WHAT RELATIONSHIP DOES COLOR HAVE WITH DESIRABILITY IN FRUITS AND VEGETABLES?

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Abstract

To study the relationship of color and desirability in fruits and vegetables, we compared participant responses to appetizing colors with memory colors. The investigated fruits and vegetables were five, namely, apples, lemons, carrots, cucumbers and eggplants. The stimuli used were five photographs, in the center of which was a silhouette of the test items on the background surrounded by control fruits and vegetables not used as test items on a monitor. The memory color or appetizing color was put on the silhouettes by choosing the color from quasi-Munsell Color Chart displayed on another monitor. Our results indicated that the appetizing color was slightly higher than the memory color, in terms of the Munsell value and chroma. On the other hand, for Munsell hue, memory and appetizing colors were almost the same. These findings suggest that the colors of fruits and vegetables which looked good were somewhat saturated and lightened memory color on the same hue.

The enjoyment of foods is derived from not only taste and smell but also appearance. One study examined the influence of the appearance of food on consumer buying intention and stated "The first taste is mostly caused from the sight" (Imram, 1999).

We examined what characteristics of the appearance of food contribute to desirability. A feasible segmentation of the external attributes of foods is shape, color, and texture. Color is a primary characteristic in the perception of quality (Francis, 1995). Here, we examined the color attribute of foods. Identifying the relationship between color and appeal would be useful for food industry and contribute to an improved understanding of the neural computation that determines palatability. Previous study has demonstrated that both memory and preference colors were quite accurate for actual food color in hue and brightness but they were more highly saturated (Siple &Springer, 1983).

In this study, we investigate the relationship between memory and appetizing colors. We hypothesized that the both colors would be slightly different but related. This contrasts with models in which memory color is indistinguishable from preference color (Siple & Springer, 1983).

Method

Figure 1 shows the experimental set-up. Two monitors, a cathode ray tube (CRT) monitor (HM204D A, Iiyama) and a liquid crystal display (LCD) monitor (RDT1955, Mitsubishi), were used for stimulus presentation. Both monitors were calibrated to gamma 2.2 and a color temperature of 6,500 degrees with a monitor calibration tool (Spyder2PRO, ColorVision). The experimental software was programmed with Matlab 7.1.0.246 (MathWorks).

In this study, five fruits and vegetables were examined: apples, carrots, lemons, cucumbers, and eggplants. These foods were selected because they are common, almost whole-colored objects that are different in color from one another.

The stimuli were five photographs. In the center of each photo was a silhouette of the test items on a background surrounded by control fruits and vegetables. The photos were presented on the CRT monitor [see Figure 2(a)]. The control fruits and vegetables were an orange, a Japanese radish, an onion, an avocado, a sweet potato, leaf of green lettuce, and bananas. The photographs were taken with a digital camera at 1024x768 pixel resolution (DSC-S75, Sony) under D65 fluorescent lights (FL20S D-EDL-D65, Toshiba).

A color palette system that included a quasi-Munsell Color Chart was displayed on the LCD monitor (see Figure 3). Participants in the study employed this palette first for selecting a color with a mouse pointer from a hue palette. Next, they chose a color from a brightness-saturation palette. These palettes were based on Munsell Color Chart. After choosing a color, the silhouette of the photograph on the CRT display was filled with this color. Over seeing the object filled with the chosen color, participants could either accept this or choose a different one.

The experiment comprised the following three sessions: (a) a memory color session, (b) an appetizing color session, (c) a matching color session. In all three sessions, a practice trial in which the silhouetted item was a potato was performed first. Then the above-mentioned test items were tested randomly three times. In the memory color session, participants were instructed to select the color of the silhouetted item from memory. In the appetizing color session, they were instructed to select the colors that were the most appealing. A matching color session was performed to test the color reproduction ability of the participant. In this session, photographs shown in Figure 2(b) were displayed on the CRT monitor. The silhouette area on the left side was colored with the original color of the test items and the silhouette on the right side was colored black. The original color was averaged from the colors extracted from the glossless area of the item in an original photograph. Participants were instructed to select the same color as the color of the colored silhouette.

