Can the position on the screen of an image influence its judgment? The case of high- and low-calorie foods

Valerio Manippa[1*], Sara Ferracci[2], Davide Pietroni[2], Alfredo Brancucci[3]

1= Department of Psychological, Health and Territorial Sciences, Università degli Studi "G. d'Annunzio" Chieti – Pescara, Chieti, Italy

2= Department of Neurosciences, Imaging and Clinical Sciences, Università degli Studi "G. d'Annunzio" Chieti – Pescara, Chieti, Italy

3= Department of Motor, Human and Health Sciences, University of Rome "Foro Italico", Rome, Italy

* Corresponding author: Valerio Manippa, Department of Psychological, Health and Territorial Sciences, University "G. d' Annunzio" of Chieti-Pescara, 66100 Chieti. E-mail address: valerio.manippa@unich.it.

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Abstract

If a food product is not perceived positively in its appearance, it is unlikely eaten. However, there are several subtle spatial cues able to bias attitudes towards food, such as the position where it is displayed. To date, no-one has investigated how the placement of high-calorie food (HcFd) or low-calorie food (LcFd) on a screen, influences its evaluations. Thus, we asked 57 participants to rate food images that appeared on the center, on the top, on the bottom, on the left or on the right side of the screen. For each item participants evaluated on a 100mm VAS the liking, the desire to eat and buy, and the willingness to pay. We found that HcFd liking and desire to eat were higher when images were shown on the bottom side and lower when shown on the left side of the screen; LcFd liking scores were lower when shown on the bottom side and higher when shown on the left side of the screen. Such results were consistent with the literature reporting a peculiar attitude bias determined by the placement of high- and low-calorie products. Both policy makers and sellers can use such knowledge respectively to prevent unhealthy food intake or to improve the effectiveness of the advertisements.

Keywords: food; attitude; calorie; evaluation; side bias

1. Introduction

Biological, psychological and social factors, are all important for eating behavior (Shepherd & Raats, 2006). Particularly, our eating habits are the result of a complex system of choices, actions and influences that require very few conscious, thoughtful, and elaborate decisions. Given the increase in the incidence of eating disorders and obesity, many researchers are now investigating how people perceive, choose and categorize foods, in order to assess the determinants of eating behavior associated with visual exposure. In fact, food cues are omnipresent in our environment and many of our food decisions are based also on visual exposure.

Attitudes are a mix of thought and ideals about an item and describe our explicit approaching or withdrawal motivation toward it. Regarding the food, the literature agrees on the assumption that if a product is not perceived positively in its appearance, smell, texture or taste, it is unlikely to be eaten (Eertmans et al., 2001; Hetherington & Rolls, 1996). Particularly, Rozin and Follon (1980) have argued about the existence of three factors underlying the acceptance or rejection of a food: i) sensory properties, ii) effects of ingestion and iii) ideational concerns. But food evaluations are also influenced by several subtle visual cues or spatial biases activating heuristic processes. For example Valenzuela and Raghubir (Valenzuela & Raghubir, 2015) showed that consumers judge products placed at the bottom (vs. top) and on the left-hand (vs. right-hand) side of the shelves as less expensive and of lower quality.

Such spatial biases usually interact with products features. For example, a study carried out by Deng and Kahn (2009) shows that the localization of food images in the product packaging can influence the “heaviness” perception in the consumers. In particular, the experiment showed that the high-energy foods (“heavier”) are more likely represented in the lower part of the packaging facades, in the right side or in the lower-right area. On the other hand, the most suitable position for the low-energy foods (“lighter”) is in the upper part of the package, on the left side or at the bottom-left.

More recently, two studies (Manippa et al., 2020; Romero & Biswas, 2016) have investigated the existence of a display bias in healthy and unhealthy products choice. They found that consumers are more likely to represent healthy items on the left (versus right) side compared to unhealthy ones. In addition, it was found that the consumption/choice of healthy products was improved when they are placed on the left side compared with unhealthy items. Even more recently a series of studies (Wang & Basso, 2021) have offered convergent evidence for the "Healthy is Up" metaphor showing that people associate healthy food with the higher placement and unhealthy food with lower placement. The authors have hypothesized that healthy foods are predominantly mentally represented on the left side and on the top, and that such cognitive representation, when exported on the real world, could facilitate perceptual processing and self-control promoting healthier food choice (Shiv & Fedorikhin, 1999).

