How Color-Harmony on a Food Plate Affects Consumers' Perceptions?

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Abstract

The aim of the present research was to explore consumers' color-harmony preferences on a food plate in relation to four different criteria; aesthetics, taste, healthiness, and satiety. With respect to this aim, four different food plates were designed based on four color-harmony types used in fine arts – analogous, complementary, triadic and quadratic. The sample of the study consisted of 1.162 participants from Turkey who responded to an online survey including pairs of color-combinations and reported their preferences in terms of the selected criteria. The results were analyzed using Cochran's Q Test and Scheffe Test. The results clearly demonstrated that people respond differently to meals comprising of different color-combinations. One major finding was that people seemed to find quadratic food-color harmony as the least tasty and healthy food even though they found it aesthetics. In correspondence to the results of several other studies, the present study found that attractiveness of food plates could be increased through the use of more colors to a certain level. Food plates with quadratic color-harmony were detected to be the least tasty and healthy and less filling by Turkish consumers.

Keywords: Food-color preference, Visual aesthetics, Food-color harmony, Food plating.

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1. Introduction

People make judgments and decisions every day. They make decisions about wearing blue or green dress, buying this or that car or facing this or that direction in a park for varying reasons. Most of the time these judgments and decisions are based on their internal aesthetic responses to varying aspects of the world surrounding them (Palmer et al., 2013). Food is one essential part of the daily world around us and with no doubt everyday aesthetics is tightly associated with food (Paakki et al., 2019). People's aesthetic considerations about food preference are quite mundane, ubiquitous and therefore are worth of scientific interest and importance (Palmer et al., 2013). People's aesthetic responses to food has much impact on their daily lives but surprisingly very little is known about them. While the study of aesthetic preference is actually one of the oldest topics among psychologists and sensory scientists, interest in food-preference has started to gain importance over the last few years or so. Generally visual aesthetics of food has been studied in terms of different plating arrangements. The research on visual composition of food that has been published to date mainly focuses on design elements such as visual balance of food plate (Banich et al., 1989; Gordon & Gardner, 1974; Locher, 1996; McManus et al., 1993; Spence et al., 2019; Velasco et al. 2016); visual orientation (Spence et al., 2019; Youssef et al., 2015), neatness (Zellner et al., 2011), and food color (Lee et al., 2013; Spence et al., 2010)

Color preference is also an important aspect of visual experience that influences a wide range of human behaviors: buying cars, choosing clothes, decorating homes, designing webpages, etc. (Palmer & Schloss, 2010). Decades of research on color-preference of humans have described it as a 'bewildering, confused and contradictory' process (Lee et al, 2013). According to a couple of researches (Hurlbert & Ling, 2007; Palmer & Schloss, 2010; Schloss et al., 2011) color preference of people is closely connected to color-associated objects meaning that

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people like or dislike colors associated with objects they like or dislike. For example, blues and cyans may be universally liked because clear sky and clean water are universally appealing, and browns and olives may be universally disliked because feces and rotting food are universally disgusting (Palmer & Schloss, 2010). Color preference of people also varies according to educational, empirical, cultural effects (Schloss et al., 2013) and demographics (Hurlbert & Ling, 2007).

Food Color Preferences

An ancient quote attributed to Apicus (first century), states that "the first taste is always with the eyes." (van der Laan et al., 2011). As the old saying states, food color is an important visual cue that affects our ability to identify a food (Zellner et al., 2014). People use food color as a visual stimulus before tasting it. Additionally they predict its taste before making a decision whether or not to purchase or eat it (Lee et al., 2013). For the first humans on earth food-color was a matter of survival (Palmer & Schloss, 2010). For example, as being one of the rarest colors in nature, blue food was and is still associated with unnaturalness and artificiality. Therefore, food-color is sometimes the most decisive element as an indicator for food selection and evaluation (Abdullah et al., 2004; Afshari-Jouybari & Farahnaky, 2011; Fernández et al., 2005; Lee et al., 2013). Color also affects the identification and acceptability of foods, anticipated safety, sensory quality, and preference (Cardello, 1996; Clydesdale, 1993; Fernández-Vázquez et al., 2011). Appearance of food conveys a lot of information about it. It is a useful tool for people to identify what they are about to eat. It is a visual clue for goodness/ badness, freshness (Clydesdale et al., 1992; Wada et al., 2010; Zellner & Durlach, 2002, Zellner & Durlach, 2003), healthiness (König & Renner, 2018), likeness / dislikeness (Zellner et al., 2004; Zellner et al., 2014).