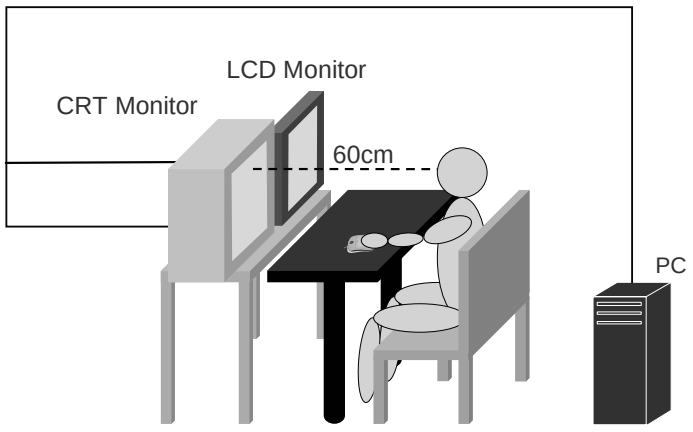
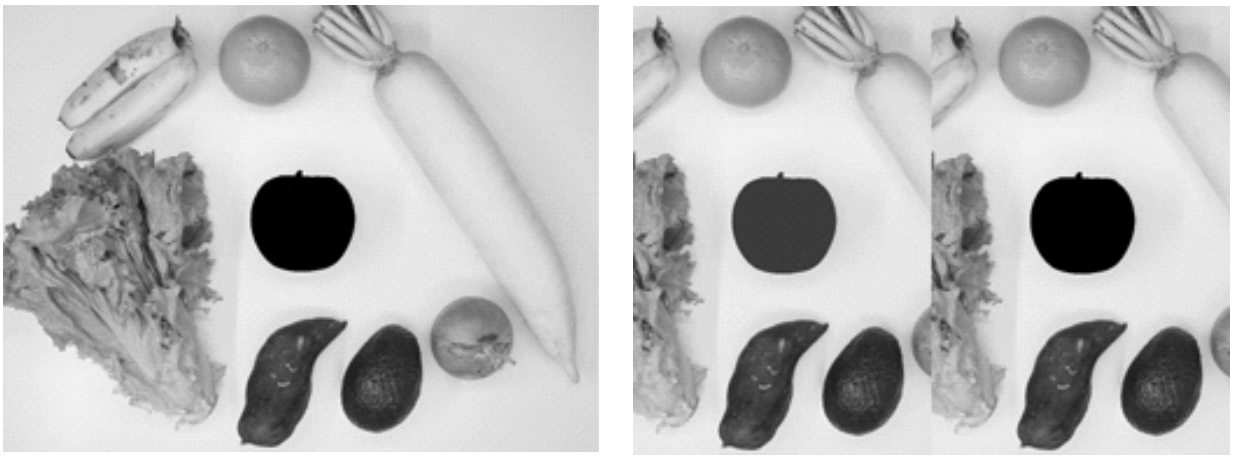


Fig. 1. Experimental design.



(a) (b)

Fig. 2. The photographs used in the experiment. (a) a sample photograph used in memory and appetizing color sessions, (b) a sample photograph used in a matching session.

Fig. 3. A sample image of the color palette system.

The colors chosen by participants were measured with the visual colorimeter function of Spyder2PRO and subsequently converted into a hue, value and chroma in the Munsell color system.

Participants were divided into two groups of seven. One group started with a memory color session and then an appetizing color session. The other group did sessions in the converse order. In both cases the matching session was last.

