I'll have this salad on the left, and I'll have it now! The influence of hunger on healthy-left nudge

Valerio Manippa[1,2*], Alfredo Brancucci[3], Davide Rivolta[1], Luca Tommasi[2]

[1]Department of Education, Psychology and Communication, University of Bari "Aldo Moro", Bari, Italy

[2]Department of Psychological, Health and Territorial Sciences, University "G. d'Annunzio" of Chieti – Pescara, Chieti, Italy

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

*****Correspondence concerning this article should be addressed to Valerio Manippa (ORCiD: 0000-0003-3892-5212), Department of Education, Psychology and Communication, University of Bari Aldo Moro, Bari, Italy. Tel: +39 0805714893; E-mail: valerio.manippa@uniba.it

Abstract

Displaying foods congruently with the healthy-left/unhealthy-right (HL/UR) horizontal mental representation could, through self-control facilitation, lead to healthier food choices. Here, by using two versions of the same on-line menu, we tested whether the healthy-left nudge was influenced by the hunger of our participants. A total of 192 participants filled the HL/UR version whereas 194 filled the specular version (unhealthy-left/healthy-right; UL/HR) of the same survey. We did not find a significant difference in healthy (Vs. unhealthy) item choices when displayed on the left Vs. the right page of the menu: this null result can be attributed to sated participants that decided to eat the product later. On the opposite, hungry participants who preferred to eat the product immediately were nudged toward healthy (Vs. unhealthy) products when they were listed on the left page as compared to the right. The implications of these findings are discussed in the context of healthy nudge.

Keywords: Non-conscious processes, Self-Regulation and Self-Control, Situation and Context Effects, Preference and Choice, Nudging

Introduction

The global prevalence of overweight and obesity has doubled since 1980, and nearly one-third of the world's population is now classified as overweight or obese. Obesity affects almost all physiological functions of the body and poses a significant public health threat (Chooi et al., 2019). Although the environment is playing a negative role in this "pandemic" (Lake & Townshend, 2006), it is also possible to implement small and subtle environmental changes able to positively modulate our behavior. *Nudges* encourage/discourage some choices or behaviors, albeit not forcing them, nor significantly changing their economic incentives (Thaler & Sunstein, 2008). Interestingly, nudges could have an impact on individual and public health. In particular, over the last few years, researchers are studying the possibility to nudge healthier food choices by manipulating the product placement or menu designs (Dayan & Bar-Hillel, 2011; Keller et al., 2015; Rozin et al., 2011). For instance, modestly but significantly reduced intake (8–16%) has been observed when products were slightly more difficult to reach, or when smaller serving utensils were used (Rozin et al., 2011). Also, products placed at the beginning or the end of the list of their category options were chosen more often compared with those placed in the center (Dayan & Bar-Hillel, 2011). Finally, Keller and coworkers (2015) showed that low-calorie cereal bars were selected almost three times more often when they were arranged in a box between two high-calorie bar boxes.

A more recent approach is focused on the congruency between the horizontal healthiness/heaviness mental representation and the lateral display of food items (Deng & Kahn, 2009; Valenzuela & Raghubir, 2015). Several years ago, Arnheim (1957) suggested that from a pictorial point of view, the heaviness of an object is inexorably linked to an imaginary pattern increasing from left to right due to the "lever" effect. Based on the consideration that high-calorie/energy foods are perceived as heavier and unhealthier as compared to low-calorie foods (Charbonnier et al., 2016; Foroni et al., 2013), Deng and Kahn (2009) showed that high-energy foods ("heavier") were more likely represented in the lower-right area of the packaging facades. On the other hand, the most suitable position for the low-energy foods ("lighter") was in the bottom-left of the package. These findings are also congruent with the mental number line (MLN) theory, which states that several numerical magnitudes are mentally represented as increasing from left to right (Giuliani et al., 2021; Izard & Dehaene, 2008). This mental representation leads to a behavioral effect called Spatial Numerical Association of Response Codes (SNARC): responses given with the left hand are facilitated when the stimulus is associated to small magnitudes, on the contrary responses given with the right hand are facilitated when the stimulus is associated to large magnitudes (Dehaene et al., 1993; Giuliani et al., 2018). In the case of food choice one of the magnitudes increasing from left to right could be the food calories, which are negatively correlated to the perceived healthiness (Deng & Kahn, 2009; Foroni et al., 2013; Manippa et al., 2019). Nevertheless, a recent research revealed a

lack of association between space and food calories when processing speed (i.e., reaction time) was measured (Gurbuz & Gokce, 2021).