Food is one essential part of our everyday life, and consequently the aesthetics related to a food plate is tightly associated with our food-color preferences (Paakki et al., 2019). In line with our general aesthetic appreciation of the visual arts, the visual presentation of food involves similar components such as arrangement, centralization, orientation, and color. Over the last decade, a number of sensory scientists, psychologists and food industry professionals have started to take an interest in systematically assessing the visual aesthetics of food plating in line with the general principles of science, art and design (Velasco et al., 2016; Youssef et al., 2015). The rapid growth of interest concerning how a dish is plated in terms of art and design has been occurred in various areas. While investigating the problem of aesthetic food plating, researches focused on the balance of food (Velasco et al., 2016), linearity (Spence et al., 2019; Youssef et al., 2015), and neatness (Zellner et al., 2011, Zellner et al., 2014).

In terms of assessing the food color as a key component of plate design, there is an intriguing body of research conducted in various settings (restaurants, cafés, science laboratories or online). In this respect, the mapping of color onto taste was analyzed in terms of different dimensions, such as their hue, saturation and brightness (see Spence et al., 2010, for review) and foreground-background color combinations (Spence, 2018; Woods et al., 2016). The majority of the food color research has studied how each food color influenced taste and flavor perception of people (Lee et al., 2013; Saluja and Stevenson, 2018; Spence et al., 2010; Spence et al., 2015). Studies mostly investigated the responses of subjects to single or paired colored samples (Woods & Spence, 2016). However, food on a plate rarely involves one single color in everyday life. Most of the time, more than one color appear on a plate. Besides, colorful food such as vegetables and fruits are more appreciated (Paakki et al., 2019). While the above mentioned studies provide evidence that food color is one of the most important attributes of an aesthetic food plate, they utterly neglect the range of variegations on a food plate.

Given the facts that color harmony is a neglected area of research and no research on the subject in food literature has been detected to date, this study investigated food plates including various color-harmonies rather than one single food color. When there are two or more colors in a design area – in this case food plate- the question of producing a pleasant effect occurs. It is of great importance to create harmonious color combinations to give rise to the pleasing effect. Up to date, the rules of color-harmony have occupied the thoughts of great artists and scientists (Westland et al., 2007). It is well known, for example, that many painters like Van Gogh, Monet, Signac, Kandinsky studied the notion of color harmony and balance, as well as the movie director Wes Anderson's precise coloration and distinct color scheme. Colors have been of great importance even thousands of years ago that, for example, Egyptian monuments were vividly colored and ancient Greek and Roman sculptures were originally painted with distinct codes of coloration.

Despite many artists, researchers and scientists who have extensively studied color combinations in various

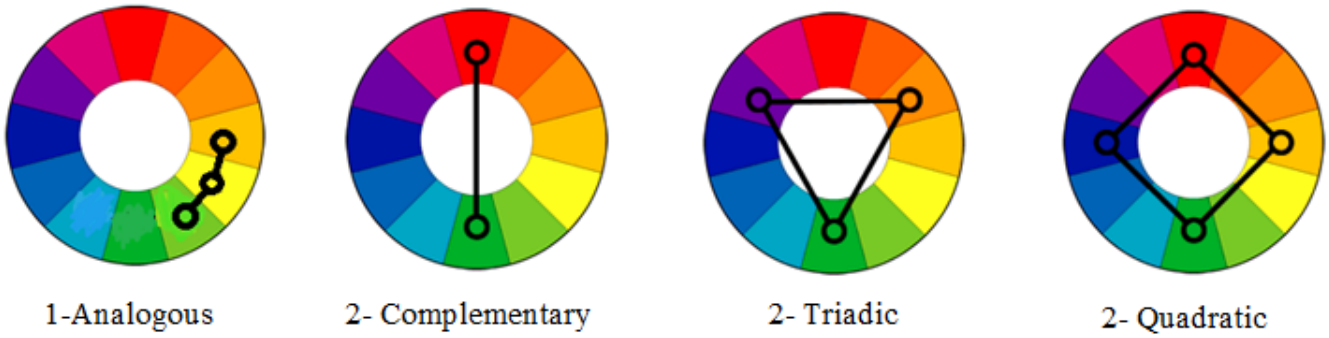

Figure 1. Four basic color harmonies chosen for this study that are applicable to food colors

research areas, surprisingly there has been no attempt by food researchers and professionals to systematically investigate the fundamentals of color harmony while creating aesthetic and pleasant food plate presentations. Worse than that, the association of color with taste has been traditionally based on the intuitions of the creative or designer involved (Spence et al., 2015). In the case of food plating the creators are commonly the chefs and their intuitions are generally directed by a series of 'rules of thumb' (Velasco et al., 2016). One such rule for Turkish chefs, for example, is that sprinkling finely chopped green parsley over almost every varicolored food plate to maintain color harmony. Given the situation about creating harmonious food presentations through various colors, the absence of relevant research on the topic encouraged researchers to apply a systematic approach to the problem. The present research aimed to project insight to the issue of presenting visually appealing plates and to articulate laws of color harmony in arts into food plating. It tested whether the fundamental laws of color harmony in arts and science could be applied to gastronomy industry in terms of food plating. In respect with this aim, four basic techniques for combining colors that could be maintained with edible food varieties were chosen (Figure 1);