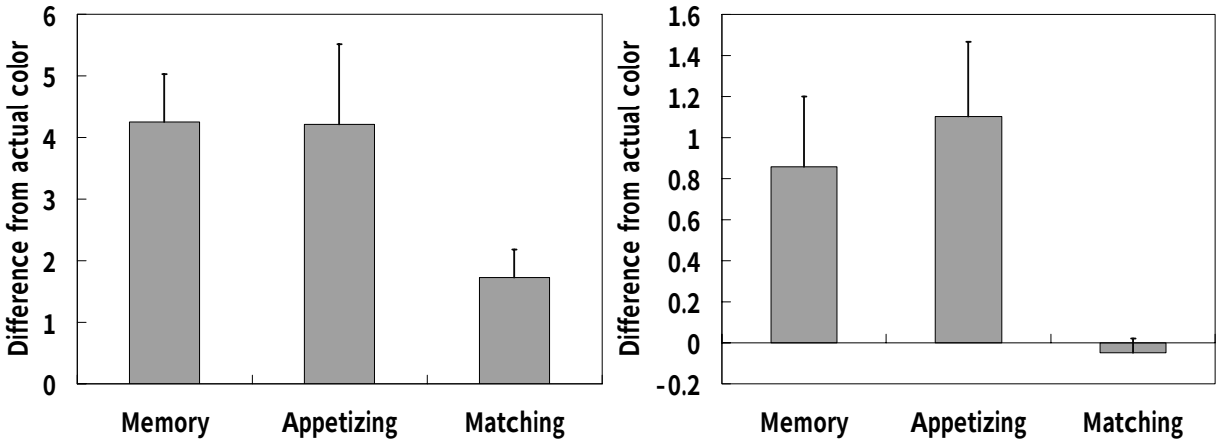
Results and Discussion

Figure 4 presents the results of the study. The ordinate represents the difference between the color chosen by the participants and the actual color displayed during the matching session. Identifying the precise color of fruits and vegetables is very difficult because they encompass a broad range of colors. Accordingly, the actual color which is the zero point of this graph is one of the typical colors of the test items.

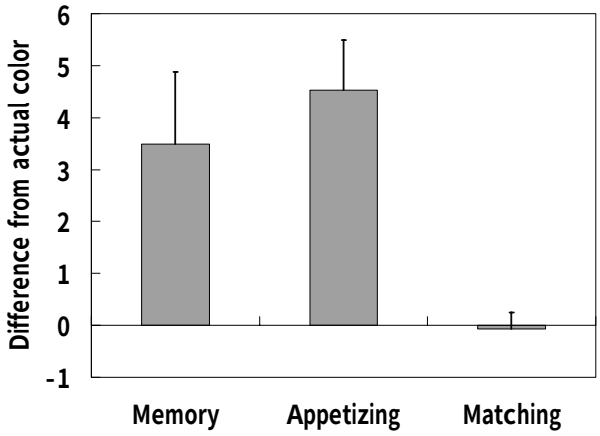
Hue

Hue is arranged circularly in the cylindrical Munsell color system.To determine the absolute hue difference between the colors chosen by the participants and the actual color for each item we first checked the directionality of the difference in color for each test item. All participants chose the colors in the same direction from actual color.

We compared the differences between the memory colors and the appetizing colors. The average hue differences are presented in Figure 4(a). The ordinate represents the absolute hue value of the difference from the actual color. A 5 (test items) x 2 (memory color session vs. appetizing color session) ANOVA revealed a significant interaction [$F(4,52)=2.834$, $p<0.05$]. Simple main effects tests also revealed that there were significant differences between sessions in carrots and cucumbers. For carrots, the appetizing color contained more red than the memory color (1.24 steps). Participants were adept at color matching as the average difference between the matched color and the actual color was only 0.08 steps. However, diffference between the memory color and appetizing color for cucumbers may be a consequence of internal variability because while the appetizing color contained more green than the memory color (1.47 steps), the matching accuracy was worse (3.44 steps).



(a) Mean hue difference. (b) Mean value difference.



(c) Mean chroma difference.

Fig. 4. Mean differences from actual color.

Value

Average differences in Munsell value are presented in Figure 4(b). The results of an ANOVA reveal that the main effects were significant [items, $F(4,52)=24.227$, $p<0.001$; sessions, $F(1,13)=6.196$, $p<0.05$]. Appetizing color was somewhat brighter than memory color (0.24 steps). There was no interaction between these variables [$F(4,52)=1.662$, *n.s.*]. Matching accuracy was good (0.05 steps).

