balance mode

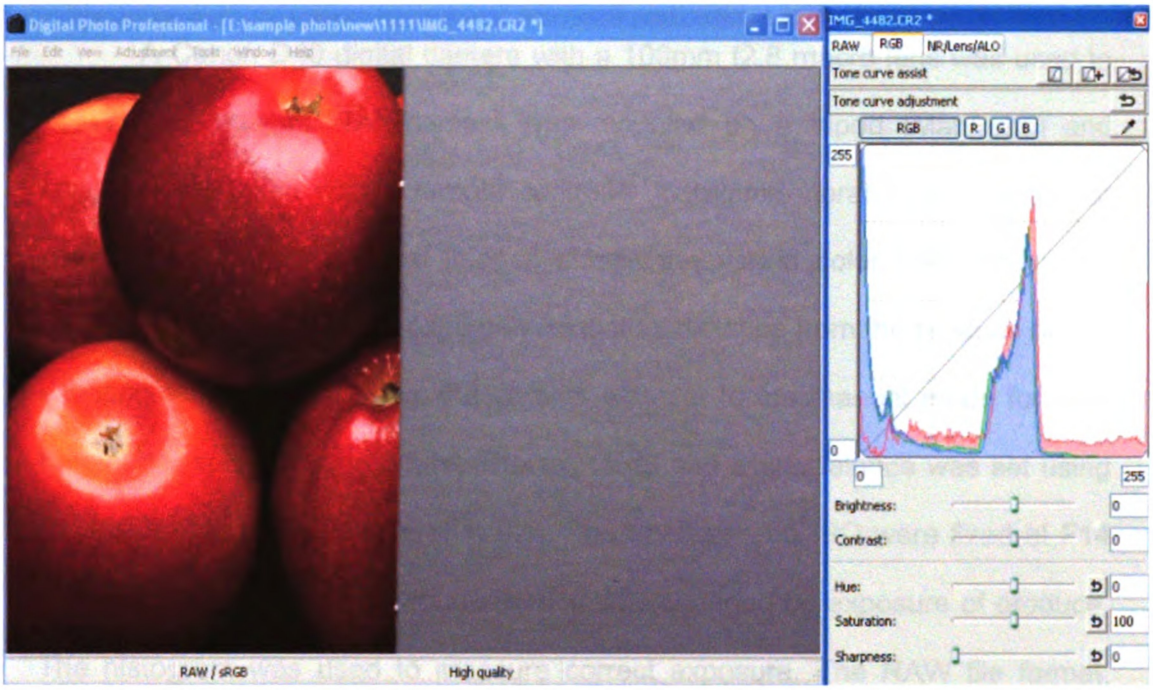


Figure cont'd of figure 10 (d) Custom white balance mode

Exposure setting: When taking a photograph, exposure is determined by two parameters: the lens aperture and shutter speed (Weston and Coe 2009). In this study, a grey card was also used to determine the correct exposure. If correctly exposed, the RGB values of a photographed grey card should have the values R=G=B=128; where the image is analyzed as a centered in histogram ranging from 0 to 255 (Weston and Coe 2009). For this study, the camera's aperture was fixed F14 (aperture) to ensure a consistent field of view and the shutter speed was changed by 2-3 steps to measure the correct exposure. To determine the shutter speed, RGB values of images with the gray card were calibrated in the histogram using the Digital Photo Professional and Photoshop programs. Table 3 indicates the setting of aperture and shutter speed used to

A Canon D40 digital camera with a 100mm f2.8 macro lens was used to capture the images. The camera was mounted on a tripod (Manfrotto) and images were taken with a remote controller to reduce vibration and to further ensure consistently identical images across the varied color treatments. The camera was located at approximately 35 inches distance from the produce on the shooting table. For shooting, the camera was set to the manual mode for both the shutter speed and aperture. The exposure and white balance was set using an 18% gray card (CPM Delta 1, Inc). The aperture and ISO were fixed at F14 and 100, respectively. The shutter speed was changed by exposure of produce. The histogram was used to measure correct exposure. The RAW file format, which contained detailed information regarding camera settings and exposures, were stored with a 3888 x 2592 pixels in resolution. The software, Canon Utilities Digital Photo Professional, was used to view a high-performance RAW image. Another software program, Adobe Photoshop CS3, was used to make block designs. Figure 11 depicts the complete process of stimulus image-making.

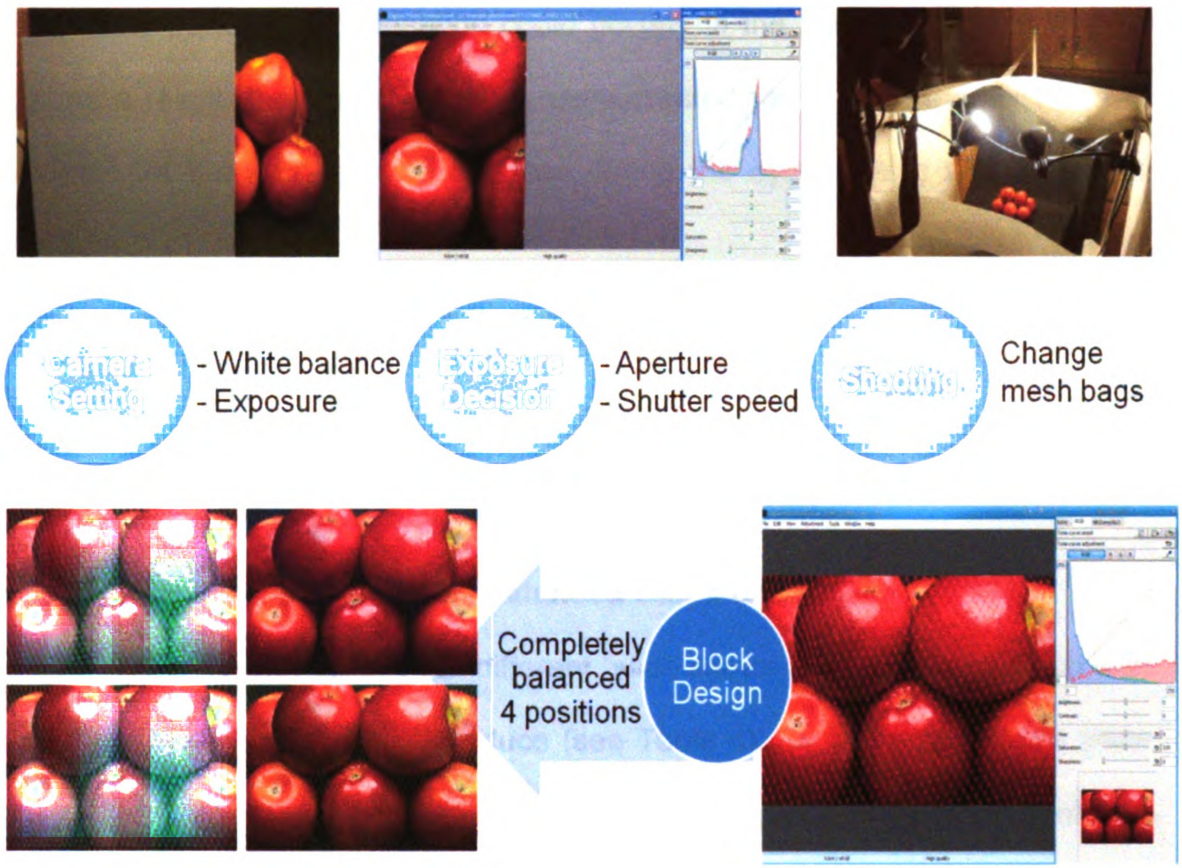


Figure 11 - The Process of Stimulus Image-Making

Stimulus image block design: Subjects viewed all four color treatments (1.The same, 2.The complementary, 3.The Complementary-analogous, 4.The Analogous) in a single image while wearing the eye tracker in order to determine the effect of the four treatments. When the four treatments were combined into a single image, Adobe® Photoshop® CS3 was used. Because of the likelihood of positional effects, several combined images were created for the same produce. Each of the four color treatments (based on the color wheel) was assigned a treatment number (1 - 4). Additionally, there were four different positions that a

given color treatment combination could occupy in the combined image (Figure 12). As a result, these four positions were created for each of the six types of produce (24 block images) to be used during the eye tracking test as stimuli (Figure 13).

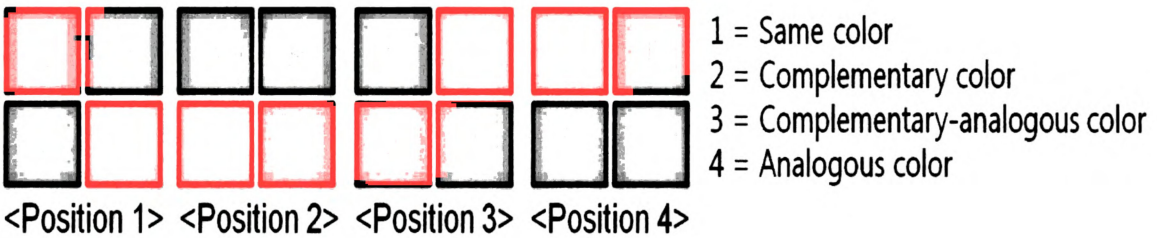


Figure 12 - Balanced Block Design

Order of stimulus: Four different "slide shows," were created, each with a single slide of each type of produce (see Table 4). As such, each slide show consisted of six produce images (one image of each produce type). Presentation orders of the slides within the show were randomized to minimize run effects by the eye tracking software.

Table 4 - Four Different Slide Shows

Set #	Randomly ordered "Slide Show"					
	Red Apple	Orange	Lemon	Green Apple	Purple Onion	White Onion
1	Position 1	Position 2	Position 3	Position 4	Position 1	Position 2
2	Position 2	Position 3	Position 4	Position 1	Position 3	Position 1
3	Position 3	Position 4	Position 1	Position 2	Position 2	Position 4
4	Position 4	Position 1	Position 2	Position 3	Position 4	Position 3

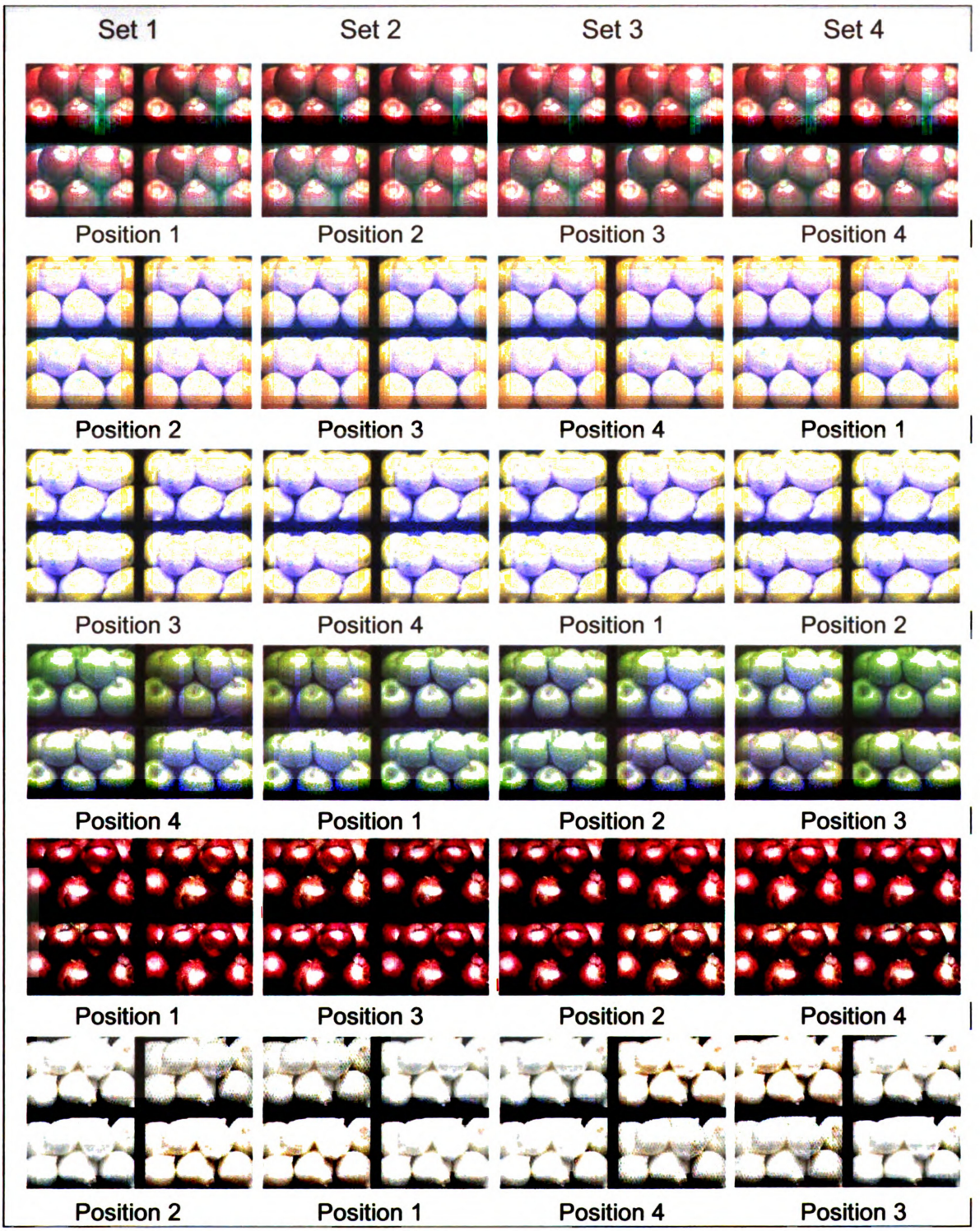


Figure 13 - Stimulus Images

Methods

Facilities

Near point visual acuity card: A near point visual acuity card manufactured by Dow Corning® Ophthalmics was used for testing and recording visual acuity. This card is placed approximately 16" from the subject's eyes. Subjects were then instructed to read the size of the smallest printed symbols that may be read. Results range from 20/20 to 20/120.

Pseudo Iso-Chromatic Plates: Pseudo Iso-Chromatic plates manufactured by Richmond products (Albuquerque, New mexico) were used to get an idea of subject's color efficiency. There are many different sets of plates which are each composed of pattern dots of similar color form. Subjects were instructed to read the figure in each card. Scores of 10 or more among the 14 charts were recorded as "normal vision".

