Assessing the influence of the color of the plate on the perception of a complex food in a restaurant setting

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Abstract

Whenever we consume food and drink, we normally do so from some sort of container/receptacle (e.g., such as a plate, bowl, cup, or product packaging). More and more importance is being given nowadays to how the food or drink is being presented. There are several reasons for this interest: With regard to the color of the plate, several recent studies have demonstrated that identical foods served on plates of different colors are often perceived differently (at both the sensorial and hedonic levels). However, these effects have not been tested in an ecologically-valid setting with a range of more complex foods in order to assess the generalizability of the findings.

The aims of the present study were therefore to test the extent to which the color of the plate may influence the gustatory and hedonic experiences of a complex food. Specifically, we investigated diners’ perception of three complex desserts served on black or white plate in a between-participants experiment.

The results demonstrated that the color of the plate exerted a significant influence on people’s perception of the food, but that this effect varied as a function of the type of dessert. Interestingly, the perceptual pattern for each dessert was constant for each plate used, this is, for all the attributes rated, the higher scores were obtained with the same plate, for all the desserts. These results therefore confirm the importance of the color of the plate on people’s perception of food, even in realistic uncontrolled conditions, such as that of a restaurant.

Keywords: food perception; color influence; flavor intensity; liking; consumer studies, restaurant setting, ecologically valid contexts
1. Introduction

When we consume food or drink, we normally do so from certain containers/receptacles (e.g., such as plates, bowls, cups, glasses or product packaging such as a drinks can or a plastic yoghurt pot). More and more importance is being given to how the food or drink is presented (Zellner, Lankford, Ambrose, & Locher, 2010). There are several reasons for this growth of interest. Researchers are interested in whether they can make the food or drink more appealing, to give us the impression that the serving is larger, etc. It is becoming increasingly clear that our perception of food is affected not only by the various sensory properties of the food itself, but also by our expectations about it, not to mention all of the other contextual factors. A great deal of research has been carried out over the years in order to investigate the influence of all of these variables on the perception of both the sensory-discriminative and hedonic attributes of a variety of different food and drink items (see Spence, Harrar, & Piqueras-Fiszman, 2012, for a recent review).

With regard to the influence of the appearance of the food on people's perception of its flavor, it is important to note that the color of a food or beverage often dominates over other sources of information regarding the flavor (Shankar, Levitan, & Spence, 2010; Spence, 2010). Numerous studies have now demonstrated the profound role that the color of a food or beverage can play in flavor perception across many different foods and drinks (e.g. see Spence, Levitan, Shankar, & Zampini, 2010, for a review). What is more, the containers from which we eat and drink, and, in particular, their color, can also influence our perception of food and beverages and the overall consumption experience to a greater extent than most of us are consciously aware of.

Focusing on a culinary context, several studies have demonstrated the effect of the color of the surroundings in which food happens to be presented (i.e., cups, plates, tablecloth, and even the ambient lighting) both on our perception of the food and on the amount that people will serve not to mention consume (e.g., Guéguen, 2003; Harrar, Piqueras-Fiszman, & Spence, 2011; Oberfeld, Hecht, Allendorf, & Wickelmaier, 2009; Ross, Bohlscheid, & Weller, 2008). For example, Van Ittersum and Wansink (2012) recently demonstrated that the color contrast between the plateware and the background color, be it the color
of the tablecloth or table, had a significant effect on serving sizes (and a
significant interaction effect with the plate size). They found that people with
white plates placed on a black tablecloth served 9.8% (p< .01) more than the
target serving size on the larger plate, and 13.5% (p< .01) less than the target
serving size on the smaller plate. However, this over/under-serving bias was
reduced for those participants with white plates situated on a white tablecloth.