Chroma

Average differences in Munsell chroma are presented in Figure 4c. An ANOVA revealed that the main effects were significant [items, $F(4,52)=27.220$, $p<0.001$; sessions, $F(1,13)=9.095$,$p<0.01$]. Chroma for the appetizing color was higher than the chroma for memory color (1.04 steps). There was no significant interaction between these variables [$F(4,52)=1.810$, *n.s.*]. Matching accuracy was good (0.07 steps).

General Discussion

In this study, the appetizing color was slightly different from the memory color. Although hue was not different overall, the appetizing color was generally a little brighter and more saturated. Figure 5 presents the difference for each items in the value and the chroma planes.

Siple and Springer did not observe any significant difference between memory color and preference color. There are some differences between their study and ours. First, the descriptors “preference” and “appetizing” may be a source of discrepancy. “Appetizing” is a more direct, sensuous, and gustatory word than “preference”. Differences in the coloring methods may also contribute to differences in these findings. Their participants made colors with an instrument that generates colors by assigning separately each of the RGB components. We attempted to repeat this technique with similar software in a pilot study but our participants reported that it was very difficult to obtain color matches. Therefore, we adopted the color palette system. Last, the individual preferences of our participants may contribute to the discrepancy between our results and those of Siple and Springer as color preference differs with age, sex, and locality of residence (Fortomaris *et al.* , 2006).

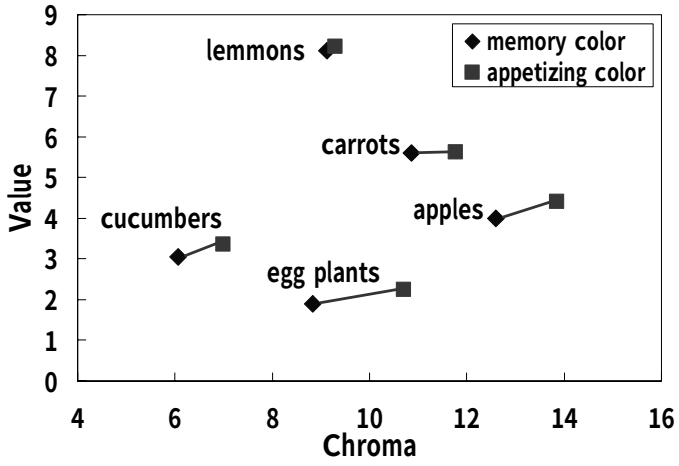


Fig. 5. The difference between memory color and appetizing color for each item in the value and the chroma planes.

There is no guarantee that the appetizing colors chosen by participants are actually appealing to them. To confirm this, another type of experiment in which participants choose memory or appetizing colors from many photographs of food that are presented diverse colors will be required.

Light colors were remembered as being lighter and dark colors were remembered correctly or darker (Pérez–Carpinell, Baldoví, Dolores de Fez, & Castro, 1998). Based on this idea, we hypothesized that the appetizing color would be the emphasized color in the direction of the change from the real color to memory color. We are now positioned to test this subsequent hypothesis.

One could interpret these results to mean that appetizing colors were somewhat saturated and lightened memory colors of the same hue. However, the numerical differences of Munsell value were small but reached significance. Additional experiment will be necessary to confirm this finding. In addition, similar studies will be required to test foods not examined here.

Acknowledgements

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References

Fortomaris, P., Arsenos, G., Georgiadis, M., Banos, B., Stamataris, C., & Zygoyiannis, D. (2006). Effect of meat appearance on consumer preferences for pork chops in Greece and Cyprus. *Meat Science, 72,* pp. 688-696.

Francis, F. J. (1995). Quality as influenced by color. *Food Quality and Preference, 6,* pp. 149-155.

Imram, N. (1999). The role of visual cues in consumer perception and acceptance of a food product. *Nutrition and Food Science, 99, 5,* pp. 224-228.

Pérez–Carpinell, J., Baldoví, R., Dolores de Fez, M., & Castro, J. (1998). Color memory matching: Time effect and other factors. *Color Research & Application, 23, 4,* pp. 234-247.

Siple, P., & Springer, R.M. (1983). Memory and preference for the colors of objects. *Perception & Psychophysics, 34, 4,* pp. 363-370.