Eye tracker: In this study, an Applied Science Laboratories (ASL) model 504 eye tracking system was used to study consumers' attentive behaviors on produce packaging. The pan/tilt optics camera, which uses reflections from the pupil and cornea to measure eye position, was mounted under the computer screen at a distance of approximately 20 inches from the subject's eye. Subjects were first calibrated using 9 fixed points that were positioned equidistantly on the desktop of a Hyundai W242D 24" LCD monitor. After calibration, subjects viewed one of the four slide shows that were randomly selected for them on the

computer screen. As mentioned, the order of presentation of the six images was randomized by the Gaze Tracker software. Each of the stimulus images appeared for a total of 13 seconds and a blank, grey screen separated the images for a period of 3 seconds. Grey screens also appeared at the show's beginning and end. Zones were drawn around the four color treatments for all four shows using the Gaze Tracker software and the data was exported into Excel to create a flat file which was statistically analyzed using SAS (Cary, NC).

Participants

A convenience sample of 50 participants were recruited through word of mouth advertising and an email announcement approved under IRB # 10-319 primarily from the student and employee population at Michigan State University. (See Appendix 2: Recruitment Advertisement).

Test procedure

Informed consent was obtained using procedures and documents approved under IRB #10-319 (See Appendix 3: Consent Form). After the consent process, demographic information was collected, along with some basic information on their purchase and consumption behaviors related to fresh produce, and the tests of corrected visual acuity and color blindness were administered (See Appendix 4: Data Recording Sheet). Eye tracking was then performed, followed by the questionnaire. Following testing, subjects were provided with a $25 Best Buy gift card for participation.

Just prior to eye tracking, the subjects sat in a chair with an adjustable height, positioned in front of the eye tracking table, approximately 25 inches from the monitor. They were asked to fix their chin on the chinrest during eye tracking. Each subject first completed an eye tracker calibration procedure using the nine point calibration target. The subject looked, in turn, at nine different points numbered in order, left to right, top to bottom on a single plane. The positions of the eye movement were recorded using the ASL software. After successful calibration, they were asked to hold their head as still as possible for the trial of eye tracking. Subjects were provided with the following scenario, "You are intending to purchase some produce in the supermarket. Please do what you would normally do." The viewing order of the 6 produce images was randomly selected by Gaze Tracker program. Subjects were given 13 seconds to view each produce image. During this time, their eye movements across the screen were recorded.

After eye tracking, subjects were given a few brief questions about their opinions of the produce images that they just viewed. During this time, they viewed the images again, and were provided the data recording sheet with the questions (See Appendix 4 cont'd).

Data processing

All data was recorded using the Gaze Tracker software. The data was collected in order to perform quantitative analyses on the subject's visual

perception. To perform analyses, the produce images were divided into 4 treatments, or "lookzones". The gaze tracker software allowed the research to gather the amount of time spent and hits of number in each of four different lookzones. This data was exported into Microsoft Excel for easy import into statistical software.

CHAPTER 6 - RESULTS AND DISCUSSION

The purpose of this chapter is to provide the results from the data collection. As explained in chapter 5, different forms of data were collected during the test procedure. All data that characterized subjects (demographic information and survey information), questionnaire evaluation, and eye tacking data exported from the Gaze Tracker software, were exported into a flat file. Ultimately, the flat file was analyzed using SAS Statistical Software (Cary, NC).

A convenience sample largely drawn from the undergraduate student population and the employee pool at Michigan State University was used for recruiting efforts (See Appendix 2: Recruitment advertisement). 50 subjects over the age of 18 participated in this research. Data was not analyzed for eight of the subjects because of difficulty tracking. These instances were not included in flat file, as such the analysis included test results for 42 of the subjects (see table 5).

Table 5 - Frequency Table of Subject Results for Varied Portions of Testing

Criterion	Success	Failure
Visual acuity test	50	0
Color blindness test (read 10 or more)	50	0
Lost eye tracking time on each image (more 20%)	44	6
Focus of images	48	2
Total subjects	42	8

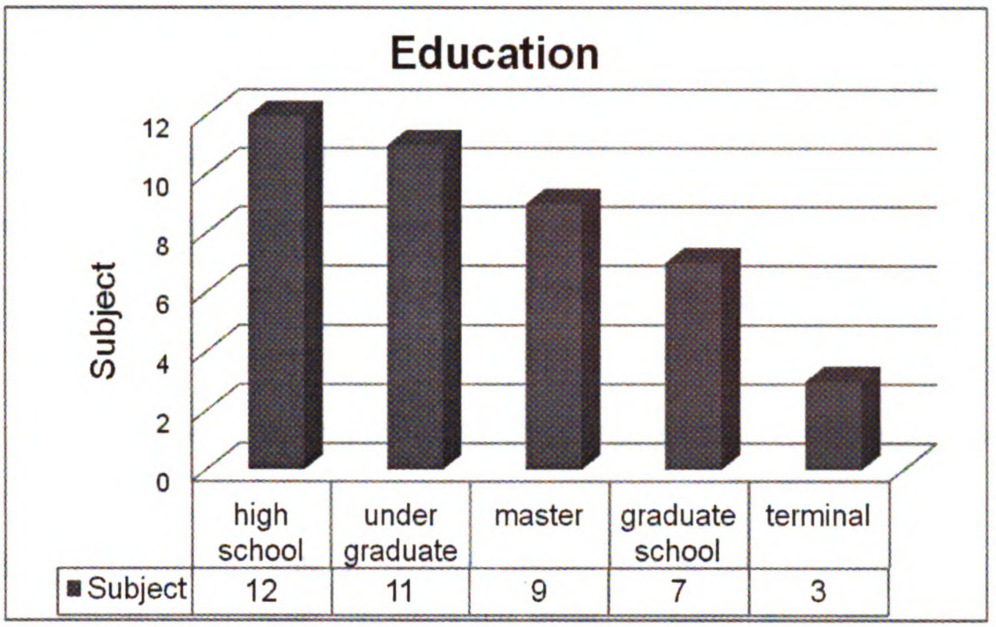
Subjects Demographics

General characteristics of subjects are shown in Table 6 and Figure 14. Analyzed data included 22 males and 20 females, and the average age of males was 28.14 years and that of females was 27.75 years. Subjects ranged in age from 20~54 years. The highest level of education that was completed was also collected: 12 subjects completed high school, 11 an undergraduate degree, 9 a master's degree, 7 were enrolled in a graduate school program, and 3 had completed their terminal degree (PhD).

Eleven of the subjects were married and 32 of subjects unmarried. 29 among the 42 self-identified as the primary grocery shopper for their household.

Table 6 - Frequency Table Regarding Subject Characteristics

Questions	Categories	N (subjects)	
Gender	Male	22	
	Female	20	
Age	Male (Avg. Age±SD)	28.14±6.87	
	Female (Avg. Age±SD)	27.75±7.21	
	Range of Age	20~54	
		N (subjects)	Percent (%)
Education	High school	12	28.57
	Undergraduate	11	26.19
	Master	9	21.43
	Graduate school	7	16.67
	Terminal	3	7.14
Total		42	100
Marriage	Yes	10	23.81
	No	32	76.19
Total		42	100
Children	Yes	7	16.67
	No	35	83.33
Total		42	100
Primary grocery shopper	Yes	29	69.05
	No	13	30.95
Total		42	100



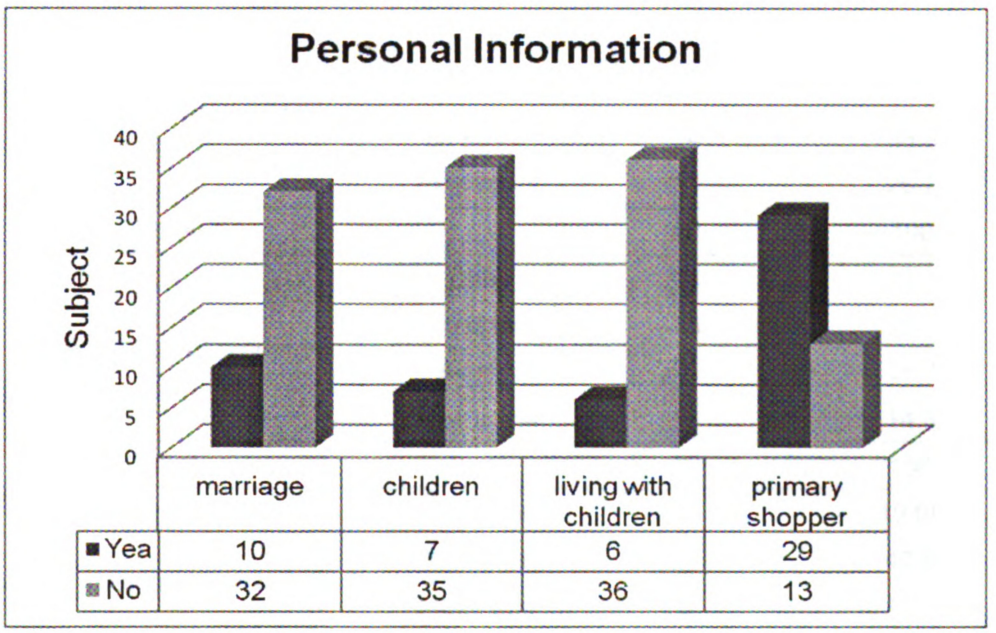
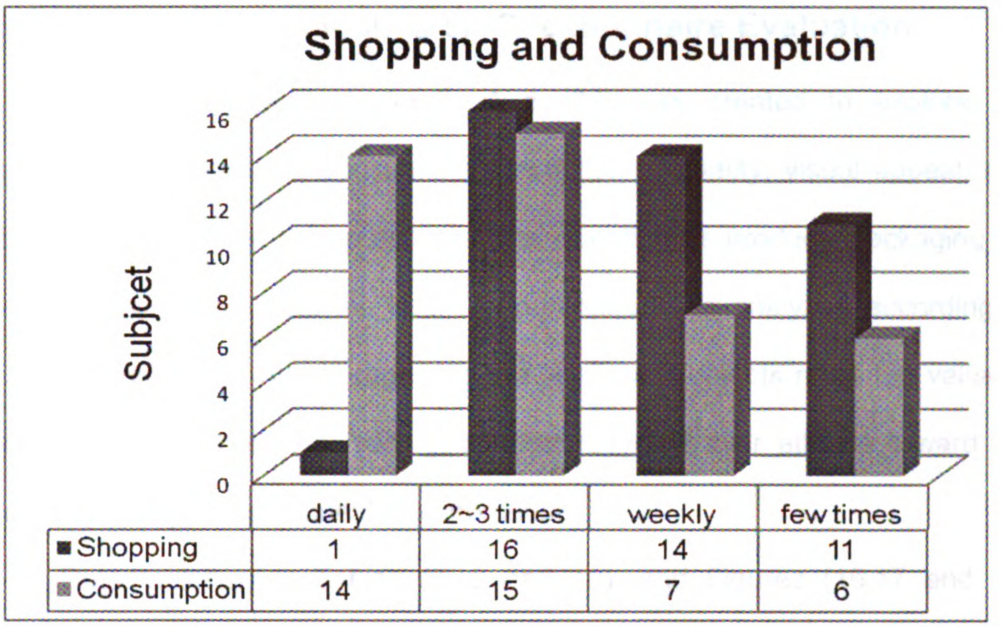


Figure 14 - Subject Education and Information

The following tabulation and corresponding charts depict the subjects' self-reports as related to shopping and consumption. More than of half of the subjects purchased groceries at least weekly and consumed produce at least one time during 2~3 days. Twenty of the subjects recalled their produce to be generally purchased in plastic bags, while 8 of the subjects indicated it to be purchased plastic trays, 6 of the subjects reported generally purchasing produce in mesh bags, and generally purchasing unpackaged produce was reported by 8 of the subjects.

Table 7 - Frequency Table Regarding General Survey on Consumption

Questions	Categories	N (subjects)	Percent (%)
Frequency of shopping	Daily	1	2.4
	2~3 / a week	16	38.1
	Weekly	14	33.3
	Few times	11	26.2
Total		42	100
Consumption of produce	Daily	14	33.3
	2~3 / a week	15	35.7
	Weekly	7	16.7
	Few times	6	14.3
Total		42	100
Generally purchase produce in?	Plastic tray	8	19.05
	Plastic bag	20	47.6
	Mesh bag	6	14.3
	Unpacked	8	19.05
Total		42	100



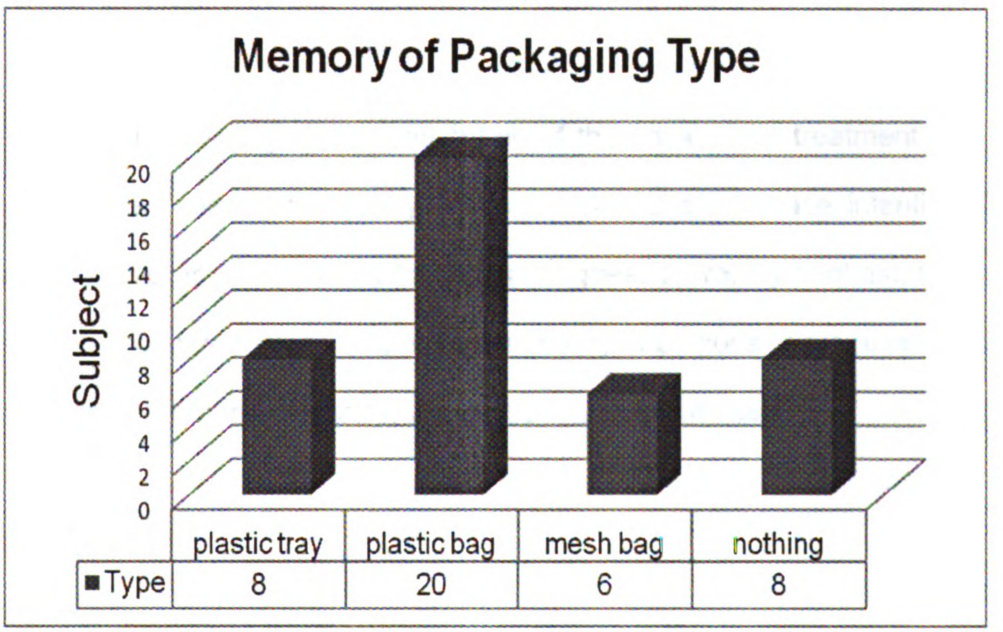


Figure 15 - Frequency Reports
Shopping and Consumption of Produce; Type of Packaging

Descriptive Statistics on Questionnaire Evaluation

The questionnaire (Appendix 4 cont'd) was created to explore the subjective evaluation of a consumer's perception of quality, visual appeal, and their self-reported intent to purchase. The question of produce packaging on quality, visual appeal, and the intent to purchase were analyzed according to each color treatment without regard to the produce. Subjects rated the value of produce (1: very poor to 5: very good) that reflected their attitude toward the perceived quality, visual appeal, and purchase.

Data in following Tables (8, 9 and 10), and Figures (16,17 and 18) represent frequency of subject response regarding the three major questions (quality, visual appeal, purchase intent) across the four color treatments.

Produce packaging in a mesh bag of the same color treatment had the highest scores relating to: quality, visual appeal, and purchase intention. The analogous color treatments had the second highest score. By contrast, the color treatments complementary and complementary-analogous were evaluated to have lower self-reports of quality, visual appeal, and purchase.