This cognitive bias could be used as nudge to promote healthy eating behaviors, because they can indirectly influence everyday nutritional choices. The term "nudging" refers in fact to those ecological strategy having the aim of altering people's behavior in a predictable way, without prohibiting any option and without any economic incentive. For instance, when identical or psychologically non-differential objects are horizontally aligned, people are said to show either middle- or right-position bias in choosing one of the objects (Dayan & Bar-Hillel, 2011). Similarly, Keller and coworkers (Keller et al., 2015) have manipulated food horizontal arrangement in a snack bar: they found that low-calorie apple bars were chosen more often when they were placed between the middle-calorie bars on the left and the high-calorie bars on the right side. On the other hand, no study has investigated how the display position of a product influences participants attitude towards it. Particularly, the aim of this study is to explore in a lab context, how the position on the screen of high and low-calorie products can influence them evaluation in terms of liking, desires to eat and buy, and the willingness to pay. We predict that:

Hypothesis 1: the evaluations of high-calorie (unhealthy) products increase when displayed on the bottom and on the right side of the screen;

Hypothesis 2: the evaluations of low-calorie (healthy) products increase when displayed on the top and on the left side of the screen.

Whether those hypotheses would be confirmed, more ecological paradigms should be implemented to verify the effectiveness of such food-related side biases in real environments.

2. Materials and methods

2.1 Participants

Fifty-seven adult participants (24 male) with age ranging from 18 to 50 years (M = 24.9, SD = 7.8) and with Body Mass Index (BMI) ranging from 17.1 to 31.8 kg/m^2, (M= 22.8, SD= 4.0), were involved in the experiment. Seven of them were left-handers, and all participants had normal or corrected to normal sight and were unaware of the specific purpose of the study. The complete characteristics of our sample are reported in the Table 1.

	57 participants		
	% (N)	*M*	*SD*
Sex (female)	57.9 (33)		
Age (years old)		24.9	7.8
Right-handers	87.7 (50)		
BMI (kg/m^2)		22.8	4.0
Normal-height	77.2 (44)		
Hungry (100mm-VAS)		29.6	27.5
Last meal (100mm-VAS)		34.7	33.7
Thirsty (100mm-VAS)		41.8	27.5
Tired (100mm-VAS)		44.8	27.2

Table 1. Characteristics of our sample

2.2 Stimuli

We selected 16 colored food product images (544 × 364 pixels) from the Full4Health Image Collection (University Medical Center Utrecht; Charbonnier et al., 2016), a database validated in different European countries (Netherlands, Scotland, England and Greece). The images were 8 high-calorie foods (HcFd) and 8 low-calorie foods (LcFd). The 2 types of stimuli had comparable mean liking but were different for perceived healthiness (LcFd perceived as healthier and vice-versa for the HcFd) and for real and perceived calories as reported by the normative data. The normative data of the selected pictures are reported in table 2. The pictures were resized to 328 x 220 pixels and then horizontally flipped to doubling the number of items.

	High-calorie foods		Low-calorie foods			
	M	SD	*M*	*SD*	*T*	*p*
Real calorie (Kcal * 100g)	378.34	100.34	61.49	30.48	8.54	< .001*
Liking	6.06	1.18	6.46	1.08	- 0.72	= .483
Perceived Calories	6.75	1.88	3.73	1.05	3.96	= .001*
Perceived Healthiness	2.81	1.55	6.86	1.34	- 5.52	< .001*

Table 2. Mean and Standard Deviation of Real Calorie (Kcal * 100g), Liking, Perceived Calories and Healthiness (ranged from 1 to 9) of the 8 high-calorie and 8 low-calorie food pictures that we extracted from the Full4Health database (Charbonnier et al., 2016). Such scores have been obtained averaging the normative data rated in Netherlands, England, Greece and Scotland. The last two columns of the table report the *t*- and the *p-value* of each comparison between high-calorie vs. low-calorie food scores. Asterisks indicate significant differences.