The existence of an association between space and healthiness have been, instead, confirmed with more ecological tasks involving food decision making. For instance, Romero and Biswas (2016) demonstrated that healthy products are mentally represented in the individuals' left space and that they are preferably chosen (and consumed) when placed on the left- rather than on the right side of the consumer. Manippa and coworkers (2020) confirmed the possibility to boost healthy food choices by arranging them on the left side (Vs. the right) of the consumer's visual field, congruently with the healthy-left mental mapping. The authors argued that displaying foods congruently with the horizontal mental representation could, through self-control facilitation, lead to healthier food choices. It remains unexplored whether the healthy-left nudge holds for those individuals that would like to consume their meal later, as it happens for take-away orders. Also, despite its key role in food liking and wanting (Finlayson et al., 2007; Hoefling & Strack, 2010; Padulo et al., 2018), no study has so far addressed the role of individuals' hunger in the healthy-left nudge effect. In fact, hungry individuals appear to be more susceptible to the appetitive properties of high-energy foods such as pizza and chocolate. This leads fasted participants to consume more unhealthy products compared to when they are sated (Finlayson et al., 2007; Padulo et al., 2018). More in general, hunger was identified as an essential factor influencing calorie consumption in interaction with impulsivity (Nederkoorn et al., 2006). However, no study so far assessed the influence of hunger on the effectiveness of healthy-left nudges.

In this brief report, we try to fill these gaps by rearranging the study 1A of Romero and Biswas (2016), in which participants were asked to choose a favorite product among four salads (i.e., the healthy products) and four burgers or sandwiches (i.e., the unhealthy products) listed on the two pages of a restaurant menu. Specifically, we asked our participants to self-report their psychophysiological state and to choose when eating the chosen product (now or later) with the aim to test if the healthy-left nudge works independently of participants' hunger. We point out that the ability to monitor one's physiological state and not to fall into food temptation requires higher-order cognitive processes, but nudges are assumed to align mainly with automatic processes (Marteau et al., 2011) related to immediate reward wanting due to the hungry state (Chen et al., 2016). For this reason, we hypothesized that the healthy-left nudge works better for hungry individuals that choose to eat the product immediately as compared to sated individuals that decide to delay the meal. The final aim of this research is to deepen knowledge about healthy-left nudge in order to improve the environmental interventions, such as menu design, capable of countering overeating.

Material and Methods

The whole procedure was carried out in accordance with the principles of the Declaration of Helsinki. The participants were recruited via snowball sampling sharing the 2 parallel versions of the online survey on Italian social networks. Initially, 434 participants started one of the two surveys but 48 did not complete them. The surveys were identical except for the placement in which products were displayed on the menu (see figure 1): particularly, in the first version the healthy options were displayed on the left side/page and the unhealthy ones on the right side/page (HL/UR) and vice-versa for the second version (UL/HR). The menu was the same as that used in the study 1A of Romero and Biswas (2016): the general layout and the food items presented were similar to those used by an actual restaurant to ensure ecological validity. Furthermore, the researchers verified through a pretest that individuals perceived the four salads healthier than the four burgers listed on the menu.

a)

b)

Figure 1. a) Healthy-Left/Unhealthy-Right (HL/UR) and b) Unhealthy-Left/Healthy-Right (UL/HR) arrangements of the menu used in the two versions of the survey. Each participant was asked to choose the favorite product from those listed on the menu (between conditions) and whether he/she would like to eat it immediately (*now*) or later on (*later*). The name of the products and their ingredients were printed in Italian (the original English version is available in the appendix of Romero & Biswas, 2016).