Table 8 - Frequency Table Regarding Quality Reports from Very Poor to Very Good (Likert Scale: 1-5)

Color treatment		Same	Comple-mentary	Complementary-analogous	Analogous
Q1: Please rate the expected quality (Freshness) of produce in each bag					
Quality N (%)	1 (Very Poor)	2 (0.79)	50 (19.84)	47 (18.65)	2 (0.79)
	2	5 (1.98)	77 (30.56)	78 (30.95)	10 (3.97)
	3 (Moderate)	41 (16.27)	65 (25.79)	72 (28.57)	49 (19.44)
	4	98 (38.89)	45 (17.86)	43 (17.06)	101 (40.08)
	5 (Very Good)	106 (42.06)	15 (5.95)	12 (4.76)	90 (35.71)
	Total	252 (100)	252 (100)	252 (100)	252 (100)

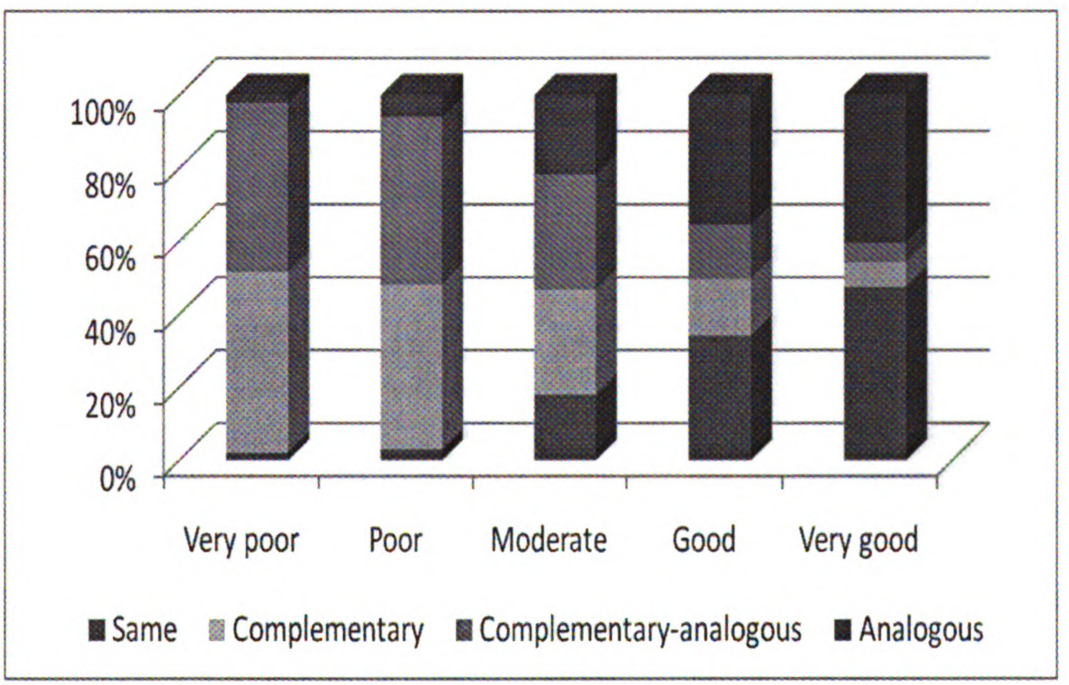


Figure 16 - Percentage of Participants that Reported Very Poor to Very Good Quality (Likert Scale: 1-5) by Treatment Type

Table 9 - Frequency Table Regarding Visual Appeal Reports from Very Poor to Very Good (Likert Scale: 1-5)

Color treatment		Same	Comple-mentary	Complementary -analogous	Analogous
Q 2: Please rate the visual appeal of produce in each bag					
Visual appeal N (%)	1 (Very Poor)	3 (1.19)	52 (20.63)	56 (22.22)	3 (1.19)
	2	8 (3.17)	80 (31.75)	77 (30.56)	16 (6.35)
	3 (Moderate)	35 (13.89)	66 (26.19)	72 (28.57)	40 (15.87)
	4	91 (36.11)	43 (17.06)	41 (16.27)	100 (39.68)
	5 (Very Good)	115 (45.63)	11 (4.37)	6 (2.38)	93 (36.90)
	Total	252 (100)	252 (100)	252 (100)	252 (100)

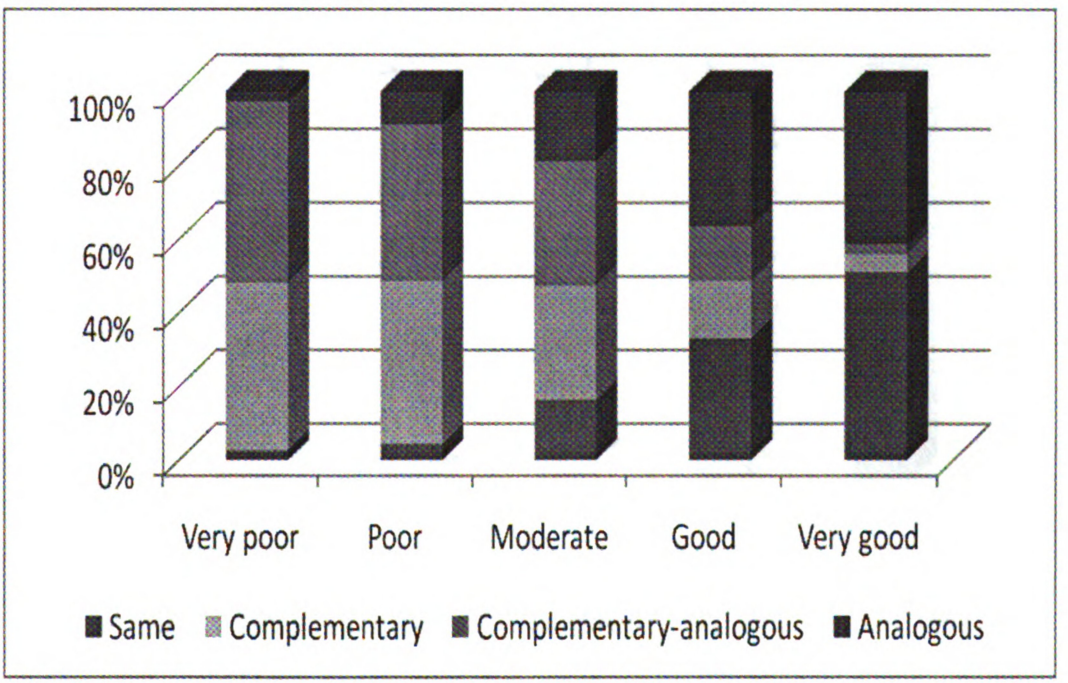


Figure 17 - Percentage of Participants that Reported Very Poor to Very Good Visual appeal (Likert Scale: 1-5) by Treatment Type

Table 10 - Frequency Table Regarding Purchase Reports from Very Poor to Very Good (Likert Scale: 1-5)

Color treatment		Same	Comple-mentary	Complementary -analogous	Analogous
Q3: Please indicate how likely you would be to purchase produce in each bag					
Purchase N (%)	1 (Very Poor)	3 (1.19)	72 (28.57)	65 (25.79)	4 (1.59)
	2	9 (3.57)	60 (23.81)	71 (28.17)	7 (2.78)
	3 (Moderate)	26 (10.32)	75 (29.76)	65 (25.79)	50 (19.84)
	4	104 (41.27)	32 (12.70)	42 (16.67)	88 (34.92)
	5 (Very Good)	110 (43.65)	13 (5.16)	9 (3.57)	103 (40.87)
	Total	252 (100)	252 (100)	252 (100)	252 (100)

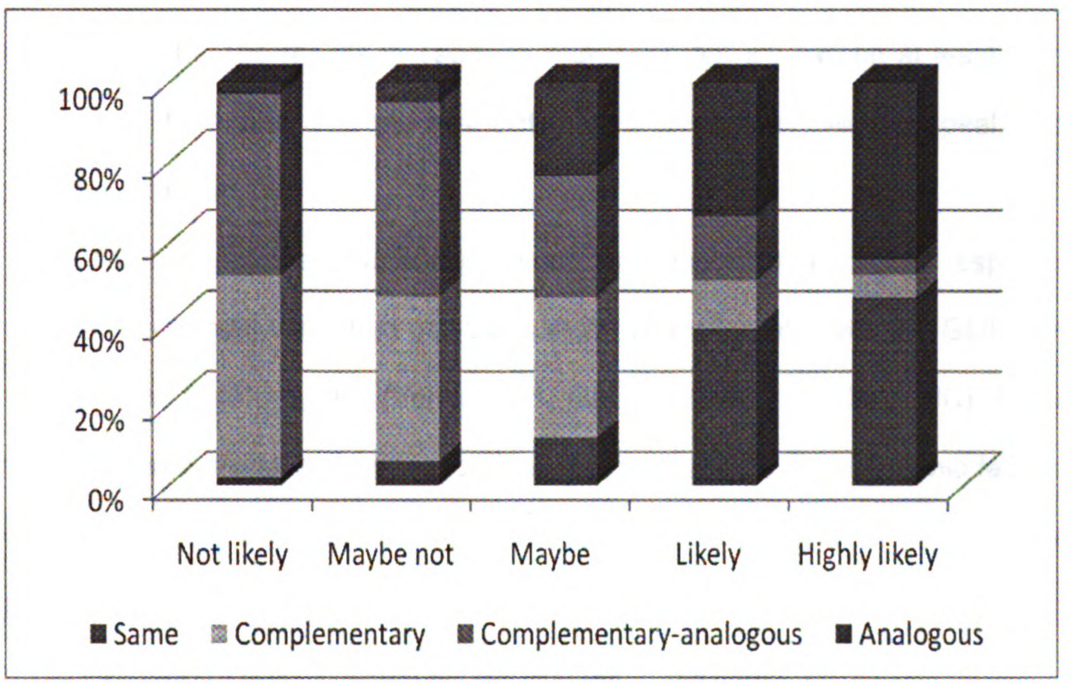


Figure 18 - Percentage of Participants that Reported Very Unlikely to Very Likely Purchase Intention (Likert Scale: 1-5) by Treatment Type

Table 11 - The Spearman Correlation Coefficients between Quality, Visual Appeal and Purchase Intention

	Quality	Visual Appeal	Purchase Intention
Quality	1.000	0.846 <0.0001	0.832 <0.0001
Visual Appeal	0.846 <0.0001	1.000	0.871 <0.0001
Purchase Intention	0.832 <0.0001	0.871 <0.0001	1.000

The correlations between quality, visual appeal and purchase intention were analyzed using Spearman correlation coefficients which is more appropriate for ordinal data. The results in Table 11 represent that we can be at least 95% certain that there was a strong association between quality, visual appeal, and purchase intention.

Quality, visual appeal and purchase were modeled as ordinal response variable. The model was fitted using a cumulative logit model with the GLIMMIX procedure of SAS program (Version 9.1, SAS Institute Inc., Cary, NC). Color treatments and produce were modeled as the fixed effects. Demographic factors were added into the model but later removed based on the Type III test p-values ($p>0.10$). The effect of color treatment ($p<0.0001$) was only considered for the model inclusion of quality, visual appeal and purchase intention.

The odds ratio estimates were conducted for all the pairwise comparisons and the 95% confidence interval estimates for odds ratios (Table 12). The means of the odds ratio between same color and complementary color treatment were significantly different from 1, indicating these two treatments did not have similar odds to be in lower quality, visual appeal and purchase scores because the 95% confidence interval did not include 1.

As the following results, therefore, same color and analogous color treatments were significantly different from complementary color and complementary-analogous color treatments in the scores of quality, visual appeal and purchase intention.

Table 12 - The 95% confidence interval estimates for odds ratios on Quality, Visual Appeal and Purchase Intention

95% Confidence Interval Estimates	Quality		Visual Appeal		Purchase	
	Lower	Upper	Lower	Upper	Lower	Upper
Odds ratio treatment 1 vs 2	**0.032**	**0.068**	**0.027**	**0.057**	**0.024**	**0.053**
Odds ratio treatment 1 vs 3	**0.031**	**0.066**	**0.024**	**0.051**	**0.026**	**0.056**
Odds ratio treatment 1 vs 4	0.552	1.068	**0.482**	**0.946**	0.565	1.105
Odds ratio treatment 2 vs 3	0.705	1.339	0.651	1.228	0.766	1.45
Odds ratio treatment 2 vs 4	**11.359**	**23.556**	**12.055**	**25.1**	**15.018**	**31.773**
Odds ratio treatment 3 vs 4	**11.721**	**24.191**	**13.476**	**28.079**	**14.308**	**30.016**

Note 1: treatment 1: same, 2: Complementary, 3: Complementary- analogous, 4: Analogous
Note 2: the significantly different results were only **bolded effects.**

Statistical Analysis on Eye Tracking Metrics

Eye tracking data was collected from a sample of 42 subjects, who were directly recruited in this research. These files were analyzed by 4 color treatment zones. In order to explore the impact of color on the attentive behavior of people viewing produce packaging, two response variables were statistically analyzed with generalized linear mixed models using the SAS program.

- The total number of hits on each treatment (Poisson variable)
  - Number of hits on each zone crossed by the subject's gaze trail.
- The total time spent on each treatment (Gaussian variable)
  - The proportion of total time per color treatment zone.

The total number of hits on each zone (Poisson variable)

The total number of hits was recorded for 4 look zones (color treatment) on each produce. The response variable, 'total number of hits,' was modeled as a Poisson distribution using a generalized linear mixed model. Color treatment and produce were modeled as the fixed effects.

Subject information (gender, education, primary shopper, status, consumption frequency, memory of packaging types purchased, visual acuity result, result of color blindness test, their indicated color preference) was considered for model inclusion, but later removed from the model if their p-values were greater than 0.10. Results of the Type III test are presented in Table 13.

This final model included the fixed effects of gender, education, packaging type, visual acuity, color blindness, color treatment and produce. Pair wise comparisons included all the significant effects from the Type III tests of fixed effects, and were conducted on the estimated least square means using the LSD procedure to provide useful comparisons. Moreover, 2-way interaction of treatment * education and treatment * produce was also conducted in this study.