2.3 Procedure

Upon arrival, participants were seated on a chair at about 57 cm from the computer monitor measuring 34 x 27 cm (15.4 inches) and were instructed to assume and maintain a relaxed position for the entire duration of the experiment. After they filled the informed consent, we administered a preliminary computer-administered survey (Qualtrics Survey Software; Provo, UT) in which we asked

participants to report their age, weight, height, and sex and to report their physiological state through a Visual Analogue Scale (VAS) for each of the following 4 questions ((Manippa et al., 2021; Padulo et al., 2018):

a) “How much time has passed since your last food intake?” (With the two extremes labeled: 0 “less than an hour” and 100 “more than 5 h”).

b) “How hungry are you now?” (With the two extremes labeled: 0 “not at all hungry” and 100 “very hungry”).

c) “How thirsty are you now?” (With the two extremes labeled: 0 “not at all thirsty” and 100 “very thirsty”).

d) “How tired are you now?” (With the two extremes labeled: 0 “not at all tired” and 100 “very tired”).

Then participants were instructed as follows: “In this experiment you have to evaluate some food that we will show on the screen. You have to watch each picture until it disappears (15 seconds), then you have to respond to 4 queries involving the liking of the product, the desire to eat it, the desire to buy it and the willingness to pay for it. You can respond to each question by marking with a pencil a point on a 100 mm visual analogue scale. There are not correct or incorrect answers, we’d like to assess only your opinion. Once the answers are given, we will move on to the next product and so on”.

Hence, since participants evaluated 32 stimuli, the experimenter provided them a booklet composed of 32 sheets, one for each stimulus, with the 4 questions and the relative VAS on each sheet. The queries were:

a) “Liking”: How much do you like the product shown in the picture? (from 0 = "not at all" to 100 = "very much")

b) “Eating”: How much would you like to eat the product shown in the picture? (from 0 = "not at all" to 100 = "very much")

c) “Buying”: How much would you like to buy the product shown in the picture? (from 0 = "not at all" to 100 = "very much")

d) “Paying”: How much would you pay to buy the product shown in the picture? (from 0 = "less than € 1" to 100 = "more than € 10")

The order of queries was randomized between participants. The evaluation was carried out after the presentation of each single picture, and the pages of the questionnaire were turned by the experimenter whenever participants moved to the next stimuli.

Food pictures were presented once at time throughout PowerPoint on a white background (720 x 438 pixels) for 15 seconds. Each stimulus (328 x 220 pixels) could randomly appear in five different positions: through a pseudorandom assignment (in which the positions of the HcFds and LcFds were counterbalanced), 8 items appeared vertically and horizontally centered on the screen (control condition), 6 items in the top and 6 items on the bottom part of the screen (horizontally centered), 6 items on the right and 6 items on the left side (vertically centered). At the end of the experiment, participants filled the Italian version of the Edinburgh Handedness Inventory (Oldfield, 1971) through Google Forms.

2.4 Data analysis

Data analysis was performed using Statistica 8.0 software (StatSoft). Each response (Like, Eat, Buy, Pay) was converted into a score from 0 to 100. The dependent variables were the average scores of each VAS for each participant. Before to carry-out the analyses, we removed the outlier values for each condition (± 3 *SD*). Then, for each VAS score we carried-out a 5 x 2 Analysis of Variance (ANOVA), using as within factors item Placement (Bottom, Top, Center, Left, Right) and product Category (Low-calorie, High-Calorie).

3. Results

The first ANOVA carried-out on "Liking" scores, showed a significant interaction between product Placement and Category ($F_{4.424} = 2.674$, $p = .033$, $\eta^2_p = .046$). Duncan's post-hoc showed that when HcFds were displayed on the bottom of the screen, individuals rated them significantly more positive compared to the LcFds displayed on the same position ($p = .040$) and compared to HcFds displayed on the left side of the screen ($p = .041$). In addition, there were two almost significant post-hoc comparisons: when LcFds were displayed on the left side of the screen, individuals rated them more positively compared with HcFds displayed on the same side ($p = .086$) and compared with LcFds displayed on the bottom ($p = .088$). No other significant effect was found.

The second ANOVA carried-out on "Eating" scores, showed a significant interaction between product Placement and Category ($F_{4.424} = 2.941$, $p = .021$, $\eta^2_p = .050$). Duncan's post-hoc showed that when HcFds were displayed on the bottom of the screen, individuals rated them significantly more positive compared to the LcFds displayed on the same position ($p = .019$) and compared to HcFds displayed on the center ($p = .043$) or on the left side of the screen ($p = .049$). No other significant effect was found.

