BEHAVIORAL INTERVENTIONS RELATED TO CHOICE DECISIONS: CONVENIENCE AND VISIBILITY INTERVENTIONS VERSUS TASTE PREFERENCE

Rapeepat Manasoontorn[1]

ABSTRACT *Successful behavioral interventions for reducing the consumption of unhealthy food can ease the burden of non-communicable diseases and their economic cost. In prior research, conventional approaches such as the provision of nutritional information were not able to overcome the impact of tasty but unhealthy food. Thus, this study was designed as a field experiment at a casual restaurant to assess the effect of taste using a behavioral approach; namely, a combination of convenience and visibility enhancements of healthier meal choices. The results of this study show that increasing the difficulty of ordering high-calorie food along with decreasing their visibility can reduce calorie intake and compensate for the calorie increase caused by ordering according to taste. However, there are differences in the effectiveness of interventions according to types of participant.*

KEYWORDS: *behavioral economics, taste, food decision, field experiment*

INTRODUCTION

It is evident that non-communicable diseases (NCDs) are one of the leading preventable causes of disease and death throughout the world. The death toll from NCDs is unprecedentedly high. These diseases create costs that extend beyond health issues – causing people to miss work, weakening workforce productivity, dampening economic growth, and creating disparities in opportunity, wealth,

1 Rapeepat Manasoontorn is Phd Candidate in the School of Development Economics, National Institute of Development Administration (NIDA), Thailand; email: topped_rm@hotmail.com. Author received support from National Institute of Development Administration and Barefoot Cafe.

and power (Bloom et al. 2011; World Health Organization [WHO] 2018). Over the next twenty years, Bloom et al. (2011) estimated that dealing with NCDs could cost more than US$30 trillion, and predicted that a significant persistent economic impact could be expected worldwide. In particular, dietary behavior has become more of a main risk factor in this regard. For example, the prevalence of obesity among adults (those aged 18 years and above) has increased dramatically to around 650 million people throughout the world (World Health Organization [WHO] 2018).

Previous interventions have focused mainly on persuading people to take better care of themselves by providing them with information about how to stay healthy. In order to encourage people to act in their own best interests in terms of their health, behavioral economists have introduced interventions that subconsciously nudge people to make decisions that optimize long-term benefits while at the same time not precluding the familiar lifestyle behaviors with which they are comfortable.

The focus and attention of economists have shifted from assuming the rational decision-making of individuals towards hypothesizing a limited role for rationality in decision-making. Previously, standard economic theories assumed that individuals made decisions rationally, but failed to explain the decisions that individuals make when, for instance, they make choices that are not in their best interest, or are sometimes even harmful to themselves. Food choices are perfect examples of such irrational decision-making, where the visibility, desirability, and availability of particular food items dominate decision-making (Cohen & Farley 2008; Marteau et al. 2012; Wansink & Sobal 2007).

Recently, behavioral economic theories have been implemented in the healthcare sector to address the risk behaviors that have resulted in poor health and increased healthcare costs. Behavioral economic interventions, employed to tackle risky behaviors in the context of NCDs, need to alter unhealthy eating habits and to have an adequate impact in order to mitigate the significant death toll from NCDs. This paper aims to identify behavioral interventions that are more effective at changing unhealthy eating behaviors and to investigate their impact and how they work. Successful behavioral interventions that reduce the consumption of unhealthy food will ease the burden of NCDs.

Based on the sizes of effects investigated per intervention type in prior research, it is anticipated to be convenience enhancements that are among the most effective interventions, being more robust than nutrition labeling. There are two main reasons why labeling may have limited effects. First, nutritional information alone cannot overpower other influences such as an unpalatable taste, or dislike of low-sugar or low-salt and low-fat food (Thunstorm & Nordstrom 2015), or the delayed benefits of having better health after healthy

eating (Lynch & Zauberman 2006; Rick & Loewenstein 2008). Second, when consumers are hungry, they tend to be in immediate need of food and thus are less motivated to process nutritional information before deciding what to eat (Wisdom, Downs, & Loewenstein 2010).

Arguably, the power of combined cognitive and behavioral interventions may prevail over taste preferences, but this statement still needs to be proven. Therefore, the present research is designed to assess the effects of a taste and eating-related behavioral intervention – namely, a combination of convenience enhancements and visibility enhancements of healthy meal choices compared with visibility enhancements alone.

The behavioral bias exploited in this research is the present-biased preference. We address this through convenience and visibility interventions that are intended to increase the immediate cost (in terms of effort) to consumers of ordering tasty but less healthy meals, thereby offsetting the immediate benefit of the former.

Interestingly, no studies in Thailand have examined the combined effect of interventions and taste controlling. The hypothesis is that combining convenience and visibility interventions can overcome the taste effect of less healthy food choices, and that the effectiveness of combined interventions is higher than visibility interventions alone. However, without the influence of taste, the effectiveness of combined interventions may be even greater.

The intention behind this paper is twofold. First, to explore the effectiveness of a combination of convenience and visibility interventions on food intake when individuals' experienced taste regarding food is taken into account. Second, to investigate whether other factors, such as individuals' eating behavior and demographic characteristics, influence the effectiveness of such interventions.