In another study, Van Ittersum and Wansink (2012) tested the effect of color
contrast between the food and the plate on the serving size in a canteen (this
time keeping the size of the plate and table/tablecloth color constant). Their
results revealed that participants in the low color contrast condition (i.e., white-
pasta sauce on a white plate, or red pasta sauce on a red plate) served
themselves significantly (p< .01) more pasta than those in the high color
contrast condition (i.e., white pasta sauce on a red plate, or red pasta sauce on
a white plate). These two studies can potentially be framed in terms of the
Delboeuf illusion - the illusion whereby we see a central circle as smaller when
surrounded by a much larger concentric circle than when surrounded by a circle
that is only slightly larger. It has been shown that this illusion is enhanced by
color contrast, and it could thus provide a possible explanation for why and how
plate size might influence serving behavior in real-life situations.

With regard to this contrast effect between the color of food (i.e., the color of the
dish/cup, etc.) and the color of the plate, there are also mechanisms that may
help to explain our perception of certain “illusory”, or more saturated, colors. For
instance, the orange of a carrot might well be intensified if it were to be served
on the same blue plate due to the phenomenon of simultaneous contrast, as
Hutchings (1994) reported as an anecdote. It might be expected that if the color
of the plate (or background) affects the way in which people perceive the color
of the food (Ekroll, Faul, & Niederée, 2004; Lyman, 1989; Hutchings, 1994), and
the color of the food is known to affect the perception of flavor, then the color of
the plate (and any contrast effect that it elicits) might be expected to influence
the perceived properties of the food (e.g., the flavor intensity, etc.). Piqueras-
Fiszman, Alcaide, Roura, and Spence (2012) studied this under laboratory
conditions, in a short within-subjects experiment using black and white plates.
Their results showed that an identical strawberry mousse (of homogeneous
color) tasted significantly more intense, sweeter, and was more liked when served from the white plate, compared to when served from the black one. However, though these interesting results were observed, they have not been tested in a natural context and with more complex foods (varying in color, texture, etc).

The aims of the present study were therefore to test the extent to which the color of the plate influences the visual and gustatory experiences of different complex foods (namely, desserts) served from them, and the extent to which these effects can be generalized in natural conditions, such as those of a real restaurant.

2. Materials and methods

The study was carried out at the experimental restaurant of the Institut Paul Bocuse (Lyon, France). Three different desserts were served either on black or white plates according to the balanced between-participants experimental design showed in Figure 1.

2.1. Food stimuli

Berry-based desserts were served on either white glossy or black matt dishes. Dessert A was a fraisier (main colors: yellow, white, and red), Dessert B was a Fraicheur of raspberry and vanilla (Figure 2), and Dessert C consisted in a vacherin glacé with vanilla, raspberry, and basil (mainly white and light pink). Importantly, although it was intended that the desserts should have been presented (and decorated) identically, this was impossible to control in this realistic setting, so at the end, they were as similar as possible. A fixed menu was kept constant throughout the two weeks the study lasted.

2.2. Plates

Black and white plates were used, since they are the most commonly used in restaurant settings. They were of the same shape and size (rectangular, 30 x 26 cm), but, as mentioned before, the white plate had a glossy finish while the black plate had a matt finish. Though, strictly-speaking, black and white are not considered as colors, they will be referred to as such for ease of exposition.
2.3. Participants

Two hundred fifty-three people (nearly all of them French) participated in the study, of which 142 were females ($M=43.4$ years, $SD=13.8$). No recruitment process was followed; the participants simply consisted of those people who had chosen to book a table for lunch or dinner.

Detailed information concerning the breakdown of the participants (age and gender) distributed for each day is shown in Table 1.

2.4. Procedure

Participants were welcomed to the experimental restaurant and it was explained to them that a quick questionnaire would be delivered at the end of the meal in order mainly to know what they thought about the dessert (so participants thought the aim was to give some feedback to the trainee chefs). They were told to read the questionnaire first, and then proceed with the dessert.

A5 pencil-and-paper questionnaires and pens were delivered with the dessert. The questions were: 1) How appetizing is the dessert (visually, once presented); 2) How much do you like the appearance of the dish overall; 3) How intense is the color of the dessert; 4) How intense is the flavor of the dessert; 5) How intense is the sweetness of the dessert; and 6) how much did you like the dessert (gustatory). Additionally some basic demographic questions were included.