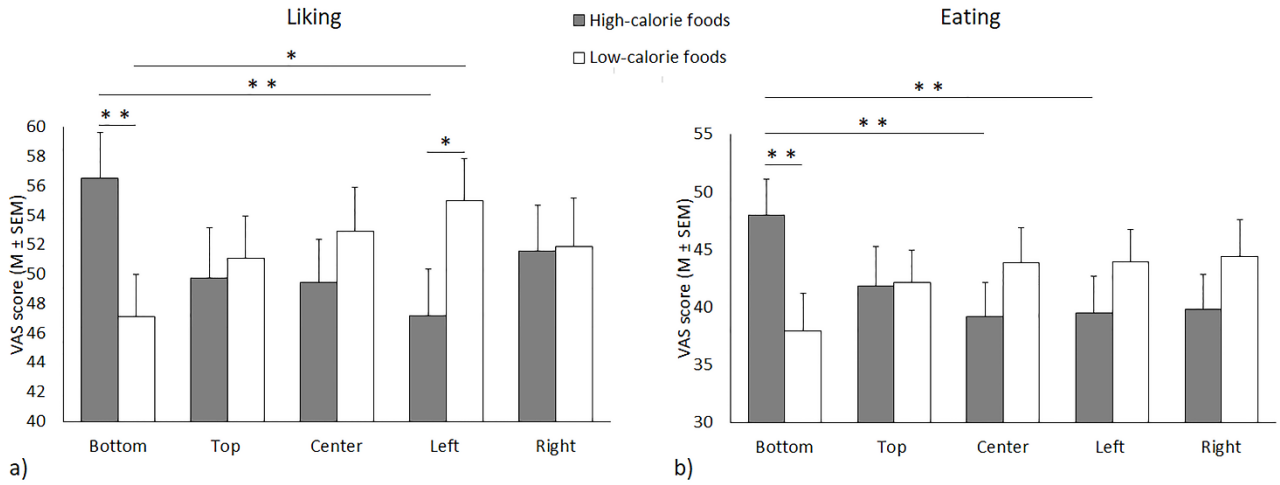

Figure 1. The 5 x 2 ANOVAs carried out on a) Liking and b) Eating scores. The horizontal axes report the Placement of the figure in the screen, the grey bars represent the high-calorie products and the white ones the low-calorie products. Data in the vertical axes are reported as mean VAS score ± standard error for the mean. Single asterisk: $p<.10$, double asterisk: $p< .05$.

The third and the fourth ANOVA carried-out respectively on "Buying" and "Paying" scores, showed no significant main or interaction effects, although regarding the Paying scores an almost significant main effect of product Category has been found ($F_{1.53} = 4.409$, $p = .067$, $\eta^2_p = .061$) with a higher willingness to pay for the low-calorie products compared to the high-calorie ones.

All the data are reported in supplementary materials.

4. Discussion

The aim of the present study was to investigate whether the attitude, in terms of liking, desire to eat, desire to buy and willingness to pay towards HcFds and LcFds, can be influenced by the position in which they are displayed on a screen. In our first hypothesis we predicted that displaying HcFds on the bottom or on the right side of the screen, our participants would rate them in a more favorable manner, whereas in our second hypothesis we predicted that a more favorable attitude toward LcFds would be expressed when they are displayed on the top and on the left side on the screen. Both our hypotheses were partially confirmed: in fact, when displayed on the bottom of the screen, liking and desire to eat scores were higher for HcFd and lower for LcFd. Further, when pictures were displayed on the left side, liking scores were higher for LcFd pictures and lower for HcFd. Generally, HcFds liking and eating scores were higher when displayed on the bottom compared with the left side of the screen. Despite that, the right and the top locations seemed to not influence item evaluations. Finally, for the desire to buy and the willingness to pay scores, no effect of the placement was found.

Our results support previous evidence suggesting that individuals associate specific food products to a specific placement depending on its calorie content/healthiness. For example research shows that individuals associate the bottom or the right side allocation to the "heavier" foods (i.e., high in calorie and unhealthy), and the top and the left side to the light foods (i.e., low in calorie and healthy; Deng & Kahn, 2009; Wang & Basso, 2021). In fact, when in our study HcFds were displayed on the bottom

rather than in the left side, they were evaluated as more pleasant and more desirable. Similarly, our data are congruent with the healthy/left-unhealthy/right bias described by Romero and Biswas (2016) and Manippa and coworkers (2020) pointing to the existence of a representational side bias that leads us to prefer healthy foods (i.e., LcFds) rather than the unhealthy ones (i.e., HcFds) when the former is displayed on our left side. Congruently, our participants rated HcFds less positively when displayed on the left side and LcFds more positively when displayed on the same side.