1. Analogous color harmony where colors are next to each other on the color wheel (e.g. orange-yellow-green)
2. Complementary color harmony where colors are opposite to each other on the color wheel (e.g. red-green)
3. Triadic color harmony where there are evenly spaced three colors around the color wheel (e.g. green-purple-orange)
4. Quadratic color harmony where there are four colors spaced evenly around the color wheel combining a square (e.g. yellow-red-green-blue)

Since food colors not only convey information about the taste but also help us identify how healthy and filling they are, this study expands its research area and investigates which color combinations are viewed as aesthetics, tasty, healthy and filling.

We hereby report the results of an online questionnaire focused on color harmony aspect of food plating. We tested people's preference for food aesthetics, appetizing, healthy and filling food that varied in terms of the different color combinations of the edible elements on the plate.

2. Method

2.1. Design and Procedure

As the main investigation subject of this study is very thin on pre-existing research, the closest literature was assessed to construct a measurement tool. The questionnaire has been built based on the existing literature on food plating in aesthetic terms (Zellner et al., 2014) and some quantitative research performed for similar design elements like color (Lee et al, 2013; Paakki et al., 2019; Saluja and Stevensen, 2018; Spence et al., 2010; Spence et al., 2015), balanced presentation (Velasco et al., 2016; Zellner et al., 2011), oblique effect (Spence et al., 2019; Youssef et al., 2015), and background color (Spence, 2018). Initially four dishes matching with four color harmonies were cooked and replaced on a white plate in order to eliminate background color effect. (1) Analogous food plate included carrot, potatoes and cabbage, the colors of which were orange, yellow and green respectively. (2) The plate belonging to complementary color harmony included red tomatoes and green pursley. (3) Triadic

Figure 2. Examples of crystallized images

color harmony was maintained by green mint leaves, purple octopus and orange carrots. (4) Quadratic color harmony comprised of red tomatoes, green leaves, yellow carrots and blue edible flowers.

The next step was taking the pictures of the dishes in the same environment so as to eliminate the brightness effect. Then the photos were crystallized through an image-processor. The idea was to make the food items unidentifiable so that the viewers could not make biased decisions based on their feelings about the food. In other words, the researchers did not want participants to guess the food and become biased. By this way the participants could not second-guess what the researchers were after and they would purely react to the main problem of food-color harmony. Crystallization also enabled researchers to eliminate other factors hue, saturation and brightness aspects of colors. Additionally, the possible effects of other design elements on a food plate like alignment, centralization, linearity, usage of space, shading, etc. on participants' decision process could be taken out through crystallization.

The questionnaire was developed and distributed in Turkish language. All respondents answered all the questions and the order of questions were fixed for all participants. Duration of the questionnaire was on average 2 minutes.

2.2. The Survey

The structured online survey consisted of two parts. In the first part, the participants (n=1162) were asked to answer some demographic questions about their age, gender, and occupation. The main purpose of gathering demographic info was to avoid unbalanced clustering of participants of the same group rather than investigating demographic variables' effects.

In the second part of the questionnaire, the crystallized image pairs are shown to participants side-by-side. Two crystallized images appeared on the screen at each click. The participants were asked to choose one of the two alternatives in response to four different questions; 'Which plate of food is more aesthetic?', 'Which plate of food is more tasty?', 'Which plate of food is more healthy?', and 'Which plate of food is more filling?'. The order of appearance of the image-pairs and the different questions were randomized. Examples of the two-crystallized images next to each other are given in Figure 2. For each question, six pairings of color combination were asked to participants. In total 24 pairings were asked to participants. Respondents were asked to choose one of the two pictures on the following variables: aesthetics, appetizing, healthiness, and satiety.

2.3. Sampling and Data Collection

Data were collected using a web-based questionnaire from 13 March, 2020 through June 6, 2020. Before being distributed to the main sample, the questionnaire was pilot tested and finalized after minor revisions. A convenience sampling process took place and researchers used internet to recruit respondents by mass e-mailing and sending out the survey link to several communities and groups that had many members. Since the questionnaire was designed in a simple structure, the method of self-completion was chosen.

2.4. Participants

The dataset reported in this study consists of the opinions of 1.162 Turkish participants. All the participants who took part in the online questionnaire were informed about the aim and nature of the study through a cover page at the beginning.