Table 13 - Results of Type III Tests on Number of Hits

Effect	Num of DF	Den of DF	F value	Pr > F
Gender	1	958	19.83	<.0001
Education	4	958	11.18	<.0001
Packaging Type	3	958	4.72	0.0028
Visual Acuity	2	958	5.04	0.0067
Color blindness	4	958	4.45	0.0014
Color Treatment	3	958	3.30	<.0001
Produce	5	958	8.17	0.0010
Education*treatment	12	958	4.14	0.0001
Produce*treatment	15	958	2.34	0.0028

The results of Type III tests suggest that gender, education, packaging type, visual acuity test and color blindness test had a significant effect on the number of hits (see Table 13). Pair-wise comparisons revealed that males had a significantly different mean of number of hits (Table 14 and Figure 19) when compared with females ($p<0.0001$). Table 15 and Figure 20 depict the mean number of hits by education level. Data indicates that subjects who completed

high school and master's degrees had a significantly lower number of hits than did those that had completed undergraduate degrees ($p<0.0001$), or were enrolled in a graduate school program ($p<0.0051$, 0.0284). Subjects who had completed an undergraduate program demonstrated a significantly higher number of hits than all of them who completed high school ($p<0.0001$), master's ($p<0.0001$), graduate school ($p<0.0083$), terminal degrees ($p<0.0024$).

Table 14 - Means of Number of Hits on Gender

Gender	Male	Female
Mean values	4.87 ± 0.16^{a}	4.18 ± 0.16^{b}

Note 1: Different lowercase letters (a, b) in the same row suggests statistical significance at the 95% confidence level.

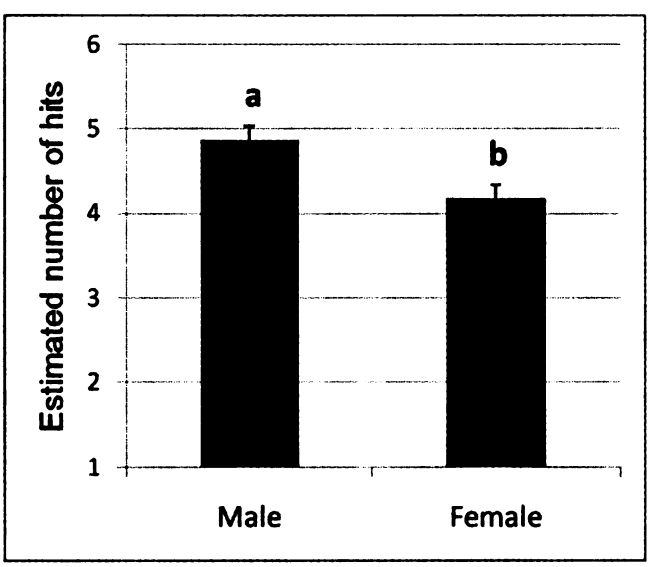


Figure 19 - Means of Number of Hits on Gender
Different letters (a, b) indicate statistically significant differences ($p< 0.05$)

Table 15 - Means of Number of Hits on Education

Education	High school	Under graduate	Master	Graduate school	Terminal
Mean values	4.09 ± 0.19^{a}	5.29 ± 0.29^{b}	4.19 ± 0.22^{a}	4.69 ± 0.26^{c}	4.39 ± 0.32^{ac}

Note 1: Different lowercase letters (a, b, c) in the same row suggests statistical significance at the 95% confidence level.

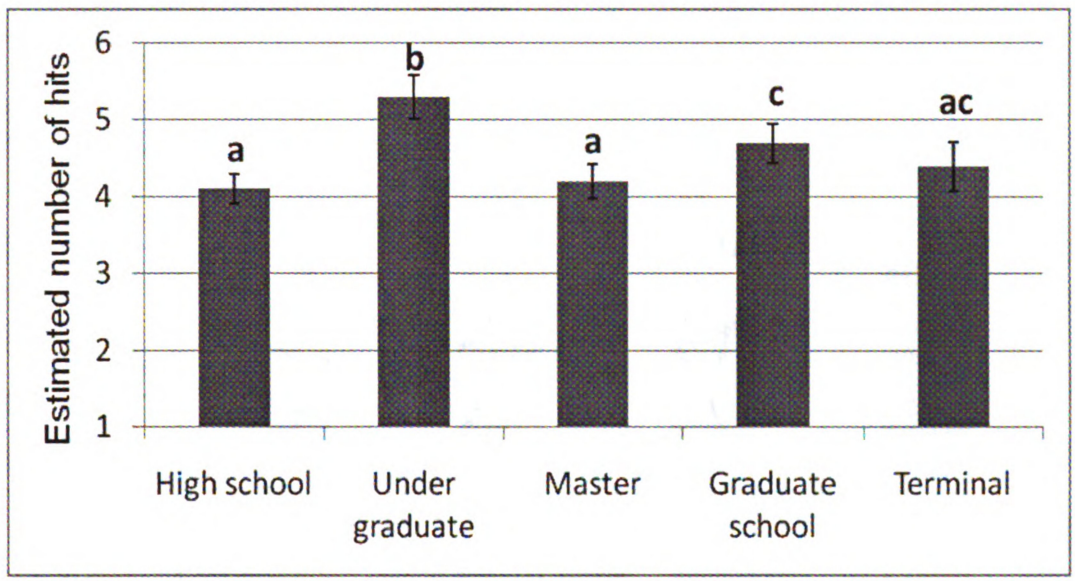


Figure 20 - Means of Number of Hits on Education
Different letters (a, b, c) indicate statistically significant differences ($p < 0.05$)

See Table 16 and Figure 21 associated with the type of packaging when it comes to produce, subjects who choose plastic tray had lower number of hits than plastic bag ($p<0.0126$) and nothing (0.0002). Pair-wise comparisons in Table 17 and Figure 22 suggest that subjects who had low visual acuity score (20/40) were a significantly different mean of number of hits when compared with all of them who had 20/20 or 20/30 visual acuity score ($p<0.0017$, 0.0024). Means of number of hits on color blindness in Table 18 and Figure 23 suggest

that subjects who missed 2 sets of plates which are each composed of pattern dots of similar color form had the lowest mean of number of hits.

Table 16 - Means of Number of Hits on Type of Packaging

Type of Packaging	Plastic Tray	Plastic Bag	Mesh Bag	Nothing
Mean values	4.07 ± 0.24 [a]	4.57 ± 0.19 [b]	4.41 ± 0.26 [ab]	5.05 ± 0.30 [c]

Note 1: Different lowercase letters (a, b, c) in the same row suggests statistical significance at the 95% confidence level.

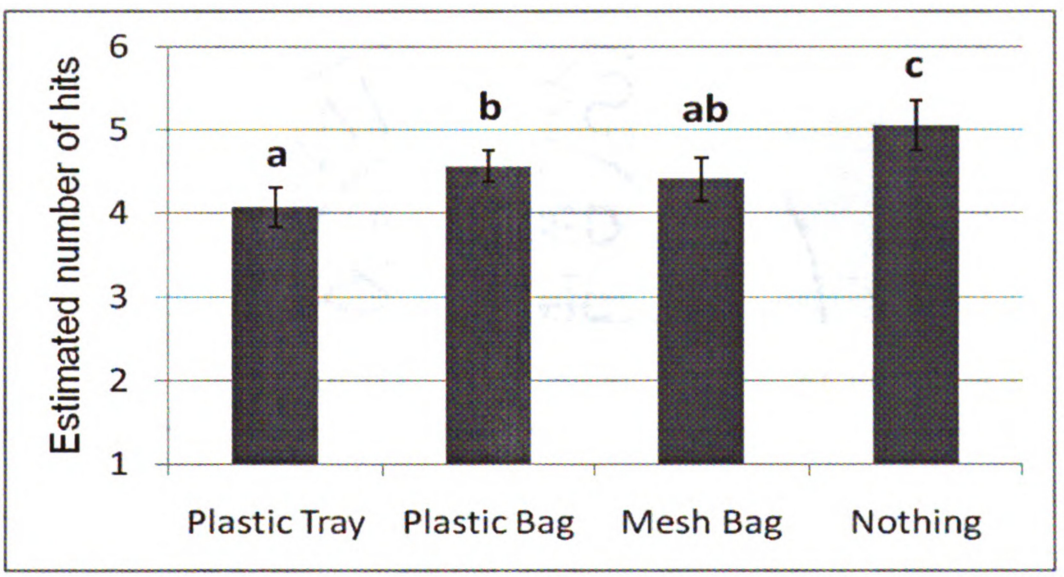


Figure 21 - Means of Number of Type of Packaging
Different letters (a, b, c) indicate statistically significant differences ($p < 0.05$)

Table 17 - Means of Number of Hits on Visual Acuity Score

Visual Acuity Score	20/20	20/30	20/40
Mean values	4.91 ± 0.18 [a]	4.89 ± 0.21 [a]	3.83 ± 0.33 [b]

Note 1: Different lowercase letters (a, b) in the same row suggests statistical significance at the 95% confidence level.

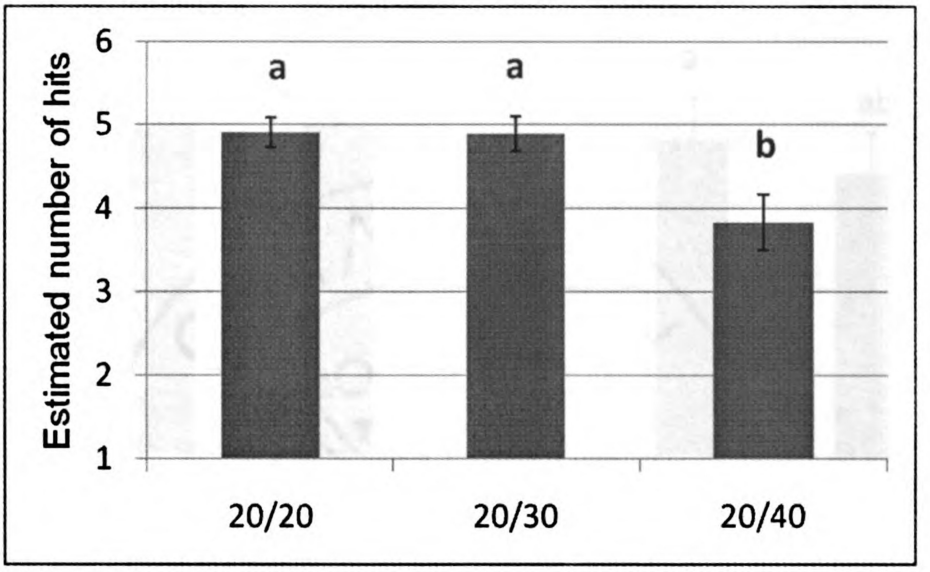


Figure 22 - Means of Number of Hits on Visual Acuity Score
Different letters (a, b) indicate statistically significant differences ($p < 0.05$)

Table 18 - Means of Number of Hits on Color Blindness (missed number)

Color blindness	0	1	2	3	4
Mean values	4.88 ± 0.16^{a}	4.93 ± 0.18^{a}	3.71 ± 0.28^{b}	4.77 ± 0.51^{a}	4.39 ± 0.48^{ab}

Note 1: Different lowercase letters (a, b) in the same row suggests statistical significance at the 95% confidence level.

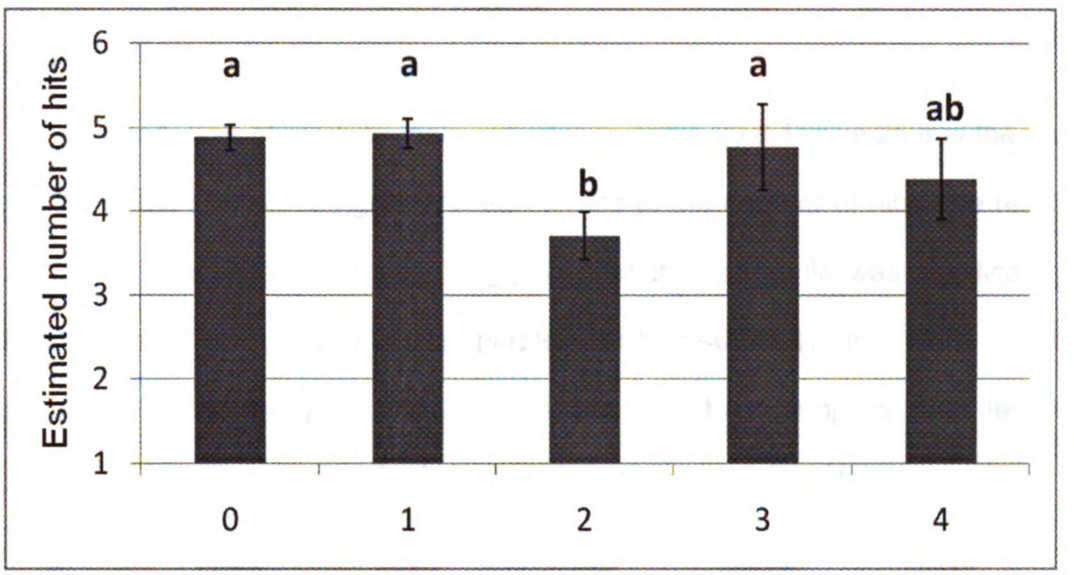


Figure 23 - Means of Number of Hits on Color Blindness (missed number)
Different letters (a, b) indicate statistically significant differences ($p < 0.05$)

The primary effect of interest for this study was color treatment and produce, which were indicated to have a significant effect on the total number of hits ($p < 0.0001$, 0.0010). Table 19 presents the mean and standard error of the number of hits on each color treatment. Results suggest that the mesh bag in the same color as the produce and those that appear in analogous colors illicit a greater number of hits than do complementary and complementary-analogous (See Table 19 and Figure 24).

Pair wise comparisons conducted using the LSD procedure indicated that the same color treatments were significantly different from both complementary color treatments ($p<0.0003$) and complementary-analogous color ($p<0.0001$). The total number of hits on the analogous treatments was also indicated to be significantly different when compared to both complementary ($p<0.0023$) and complementary-analogous treatments ($p<0.0008$).

In the case of produce, data indicates in Table 20 & Figure 25 that the red apple and the orange had greater mean values of the number of hits. The result created by pair wise comparison suggests that the red apple was significantly different from lemon ($p<0.0402$), purple onion ($p<0.0004$) and white onion ($p<0.0170$). The orange also had more attention from subjects than lemon ($p<0.0296$), purple onion ($p<0.0003$) and white onion ($p<0.0121$).

Table 19 - Means of Number of Hits on Each Color Treatment (zone)

Treatment (zone)	Same	Complementary	Complementary-analogous	Analogous
Mean values	4.93 ± 0.25 [a]	4.21 ± 0.22 [b]	4.15 ± 0.22 [b]	4.82 ± 0.25 [a]

Note 1: Different lowercase letters (a, b) in the same row suggests statistical significance at the 95% confidence level.