The survey was self-administered using Qualtrics (Provo, UT) and it was divided into four sections: after the informed consent section, the following statement (translated in Italian) was shown to the participant "Imagine being in a restaurant. Your physiological state (in terms of hunger) is that currently experienced. In the menu below the 8 main dishes of the restaurant are listed. Considering that all portions and prices across the different options are equivalent and that you can choose only one product to eat now or later, what would you like to order?". Below these instructions, only one of the two menus arranged according to an HL/UR or a UL/HR design was shown. Subsequently, the participant had to type the name of the favorite product in a proper response line by using the keyboard and then he/she had to flag the option "Eating immediately" or "Eating later". In the second section, participants responded to five Visual Analogue-Scales (VASs) investigating their current psychophysiological state and particularly their hunger, thirst, tired, (ranges 0 "not at all hungry/thirsty/tired" to 100 "very hungry/thirsty/tired") time since the last complete meal and time since the last food intake (ranges 0 "less than an hour" to 100 "more than five hours") (Foroni et al., 2013; Padulo et al., 2017). In the third section, they were invited to report their age, sex, weight, height, and feeding restrictions (e.g., religious restrictions, medical restrictions, vegetarianism, etc.). In the last session, participants filled out two questionnaires: the Edinburgh Handedness Inventory (Oldfield, 1971) and the Dutch Eating Behavior Questionnaire (Dakanalis et al., 2013; Van Strien et al., 1986). The final sample was composed of 192 participants who completed the HL/UR version and of 194 who completed the UL/HR version. The two groups were comparable for all the relevant independent variables assessed (see Table 1).

	Sex	FR	LH	Age	BMI	ReEt	EmEt	ExEt
	F/M	*N*	*N*	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*	*M (SD)*
HL/UR (n=192)	148/44	52	14	27.32 (6.58)	24.87 (4.18)	2.71 (0.88)	2.50 (0.95)	3.33 (0.56)
UL/HR (n=194)	150/44	59	15	27.42 (7.48)	24.00 (6.16)	2.57 (0.85)	2.58 (0.94)	3.20 (0.55)

Table 1. Statistical report of participants who completed the two parallel versions of the survey. FR = Feeding restrictions, LH = Left-handed; BMI = Body Mass Index (kg/cm^2), ReEt = Restrained eating score; EmEt = Emotional Eating score, ExEt = External eating score.

Data analysis

Our dependent variable was the number of healthy products (salads) chosen by participants. We ran a Chi-square test ($\chi 2$) to compare the distribution of the healthy products chosen from the HL/UR Vs. UL/HR menu. Then, we divided our sample according to their willingness to eat the product immediately (*now* responder, n = 186) or in a second moment (*later* responder, n = 200). To ensure that this index was related to the hunger and the distance from the previous meal, we ran five Student t-tests for independent samples to compare the psychophysiological state assessed by the five VASs of *now* Vs. *later* responders. We ran a Pearson's Chi-square test to test whether the distribution of healthy products chosen by the *now* and the *later* responders in the HL/UR Vs. UL/HR differed from chance. Finally, we compared through 2 Chi-square tests the distribution of the healthy products chosen in the HL/UR Vs. UL/HR separately for *now* and *later* responders.

Results

First, we did not find a preference for healthy items when they were displayed to the left (HL/UR menu) Vs. right (UL/HR menu) of the unhealthy items ($\chi^2 = 2.27$, $p = .13$; Figure 2a). The five t-tests for independent samples performed on psychophysiological state VASs showed that *later* responders scored lower in hunger ($t = 14.17$, $p < .001$), time since the last complete meal ($t = 5.79$, $p < .001$) and time since the last food intake ($t = 2.63$, $p = .009$) compared with *now* responders, while no difference was found for thirst and tiredness scores. Then, although the Pearson Chi-square test showed only a trend ($\chi^2 = 3.23$, $p = 0.07$), the *now* responders showed a significant healthy products preference in the HL/UR as compared to the UL/HR menu arrangement ($\chi^2 = 5.56$, $p = .02$) that was not observed in the *later* responders ($\chi^2 = 0.00$, $p = 1.00$; see Figure 2b). The complete data reports are available in supplementary materials.