THEORETICAL BACKGROUND

Traditional interventions, such as subsidies for healthy foods or taxes on unhealthy foods and nutrition-related education, have been employed to tackle the aforementioned problem. In spite of these interventions, results indicate that the adult obesity rate has not yet subsided (World Health Organization [WHO], 2018). Afshin et al. (2017), who conducted a meta-analysis of healthy-food-subsidy- and unhealthy-food-tax-related studies, found that healthy food subsidies are more effective than taxing unhealthy food. Taxing sugary beverages has only a moderate effect on normal-weight individuals, and no effect on overweight individuals. These results suggest the possibility that other factors,

such as nutrition-related education or food attractiveness, should be involved in subsidizing and taxing interventions. Murimi et al. (2017) studied nutrition-related educational interventions (e.g., counseling and education about the need to increase fruit and vegetable consumption) and suggested that insufficient time spent on interventions, incomplete intervention delivery, and inadequate support for the "choice environment" contribute to less effective interventions.

In the last few years, evaluating the health consequences of eating habits has loomed as an influential and meaningful research topic (Antunez, Gimenez, & Alcaire 2017; Jo & Lusk 2018; Kurz 2018; Oliveira, Ares, & Rosires 2018; Tangtammaruk 2017). The research objective here is to explore the important but overlooked factors in unhealthy eating. Among such factors is the fact that consumers may intuitively be drawn to a particular food because of its unhealthiness.

"Tasty = unhealthy?"

Taste is generally cited as the foremost reason, or among the top reasons, for consumers choosing particular foods, followed by health concerns and other reasons (Glanz, Basil, Maibach, Goldberg, & Snyder 1998; Lennernas et al. 1997; Tepper & Trail 1998). Consequently, it is very difficult to promote healthy food because taste is often enhanced by the addition of unhealthy ingredients such as sugar, fat, and salt (Drewnowski 1997), and consumers are not willing to substitute taste for the putative health benefits of less tasty food (Verbeke 2006).

Educating consumers about the health benefits of good nutrition not only contributes to changing their perceptions about health, but also to their perceptions with regard to taste (Teisl, Bockstael, & Levy 2001; Mai & Hoffmann 2015). Previous research has revealed a negative relationship between perceived healthiness and taste. Raghunathan et al. (2006) found support for the intuition that "tasty=unhealthy" in that consumers saw less healthy food as tasting better and being more enjoyable to consume, and thus preferred by consumers who value joyful eating over health. They also concluded that American consumers tend to over-consume unhealthy foods because they subconsciously consider unhealthy foods to taste better than healthy foods.

In spite of the strong "tasty=unhealthy" association, there is some evidence of a positive relationship between health and taste. For example, Chinese consumers, unlike their American counterparts, were found to tend to view healthy foods as tasty (Jo & Lusk 2018). Likewise, Jo, Lusk, Muller, and Ruffieux (2016) and Werle, Trendel, and Ardito (2013) found evidence that the equation "tasty=unhealthy" may not be universal. In fact, they found evidence for the

opposing association ("tasty=healthy") in France, where healthier food is rated as tastier. Ultimately, Werle et al. (2013) concluded that cultural and product differences play a role in the variety of consumer perceptions.

Some other groups have also been shown to less strongly associate "tasty" with "unhealthy" (Howlett, Burton, Bates, & Huggins 2009; Irmak, Vallen, & Robinson 2011). Evidence has indicated that health-conscious consumers tend to believe that their actions matter to their health, and thus engage in more preventive health activity than less health-conscious consumers (Gould 1988; Jayanti & Burns 1998). Furthermore, Verbeke (2005) found that both female and older consumers are willing to substitute some loss of taste for the greater health benefits of functional foods. Also, when there is a dire need for food, such as in some underdeveloped countries where some people survive on barely enough food, tastiness is believed to have a positive relationship with healthiness (Drewnowski 1997; Smith 2004).

Heuristics, biases and interventions

Consumers make quite a number of meal-related decisions per year, and food choices involve a complex process that is influenced by many factors – for example, the characteristics of products, the consumers themselves, and context. In order to ease decision-making, these decisions are deeply influenced by heuristics – a rapid form of thinking that creates sufficient but not optimal solutions to accelerate the decision-making process (Wansink & Chandon 2006; Haws, Reczek, & Sample 2017).

To help consumers make healthier meal choices, given that people's choices are not fully rational, interventions that alter the environments in which people make decisions are needed and have become more popular. Hollands et al. (2013) defines interventions as consisting of the changing of various properties; i.e., the placement of items or stimuli as a part of "small environments" with the aim of subconsciously influencing people's behavior via "choice architecture."

These "changing proximity" interventions rely on present-biased preferences. Individuals who have present-biased preferences more highly value present payoffs in relation to future payoffs (O'Donoghue & Rabin 1999). In the context of eating behavior, people's time-inconsistent preferences cause them to choose less healthy food in the present at the expense of poor health in the future. Interventions that affect such present-biased preferences thus need to put disproportionate weight on favoring healthier options.