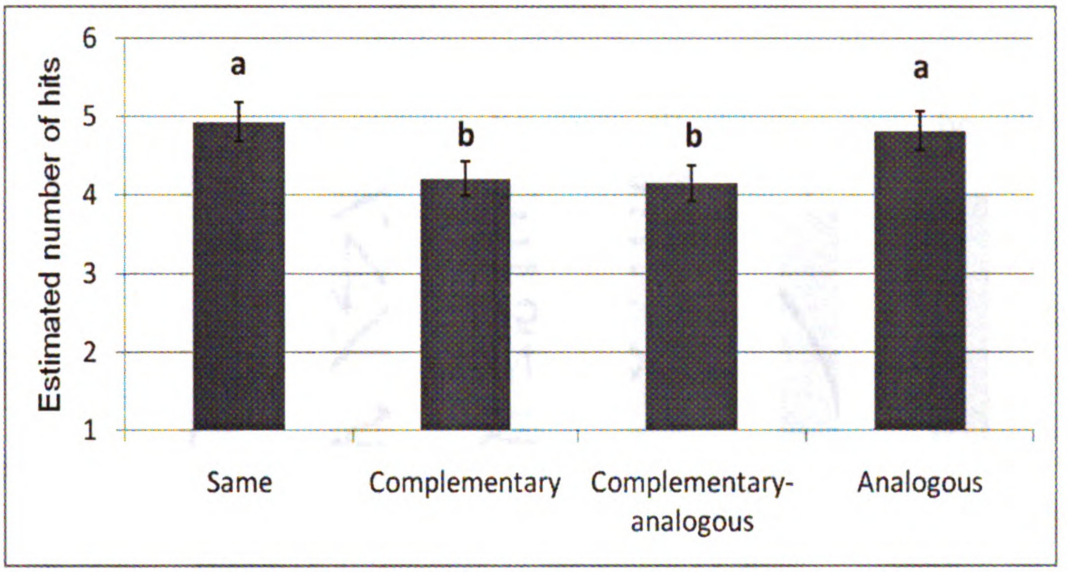


Figure 24 - Means of Number of Hits on Each Color Treatment (zone)
Different letters (a, b) indicate statistically significant differences ($p < 0.05$)

Table 20 - Means of Number of Hits on Each Produce

Produce	Red Apple	Orange	Lemon	Green Apple	Purple Onion	White Onion
Mean values	4.84 ± 0.26 a	4.87 ± 0.26 a	4.39 ± 0.24 bc	4.63 ± 0.25 ab	4.09 ± 0.23 c	4.32 ± 0.24 bc

Note 1: Different lowercase letters (a, b) in the same row suggests statistical significance at the 95% confidence level.

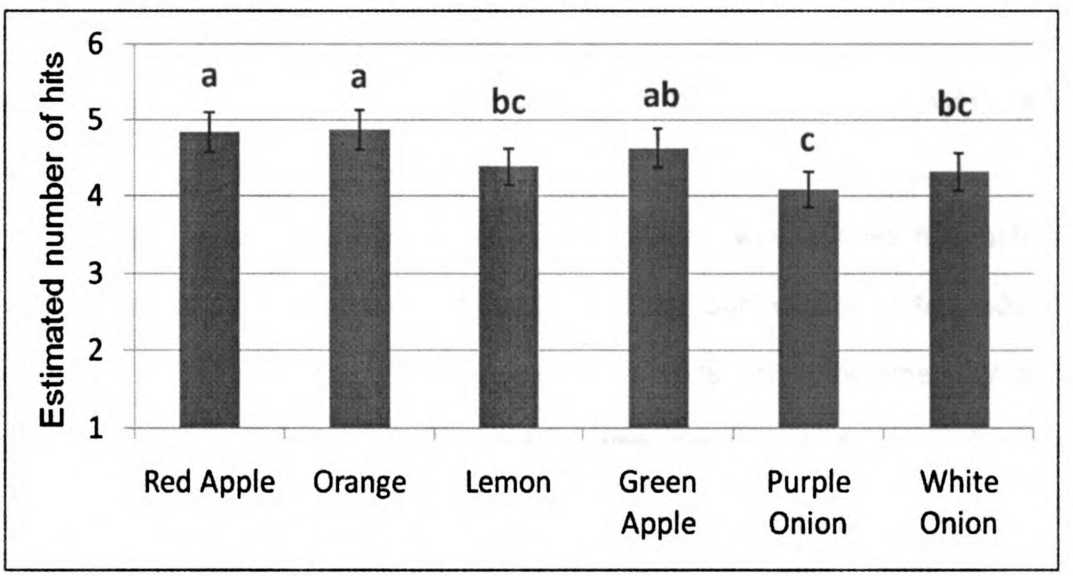


Figure 25 - Means of Number of Hits on Each Produce
Different letters (a, b) indicate statistically significant differences ($p < 0.05$)

A subject's education level (1.High school, 2.Under graduate, 3.Master, 4.Graduate school, 5.Terminal) also provided evidence of statistical significance on the mean number of hits on each treatment ($p<0.0001$) (See Table 13).

Table 21 and Figure 26 depict the results of the 2-way interaction between education and treatment. Subjects who, at their highest level of education, had completed high school level education had a lower number of hits

on each treatment for all but a few comparisons. Among those that just completed high school among education levels, there was a significantly greater number of hits on the same color treatments when compared to the other treatments (α=0.05 for all). Subjects who completed undergraduate had significant differences among complementary, complementary-analogous, and analogous (α=0.05). Subjects enrolled in a graduate school program had lower attention on complementary color treatment than same ($p<0.0061$) and analogous color treatment ($p<0.0127$).

In the case of same color treatments, subjects who finished high school paid a greater attention than masters ($p<0.0267$). Subjects of undergraduate level had a higher mean value of number of hits on complementary and analogous color treatment than subjects who completed different degrees ($p<0.05$). Complementary-analogous color treatment were significantly different between high school and undergraduate ($p<.0001$).

Table 21 - The 2-way Interaction between Education and Color Treatment

Treatment* Education	Same	Complementary	Complementary - analogous	Analogous
High school	5.29 ± 0.32 $^{A\ a}$	3.45 ± 0.24 $^{A\ b}$	3.79 ± 0.26 $^{A\ bc}$	4.07 ± 0.27 $^{A\ c}$
Under graduate	4.96 ± 0.35 $^{AB\ ab}$	5.50 ± 0.38 $^{B\ b}$	4.53 ± 0.33 $^{B\ a}$	6.32 ± 0.42 $^{B\ c}$
Master's	4.42 ± 0.32 $^{B\ a}$	3.99 ± 0.30 $^{A\ a}$	3.91 ± 0.29 $^{AB\ a}$	4.47 ± 0.32 $^{AC\ a}$
Graduate Student	5.23 ± 0.40 $^{AB\ a}$	4.05 ± 0.34 $^{A\ b}$	4.47 ± 0.36 $^{AB\ ab}$	5.11 ± 0.39 $^{C\ a}$
Terminal	4.80 ± 0.54 $^{AB\ a}$	4.28 ± 0.51 $^{A\ a}$	4.09 ± 0.49 $^{AB\ a}$	4.43 ± 0.52 $^{AC\ a}$

Note 1: Different lowercase letters (a, b) in the same row suggests statistical significance at the 95% confidence level.
Note 2: Different capital letters (A, B, C) in the same column suggests statistical significance at the 95% confidence level.

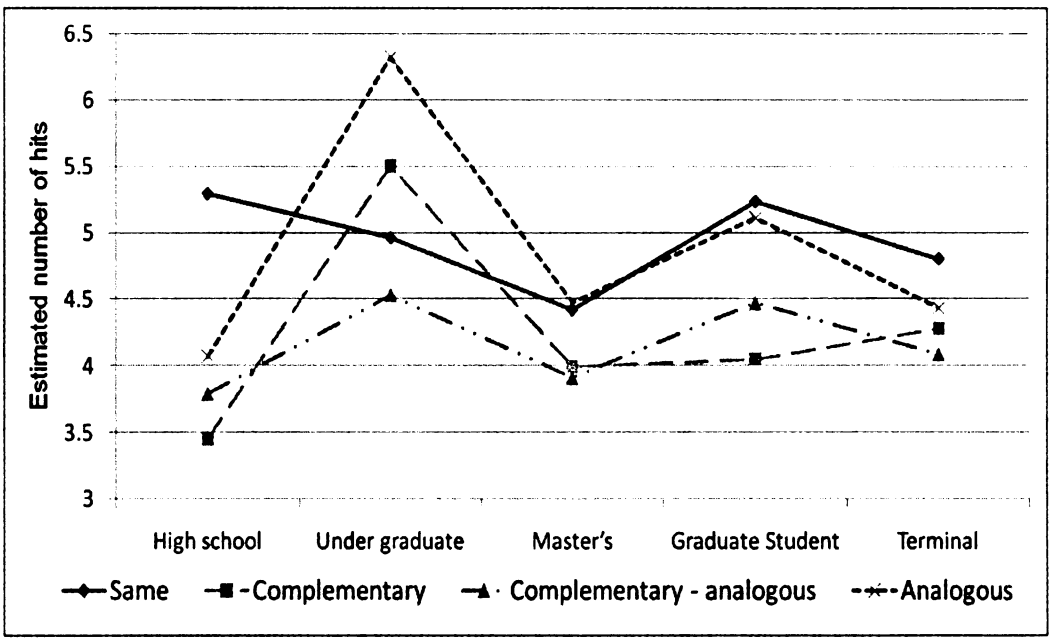


Figure 26 - The Interaction of Education and Color Treatment on Number of Hits

Moreover, the 2-way interaction of color treatment and produce was tested because it found to be significant ($p=0.0028$) (See Table 13). Comparing data in Table 22, treatments in the same and analogous colors were statistically significantly different when those for the orange was compared to the complementary-analogous color for the same produce ($p<0.05$). White onion that appeared in packaging of the same color induced a significantly greater number of hits than any other color treatments ($p<0.05$ for all). In general, produce in mesh bags of the same color, or packaged in an analogous color treatment induced a greater number of hits, but, the purple onion and the white onion did not follow this pattern (See table 22 and figure 27).

The orange and white onion in the same color mesh bags had significantly greater means of number of hits than the green apple and purple onion ($p<0.05$). In the case of analogous color treatment, however, white onion was significant differences from red apple, orange and green apple. Among produce in complementary color treatment, green apple had the highest mean of number of hits, but white onion was paid the lowest attention. In addition, red apple and purple onion in complementary-analogous color treatment were significantly different ($p<0.0203$).

Table 22 - The 2-way Interaction between Produce and Color Treatment

Treatment *Produce	Same	Complementary	Complementary - analogous	Analogous
Red apple	5.20 ± 0.40 AB a	4.44 ± 0.36 A a	4.66 ± 0.37 A a	5.10 ± 0.40 A a
Orange	5.77 ± 0.43 A a	4.40 ± 0.36 A b	4.02 ± 0.34 AB b	5.49 ± 0.41 A a
Lemon	4.87 ± 0.38 AB a	4.04 ± 0.34 AB ab	3.98 ± 0.34 AB b	4.75 ± 0.37 AB ab
Green apple	4.84 ± 0.36 BC a	4.81 ± 0.38 A a	4.31 ± 0.35 AB a	5.07 ± 0.39 A a
Purple onion	3.96 ± 0.33 C ab	4.10 ± 0.34 AB ab	3.69 ± 0.32 B b	4.65 ± 0.37 AB a
White onion	5.67 ± 0.42 A a	3.55 ± 0.31 B b	4.31 ± 0.35 AB b	4.01 ± 0.33 B b

Note 1: Different lowercase letters (a, b) in the same row suggests statistical significance at the 95% confidence level.
Note 2: Different capital letters (A, B, C) in the same column suggests statistical significance at the 95% confidence level.

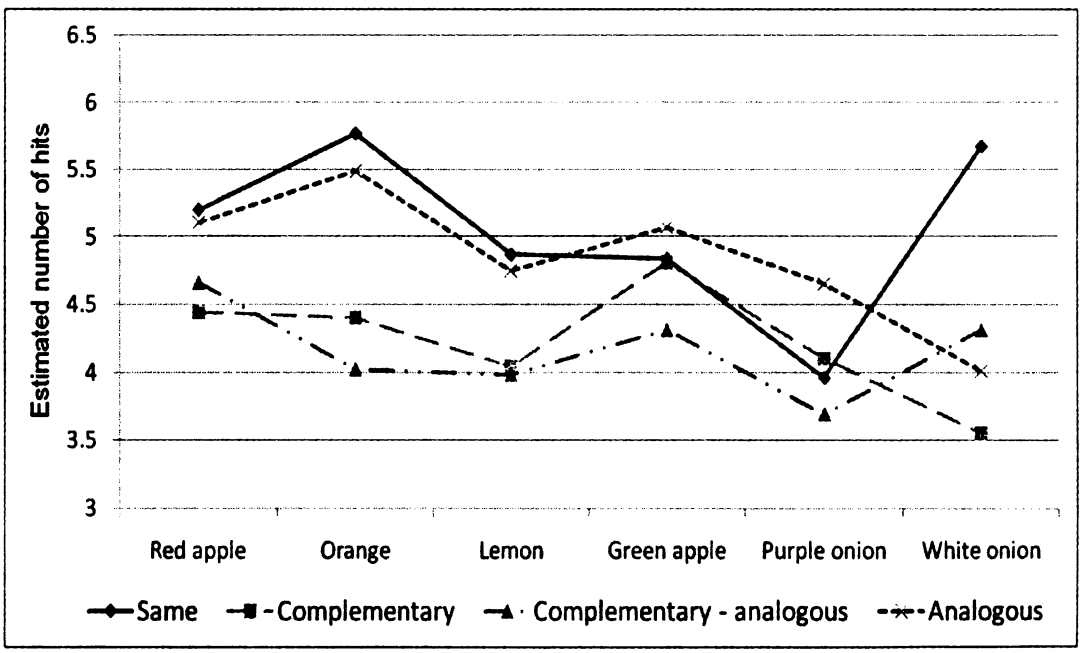


Figure 27 - The Interaction of Produce and Color Treatment on Number of Hits

The total time spent on each zone (Gaussian variable)

In addition to the ordinal response, number of hits, the total time spent in each color treatment was also examined for statistical significance. 'Total time spent' was transformed using a square root transformation to meet normality assumptions demanded of the model, and modeled as a Gaussian variable using a generalized linear mixed model.

The model included the fixed effects of treatment and produce. Subject information (gender, education, primary shopper, status, consumption frequency, memory of packaging types purchased, visual acuity result, result of color blindness test, their indicated color preference) was considered for model inclusion, but later removed from the model if their p-values were greater than 0.10 (table 13).

Pair wise comparisons were conducted on the estimated least square means of color treatment using the LSD procedure to provide useful comparisons. Moreover, 2-way interaction of treatment and produce was also conducted in this study.

