Food Quality and Preference 56 (2017) 173–180

Contents lists available at ScienceDirect

Food Quality and Preference

journal homepage: www.elsevier.com/locate/foodqual

Colored backgrounds affect the attractiveness of fresh produce, but not it's perceived color

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ARTICLE INFO

Article history:
Received 18 June 2016
Received in revised form 20 October 2016
Accepted 21 October 2016
Available online 22 October 2016

Keywords:
Vegetables
Retail design
Color assimilation
Color contrast
Simultaneous contrast

ABSTRACT

The color of the background on which products are presented may affect their perceived attractiveness. We presented five different vegetables (tomato, carrot, yellow bell pepper, cucumber, eggplant) on four different background colors (orange or blue, either light or dark). Although the backgrounds did not affect the direct color perception of the vegetables, they did affect their perceived attractiveness, with quite different backgrounds proving optimal for the various vegetables. These outcomes suggest that it is difficult to find non-neutral background colors on which a large number of vegetables can be presented in an optimal way.

1. Introduction

In order to stimulate the sales of fresh produce in retail stores, it is important that the products are presented in an attractive manner, so that they look appetizing. One important aspect for an attractive presentation concerns the color of the materials on which products are presented. In many retail settings a number of fruits or vegetables are presented on a tray or in a crate, possibly covered with a transparent material. Alternatively, the produce may be packed in a fully transparent packaging that is presented on retail shelves or in common crates. Hence, packaging materials are not only important to protect products during transport and handling, but together with the trays, crates, or shelves on which products are presented, they form the colored backgrounds against which potential buyers and consumers evaluate fresh produce.

Theoretically, the perceived color of objects may be affected by the color of the background on which it is presented. In the literature on fundamental visual perception mechanisms, two well-known effects regarding background and foreground colors are called color assimilation and simultaneous color contrast (e.g., Stockman & Brainard, 2009). In the case of color assimilation the color of an area is perceived to be closer to that of the surround than when viewed in isolation, whereas in the case of color contrast it has shifted in the opposite direction. Hence, the perception of produce presented on a colored background might change, depending on the color of the background on which it is presented.

However, many studies in visual perception research have been performed using two-dimensional and quite abstract stimuli, instead of using realistic 3D objects. The classical papers by Edwin Land (Land, 1959a,b,c; Land & Daw, 1962) already made clear that color percepts of natural, complicated images are dependent on the interplay of elements over the total visual field. Recent studies showed that for real, 3D objects in articulated scenes color constancy under illuminant changes is enhanced relative to 2D setups (Hedrich, Bloj, & Ruppertsberg, 2009). In studies with 3D objects the background had little effect on perceived object colors in contrast to 2D scenes (Allred & Olkkonen, 2013), and the hue could be matched quite accurately for smooth and glossy as well as matte and rough objects (Giesel & Gegenfurtner, 2010).

Nonetheless, visual as well as spectral color measurements of orange juice dilutions have been shown to be influenced by the background on which they are presented (Meléndez-Martínez, Vicario, & Heredia, 2005). In this case, however, the effect of background is likely being caused by an optical mechanism: Because orange juice is fairly translucent, the background shines through the fluid. Hence, this situation is different from when a colored background is put behind an (almost) opaque object.

As concerns aesthetic responses (preference, liking, attractiveness) with 2D stimuli, Schloss and Palmer (2011) have shown that all foreground colors are generally liked when presented on a cool colored background (e.g., blue), while only the cool foreground

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http://dx.doi.org/10.1016/j.foodqual.2016.10.011
0950-3293/

colors are liked when presented on a warm colored background (e.g., orange). If this also holds for 3D objects, the attractiveness of fresh produce in retail stores is likely to depend highly on the colors of the materials on which it is presented.

Nonetheless, it seems as if the colors of the fresh produce displays in most outlets have received only limited attention in everyday retail practice. In many cases fresh produce is presented in plastic crates with relative neutral, uniform colors, such as black or grey, which seem to be the result of practical concerns during transportation, and not of explicit considerations of the way in which retailers can optimize product presentation. Alternatively, fruits and vegetables may be presented on wood-like materials, probably with the intention to evoke associations of naturalness, even though the material may be difficult to clean, accommodate harmful insects, and damage the produce through wood splinters. Hence, it is important to investigate to what extent the consumer perception of produce depends on the colors of background materials, in order to determine whether retail managers should take these effects into account when displaying their products.