Changes in convenience – either making healthier food more convenient or making less healthy food less convenient – have been shown to reduce food

intake (Hanks, Just, Smith, & Wansink 2012; Rozin et al. 2011; Wisdom, Downs, & Loewenstein 2010). This is equivalent to adding an extra cost to the "present" by making unhealthy options less accessible. After a period of time, making unhealthy food harder to access helps contribute to body weight loss and is potentially an exceptional strategy among all other healthy eating strategies (Meiselman, Hedderley, Staddon, Pierson, & Symonds 1994; Rozin et al. 2011). In addition, making healthy food more visible by changing the order of items on a menu, or serving healthy food first can increase healthy food ordering and consumption (Dayan & Bar-Hillel 2011; Elsbernd et al. 2016; Kurz 2018). Despite significant results with convenience and visibility interventions, Painter, Wansink, and Hieggelke (2002) went on to test the effectiveness of both convenience and visibility simultaneously and found that food that is more convenient to consume contributes more to overeating than does its visibility.

Other studies have found different results. Harnack et al. (2012) show that serving both fruit and vegetables before other meal items increases only fruit intake but not that of vegetables, which may reflect a compensation mechanism between fruits and vegetables and other menu items. Worst of all, de Wijk et al. (2016) found that making whole grain bread more accessible compared to white bread does not increase its sales. This lack of effect may be explained by a couple of factors. First, people with strong preferences might not primarily be affected by the intervention (Kurz 2018). Second, the effectiveness of interventions is context specific (de Wijk et al. 2016). Hence, interventions require a certain degree of effectiveness if they are to influence consumer decision-making.

Which behavioral intervention is the most effective?

Cadario & Chandon (2019) reanalyzed data in a meta-analysis of healthy eating interventions and made comparisons between them. They divided seven interventions into three types of "nudges" – namely, cognitively oriented nudges, affectively oriented nudges, and behavioral-oriented nudges. First, cognitively-oriented nudges are interventions that attempt to change people's thoughts. For example, food labeling gives nutritional information to people, and visibility enhancements indirectly change information about food options. Second, affectively oriented nudges attempt to change people's feelings without changing their thoughts. These interventions provide hedonic enhancement in the form of attractive pictures of food or mouth-watering food descriptions. Third, behavioral-oriented nudges attempt to change people's behaviors unconsciously. Changes in convenience are located in this category.

Comparison of each intervention type shows that the size of effects increases when changing from cognitively oriented nudges to behaviorally oriented nudges. Interestingly, the best intervention may be expected to be six times more effective than the average intervention, and interventions are more effective at reducing unhealthy eating than increasing healthy eating or reducing eating per se (Cadario & Chandon 2019).

These results give insight into where follow-up research should be heading. First, conducting a study on behavioral interventions for reducing unhealthy eating is likely to be the more effective approach. Second, the lack of evidence regarding the effectiveness of combined interventions should encourage the further study of the effectiveness of mixed interventions such as a combination of behaviorally oriented nudges and other nudges.

METHODOLOGY

Experimental design

The following procedure, as shown in Figure 1, was employed in the study.

Figure 1 *Steps in the experiment*

Step 1	Participants are recruited	PARTICIPANTS
Step 2	Participants rate tastiness of seven pasta dishes	INTERVENTIONS
Step 3	Participants order food from menu	
Step 4	Participants answer surveys	MEASURES

Participants

Three hundred and ninety participants were recruited in this study over a six-month long experiment (15 February 2019 – 15 September 2019) at an Italian fusion restaurant called Barefoot in Chiangmai, Thailand. The experiment was conducted every day during lunch time from 11 A.M. to 3.00 P.M. except on Tuesdays and Wednesdays, when the restaurant was closed. Participants were invited, through a separate advertisement posted in the restaurant and via the

restaurant's social media, to participate in a taste experiment. Participants who agreed to participate needed to buy a lunch set (pasta dish, side dish, drink, and sweet) priced at 300 Thai baht (3,000 Hungarian Forints). A lucky dip draw to win a 1%, 10%, 20%, or 50% discount or a free meal at the restaurant was offered to participants who completed the taste experiment and survey.

Interventions

The study implemented a 2 (taste experiment or not) × 3 (visibility of most calorific, least calorific, or a mix of pasta dishes) × 2 (least convenient of most calorific pasta dishes or not) experiment.

Taste experiment

Participants were invited to the restaurant and lined up to taste the pasta dishes. Different flavored pasta dishes, labeled A to H, were assembled on small plates in equal one-bite-size portions for each participant and were presented one at a time in a random order. The participants were asked to score the taste of the eight different pasta dishes on a scale from "1" ("very poor") to "7" ("very good"). The scores were written down on the form that was provided.

Visibility intervention

After having rated the taste of the different pasta dishes, participants were asked to pick their meal from the menu, first choosing a pasta dish from the pasta dishes they had just tasted, followed by a side dish (seasonal salad, Caprese salad, fried tofu, or potato fries), a drink (latte, milk tea, green tea, or water), and a sweet (panna cotta or Greek yogurt). The presentation of side dishes, drinks, and sweets on the menu was the same across treatments.