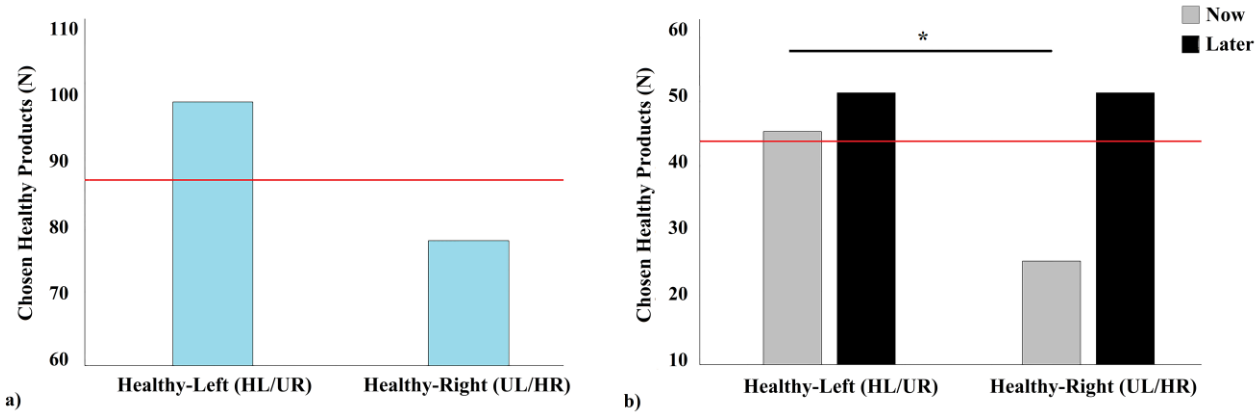

Figure 2. The main results of the experiment: a) number of healthy products chosen when they were displayed on the left (HL/UR group) Vs. on the right page (UL/HR group) of the menu; b) number of healthy products chosen for the *now* (grey bars) and *later* (black bars) responders in the HL/UR Vs. UL/HR groups. Red lines indicate chance probability (* = $p < .05$).

Discussion

In this experiment we tested whether individuals' hunger plays a role in the left-displayed healthy product preferences. First, we did not find a significant difference in healthy (as compared to unhealthy) items choice when they were displayed on the left Vs. the right page of the menu. Second, we found that this null result can be attributed to sated participants that decided to eat the product later. On the contrary, hungry participants who preferred to eat the product immediately, were nudged toward healthy (as compared to unhealthy) products when they were listed on the left page as compared to the right page. Although this result appears to be in contrast with previous ones reporting a generalized preference for left-displayed healthy products (Manippa et al., 2020; Romero & Biswas, 2016), our study is the first in which participants could decide when to eat the selected item. We point out that we divided our participants according to their willingness to eat the product immediately (*now* responders) or later on *(later*). Such variable was a good index of individuals' hunger state, since *now* responders reported to be hungrier and having eaten the last meal earlier than *later* responders.

Hence, our study demonstrates that the healthy-left nudge works only for individuals who decide to eat the chosen product immediately, suggesting that the healthy-left bias enhances self-control mainly in hungry individuals. We propose an explanation involving the dual-processing theories (Evans, 2008; Satpute & Lieberman, 2006). In particular, we suggest that the ability to delay the meal requires self-control, and this could reduce the nudging effects of the healthy-left bias. On the other hand, the choice of hungry individuals to eat immediately what chosen is mainly

mediated by automatic processes, and in this case the self-control enhancement caused by the healthy-left bias could be more effective (Chen et al., 2016; Marteau et al., 2011). Hunger is an empirical strategy used to decrease self-control in a wide range of experiments. For instance, a paper (Gailliot, 2013) demonstrated that higher levels of hunger predicted reduced self-control in terms of increased racial prejudice, sexual infidelity, passivity, accessibility to death thoughts and perceptions of task difficulty, as well as impaired Stroop performance and decreased self-monitoring. In addition, increased rates of hunger measured across 200 countries predicted increased war killings, suggestive of reduced aggressive restraint. Regarding eating behavior, hunger indirectly triggers unhealthy high-calorie food consumption through its positive effect on the incentive value (or "wanting") for food (Cheval et al., 2017). Our findings demonstrate the possibility to nudge healthy food choice contrasting the general lack of self-control due to hunger. Such experiment should be replicated in a real context in which the cost of the products and the sociocultural environment could moderate these effects.