Although we investigate color in the present study as a color perception phenomenon, it is important to realize that consumers may attach different types of meanings to colors. For instance, natural variations in product color may be associated with ripeness and sour-sweet ratio (green, yellow, red) and with spoilage (browning) for produce. In this case, the colors are directly instrumental in communicating product properties. Furthermore, for many processed foods the colors of its packaging may be associated with particular product variants or flavors (Ngo, Piqueras-Fiszman, & Spence, 2012; Piqueras-Fiszman, Velasco, & Spence, 2012; Velasco et al., 2014) or with particular product properties (Roullet & Droulers, 2005). In this case, the packaging color itself can facilitate the identification of certain product aspects. Besides, colors may also have a symbolic value and generate particular cognitive associations (Ares & Deliza, 2010) and these associations may differ between cultures (Madden, Hewett, & Roth, 2000). For instance, the color red is a signal for danger in many societies, which may decrease consumption probability (Genschow, Reutner, & Wänke, 2012; Reutner, Genschow, & Wänke, 2015), but in China the color red is likely to have an opposite effect, because there it is associated with good luck and prosperity. Furthermore, colors may also bring their own hedonic evaluations (Madden et al., 2000; Valdez & Mehrabian, 1994; Whitfield & Wiltshire, 1990), even though color preferences highly depend on the context in which they are perceived (e.g., the size and the type of object that carries the color; Holmes & Buchanan, 1984). Although color meaning could have an impact on the perceived attractiveness of colors and objects, we focus here mainly on how product evaluations are affected by the visual perception of background color.

In the current paper we investigate the effects that background colors have on the direct color perception and the evaluation of the attractiveness of fresh vegetables. We evaluate whether principles demonstrated in the visual perception literature can be extrapolated to the presentation of fresh produce and if product attractiveness judgments are affected. Because we would like our study to be relevant for retail practice, we asked a professional designer to select the background colors for the test.

2. Method

2.1. Participants

Forty-four volunteers, 19 females and 25 males, participated in the study. The females varied in age between 18 and 29, with a mean age of 20.7 years. The males varied from 21 to 31, with a mean age of 23.5 years. 93% of respondents were students of Brigham Young University (BYU), 7% were friends or family members associated with the students. The majority of participants (61%) were undergraduate students from the Industrial or Graphic Design Departments, and another significant part (23%) had an engineering/technical background. The remainder (16%) came from a variety of backgrounds. All participants were screened for color blindness using an Ishihara test before participating. The experiment was approved by the BYU Institutional Review Board (IRB) for Human Subjects (study number E15416).

2.2. Stimuli

The study was performed with five different vegetables, each in a different color: tomato (red), carrot (orange), bell pepper (yellow), cucumber (green), and eggplant (blue/purple). These products were chosen, because they were prototypical examples of the vegetables in these color categories, had similar smooth skin textures and had fairly homogeneous colors over their whole surface.

We used an elaborate procedure to identify the colors from the NCS atlas that best describe the actual colors for each of the five vegetables as objectively as possible. These assessments were necessary to select the pages of the color atlas that we provided to the participants in the color matching task. A professional designer (the second author) removed swatches from the NCS color atlas and held them close to the vegetable sample in the experimental setup, so that the lighting was the same as during the experiment. He varied the comparison location over the sample, to take into account any color variation over the sample surface. By stepping back and forth through the swatches of the atlas, the best overall match was determined for each sample. The selection thus made consisted of the following hues: tomato (Y80R), carrot (Y50R), bell pepper (Y10R), cucumber (G40Y), and eggplant (R).

The Natural Colour System (NCS) is a logical, perception-based color notation system. The NCS codes describe a color by its hue, blackness and chromaticness (see Fig. 1 for a photograph of two of its pages). The hue is described by its degree of similarity to the elementary colors yellow, red, blue, and green. Blackness is how dark the hue is and chromaticness is how saturated the hue is. On each NCS atlas page (41 pages in total), the approximately 50 unique color swatches exhibit many variations in blackness and chromaticness, but the hue is constant.

2.3. Backgrounds

In order to select background colors for the present study, we wanted to use blue and orange as backgrounds, based on the experimental finding that all foreground colors are liked when presented on a cool colored background, while only the cool figure colors are liked when presented on a warm colored background (Schloss & Palmer, 2011). Hence, we expect that products with warm colors (red, orange, yellow) are perceived as less attractive when presented on an orange than on a blue background, whereas products with cool colors (green, blue) are perceived as equally attractive when presented on the different backgrounds.

In addition, we make use of the finding that simultaneous contrast can enhance a product's appeal when presented on a background that contrasts with the presented product (Lyman, 1989). Therefore, we will use both light and dark background colors and we expect that products with dark colors are perceived as more attractive when presented on a light background than on a dark background, while the opposite is true for products with light colors.

In order for our finding to be relevant for design practice, we asked a professional designer (the second author) to select blue