Table 23 - Results of Type III Tests on Number of Hits

Effect	Num of DF	Den of DF	F value	Pr > F
Color Treatment	3	984	36.54	<.0001
Produce*treatment	15	984	2.59	0.0008

As with the number of hits, the dependent variable, time in each color treatment, was found to be significant ($p<0.0001$). Table 22 indicates the magnitude (mean and standard error) of this effect by each color treatment (raw values). Pair wise comparisons conducted on the estimated least square means using LSD procedure are shown in Table 22. The result of analysis indicates that subjects devoted a greater amount of time to the same color and the analogous color when compared with the complementary ($p<0.0001$) and complementary-analogous color treatments ($p<0.0001$) (See Table 22 and Figure 29). This pattern was very similar to that indicated when the dependent variable was considered to be the number of hits to each color treatment (See Table 19 and Figure 24)

Table 24 - Means of Total Time Spent on Each Color Treatment (zone)

Treatment (zone)	Same	Complementary	Complementary-analogous	Analogous
Mean values	3.74 ± 0.14^{a}	2.35 ± 0.09^{b}	2.32 ± 0.10^{b}	3.75 ± 0.14^{a}

Note: Different lowercase letters (a, b) in the same row suggests statistical significance at the 95% confidence level.

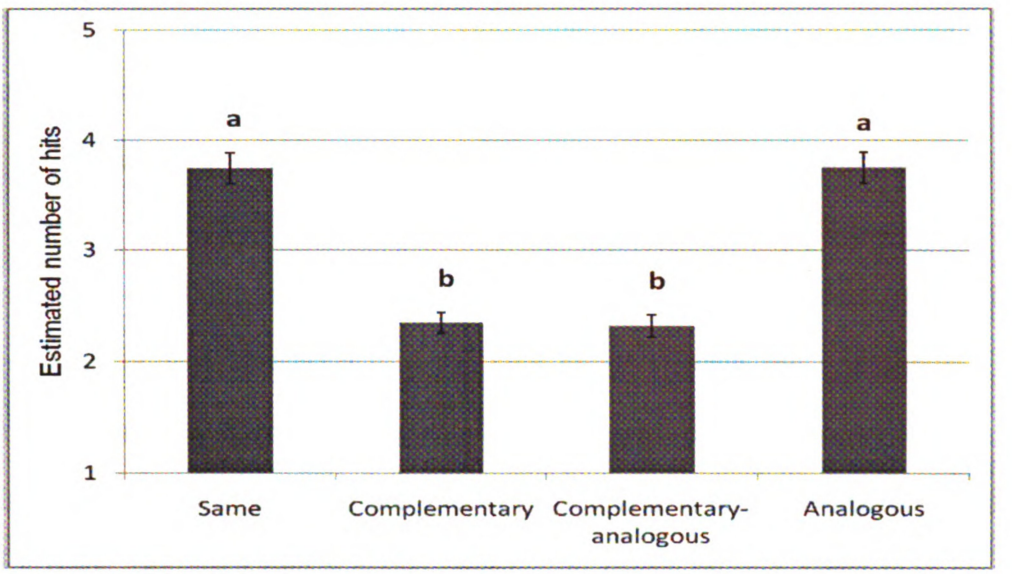


Figure 28 - Means of Total Time Spent on Each Color Treatment (zone)
Different letters (a, b) indicate statistically significant differences ($p < 0.05$)

Moreover, the 2-way interaction of color treatment and produce, as it impacted the total time spent was further examined because the initial analysis provided evidence of significance ($p<0.0008$). Table 19 and Figure 24 depict the 2-way interaction. On the whole, the result of the 2-way interaction between color treatment and produce indicated that subjects who participated in the eye tracking test spent longer time on the same and analogous treatment zones than complementary and complementary-analogous color zones.

The means of total time spent on each treatment for the orange, lemon, and purple onion suggested that the same and analogous color treatments resulted in a significantly different amount of viewing time when they were

compared with the complementary color and complementary-analogous color treatments for the same fruits (α=0.05).

For the red apple, mesh and produce combination that appeared in the same color treatment significantly differed from the complementary color treatment ($p<0.0069$) and complementary-analogous color treatment ($p<0.0015$). There was enough evidence that the time spent viewing the analogous color compared to the complementary ($p<0.0458$) and complementary-analogous (0.0013) color treatments for the green apple. The white onion indicated that same color treatment had a statistically higher mean of time spent than others (α=0.05).

In the case of the same color treatments, the subjects spent fewer time viewing the green apple, conversely paid more attention to the white onion ($p<0.0079$) in each same color bag. However, for the complementary treatments, the green apple received much more attention than the orange, lemon and white onion, respectively ($p<0.0093$, 0.0016, and 0.0011). The white onion in the complementary-analogous color treatments was significantly different amount of viewing times when compared with the orange ($p<0.0118$) and lemon (0.0175). The analogous color mesh of white onion had a much lower mean of time spent than others in the analogous color treatments.

Table 25 - The 2-way Interaction between Produce and Color Treatment

Treatment *Produce	Same	Complementary	Complementary-analogous	Analogous
Red apple	3.87 ± 0.35 AB a	2.66 ± 0.22 AC b	2.37 ± 0.25 AB b	3.27 ± 0.35 AC ab
Orange	3.89 ± 0.35 AB a	2.10 ± 0.22 AB b	1.96 ± 0.25 A b	3.92 ± 0.35 AB a
Lemon	3.55 ± 0.35 AB a	1.92 ± 0.22 B b	2.02 ± 0.25 A b	4.39 ± 0.35 B a
Green apple	3.10 ± 0.35 B ab	2.93 ± 0.22 C b	2.26 ± 0.25 AB b	3.81 ± 0.35 ABC a
Purple onion	3.47 ± 0.35 AB a	2.44 ± 0.22 ABC b	2.32 ± 0.25 AB b	4.03 ± 0.35 AB a
White onion	4.42 ± 0.35 A a	1.88 ± 0.22 B b	2.88 ± 0.25 B c	2.92 ± 0.35 C c

Note 1: Different lowercase letters (a, b, c) in the same row suggest statistical significance at the 95% confidence level.
Note 2: Different capital letters (A, B, C) in the same column suggest statistical significance at the 95% confidence level.

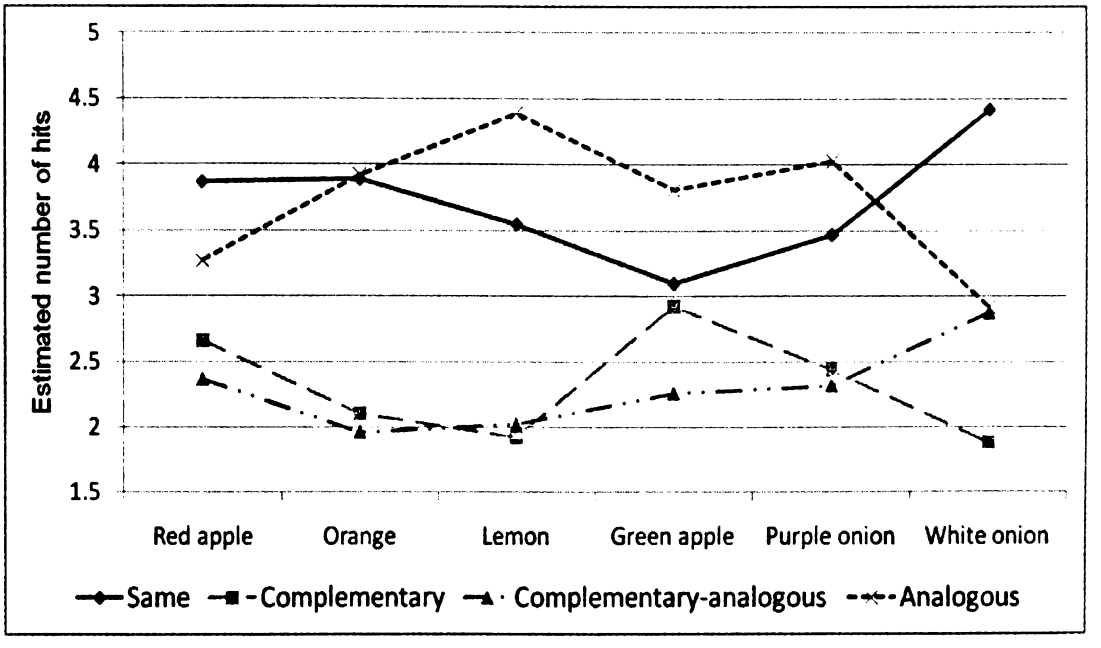


Figure 29 - The Interaction of Produce and Color Treatment on Time Spent

CHAPTER 7 - CONCLUSIONS

The objective of this research was to identify the combined effect of package color and produce color on consumers' attentive behaviors and quality (freshness) perception using eye tracking and a brief survey. For this research, various colors of mesh bags and six kinds of produce (red apples, oranges, lemons, green apples, purple onions, and white onions) were combined based on double-complementary color schemes and reproduced as stimulus images for an eye tracking test.

This chapter includes a conclusion of the investigation as well as a summary of the limitations in this study. The latter part of this chapter suggests brief ideas for future research regarding packaging color and design on consumer perception and behavior.

Consumers are faced with specific product and packaging attributes at the purchasing point. They compare various products in order to ascertain the value of the product before purchasing. Consumers perceive the total appearance of products differently, as influenced by several factors (previously described in chapter 3). Their attentive behavior provides insights into the decision-making process and has been indicated in previous research to provide some indication of their intention to purchase.

The results of this study indicate that the varied combinations of produce color and packaging color have an effect on consumers' attentive behaviors and

perception of freshness. The results of both response variables (total number of hits to a zone and the total time spent on each zone) provide evidence that color combinations promote differences in the attentive behaviors of people viewing produce packaging when measured with eye tacking.

Monochromatic (same) and analogous color combination of produce and packaging (mesh bags) garnered more attention than the other treatments. These color treatments were also indicated (through the subsequent survey) to be more visual appealing than complementary and complementary-analogous color treatments. In particular, the same and the analogous color mesh bags for the red apple, the orange, and the lemon, provide a clearly positive effect on the attentive behavior of participants from the results of both response variables.

The results of the analysis of the questionnaire: quality, visual appeal, and purchase intention (using Likert scale 1=very poor, 5=very good) were also investigated. Same color treatment and analogous color treatment had the high scores relating to: quality, visual appeal, and purchase intention. By contrast, subjects recorded lower self-reports of quality, visual appeal, and purchase for the color treatments complementary and complementary-analogous.

Subjects also paid more attention to produce packaged in the same or analogous mesh bags at the different values of quality, visual appeal, and purchase intention. Therefore, it can be conclude that the combination of same

color or analogous color between produce and packaging improve consumers' attentive behaviors and perceived quality.

As described in chapter 4, color influences other colors surrounding it in the phenomena of color perception. In this research, the relationships between similar hue colors (same or analogous) generally elicited a greater response than the same produce packaged in a complementary or complementary-analogous color mesh bags, with a few exceptions. The reason this results presented is that mesh bags used in this research caused the assimilative color effect which is appeared by narrow pattern or stripe (Figure 4 b: dark bars interrupt to appear brighter color than bright bars). Therefore, it is possible that the produce color is reinforced by transmittance of packaging materials or neighboring color of packaging (Ripamonti and Gerbino 2001).

Based on results presented here, color has the potential to affect the attentive behaviors and perception of quality of consumers. The color combinations of mono-chromatic and analogous between packaging color and produce color, based on the effect of color assimilation and warm color characteristics, generally induce more attentions (as measured by both time in zone and number of hits), improved perceived quality scores (based on likert scale), and were reported to be more visually appealing and purchase intention (based on likert scale reports).

Limitations

As with all research, the study presented here has a number of limitations. Produce choice was limited to those which typically employed mesh bags on the RBY color wheel. In reality, the produce market consists of far more varieties packaged in multiple platforms. Stimulus material was created using photographic means and then displayed on a computer screen so that images could be precisely and completely controlled. It should be noted, however, that this was the case, and that subjects were not looking at objects under the illumination that would be typical of a grocery store. Further, subjects were asked to sit at an eye tracking table and fix their chin on a chin rest. Participants spent a long time to complete the questionnaire while continuing to examine the images. It is possible that the decisions of subjects were influenced by other factors during a post-test due to the nature of this study. Due to the limited sample and recruiting techniques employed, readers are cautioned that results are not generalizable.

Future Research

This study, exploratory in nature, suggests that varying the color combinations of the packaging of produce has an effect on the attentive behaviors and perception of consumers viewing it. Future study using a sample more representative of the population is recommended. Further, it is recommended that future studies include focus groups from varied demographic

segments so that both attentive behaviors and perceptions can be examined by demographic segment.

Additionally, more ecologically valid studies which examine the design factors (e.g. lighting) at the point of purchase are recommended. This could be done using some of the Mobile eye tracking units that are currently available.

The analysis of questionnaire regarding quality, visual appeal and purchase intention correlated to the data collected through eye tracking, is also recommended for future study.

APPENDIX 1: PRODUCE PACKAGING COMBINATION

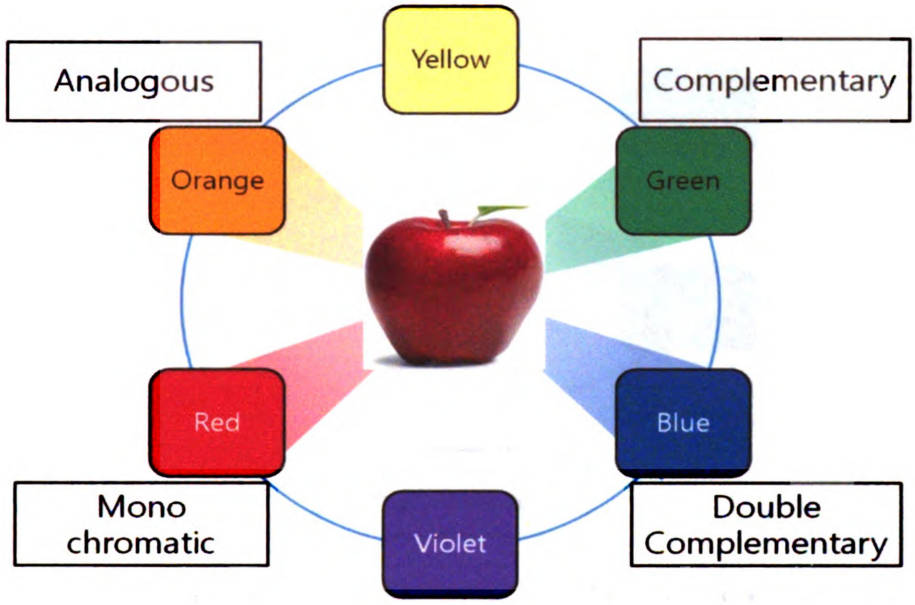


Figure 30 - The Combination of Red Apples and Packaging
Red, Green, Orange, and Blue colored meshes on Red Apples