The visibility intervention was applied in this experiment by listing the non-highlighted items after the highlighted pasta dishes on the menu. The highlighted menu, however, listed two of the eight pasta dishes. This menu consisted of three treatments, either 1) the two most calorific (carbonara pasta and lasagna), 2) the two least calorific (olio mushroom pasta and chicken sausage pasta), or 3) a mix of both types of pasta dishes (carbonara pasta and olio mushroom pasta), as the status-quo control environment.

Convenience intervention

The convenience intervention came into play when participants choose the pasta dish from the supplementary menu. Participants were given instructions at the bottom of the main menu that said that they could either order the pasta dish from the main menu or the supplementary menu, but that the latter menu was on the back of the menu page. Also, participants needed to write down the name of the dish from the supplementary menu. However, the participants only needed to check off their choice of pasta dish on the main menu.

Both convenience and visibility interventions were implemented only for a choice of pasta dishes so as to observe the compensatory effect on non-pasta dishes. This is because making a choice between the least calorific pasta dishes might have caused participants to compensate themselves with higher-calorie side dishes, drinks, and sweets later on.

Measures

Following meal selection, participants were asked to complete the survey and were informed once again that they would be awarded a random draw of either a discount coupon or a free meal coupon for participating in the taste experiment after they had finished their meals.

Effect of interventions on total calorie intake and pasta calories

The impact of both visibility and convenience interventions on total calorie intake and pasta calories were estimated with Ordinary Least Square (OLS) regression, controlling for taste and participant characteristics. A separate OLS was estimated to examine the compensatory effect on the calorie intake of non-pasta dishes (side dish, drink, and sweet).

Effect of interventions on least calorific dishes

To control for both the impact of taste and the interventions on the choice of the two least calorific pasta dishes, logistic regression was estimated.

Dependent variables and explanatory variables included in this model are as follows:

Table 1 *Variables and definitions*

Variable	Definition
totalcal	Total calorie intake of participant's meal
choselowcalpasta (dummy)	Choice of low-calorie pasta, taking value of "1" if participant chooses one of the two least calorific pastas (olio mushroom pasta & chicken sausage pasta), and "0" otherwise
pastacal	Pasta calorie intake of participant's meal
nonpastacal	Non-pasta calorie intake of participant's meal (side dish, drink, and sweet)
taste (dummy)	Participant involvement in the taste experiment, taking value of "1" if participant engages in the pasta taste experiment or otherwise "0"
vishigh (dummy)	Visible intervention on most calorific pasta menu, taking value of "1" if participant receives this menu, and "0" otherwise
vislow (dummy)	Visible intervention on least calorific pasta menu, taking value of "1" if participant receives this menu, and "0" otherwise
vismixed (dummy)	Visible intervention on mix of both most and least calorific pasta menu, taking value of "1" if participant receives this menu, and "0" otherwise
visconhigh (dummy)	Visible and convenient intervention on most calorific pasta menu, taking value of "1" if participant receives this menu, and "0" otherwise
visconlow (dummy)	Visible and convenient intervention on least calorific pasta menu, taking value of "1" if participant receives this menu, and "0" otherwise
visconmixed (dummy)	Visible and convenient intervention on mix of both most and least calorific pasta menu, taking value of "1" if participant receives this menu, and "0" otherwise
age	Participant's age
bmi	Body Mass Index is ratio of participant's weight (kilograms) to square of participant's height (meters)
female (dummy)	Female participant, taking value of "1" if participant is female, or "0" otherwise
diet (dummy)	On diet participant, taking value of "1" if participant states that he/she is currently watching or restricting their number of calories, and "0" otherwise
yearedu	Participant's years of education
income	Participant's monthly salary, ranging from "1" (below 5,000 baht) to "7" (30,001 and higher)
enjoymeal	Participant's response to "How much do you think you will enjoy your meal?", on a scale from "1" (won't enjoy very much) to "7" (will really enjoy it)
hungry	Participant's response to "How hungry do you feel right now?" on a scale from "1" (not at all hungry) to "7" (extremely hungry)

RESULTS

Participants

A total of 390 participants engaged in the experiment (180 in visibility treatment, 180 in visibility and convenience treatment, and 30 in super control treatment). The majority of participants reserved seats in advance to take part in the experiment. Sixty-five percent were female, 94.36 percent Thai, 4.6 percent other Asian, and 1.04 percent American/European. The average age of participants was 29.77 years old, and ages ranged from 5 to 69. The average body mass index (BMI) of participants, calculated from participant-reported weight (kilograms) divided by squared height (meters), was 22.62, ranging from 13.76 to 37.83.

Twenty four percent of participants were overweight according to the commonly accepted threshold (BMI $\geq$ 25). Thirty-three percent of participants reported that they were currently dieting. Participants reported a mean hunger level of "6" and a mean anticipated meal enjoyment of 4.97 (both on 1-to-7 scales). The majority of participants reported that their income was higher than 30,001 Thai Baht (300,000 Hungarian Forints) per month and two-thirds of participants reported that they visited the Barefoot restaurant where the study was conducted about once a year or less. Participants' educational level was a bachelor degree on average.