Researchers have proposed various theories to explain the healthy-left/unhealthy-right bias such as a calorie/healthiness MNL and the consequent SNARC effect. The presence of an association between space and calories is expected to lead to a faster processing of lower (higher) calorie magnitudes on the left (right) side. Despite that, in three experiments, Gurbuz and Gokce (2021) demonstrated that the non-numerical SNARC effect cannot be generalized to the food calorie domain. Differently, in other experiments involving decision-making tasks, a consistency in the associations between healthy food and the left visual field has been confirmed. For instance, Manippa and coauthors (2022) reporting an increased liking for low-calorie food and a decreased liking for high-calorie food when shown on the left side of the consumer. This result is congruent with the theory proposed by Manippa and coworkers (2020), in agreement with Romero and Biswas (2016): the arrangement of food congruently with the heaviness/healthiness horizontal mental representation could facilitate higher-level information processing, which should in turn enhance self-control and resistance to temptation, leading to healthier food choices. We point out that in Experiment 4 of Manippa and coworkers' (2020), in which the healthy-left nudge had been observed in a paired food choice task, participants were sated. In that case the task request was to choose the "product they wanted to eat at that moment", a condition comparable with the choice of our *now* responders. On the other hand, the question of study 1A of Romero and Biswas was vague from a temporal point of view and the hunger of participants was not assessed (2016). Researchers should not neglect the influence of hunger on all studies investigating food choice, preferences, and nudges. Our data shed light on the influence of participants' hunger and, more in general, on the delayed time they were supposed to eat the purchased products, concerning the healthy-left nudge.

Conclusions, limitations, and future directions

Our study suggests that i) the healthy-left nudge is not very effective when participants are free to choose when consuming the product; ii) those who want to eat the product immediately were mainly hungry individuals and iii) only these latter participants were more likely to choose healthy products (salads) when they were displayed on the left side of the unhealthy products (burgers and sandwiches) as compared to a specular arrangement. To sum up, the healthy-left/unhealthy-right bias nudges healthier choices mainly in hungry people that would like to consume the products immediately enhancing their self-control.

Our study is not without limitations. Particularly, since participants were recruited using posts on social media, our sample was composed mainly of young adult normal-weight females. A recent study provides evidence that, beside the hunger, several variables such as sex, age, education and BMI can affect the effectiveness of food nudges (Dolgopolova et al., 2021). The role of such sociodemographic variables on the modulation of healthy-left nudge effectiveness should be deepened by future studies. Further, it is well-known that reward sensitivity plays a role in overeating whereas prepotent response inhibition could works as a protective factor (e.g., Guerrieri et al., 2007, 2008). For instance, Cheval and coworkers (2017) demonstrated that impulsive approach tendencies toward healthy food play a protective role by preventing unhealthy food consumption and wanting. Another study reported that restrained eating (i.e., the intention to restrict food intake deliberately in order to prevent weight gain or to promote weight loss) but not emotional and external eating, predicts dietary behavior in obese participants (Brogan & Hevey, 2013). Thus, the cognitive control/impulsivity traits and specific eating traits should be deepened in the context of healthy-left nudge.

Finally, we encourage the use of non-ready-to-eat food lists, such as grocery flyers, to test the effect of healthy-left nudge on even longer-term purchases. In fact, our products are expected to be consumed within few hours, while in the grocery it is possible to buy products that will be consumed following several days. The final step should be the translation of these preliminary findings into ecological contexts (e.g., restaurants, grocery stores) in order to evaluate the real impact on calorie and food consumption. The possibility to nudge consumers toward healthier lifestyles is a growing field of research (Papies, 2016). Particularly the manipulation of menu design and layout could play a key role in slowing the rising of obesity incidence (Bergeron et al., 2019; Dayan & Bar-Hillel, 2011; Ozdemir & Caliskan, 2015). Rozin state that “Very small but cumulated decreases in food intake may be sufficient to have significant effects, even erasing obesity over a period of years” (Rozin et al., 2011). We hope our study will draw attention to the potential benefit that simple and convenient changes, as the food arrangement on a menu, could have on public health.

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