2.5. Data Analysis

Statistical analyses were performed using SPSS 21.0. Initially, descriptive analysis was conducted in order to sketch the socio-demographic profile of the

respondents. Cochran's Q Test, an extension of the McNemar test, was used in order to assess differences in matched sets of four dimensions. Cochran Q test enabled researchers to test the differences on dichotomous independent variables that were paired color harmony combinations, between four groups; aesthetics, taste, healthiness and satiety. The results of Cochran's Q test revealed significant differences for all four dependent variables, in order to find out which color-harmony types were significantly different from each other a post-hoc test Scheffe was used.

3. Results

3.1. Sample characteristics

The sample is a good representative of Turkish population and it reflects main socio-demographic characteristics. The sample of 1.162 participants had a fair distribution of gender (females; n=723, 62.2% and males; n=439, 37.8%) with a prevalence of females. However, the relatively high numbers of females were within tolerance intervals and did not seem to influence the results. The participants were almost age-balanced, with a small preponderance of 21-30 age segment (33.9%, n=395). Regarding occupation, more than half of the respondents were full-time employees (51.9%, n=603), and a considerable amount 29.2% (n=339) of them were students.

3.2. Preferences for Color Harmonies

Furthermore, in order to asses which color-harmony was more appreciated in terms of aesthetics, taste, healthiness and satiety variables, respondents were asked to choose one of the two color-harmonies. This part presents the results aof the Cochran Q and multi comparison Scheffe Test conducted based on these variables.

Based on the results of Cochran Q test, a statistically significant difference between the color-harmony types for each of the dependent variables (Aesthetics; p=.001, p<.001; Taste; p=.000, p<.001; Healthiness; p=.003, p<.01; Satiey; p=.000, p<.001) were detected. At this point it is very important to note that as Table 1 includes the measures of occurrences rather number of respondents, f values are approximately three times higher than number of individuals. In other words, since the respondents were asked to compare each color harmony variation with the other three harmonies, the results appeared to be higher than actual number of respondents. A post hoc test, Scheffe was carried for additional exploration of the differences among multiple groups in order to find out which color-harmony types were significantly different from each other. The results indicated that triadic and quadratic color harmonies (Group 3,4) were both considered more aesthetics than analogous and complementary color harmonies (Group 1,2). More specifically, a food plate designed with three or four colored food items is found more aesthetic and appealing than single or two colors dominated food plates.

According to the post hoc test results regarding 'taste' dimension, it can be stated that quadratic color harmony (Group 4) was significantly the least tasty type (f=1.230), while analogous, complementary, and triadic color harmonies (Group 1,2,3) were found to be more delicious.

Concerning the participants' responses based on 'healthiness' dependent variable, food plates with quadratic color harmony (Group 4) were detected as the least preferred (f=1.149). Food plates with analogous, complementary, and triadic color

Table 1. Results of Cochran Q and Scheffe tests

Dependent Variables	*Independent Variables*	*f*	*%*	*Chi-squared*	*p*	*Multiple Comparisons*
Aesthetics	Analogous	1.303	18.69	1,930,805	.000***	1,2 – 3,4
	Complementary	1.096	15.72			
	Triadic	2.789	40.00			
	Quadratic	1.784	25.59			
Taste	Analogous	1.818	26.08	249,347	.000***	1,2,3 - 4
	Complementary	1.759	25.23			
	Triadic	2.165	31.05			
	Quadratic	1.230	17.64			
Healthiness	Analogous	1.987	28.50	489,401	.003**	1,2,3 - 4
	Complementary	1.927	27.64			
	Triadic	1.909	27.38			
	Quadratic	1.149	16.48			
Satiety	Analogous	2.774	39.79	2,616,752	.000***	1,2 – 3,4
	Complementary	2.216	31.78			
	Triadic	1.046	15.00			
	Quadratic	936	13.43			

harmonies (Group 1,2,3) were considered healthier than quadratic color combination.

In terms of 'satiey' variable, results appeared to be same with findings of aesthetics variable. In this regard analogous and complementary color harmonies (Group 1,2) were both considered more filling (f=2.774 and f=2.216 respectively) than triadic and quadratic color harmonies (Group 3,4).

4. Discussion

This study provides insights into the preferences of Turkish individuals for color harmonies in terms of different attributes– aesthetics, taste, healthiness, filling- of food plates. In this perspective, participants' ideas about food color harmony types were investigated. Given the evidences regarding color-harmonies' influence on pleasure related features, taste, healthiness and satiation, the results pertaining to each of these are interpreted separately in this section.