The participants had to rate each question on 9-point scales labelled at their anchors with “not at all” and “very much”. Questions 1-3 were meant to be completed prior to tasting, while the others could be filled in during or at the end (to keep the situation as natural for them as possible).

After the meal, the questionnaires were collected, the diners paid their bill as in any normal restaurant, and they were thanked once again for their participation.

2.3. Data analysis

In order to determine whether the color of the plates exerted a significant effect on the attributes in question, a three-way analysis of variance (ANOVA) was performed on the data considering the meal session (lunch or dinner), the
dessert (A, B, or C), the plate (white or black), and their interactions as explanatory variables.

When the effects were significant, honestly significant differences were calculated using Tukey’s test. Differences were considered significant when $p<.05$. Statistical analyses were performed using XLStat 2011 (Addinsoft, NY, USA).

3. Results

Importantly, it was observed that all the diners ate nearly all of the food served, and that all of them finished the dessert (as reported by the restaurant manager). This fact helps to match the conditions across participants.

3.1. The effect on the pre-tasting attributes

Liking of the overall presentation. According to the results of the ANOVA, the dessert and the color of the plate exerted a significant effect on consumers’ liking ratings of the overall presentation of the dish ($p<.0001$ and $p<.01$, respectively). However, this effect was not observed for all the desserts, as indicated by the significant interaction effect between the plate and the type of dessert ($p<.0001$). In fact, only Dessert A was significantly more liked on the white plate than when served on the black plate ($M=6.9$ vs. $4.7$; see Fig. 3a). The results also highlighted a tendency for Dessert C to be liked more on the white plate, whereas the opposite results were observed for Dessert B. Note, though, that these latter two differences between plate color were not significant.

Appetizing ratings. The results of the appetizing ratings followed exactly the same pattern as those described above. The color of the plate exerted a significant effect on consumers’ appetizing appraisal of the desserts ($p<.0001$). Once again, this effect was only observed for Dessert A, which was perceived as significantly more appetizing on the white plate as compared to the black plate ($M=7.7$ vs. $5.0$). Very similar results to those of the liking ratings were found for the other two desserts in this case (see Fig. 3b).
Color intensity of the desserts. Regarding the perceived color intensity of the desserts, the color of the plates, the type of dessert, and their interaction had significant effects (p<.05, p<.001, and p<.01, respectively). In general, taking the three desserts as a group, their color was perceived as more intense from the white plate (M= 6.6 vs. 6.0); however, at an individual level, the intensity of the desserts’ color was not significantly different when any of the desserts were served from either a white or black plate (Fig. 3c).

3.2. The effect of the plate on the desserts’ gustatory attributes

The results presented so far demonstrate an effect of the color of the plates on the attributes rated, which are mainly based on the appearance of the presentation of the desserts (presumably prior to their having been tasted). The following section describes its impact on the oral perception of the desserts.

Flavor intensity. Contrary to what one might have expected, no main effects of the color of the plate were observed. The flavor intensity was only affected by the type of dessert and its interaction with the color of the plate (p<.001 and p<.01, respectively). Only the flavor of Dessert B was perceived as significantly more intense (p<.05) when presented on the black plate (Fig. 3d). It is interesting to highlight that the pattern of results (Dessert B scoring higher on the black plate and the contrary being observed for A and C, for all the attributes, even if not reaching significant levels) is maintained.

Sweetness intensity. Only the dessert had a significant effect on the perceived sweetness, which means that Dessert A was rated as sweeter than Desserts B and C regardless of the color of the plate that they were served on (Fig. 3e).