Tastiness versus healthiness

Figure 2 shows how each pasta type, tastiness, and the calories of pasta items interact. Lasagna was the most preferred dish, whereas olio mushroom, chicken sausage, and bacon sun-dried chili were among the least preferred. The average taste scores for all pasta alternatives range from 4.24 to 5.84 (on 1-to-7 scales), and the average taste scores for the top two least calorific pastas was 4.29 (healthy alternative) and 5.22 (unhealthy alternative) for the top two most calorific types of pasta, and an average of 4.76 across all pasta dishes.

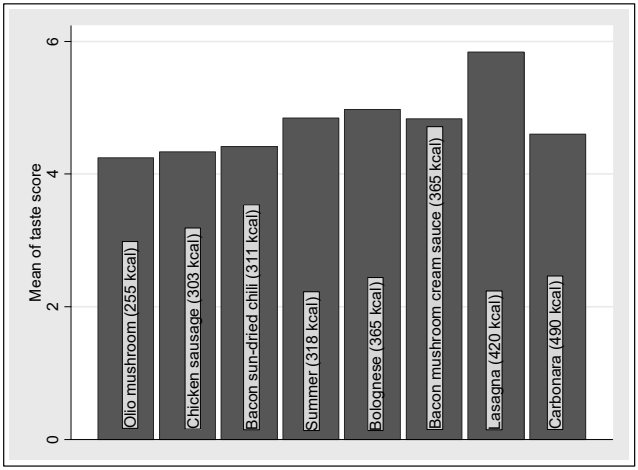
Taste tends to be positively related to calories because taste is boosted by fatty, sugary, and salty components, which are unhealthy. That is, the mean taste score of pasta was strongly related to number of calories, if the five lowest calorie pastas are considered ($r = 0.81$, $p < 0.1$). Results seem to support the UTI (unhealthy=tastiness) hypothesis in which tastiness and healthiness are negatively related. Essentially, tastiness is enhanced by unhealthy food

ingredients. Without considerations of health consciousness and other influencing environments, food choices are mainly based on food flavor.

The taste experiment was included in the regressions to estimate the impact of taste and visibility and convenience on pasta choice and calorie intake. The results of the taste experiment are reported first, followed by those of the regressions on calorie intake determinants.

The results of the taste experiment confirm a strong positive effect of taste on calorie intake (Figure 3). When compared to the no-tasting group, the tasting treatment led to higher calorie intake in every menu offered. Statistically, if participants awarded taste a score of more than "4" to any type of pasta, this reduced their chance of picking a low-calorie pasta by 41%. Taste boosted pasta calories and meal total calories by around 30 calories and 100 calories, respectively.

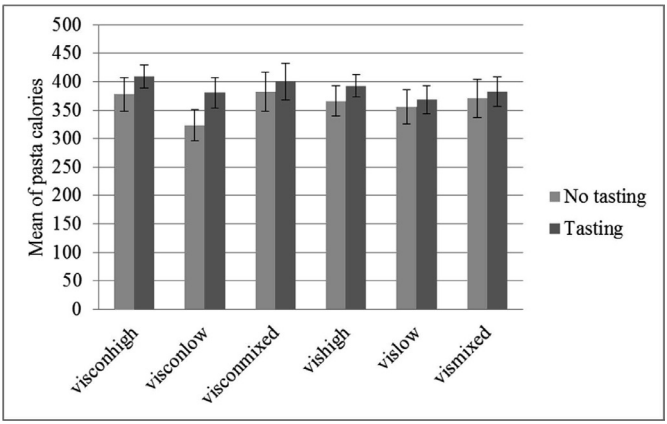
Figure 2 *Taste score*



Surprisingly, participation in the tasting treatment not only had an effect on pasta calories but also non-pasta calories, even if participants tasted only pastas. It is possible that the taste of pasta may have worked as an anchor that strongly influenced non-pasta orders. Participants tended to order more non-pasta calories when they tasted pastas first.

Overall, the results imply that the less healthy the food, the higher the taste score and the more calories consumed by participants.

Figure 3 *Comparison of mean pasta calories consumed and 95% confident intervals across menu*



Nudge effects on pasta and meal calories

A regression analysis was implemented to test the hypotheses and the impact of nudge effects on calorie intake, with controls for demographic characteristics. At the designated restaurant, the salience of the low-calorie or high-calorie or mixed-calorie pastas was increased by adjusting the menu (visibility) and manner of ordering (convenience). Table 2 separates the results into three types by interventions: 1) only visibility, 2) visibility and convenience, and 3) aggregating 1 & 2.

Visibility

Two dummy variables of nudges were included in the regression to test the visibility effect of both least calorific and most calorific pasta menus, compared to the mixed-calorie pasta menu. In the visibility intervention (Column (1) in Table 2), the least calorific menu *(vislow)* had a significant negative impact on total meal calories with an estimated coefficient of −50.17, even though it was intended to refer directly to only the pasta menu. However, the most calorific menu did not significantly affect total meal calories.