4.1. Aesthetics in food color

The term 'aesthetics' was not explained or defined to the respondents of this study; therefore, the respondents used their own personal interpretation of the term. In accordance with the Turkish vocabulary, in which the word 'aesthetics' refers to beauty, pleasantness, and likeness (Turkish Dictionary, n.d.), 'an aesthetic food plate' is regarded as something beautiful, pleasant and linked to sensory experiences. The present study revealed that the basic requirements of aesthetics in food plate were the existence of triadic and quadratic color harmonies. Food plates including analogous color harmony in which there are three neighboring colored edibles and food plates with complementary color harmony in which there are two contrasting colors are found to be less pleasant and beautiful compared to triadic and quadratic color combinations. Most of the respondents considered colorful food plates as pleasant and beautiful. This result is in line with Paakki et al., (2019)'s study findings showing that people prefer colorful food, and colorful food was considered attractive and pleasant. In contrast, colorless food that consisted of three neighboring colors or two contrasting colors were not considered equally aesthetics in line with the existing literature.

An interesting finding of this study reveals that complementary color contrasts such as red tomatoes and green salads, were not always the most aesthetic and beautiful alternative, contrary to traditional belief and existing literature (Paakki et al., 2019). When people were provided with more colors on the plate, they seemed to have a clear preference for triadic and quadratic color harmonies with three or more contrasting colors over two contrasting colors. Therefore, it can be stated that the more colors and contrasts exists, the more beautiful and pleasant the food plates become.

4.2. Tasty and healthy food colors

Statistical analyses performed for 'taste' and 'healthiness' variables suggested that analogous and complimentary color harmonies were more appreciated in visual representation of foods. In this study analogous color harmony was maintained through yellow, green and orange dominant foods. This is a result worth to be discussed in line with the findings of an earlier and a relatively closer research to this study. In their studies aimed to assess the association between color pairings and basic tastes, Woods and Spence (2016), detected yellow-green color pairing having the highest percentage of sour taste association, However, Turkish respondents appreciated it as tasty and delicious. This finding lends to raise a new research question about a possible relationship between sour tastes and deliciousness of Turkish consumers. More research is thus needed in order to detect alternative explanations for this possible association.

The results indicate that quadratic color harmony exerts a significant negative influence over 'taste' and 'healthiness' criteria. More specifically speaking, respondents of this study did not prefer food plates with colorful appearance as 'tasty' and 'healthy'. This outcome was quite interesting even though it was regarded as one of the aesthetic food plate presentations. The possible reasons to this are discussed under a separate 'quadratic color harmony' heading below.

4.3. Filling food

The major conclusion that derives from 'satiety' variable is the respondents' appreciation of ordinary food color harmonies. Food plates that comprises of neighboring or contrasting color harmonies were perceived more satisfactory in terms of making oneself full. Analogous and complimentary food color combinations belong to everyday aesthetics as they are typically colored, ordinary, and unsurprising. These attributes are considered important at an ordinary meal where the main concern is to get full. In addition, those color combinations can easily be maintained with everyday food. In the case of Turkish cuisine, most of the everyday dishes' appearances fall into these color-

Figure 3. Examples of crystallized images

combination categories. An example of a traditional traditional Turkish lunch buffet that offers basic and ready to serve Turkish food to its consumers is given in Figure 3. As seen most of the dishes belong mainly to analogous and complimentary color-harmonies and do not have much color variability and diversity. The dominant colors are mainly red, green and yellow.

4.4. Quadratic food color harmony: Neither tasty nor healthy.

A further interesting finding in this study is that quadratic color harmony in which there are four different colors –yellow, red, green, and blue– on the plate is considered as the least tasty and healthy meal compared to food plates with three or less color pairings. This might derive from three possible reasons: First, is the existence of blue on the plate that included quadratic color harmonious food. Although blue is a primary color like yellow or red, it is the rarest food color and sometimes it seems unnatural. In their natural state not many food has blue color, therefore blue raises the suspicions of artificial and synthetic coloring. For the majority of consumers, naturalness in food products is important and natural foods are supposed to be free from artificial colorings (Román et al., 2017). Blue is considered as an appetite suppressant thus many diet plans suggest the use of blue color in the dining environment like blue plates, blue tablecloths, blue lightning, etc. At this point it is important to note that peoples' associations with blue color are undoubtedly changing. An interesting example given in a study conducted by Spence et al. (2015) stated that although blue color was an absolute no-no in the market place and would never succeed during 70's and 80's, nowadays, by contrast, blue drinks were reasonably common in the drink aisles. Interestingly in this study, despite this changing trend, results with Turkish participants did not change in the same way. Turkish people might not be still ready to accept this changing trend.

Second reason might be because of the relationship between colors and tastes that had been found in many studies (Koch & Koch, 2003; O'Mahony, 1983; Spence et al., 2015, Tomasik-Krótki & Strojny, 2008; Wan et al., 2014). It is evident in the literature that people assign colors to tastes. For example red color was found to be associated with sweet, and green color with both bitter and sour. Associations were also documented between yellow and sour, as well as between blue and salty. In this study quadratic color harmony comprised of food in four different colors that were yellow, red, green and blue. This might result with four different assigned tastes on the same plate which might confuse participants' minds especially those who do not seek for variety.