The results of our study are in line also with Arnheim's theories (Arnheim, 1957) stating that, from a pictorial point of view, the heaviness of an object is inexorably linked to the "bottom" of any visual field due to the gravitational attraction, and to the right side due to the "lever" effect. On the contrary, what is perceived as light is usually represented on the top (as it flies) or on the left side, where the “imaginary” lever effect is weaker. But this is not the only theory that tried to explain how the position of an item on the vertical or the horizontal axes can influence its processing. For example, Lakoff and Johnson (1980), have found that words expressing positive concepts such as "happiness", "strength" and "health" were associated with the upper side of the screen, while the opposite concepts of "unhappiness", "weakness" and "illness" were associated with the bottom side, due to a metaphorical use of the verticality that is reflected above all in language. A similar cognitive bias was found for the horizontal axis: whereas Deng and Kahn (2009) demonstrated that food images presented in the lower right corner of a package façade result in the product being perceived as heavier, Manippa and coworkers (2020) and Romero and Biswas (2016) found that the left side is associated with healthy food products, whereas the right side with unhealthy ones.

Consequently, we theorize that the results of our study may be due to a representative/perceptual or metaphorical (in)congruence effect: our participants evaluated HcFds more positively compared with LcFds, when the formers were shown on the bottom of the screen, due to a congruence effect between the mental (spatial) representation of the heaviness/unhealthiness and the actual products display position. Conversely, LcFds, when displayed on the bottom, are arranged in an incongruent placement

making their evaluation more negative. A similar explanation can be hypothesized for the left placement: the evaluation of HcFds decreases when displayed on the left, being incongruent with the left side mental representation of lightness and healthiness, whereas LcFds evaluation increases.

4.1. Limitations, future research and conclusion

We point out that there are some grey spots in our results. First, we found no influence of food placement on the desire to buy and on the willingness to pay. Our subtle manipulation might be too week to affect the response to such questions, that require an economical reasoning mediated by many social factors (e.g., brand preference, average individual's income and so on). Secondarily, we found effects regarding the bottom (heaviness) and the left side (lightness) placement, whereas their counterpart (top and right placements) seemed not to influence participants judgments. Lastly, in our experiment it was the judgment about HcFds, more than the one about LcFds, to be influenced by the placement on the screen. Regarding these latter considerations, we point out that this study is one of the first trying to deepen which kind of evaluative effect can bias individual choice, purchase, or intake of specific food. For example, there are consistent findings about a preference for healthy products when placed on the left side of the observer, but the perceptive/affective mechanism that drives such nudge is still little understood (Manippa et al., 2020; Romero & Biswas, 2016). Our study suggests that the placement on the left side and on the bottom affects the liking and the desire of a product, and that such display bias seems stronger for high-calorie (unhealthy or heavier) products compared with low-calorie (healthy or lighter) products.

Obviously, further variables could modulate the effects we observed. Continuous and systematic research in this field of study would be essential, as it is clear how environmental factors are effective in modulating food attitudes, nudging (un)healthy nutritional choice (Dayan & Bar-Hillel, 2011; Rozin et al., 2011). In the present research we have not tested the effect of individual variables on our hypotheses, since the research on the food-related side biases is still dawning: future studies could fill this gap, testing, on larger samples, the moderating effects of variables such as participants age,

sex, BMI or physiological state. Finally, it would be appropriate to investigate how the horizontal and vertical placement of a food product can influence its purchase in ecological contexts, such as in a supermarket or in a restaurant (e.g., manipulating the arrangement of the products on the shelves or menu design). Watching to single food picture arranged on a computer screen in a lab context is too different from watching them in the real environment, where products are usually displayed together with other products and so they can assume both an absolute and a relative placement.

Summarizing, our study would confirm that the placement of a food item on the screen, both on the horizontal and vertical axes, can influence observer/buyer attitudes toward food depending on its calorie contents/perceived healthiness. To the best of our knowledge, our findings are in line with the current literature involving the effect of visual spatial biases on foods perception/preference. Anyway, those results should be confirmed by more ecological studies: such biases, using as nudges, could help policy makers to prevent unhealthier choices and marketers and sellers to implement more effective advertisements and products arrangement.

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