Table 2 *Regression on total calorie consumption & pasta calorie consumption*

VARIABLES	(1) Visibility	(2) Visibility and Convenience	(3)All	(4) Visibility	(5) Visibility and Convenience	(6)All
	Total calorie	Total calorie	Total calorie	Pasta calorie	Pasta calorie	Pasta calorie
taste	121.6*** (23.91)	91.27*** (27.20)	106.1*** (17.79)	13.45 (11.68)	39.31*** (12.20)	26.61*** (8.287)
vishigh	20.67 (28.06)		-15.88 (26.07)	3.722 (13.70)		-7.019 (12.15)
vislow	-50.17* (29.20)		-82.31*** (26.36)	-18.14 (14.26)		-24.73** (12.28)
age	-4.171** (1.765)	-2.567* (1.453)	-2.665** (1.063)	-1.493* (0.862)	-1.452** (0.652)	-1.542*** (0.495)
bmi	11.92*** (2.734)	8.074** (3.689)	9.425*** (2.201)	2.749** (1.335)	1.853 (1.655)	2.136** (1.025)
female	-0.730 (24.97)	29.44 (29.06)	16.71 (18.94)	-9.974 (12.19)	12.91 (13.04)	1.810 (8.824)
diet	-82.40*** (25.15)	-15.42 (29.10)	-46.14** (18.98)	-2.688 (12.28)	-3.753 (13.06)	-1.902 (8.845)
yearedu	3.031 (5.301)	8.237 (6.357)	6.159 (13.06)	-0.109 (2.588)	1.677 (2.852)	1.535 (1.890)
income	6.301 (6.928)	0.0248 (7.544)	1.295 (5.012)	0.184 (3.383)	3.085 (3.385)	1.334 (2.335)
enjoymeal	-9.596 (13.12)	0.467 (14.78)	-4.786 (9.696)	-2.560 (6.404)	2.015 (6.632)	0.634 (4.517)
hungry	25.24*** (8.902)	28.23*** (10.09)	25.00*** (6.644)	-6.133 (4.347)	6.611 (4.529)	-0.559 (3.095)
visconhigh		-53.84* (32.40)	-20.58 (26.12)		0.729 (14.54)	10.05 (12.17)
visconlow		-84.36*** (31.78)	-55.64** (25.42)		-41.07*** (14.26)	-30.37** (11.84)
Constant	464.2*** (133.7)	420.6*** (155.9)	445.6*** (101.7)	409.5*** (65.27)	279.4*** (69.95)	338.3*** (47.37)
Observations	175	174	349	175	174	349
R-squared	0.305	0.170	0.209	0.103	0.166	0.110

*Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1*

Visibility and convenience

Results indicate that visibility and convenience can influence calorie intake ($B = -84.36$, $p < 0.01$) almost as much as taste ($B = 91.27$, $p < 0.01$) if only total meal calories are considered (Column (2)). Visibility and convenience

interventions on the low-calorie menu (*visconlow*) led participants to order significantly fewer calories.

Interestingly, when considering only pasta calories, which is what was intended from the menu, visibility and convenience combined in the low-calorie menu to outperform the taste effect. In terms of numbers, visibility and convenience reduced the pasta calories consumers ordered by 41.07 calories compared to a 39.31 increase in pasta calories by taste (Column (5)). That is, taste had less power to influence what participants would eat than the environments did during the decision-making.

Aggregating all interventions

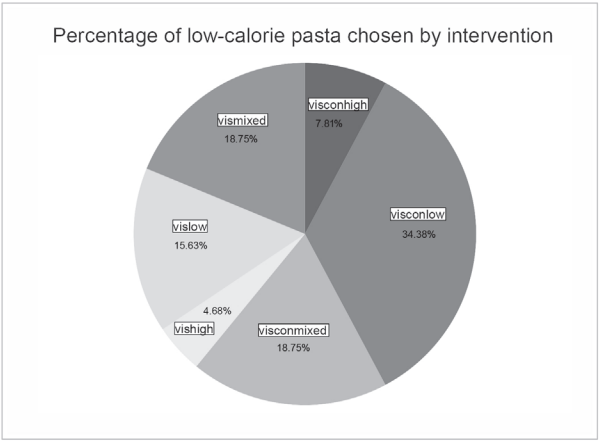
Comparison of the impact of the two interventions on total calories and pasta calories can be observed in Columns 3 & 6 in Table 2. The significant negative interaction between the visibility intervention and total calories signifies that weaker intervention (only visibility: *vislow*) had a significantly larger impact on total calories ($B = -82.31$, $p < 0.01$) than did stronger intervention (both visibility and convenience interventions: *visconlow*) ($B = -55.64$, $p < 0.05$) (Column (3)). However, this effect could not overpower the taste effect ($B = 106.1$, $p < 0.01$). When considering pasta calories instead of total calories, the effect was the opposite. The stronger intervention ($B = -30.37$, $p < 0.05$) overpowered both the weaker intervention ($B = -24.73$, $p < 0.05$) and taste ($B = 26.61$, $p < 0.01$) (Column 6).