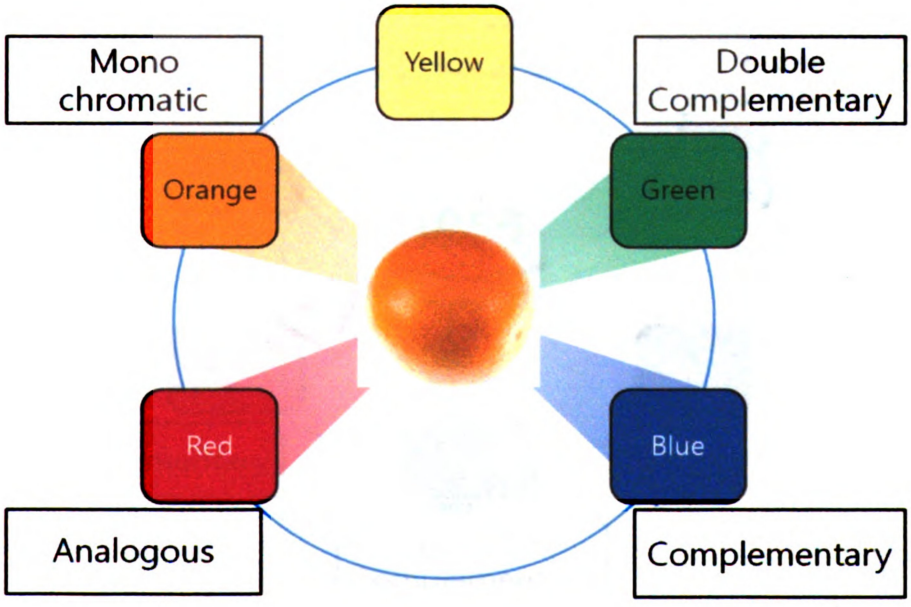


Figure 31 - The Combination of Oranges and Packaging
Orange, Blue, Red, and Green colored meshes on Oranges

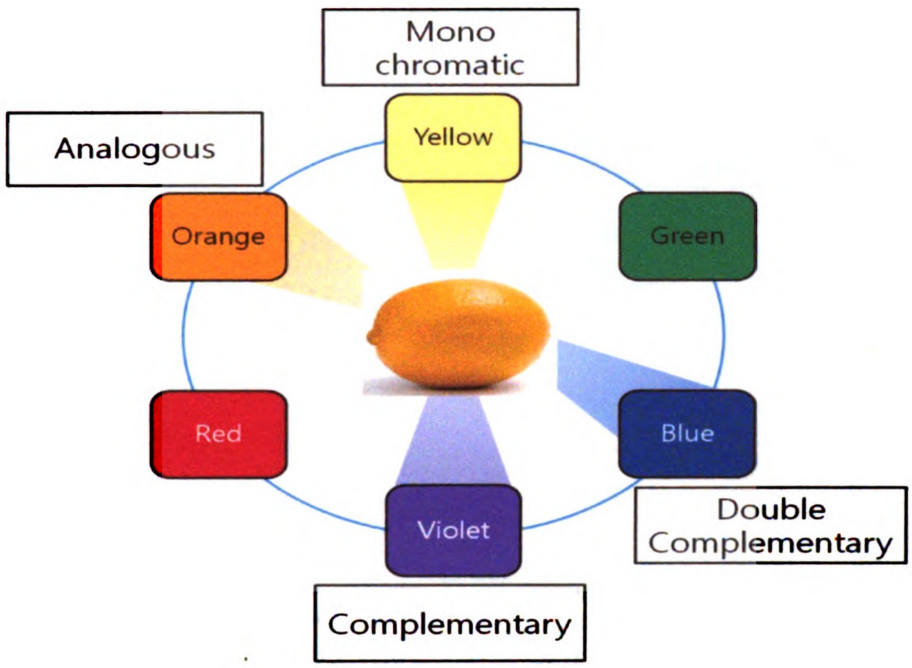


Figure 32 - The Combination of Lemons and Packaging
Yellow, Violet, Orange, and Blue colored meshes on Lemons

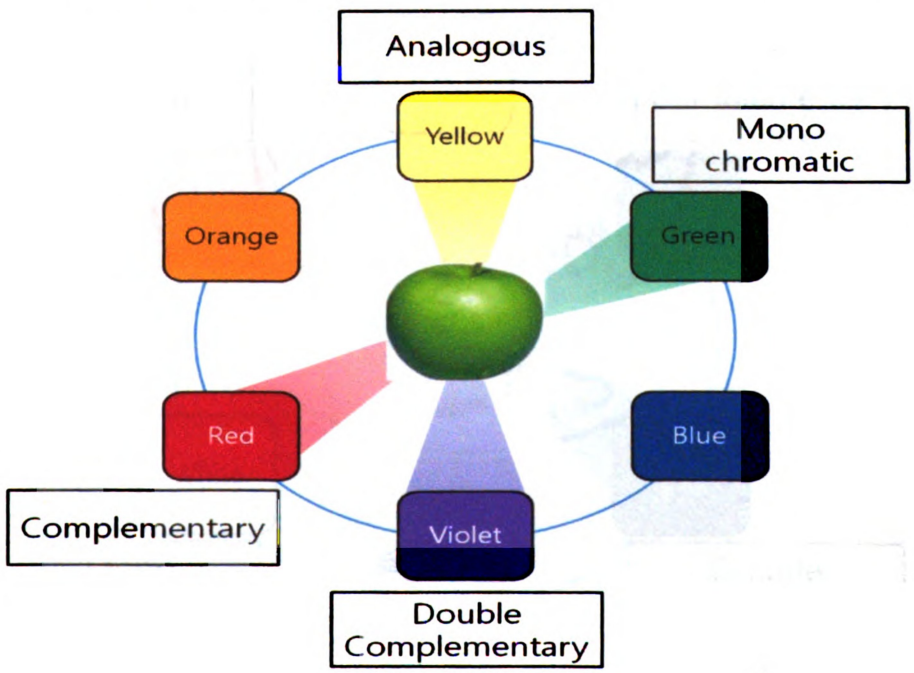


Figure 33 - The Combination of Green Apples and Packaging
Green, Red, Yellow, and Violet colored meshes on Green Apples

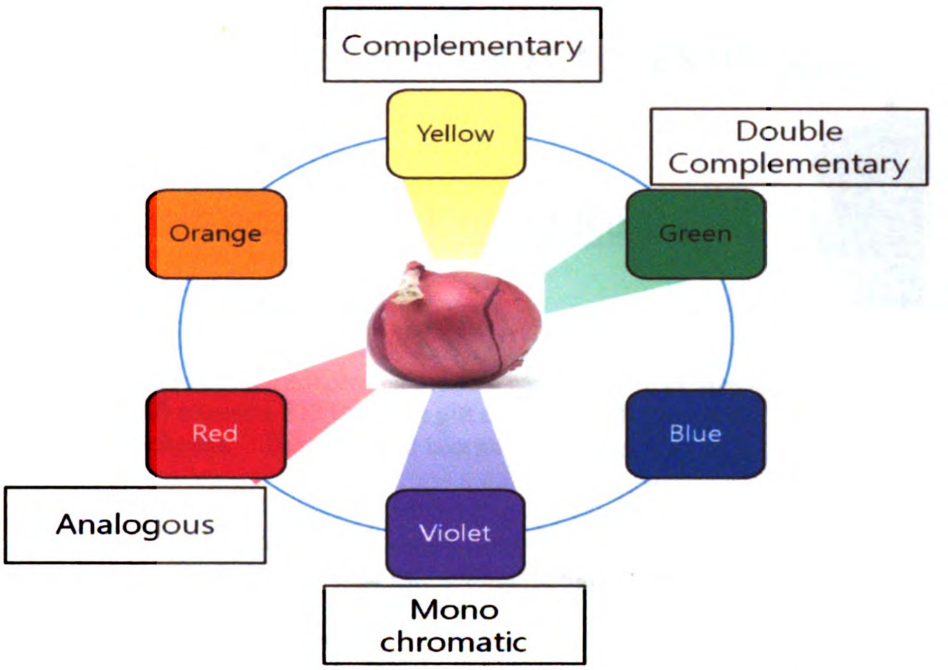


Figure 34 - The Combination of Purple Onions and Packaging
Violet, Yellow, Red, and Green colored meshes on Purple Onions

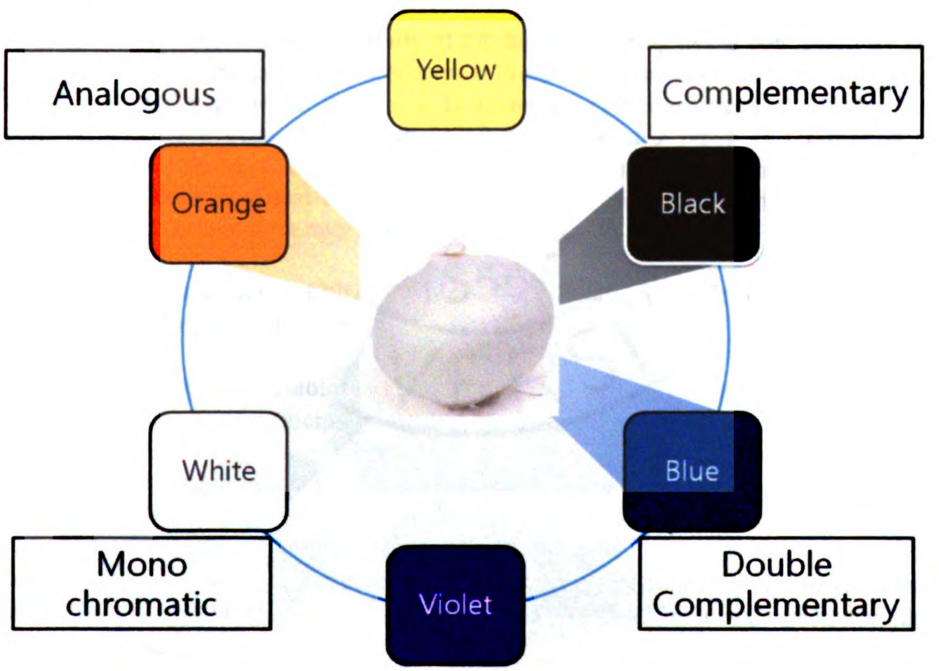


Figure 35 - The Combination of White Onions and Packaging
White, Black, Orange, and Blue colored meshes on White Onions

APPENDIX 2: RECRUITMENT ADVERTISEMENT

Produce Packaging Research

Participants wanted for research concerning produce packaging. In exchange for your participation, you will receive a $10 Best Buy gift certificate OR extra credit in PKG 480 or PKG 323, whichever you choose. The study will take no longer than 1 hour. To participate in this study:

- You must consume produce (fruits and/or vegetables)
- You must be able to provide your own transportation to the School of Packaging at Michigan State University
- You must be over 18 years of age
- You must not be legally blind
- You must not wear hard contact lenses
- You must be willing to provide a contact phone number or email so that researchers can contact you to remind you of your appointment

You are being asked to participate in a study of produce packaging being conducted by graduate student Won-Tae Seo. As part of his Master's Program, Won-Tae Seo is investigating the packaging of fruits and vegetables. To do this, he is using an ASL eye tracker. If you choose to participate, we will track your eye movements as you look at 9 types of produce in various packages. You will also be asked to answer a brief questionnaire about your eating habits and produce purchasing behaviors and be asked basic demographic information. Instrument set up and the test itself should take no longer than 40 minutes.

Prior to testing, your visual acuity (20/20,20/30, 20/40, etc.) and a test for color blindness will be administered. These tests involve viewing a series of cards.

If at any time you are uncomfortable with the testing or wish to discontinue the data collection process, you may discontinue participation without penalty.

If you are interested in pursuing this opportunity, please contact Won-Tae Seo at seowonta@msu.edu to make an appointment.

If you have questions or comments regarding this study, please contact Dr. Laura Bix, Associate Professor of Packaging at Michigan State University at 517-355-4556 or bixlaura@msu.edu.

APPENDIX 3: CONSENT FORM

Michigan State University
School of Packaging

INSTRUCTIONS AND RESEARCH CONSENT FORM
Consumer Preference for Produce Packaging

You are being asked to take part in a research study regarding consumer preference for produce packaging using eye tracking. The purpose of this study is to develop an understanding of consumer preference for various produce packages. Participation is voluntary, you may choose not to participate at all, or you may refuse to participate in certain procedures or answer certain questions or discontinue at any time without consequence (e.g. this will not affect your grade, evaluation or eligibility for the gift card). Please read this form carefully and ask any questions you may have before agreeing to take part in the study. Each participant of testing will be provided the $10 Best Buy gift card OR extra credit if you are taking PKG 323 and PKG 480 classes, whichever you choose.

In order to participate in this study you must:

- Consume produce (fruits and/or vegetables)
- Not be legally blind
- Not wear hard contact lenses
- Have transportation to the School of Packaging
- Be willing to provide contact information for scheduling

If you agree to participate in this study, we will record your gender, age, marriage status, ethnicity, educational background and ask you to fill out a brief survey regarding your thoughts and feelings about the produce and packaging that you have viewed. Additionally, you will be asked about your food consumption habits and shopping behaviors. This information will be tied to a subject number; you will not be identified by name and your privacy will be maintained to the maximum extent of the law. Information collected during the study will be stored in a password protected computer in locked laboratories/office in the school of packaging for a minimum of 3 years. The rooms will only be accessible to authorized researchers from Dr. Laura Bix's research team. The study will take no longer than 40 minutes of your time.

During the first part of the study, we will test your ability to see color and characterize your visual acuity (20/20, 20/30, 20/40, etc.). We will do this by asking you to view a series of cards and read what you see aloud.

Instrument: Eye tracking
After we have assessed your ability to see color and your visual acuity, we will begin the eye tracking portion of the study. The eye tracker is a very sensitive eye movement monitor, which can tell us exactly where your eyes are looking. A beam of light that cannot be detected by the human eye will be shone into your eye. The instrument tracks the movement of your eye by tracking the movement of the beam.

You will be asked to sit in front of a computer monitor that is connected to an eye tracking camera. This camera will track the position of your eye as you view a series of pictures that are shown on the computer screen. You will be asked to sit as still as possible with your chin on the chinrest, and move nothing but you eyes. To calibrate the instrument, you will first be asked to look at certain locations in the monitor screen that are identified by a series of dots. After calibration, we ask that you continue to sit as still as possible with your chin on the chinrest, and move nothing but your eyes. During this time, we will show you a series of photos of produce that appears in different packages. Each image that you view will appear for a period of ten seconds.

After you have viewed the images with the eye tracker, we will show you each again. At that point we will ask you to fill out a survey regarding your opinions of the produce in the varied packages, and which you would purchase.

If you have any questions at any time please ask.

Risks and Benefits
The procedures used in this study have no more risk of harm to you than what you experience in everyday life. However, it is possible that you will experience some discomfort while you are asked to remain still with your head on the chin rest, please let us know if you do experience any discomfort at any time. You may discontinue participation at anytime without penalty; you will still be eligible for the gift card, or extra credit, whichever you choose.

You may also be uncomfortable answering some questions, such as your height and weight. You may choose to discontinue without penalty or fail to answer things that you do not wish to share.