Third reason might be related to increased surprisingness attribute on the food plate. In the case of Turkish food when more colors are added, the food becomes away from being ordinary, typical and difficult

to identify. Therefore the food might be perceived risky and unhealthy. This is a result that appeared to be different from a couple of previous studies (Wadhera & Capaldi-Philips, 2014; Paakki et al, 2019) suggesting the idea that color variety and colorfulness in food would add to the variety and diversity of people's diet, thus people could be enticed to eat more healthily. Average color variety in food would increase the consumption of varicolored vegetables (König & Renner, 2018) and having more vegetables in one's diet was associated with a healthier diet. Therefore, it may be concluded that people would prefer more colorful plates to a certain extend when they make a decision about their taste and healthiness. If that level is exceeded -in this case four quadrant colors are served- they would not favor the food as tasty and healthy no matter how visually appealing it is.

5. Conclusions

This study aimed at characterizing people's aesthetic responses to color pairs in terms of which color combinations were preferred to be more aesthetics, tasty, healthy and filling. The results revealed that people have differing preferences for different food plates that were designed with various color combinations. This is the first published empirical evidence that color-combination on a food plate affects people's attitudes towards its pleasure-related features, taste, healthiness, and satiety attributes. In correspondence to the findings of several other studies (Paakki et al., 2019; Wadhera & Capaldi-Philips, 2014), this study found that attractiveness of food plates could be increased through the use of more colors. However, this paper detected a limit to this colorfulness. Too much color like in quadratic color-harmony are found to be less appealing to consumers in terms of taste and healthiness. Especially food plates having quadrant colors were considered as the least preferred food when the aim was to get full.

Both theoretical and practical implications emerged from this paper. At the theoretical level, this paper adds to the literature a totally new research area that combines gastronomy, art and science. Since existing literature has been detected on preference for food color harmonies, this study is in a position to become the point of reference for future studies on the same subject. In terms of practical implications, this paper informs Turkish food professionals mainly chefs, food and beverage managers, researchers, writers on how color combinations are viewed by consumers. Given the impact of various color harmonies on the perception of aesthetics, taste, healthiness and satiety, these results should be of great interest to those working in a number of sectors. For instance, chefs, dietitians, restaurateurs, caterers, the tremendously increasing number of food bloggers and social media influencers should all be able to use such insights in order to optimize the appearance of their food images and products on their food plates, web sites, social media accounts, packages, etc. In addition, results suggesting that food color combinations on a plate affects consumers' perception of taste, healthiness, and satiation attributes of a meal, should be of interest to those wanting to loose or gain weight. For instance, an obese patient who needs to eat less but wants to feel full at the same time, should avoid many colors (in this case quadratic color harmony) on plate and prefer plates that has two or three neighboring or contrasting colored food items on it. Meanwhile, gaining a better understanding of the importance of color-combinations on food plate should be relevant to chefs in order to question their own food plating approaches that might neglect the perceptions of consumers. For example, the result stating that more colors on a plate increases the perception of visual aesthetics but decreases the message of being tasty and filling should be of their great interest while designing and decorating their dishes and menus.

6. Limitations

It is of great importance to note that small lightness and saturation differences between colors of the food cooked may have reduced the harmony of the pairings. Due to various factors such as nature of the food, cooking temperatures and techniques, and technology used in this study, minor deviations in colors might have arisen. An adjustment can perhaps be made for this unavoidable condition through more precise measurement tools like using images designed in laboratory settings and stabilizing hue, brightness and saturation values.

Although there is a strong relationship between color harmony and color preference, they are different concepts (Ou et al., 2004). Theoretically, people's responses to color combinations might be of question whether they are the sum of responses to each individual color on the plate or a response to one of the colors, particularly to the strongest single color in the harmony (see Woods & Spence, 2016; Woods et al, 2016 for details). Another possibility here is that might be actually some memory prompted by a single color or a color-combination due to psychological and symbolic meanings of colors (Spence et al., 2015).

It is also important to keep in mind that there are no universal laws of color harmony and ideas about color harmony shift over time and between cultures and are application-specific as Westland et al. (2007) states. The findings of this study are relevant to a specific group of people and time. Therefore, the results are subject to change. The hope here is that the method outlined here could be used in the future to address the preferences of different samples belonging to different populations.

7. Recommendations for future studies

As being the first study to study color combinations' preference on food plate, this study is a totally new subject for future trials in varying societies, economies or environments. The discoveries of this study are relevant and useful for mainly Turkish gastronomy professionals. It should be noted that these findings have to be dealt with caution and the generalization of conclusions should be avoided, as it is quite evident in the existing literature that perceptions of beauty and harmony are strongly influenced by nurture and culture (Kuehni, 2005; Westland et al., 2007).