While overall calorie intake can be decreased with the help of nudges, the data show that some participants' characteristics may also strengthen nudge power. Older participants and those who self-reported being on a diet consumed significantly fewer total calories. However, participants with higher BMIs and levels of hungriness took in more calories (Table 2). Surprisingly, female participants tended not to order low-calorie pasta, and education, income, and enjoyment were not significant.

Pasta versus non -pasta calories and compensatory effect

Figure 4 gives a brief overview of how each intervention interacted with low-calorie pasta choice. Visibility on the least-calorific menu combined with convenience responded best to low-calorie pasta choice, while visibility on the most-calorific menu alone or combined with convenience were among the worst. Thirty-five percent of participants who received visibility plus convenience on the least-calorific menu chose low-calorie pasta.

Figure 4 *Proportion of diners choosing low-calorie pasta according to intervention (%)*



The reasons why each intervention worked (or not) were explored further through separate regressions. The determinants of low-calorie pasta choice and non-pasta calories (side dish, sweet, and drink) were regressed (Tables 4 & 3).

The visibility intervention alone on the low-calorie menu (*vislow*) or visibility and convenience combined on the high-calorie menu (*visconhigh*) may have significantly helped participants but could have indirectly resulted in total calorie reduction (Columns 2 & 3 in Table 3) through decreasing by 57.78 and 54.57 non-pasta calories, respectively (Columns 1 & 3 in Table 3).

Table 3 *Regression on non-pasta calorie consumption*

VARIABLES	(1) All	(2)Visibility	(3) Visibility and Convenience
taste (dummy)	79.48*** (15.57)	108.2*** (21.25)	51.96** (23.58)
vishigh (dummy)	-8.858 (22.82)	16.95 (24.93)	
vislow (dummy)	-57.58** (23.07)	-32.03 (25.94)	
age	-1.122 (0.930)	-2.678* (1.569)	-1.115 (1.260)
bmi	7.288*** (1.926)	9.166*** (2.429)	6.221* (3.198)

female (dummy)	14.90 (16.58)	9.244 (22.19)	16.53 (25.20)
diet (dummy)	-44.24*** (16.62)	-79.71*** (22.35)	-11.67 (25.22)
yearedu	4.624 (3.552)	3.140 (4.711)	6.560 (5.511)
income	-0.0392 (4.387)	6.117 (6.156)	-3.060 (6.540)
enjoymeal	-5.420 (8.487)	-7.036 (11.65)	-1.549 (12.81)
hungry	25.56*** (5.816)	31.37*** (7.911)	21.62** (8.749)
visconhigh (dummy)	-30.63 (22.86)		-54.57* (28.09)
visconlow (dummy)	-25.27 (22.25)		-43.29 (27.55)
Constant	107.3 (88.99)	54.76 (118.8)	141.2 (135.1)
Observations	349	175	174
R-squared	0.174	0.290	0.109

*Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1*

Additionally, logistic regression was applied to examine the effectiveness of interventions on the choice of low-calorie pasta (Table 4) where the reported parameters were the regression coefficients. Table 4 (Columns 1 & 3) shows that there was neither significant impact on pasta choice when applying a visibility intervention on the low-calorie menu *(vislow)* nor on visibility and convenience intervention on the high-calorie menu (*visconhigh*), although interventions were intended to affect pasta decisions. These findings lead to the explanation that there was a potential trade off or compensatory effect between consuming higher calorie pasta and then consuming fewer non-pasta calories. Participants who ordered higher calorie pasta may have later preferred to reduce overall calorie intake by ordering fewer non-pasta calories. It is worth noting that this effect was eliminated when drink-related calories were excluded.

Table 4 *Logistic regression on choice of low-calorie pasta*

VARIABLES	(1) All	(2) Visibility	(3) Visibility and Convenience
taste (dummy)	-0.992*** (0.207)	-0.642** (0.297)	-1.328*** (0.323)
vishigh (dummy)	-0.868** (0.360)	-0.974** (0.385)	
vislow (dummy)	-0.104 (0.273)	-0.240 (0.329)	
age	0.0369*** (0.0104)	0.0202 (0.0199)	0.0517*** (0.0142)
bmi	-0.101*** (0.0314)	-0.100** (0.0437)	-0.125*** (0.0475)
female (dummy)	-0.308 (0.212)	0.142 (0.333)	-0.754** (0.309)
diet (dummy)	0.571*** (0.210)	0.567* (0.306)	0.756** (0.332)
yearedu	-0.0308 (0.0411)	0.0319 (0.0623)	-0.0575 (0.0585)
income	-0.0619 (0.0548)	-0.0152 (0.0850)	-0.127 (0.0809)
enjoymeal	0.110 (0.100)	0.258 (0.162)	0.0205 (0.145)
hungry	-0.162** (0.0726)	-0.0905 (0.111)	-0.289*** (0.111)
visconhigh (dummy)	-0.593* (0.320)		-0.348 (0.396)
visconlow (dummy)	0.626*** (0.237)		0.962*** (0.332)
Constant	1.814 (1.146)	-0.388 (1.756)	3.847** (1.646)
Observations	349	175	174

*Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1*

The visibility and convenience interventions on the least calorific menu, on the other hand, had their strongest effect on pasta choice, which was not unexpected because the interventions were aimed at pasta order, but not at side dish, sweet, and drink choice. As many as 36.67 percent of participants chose the least calorific pasta when this intervention was implemented. The regression results support this descriptive analysis. There was an increase in the predicted probability of participants choosing a low-calorie pasta when the least calorific menu was made visible and convenient (*visconlow*). Conversely, participants were less likely to order low-calorie pasta when the most calorific menu was made visible and convenient (*visconhigh*). Likewise, weaker intervention on

the high calorific pasta menu (*vishigh*) decreased the predicted probability of choosing a low-calorie pasta (Table 4).