Although there is no direct benefit to you for participating in this study, it is our hope that this research will provide insights regarding consumer behavior and packaging. This type of information is not only relevant to the companies that sell these products, but could also lead to package that facilitate healthier dietary choices.

Confidentiality
Collected data will be identifiable only through subject number, and your name and

number will not be tied. Collected data will be treated in strict confidence. Your privacy will be protected to the maximum extent allowable by law. Within these restrictions, results of this study will be made available to you at your request. All of the data will be stored on a password protected computer in the Packaging Building and in a locked file cabinet in Laura Bix's office at Michigan State University, which is also locked at all times. All data and documents of this study will be kept for a minimum of 3 years beyond the termination of the study and then destroyed. Michigan State University's Institutional Review Board (IRB) will also have access to the data upon request.

Questions

If you have any concerns or questions about this research study, such as scientific issues, how to do any part of it, or to report an injury, please contact the researcher, Dr. Laura Bix, 153 Packaging East Lansing, MI 48824 at 517-355-4556 or bixlaura@msu.edu.

If you have questions or concerns about your role and rights as a research participant, would like to obtain information or offer input, or would like to register a complaint about this study, you may contact, anonymously if you wish, the Michigan State University's Human Research Protection Program at 517-355-2180, Fax 517-432-4503, or e-mail irb@msu.edu or regular mail at 207 Olds Hall, MSU, East Lansing, MI 48824.

I voluntarily agree to participate in the Eye Tracking study of produce packaging.

Date: _____ **Consent Signature of Participant**_____

You will be provided with a copy of this consent form.

APPENDIX 4: DATA RECORDING SHEET

The Data Recording Sheet

subject#_____

Demographics and General survey

Please place a check (✓) in the box to select your answer after reading each questions carefully. Choose the one best answer.

1. Gender ❑ Male ❑ Female _____ other

2. What is your age? _____

3. What is the highest level of education that you have COMPLETED?

   ❑ High School ❑ Undergraduate ❑ Masters ❑ Graduate school student
   ❑ Terminal (PhD, MD, JD, etc.) ❑ Other

4. Are you married? ❑ Yes ❑ No

5. Do you have children? ❑ Yes ❑ No Please list their ages_____

6. Do you have children living in your household? ❑ Yes ❑ No

   If so, please list their ages_____

7. Are you the primary grocery shopper for your household? ❑ Yes ❑ No

8. How often do you shop for food?

❑ Daily ❑ 2~3times a week ❑ weekly ❑ A few times a month ❑ Monthly

9. How often do you consume produce (fruits and vegetables)?

❑ Daily ❑ 2~3times a week ❑ weekly ❑ A few times a month ❑ Monthly

10. What type of packaging do you think of when it comes to produce (fruits and vegetables)?

❑ Plastic tray ❑ Plastic bag ❑ Mesh bag ❑ Nothing

Visual Acuity Score 20/20 20/30 20/40 20/50

Pseudo Isochromatic Plates_____# missed

----------STOP----------

All eye tracking data is collected and then questionnaire

Evaluation Questionnaire on Produce Packaging

subject #_____

Please place a check (✓) in the box to select your answer after reading the question carefully.

- **Red Apple**

1. Please rate the expected quality (Freshness) of red apples in each bag.

		Very Poor	Poor	Moderate	Good	Very good
1	Apples in the **Red** mesh bag	1	2	3	4	5
2	Apples in the **Orange** mesh bag	1	2	3	4	5
3	Apples in the **Green** mesh bag	1	2	3	4	5
4	Apples in the **Blue** mesh bag	1	2	3	4	5

2. Please rate the visual appeal of red apples in each mesh bag.

		Very Poor	Poor	Moderate	Good	Very good
1	Apples in the **Red** mesh bag	1	2	3	4	5
2	Apples in the **Orange** mesh bag	1	2	3	4	5
3	Apples in the **Green** mesh bag	1	2	3	4	5
4	Apples in the **Blue** mesh bag	1	2	3	4	5

3. Please indicate how likely you would be to purchase red apples in each bag if were purchasing red apples.

		Not Likely	Maybe Not	Maybe	Likely	Highly likely
1	Apples in the **Red** mesh bag	1	2	3	4	5
2	Apples in the **Orange** mesh bag	1	2	3	4	5
3	Apples in the **Green** mesh bag	1	2	3	4	5
4	Apples in the **Blue** mesh bag	1	2	3	4	5

4. If forced to rank the red apples from most appealing to least appealing (by bag color), what would your rankings be?
   A. Most appealing_____
   B. Appealing_____
   C. Moderate_____
   D. Less_____

5. Which packaging first grabbed your attention?

❑ **Red** mesh bag ❑ **Orange** mesh bag ❑ **Green** mesh bag ❑ **Blue** mesh bag

6. Have you ever eaten red apples? ❑ Yes ❑ No

7. Do you currently eat red apples? ❑ Yes ❑ No

8. Do you currently purchase red apples? ❑ Yes ❑ No

9. If so, have any been in mesh bags? ❑ Yes ❑ No

If you know, please state the color of mesh bag _____

- **Oranges**

10. Please rate the expected quality (Freshness) of oranges in each bag.

		Very Poor	**Poor**	**Moderate**	**Good**	**Very good**
1	Oranges in the **Red** mesh bag	1	2	3	4	5
2	Oranges in the **Orange** mesh bag	1	2	3	4	5
3	Oranges in the **Green** mesh bag	1	2	3	4	5
4	Oranges in the **Blue** mesh bag	1	2	3	4	5

11. Please rate the visual appeal of oranges in each mesh bag.

		Very Poor	**Poor**	**Moderate**	**Good**	**Very good**

1	Oranges in the **Red** mesh bag	1	2	3	4	5
2	Oranges in the **Orange** mesh bag	1	2	3	4	5
3	Oranges in the **Green** mesh bag	1	2	3	4	5
4	Oranges in the **Blue** mesh bag	1	2	3	4	5

12. Please indicate how likely you would be to purchase oranges in each bag if were purchasing oranges.

		Not Likely	**Maybe Not**	**Maybe**	**Likely**	**Highly likely**
1	Orange in **Red** mesh bag	1	2	3	4	5
2	Orange in **Orange** mesh bag	1	2	3	4	5
3	Orange in **Green** mesh bag	1	2	3	4	5
4	Orange in **Blue** mesh bag	1	2	3	4	5

13. If forced to rank the oranges from most appealing to least appealing (by bag color), what would your rankings be?
    A. Most appealing_____
    B. Appealing_____
    C. Moderate_____
    D. Less_____

14. Which packaging first grabbed your attention?

❑ **Red** mesh bag ❑ **Orange** mesh bag ❑ **Green** mesh bag ❑ **Blue** mesh bag

15. Have you ever eaten oranges? ❑ Yes ❑ No

16. Do you currently eat oranges? ❑ Yes ❑ No

17. Do you currently purchase oranges? ❑ Yes ❑ No

18. If so, have any been in mesh bags? ❑ Yes ❑ No

If you know, please state the color of mesh bag _____

- **Lemon**

19. Please rate the expected quality (Freshness) of lemons in each bag.

		Very Poor	Poor	Moderate	Good	Very good
1	Lemons in the **Yellow** mesh bag	1	2	3	4	5
2	Lemons in the **Orange** mesh bag	1	2	3	4	5
3	Lemons in the **Violet** mesh bag	1	2	3	4	5
4	Lemons in the **Blue** mesh bag	1	2	3	4	5

20. Please rate the visual appeal of lemons in each mesh bag.

		Very Poor	Poor	Moderate	Good	Very good
1	Lemons in the **Yellow** mesh bag	1	2	3	4	5

2	Lemons in the **Orange** mesh bag	1	2	3	4	5
3	Lemons in the **Violet** mesh bag	1	2	3	4	5
4	Lemons in the **Blue** mesh bag	1	2	3	4	5

21. Please indicate how likely you would be to purchase lemons in each bag if were purchasing lemons.

		Not Likely	**Maybe Not**	**Maybe**	**Likely**	**Highly likely**
1	Lemons in the **Yellow** mesh bag	1	2	3	4	5
2	Lemons in the **Orange** mesh bag	1	2	3	4	5
3	Lemons in the **Violet** mesh bag	1	2	3	4	5
4	Lemons in the **Blue** mesh bag	1	2	3	4	5

22. If forced to rank the lemons from most appealing to least appealing (by bag color), what would your rankings be?
    A. Most appealing_____
    B. Appealing_____
    C. Moderate_____
    D. Less_____

23. Which packaging first grabbed your attention?

❑ **Yellow** mesh bag ❑ **Orange** mesh bag ❑ **Violet** mesh bag ❑ **Blue** mesh bag

24. Have you ever eaten/used lemons? ❑ Yes ❑ No

25. Do you currently eat/use lemons? ❑ Yes ❑ No

26. Do you currently purchase lemons? ❑ Yes ❑ No

27. If so, have any been in mesh lemons? ❑ Yes ❑ No

If you know, please state the color of mesh bag _____

- **Green Apple**

28. Please rate the expected quality (Freshness) of green apples in each bag.

		Very Poor	**Poor**	**Moderate**	**Good**	**Very good**
1	Green apples in the **Yellow** mesh bag	1	2	3	4	5
2	Green apples in the **Green** mesh bag	1	2	3	4	5
3	Green apples in the **Violet** mesh bag	1	2	3	4	5
4	Green apples in the **Red** mesh bag	1	2	3	4	5

29. Please rate the visual appeal of green apples in each mesh bag.

		Very Poor	**Poor**	**Moderate**	**Good**	**Very good**
1	Green apples in the **Yellow** mesh bag	1	2	3	4	5
2	Green apples in the **Green** mesh bag	1	2	3	4	5

3	Green apples in the **Violet** mesh bag	1	2	3	4	5
4	Green apples in the **Red** mesh bag	1	2	3	4	5

30. Please indicate how likely you would be to purchase green apples in each bag if were purchasing green apples.

		Not Likely	**Maybe Not**	**Maybe**	**Likely**	**Highly likely**
1	Green apples in the **Yellow** mesh bag	1	2	3	4	5
2	Green apples in the **Green** mesh bag	1	2	3	4	5
3	Green apples in the **Violet** mesh bag	1	2	3	4	5
4	Green apples in the **Red** mesh bag	1	2	3	4	5

31. If forced to rank the green apples from most appealing to least appealing (by bag color), what would your rankings be?
    A. Most appealing_____
    B. Appealing_____
    C. Moderate_____
    D. Less_____

32. Which packaging first grabbed your attention?

❑ **Yellow** mesh bag ❑ **Green** mesh bag ❑ **Violet** mesh bag ❑ **Red** mesh bag

33. Have you ever eaten green apples? ❑ Yes ❑ No

34. Do you currently eat green apples? ❑ Yes ❑ No

35. Do you currently purchase green apples? ❑ Yes ❑ No

36. If so, have any been in mesh bags? ❑ Yes ❑ No

If you know, please state the color of mesh bag _____

- **Purple Onion**

37. Please rate the expected quality (Freshness) of purple onions in each bag.

		Very Poor	Poor	Moderate	Good	Very good
1	Purple onions in the **Yellow** mesh bag	1	2	3	4	5
2	Purple onions in the **Red** mesh bag	1	2	3	4	5
3	Purple onions in the **Violet** mesh bag	1	2	3	4	5
4	Purple onions in the **Green** mesh bag	1	2	3	4	5

38. Please rate the visual appeal of purple onions in each mesh bag.

		Very Poor	Poor	Moderate	Good	Very good
1	Purple onions in the **Yellow** mesh bag	1	2	3	4	5
2	Purple onions in the **Red** mesh bag	1	2	3	4	5
3	Purple onions in the **Violet** mesh bag	1	2	3	4	5

4	Purple onions in the **Green** mesh bag	1	2	3	4	5

39. Please indicate how likely you would be to purchase purple onions in each bag if were purchasing purple onions.

		Not Likely	**Maybe Not**	**Maybe**	**Likely**	**Highly likely**
1	Purple onions in the **Yellow** mesh bag	1	2	3	4	5
2	Purple onions in the **Red** mesh bag	1	2	3	4	5
3	Purple onions in the **Violet** mesh bag	1	2	3	4	5
4	Purple onions in the **Green** mesh bag	1	2	3	4	5

40. If forced to rank the purple onions from most appealing to least appealing (by bag color), what would your rankings be?
    A. Most appealing_____
    B. Appealing_____
    C. Moderate_____
    D. Less_____

41. Which packaging first grabbed your attention?

❑ **Yellow** mesh bag ❑ **Red** mesh bag ❑ **Violet** mesh bag ❑ **Green** mesh bag

42. Have you ever eaten purple onions? ❑ Yes ❑ No

43. Do you currently eat purple onions? ❑ Yes ❑ No

44. Do you currently purchase purple onions? ❑ Yes ❑ No

45. If so, have any been in mesh purple onions? ❑ Yes ❑ No

If you know, please state the color of mesh bag _____

- **White Onion**

46. Please rate the expected quality (Freshness) of white onions in each bag.

		Very Poor	Poor	Moderate	Good	Very good
1	White onions in the **White** mesh bag	1	2	3	4	5
2	White onions in the **Black** mesh bag	1	2	3	4	5
3	White onions in the **Blue** mesh bag	1	2	3	4	5
4	White onions in the **Orange** mesh bag	1	2	3	4	5

47. Please rate the visual appeal of white onions in each mesh bag.

		Very Poor	Poor	Moderate	Good	Very good
1	White onions in the **White** mesh bag	1	2	3	4	5
2	White onions in the **Black** mesh bag	1	2	3	4	5
3	White onions in the **Blue** mesh bag	1	2	3	4	5
4	White onions in the **Orange** mesh bag	1	2	3	4	5

48. Please indicate how likely you would be to purchase white onions in each bag if were purchasing white onions.

		Not Likely	Maybe Not	Maybe	Likely	Highly likely
1	White onions in the **White** mesh bag	1	2	3	4	5
2	White onions in the **Black** mesh bag	1	2	3	4	5
3	White onions in the **Blue** mesh bag	1	2	3	4	5
4	White onions in the **Orange** mesh bag	1	2	3	4	5

49. If forced to rank the white onions from most appealing to least appealing (by bag color), what would your rankings be?
    A. Most appealing_____
    B. Appealing_____
    C. Moderate_____
    D. Less_____

50. Which packaging first grabbed your attention?

❑ **White** mesh bag ❑ **Black** mesh bag ❑ **Blue** mesh bag ❑ **Orange** mesh bag

51. Have you ever eaten white onions? ❑ Yes ❑ No

52. Do you currently eat white onions? ❑ Yes ❑ No

53. Do you currently purchase white onions? ❑ Yes ❑ No

54. If so, have any been in mesh bags? ❑ Yes ❑ No

If you know, please state the color of mesh bag _____

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