This study has chosen to collect its data through an online questionnaire due to limitation costs of the researchers. Additionally data collection was done during Covid-19 pandemics in Turkey. This was a period when the restaurants were either closed or limited their number visitors in order to maintain social distancing. Further studies that have higher budgets can investigate the subject in a physical setting (for instance, in a restaurant) through serving real food samples instead of showing food plate images to participants.

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The author declares that there is no conflict of interest.

Author Contributions

D. Akdeniz (0000-0001-8572-5438): Conceptualization, Investigation, Methodology, Visualization, Writing-Original Draft Preparation, Editing, Resources.
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References

Abdullah, M.Z., Guan, L.C., Lim, K.C., & Karim, A.A. (2004). The applications of computer vision system and tomographic radar imaging for assessing physical properties of food. Journal of Food Engineering, 61(1), 125–135.

Afshari-Jouybari, H., & Farahnaky, A. (2011). Evaluation of Photoshop software potential for food colorimetry. Journal of Food Engineering, 106 (2), 170–175.

Banich, M., Heller, W., & Levy, J. (1989). Aesthetic preference and picture asymmetries. Cortex, 25, 187–195.

Cardello, A.V. (1996). The role of the human senses in food acceptance. In: Meiselman, H.L., McFie, H.J.H. (Eds.), Food Choice, Acceptance and Consumption. London: Blackie A&P, an imprint of Chapman & Hall, 1–82.

Clydesdale, F. M., Gover, R., Philipsen, D. H., & Fugardi, C. (1992). The effect of color on thirst quenching, sweetness, acceptability and flavor intensity in fruit punch flavored beverages. Journal of Food Quality, 15, 19–38.

Clydesdale, F.M. (1993). Color as a factor in food choice. Critical Reviews in Food Science and Nutrition, 33, 83–101.

Fernández, L., Castillero, C., & Aguilera, J.M. (2005). An application of image analysis to dehydration of apple discs. Journal of Food Engineering, 67 (1–2), 185–193.

Fernández-Vázquez, R., Stinco, C.M., Meléndez-Martínez, A.J., Heredia, F.J., & Vicario, I.M. (2011). Visual and instrumental evaluation of orange juice color: a consumers' preference study. Journal of Sensory Studies, 26, 436–444.

Gordon, I.E., & Gardner, C. (1974). Responses to altered pictures. British Journal of Psychology, 65, 243–251.

Holmes, C.B., & Buchanan, J.A. (1984). Color preference as a function of the object described. Bull Psychon Soc, 22, 423–425.

Hurlbert, A.C., & Ling, Y. (2007). Biological components of sex differences in color preference. Current Biology, 17 (16), 623–625.

Koch, C., & Koch, E.C. (2003). Preconceptions of taste based on color. The Journal of Psychology, 137, 233–242.

König, L.M., & Renner, B. (2018). Colourful = healthy? Exploring meal colour variety and its relation to food consumption. Food Quality and Preference, 64, 66–71.

Kuehni, R. G. (2005). Color – An introduction to practice and principles. Hoboken, NJ: John Wiley and Sons.

Lee, S.M., Lee, K.T., Lee, S.H., & Song, J. K. (2013). Origin of human colour preference for Food. Journal of Food Engineering, 119, 508-515.

Locher, P. (1996). The contribution of eye-movement research to an understanding of the nature of pictorial balance perception: a review of the literature. Empirical Studies of the Arts, 14, 143–163.

McManus, I.C., Cheema, B., & Stoker, J. (1993). The aesthetics of composition: a study of Mondrian. Empirical Studies of the Arts, 11, 83–94.

O'Mahony, M. (1983). Gustatory responses to nongustatory stimuli. Perception, 12, 627–633.

Ou, L., Luo, M.R., Woodcock, A., & Wright, A. (2004). A Study of Colour Emotion and Colour Preference. Part 1: Colour Emotions for Single Colours. Colour Research and Application, 29 (3), 232–240.

Paakki, M., Aaltojärvi, I., Sandell, M., & Hopia, A. (2019). The Importance of the Visual Aesthetics of Colours in Food at a Workday Lunch. International Journal of Gastronomy and Food Science, 16, 100131.

Palmer, E.S., & Schloss, K.B. (2010). An Ecological Valence Theory of Human Color Preference. PNAS, 107 (19), 8877-8882.

Palmer, E.S., Schloss, K.B., & Sammartino, J. (2013). Visual aesthetics and human preference. Annual Review of Psychology, 64, 77–107.