3.3. Overall liking

Regarding the overall liking (assessed after having tasted the dessert), only the interaction effect between the color of the plate and the dessert was significant. Figure 3f reveals that Desserts A and C resulted in very similar scores for both plates, while essentially the reverse pattern was obtained for Dessert B. Dessert B was significantly more liked on the black plate than on the white one (M= 7.6 vs. 6.5, p<.05), and marginal differences were observed for Dessert C, which was slightly more liked on the white one (M= 7.6 vs. 6.8, p=.09).
Taken together, then, these results suggest that the diners’ actual liking of the dessert was not necessarily influenced by their appreciation for the presentation, or by how appetizing they appeared visually.

4. Discussion and conclusions

The present study investigated whether or not the color (either black or white) of the plate would exert a significant influence on how appealing and appetizing various desserts were rated as being (prior to consumption) and on the perceived flavor intensity, sweetness, and liking of three different desserts served in as similar a manner as possible from those plates. The results demonstrated that consumers’ perception varied, as highlighted by the significant differences in the mean scores. The color of the plate exerted a significant effect on participants’ perception of the majority of the attributes that were evaluated, but these effects varied as a function of the dessert that was served.

Given the complexity in the visual appearance of the desserts (i.e., with layers and decorations of different colors and tastes), no clear conclusions can be extracted relating to the impact of any color contrast between the dessert and the plate with respect to the diners’ responses. What can be concluded, though, regarding color perception, is that the flavor intensity patterns observed for all the desserts (Fig. 3d) were similar to those of the perceived color intensity of the desserts (Fig 3c), which could suggest that they perceived the flavor to be more intense if the color was also perceived as such. Moreover, looking at all the panels in Figure 3, it can be noticed that Desserts A and C had the higher scores when served on the white plate, whereas the opposite occurred for Dessert B. This overall result suggests that all of the attributes were somewhat positively correlated within each dessert condition, as perhaps might have been expected. That is, when the color of one dessert was perceived as being more intense on a plate of one color, it was also rated as being more appetizing, more liked, and more intense in flavor on the same plate (though this can only be inferred given the pattern of results observed).
It is understandable that results regarding the gustatory attributes are not as strong as in the study by Piqueras-Fiszman et al. (2012), given that in the context of a real restaurant, the stimuli cannot be perfectly matched for all consumers, and the conditions for all the diners cannot be kept the same (i.e., they may or may not drink while eating, some may have eaten more rapidly than others, etc.). For these reasons, these results are more ecologically valid, and although no generalization can be put forward here as to which background color is better ‘flavor-wise’ for a given food (dessert), our results nevertheless do highlight the fact that the color of the plateware can exert a significant impact upon consumers’ appraisal of the food, prior and after consumption, in spite of the complex uncontrolled conditions, which make obtaining significant effects in the results even more challenging.

These results therefore contribute to the emerging literature about how extrinsic variables can influence food perception, highlighting that the impact they might have is dependent on the specific food being evaluated. In the future it would be particularly interesting to further investigate the effects of other colors (or, more correctly, plates having different hues) and characteristics of the plates in order to discover possible ways in which to enhance the perception and experience of food, apart from modifying the ingredients of the food.

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References


Piqueras-Fiszman, B., Alcaide, J., Roura, E., & Spence, C. (2012). Is it the plate or is it the food? Assessing the influence of the color (black or white) and shape of the plate on the perception of the food placed on it. *Food Quality and Preference, 24*, 205-208.


Figure captions

Figure 1. Outline of the procedure followed during the two-week study.

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<td>Lunch</td>
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Figure 2. Picture of Dessert B (a fraicheur of raspberry and vanilla) presented on the black and white plates.

Figure 3. a) Mean ratings of a) the liking of the presentation, b) appetizing ratings; c) perceived color intensity; d) perceived flavor intensity; e) perceived sweetness intensity; and f) gustatory liking of the desserts. All of the attributes rated on 9-point scales. Error bars represent the 95% confidence intervals.
### Table 1. Information concerning the participants (males / females).

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<tr>
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Age: M=45, SD= 12  
Age: M=42, SD= 13  
Age: M=44, SD= 16