Román, S., Sánchez-Siles, L.M., & Siegrist, M. (2017). The importance of food naturalness for consumers: results of a systematic review. Trends in Food Science and Technology, 67, 44–57.

Saluja, S., & Stevenson, R.J. (2018). Cross-Modal Associations Between Real Tastes and Colors. Chemical Senses, 43, 475-80.

Schloss, K.B., Poggesi, R.M., & Palmer, S.E. (2011). Effects of university affiliation and "school spirit" on color preferences: Berkeley versus Stanford. Psychonomic Bulletin Review, 18 (3), 498–504.

Schloss, K.B., Strauss, E.D., & Palmer, S.E. (2013). Object color preferences. Colour Research and Application, 38, 393 – 411.

Spence, C. (2018). Background color & its impact on food perception & behavior. Food Quality and Preference, 68, 156-166.

Spence, C., Levitan, C.A., Shankar, M.U., & Zampini, M. (2010). Does Food Color Influence Taste and Flavor Perception in Humans?. Chemosensory Perception, 3, 68-84.

Spence, C., Wan, X., Woods, A., Velasco, C., Deng, J., Youssef, J., & Deroy, O. (2015). On tasty colours and colourful tastes? Assessing, explaining, and utilizing crossmodal correspondences between colours and basic tastes. Flavour, 4 (23), 1-17.

Spence, C., Youssef, J., Michel, C., & Woods, A. (2019). Assessing the aesthetic oblique effect in painting and plating. International Journal of Gastronomy and Food Science, 17, 100168.

Tomasik-Krótki, J., & Strojny J. (2008). Scaling of sensory impressions. Journal of Sensory Studies, 23, 251–266.

Turkish Dictionary (n.d.). In Türk Dil Kurumu Sözlüğü. Retrieved June 1, 2022, from https://sozluk.gov.tr/

Van der Laan, L.N., de Ridder, D.T.D., Viergever, M.A., & Smeets, P.A.M. (2011). The first taste is always with the eyes: A meta-analysis on the neural correlates of processing visual food cues. NeuroImage, 55, 296–303.

Velasco, C., Michel, C., Woods, A.T., & Spence, C. (2016). On the Importance of Balance to Aesthetic Plating. International Journal of Gastronomy and Food Science, 5-6, 10-16.

Wada, Y., Arce-Lopera, C., Masuda, T., Kimura, A., Dan, I., Goto, S., Tsuzuki, D., & Okajima, K. (2010). Influence of luminance distribution on the appetizingly fresh appearance of cabbage. Appetite, 54, 363–368.

Wadhera, D., & Capaldi-Phillips, E.D. (2014). A review of visual cues associated with food on food acceptance and consumption. Eating Behaviors, 15,132–143.

Wan, X., Woods, A.T., van den Bosch, J.J., McKenzie, K.J., Velasco, C., & Spence, C. (2014). Cross-cultural differences in crossmodal correspondences between basic tastes and visual features. Frontiers in Psychology, 8, 5, 1365.

Westland, S., Laycock, K., Cheung, V., Henry, P., & Mahyar, F. (2007). Colour Harmony. Colour: Design & Creativity, 1 (1), 1–15.

Woods, A.T., & Spence, C. (2016). Using single colors and color pairs to communicate basic tastes. I- Perception, 7 (4), 1-15.

Woods, A.T., Marmolejo-Ramos, F., Velasco, C., & Spence, C. (2016). Using Single Colors and Color Pairs to Communicate Basic Tastes II: Foreground–Background Color Combinations. I- Perception, 7 (5), 1-20.

Youssef, J., Juravle, G., Youssef, L., Woods, A., & Spence, C. (2015). Aesthetic plating: a preference for oblique lines ascending to the right. Flavour, 4 (1), 27.

Zellner, D.A., & Durlach, P. (2002). What is refreshing? An investigation of the color and other sensory attributes of refreshing foods and beverages. Appetite, 39, 185–186.

Zellner, D.A., & Durlach, P. (2003). Effect of color on expected and experienced refreshment, intensity, and liking of beverages. The American Journal of Psychology, 116, 633–647.

Zellner, D.A., Loss, C.R., Zearfoss, J., & Remolina, S. (2014) It Tastes as good as it Looks! The effect of Food Presentation on Liking for the Flavor of Food. Appetite, 77C, 31-35.

Zellner, D.A., Siemers, E., Teran, V., Conroy, R., Lankford, M., Agrafiotis, A., Ambrose, L., & Locher, P. (2011). Neatness Counts. How Plating affects liking for the Taste of Food. Appetite, 57, 642-648.

Zellner, D.A., Strickhouser, D., & Tornow, C.E. (2004). Disconfirmed hedonic expectations produce perceptual contrast, not assimilation. The American Journal of Psychology, 117 (3), 363–387