Effects among overweight participants

The aforementioned analyses are based on the entire population of this study, who may not have had health problems or any reason to change their eating habits. This section, on the other hand, measures the impact of interventions on overweight participants (BMI ≥ 25) who typically need to cut down meal-related calories.

Table 5 shows regression results for the overweight participants (n = 95; 24.48 percent of the sample). Dependent variables are total meal calories and pasta calories (Columns 1 & 2) and non-pasta calories (Column 3). Independent variables are the same as for the whole population.

Table 5 *Effects of taste, visibility, and convenience on overweight participants (BMI≥25)*

VARIABLES	(1)	(2)	(3)
	Total calorie	Pasta calorie	Non-pasta calorie
taste (dummy)	72.56*	4.753	67.81**
	(37.45)	(19.03)	(32.32)
vishigh (dummy)	-59.62	-8.226	-51.40
	(58.16)	(29.56)	(50.20)
vislow (dummy)	22.23	-29.14	51.37
	(57.37)	(29.16)	(49.51)
age	0.814	-1.980**	2.794*
	(1.758)	(0.894)	(1.518)
bmi	11.77**	5.437*	6.336
	(5.759)	(2.927)	(4.971)
female (dummy)	1.142	1.399	-0.257
	(35.15)	(17.87)	(30.34)
diet (dummy)	-42.60	-0.277	-42.32
	(36.08)	(18.34)	(31.14)
yearedu	9.704	4.706	4.998
	(12.04)	(6.120)	(10.39)
income	-2.640	0.732	-3.373
	(10.20)	(5.183)	(8.801)
enjoymeal	-11.90	-4.789	-7.115
	(20.20)	(10.27)	(17.43)
hungry	24.69*	-8.370	33.06***
	(13.72)	(6.971)	(11.84)

visconhigh (dummy)	13.14 (55.72)	-16.09 (28.32)	29.23 (48.09)
visconlow (dummy)	-180.9*** (48.31)	-35.33 (24.55)	-145.5*** (41.70)
Constant	295.2 (284.6)	292.7** (144.6)	2.519 (245.6)
Observations	86	86	86
R-squared	0.344	0.219	0.329

*Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1*

Compared to the whole population, all nudges converted 15.46% of overweight individuals' choice of pasta to low-calorie pasta – approximately 2% less than for the total population. While the taste of pasta and combined interventions on the least-calorific pasta menu had the same effect on calories consumed among overweight participants, the single intervention (*vislow*) did not work on overweight participants. In fact, the single intervention resulted in movement in the opposite direction towards total calories, but this was not significant (Column 1 in Table 5).

Since only visibility and convenience in combination worked on overweight participants rather than visibility alone, this suggests that convenience was significant in determining what overweight individuals would eat. Moreover, this finding emphasizes the need to further investigate the effectiveness of interventions in more detail on this sub-sample, since it is this group of people who urgently need to shift their behavioral patterns to make sure that a desirable effect is achieved.

DISCUSSION

General discussion

This study is among the first pieces of research to investigate the effects of both taste and nudges (namely, visibility and convenience) on food consumption. The differences in nudging effectiveness on each type of participant (for example, overweight and normal weight participants) make this topic more worthy of investigation. Also, the taste effect that may alter nudging effectiveness also requires research attention.

The results of this study show that consumers can be nudged to order lower-calorie food even when the influence of taste is accounted for. Both visibility and convenience played a role in determining consumption choice at the

restaurant. These findings support the claim of previous studies that behavioral interventions are among the most effective ways of reducing unhealthy eating, but suggest that combined cognitive and behavioral interventions are stronger. Judging by the calorific intake of our sample, combined interventions can nudge consumers, with or without the influence of taste, to reduce unhealthy eating. Considering broader samples, both visibility and convenience on the least calorific menu decreased the total calories ordered. The combined interventions on the least calorific menu also reduced pasta calories and influenced pasta choice significantly, whereas the visibility intervention alone on the least calorific menu only reduced total calories but did not influence pasta choice. However, applying the single intervention on overweight consumers neither helped reduce calorie intake nor affected pasta choice.

Unlike previous studies, the impact of combined interventions on high-calorific pasta was surprisingly weakened by compensatory effects. Instead of compensating using a low-calorie menu now with a high-calorie menu later, the higher calorie content of pasta choices was compensated for and overpowered by the lower calorie content of the non-pasta choice. This finding suggests that merely making a high-calorific menu more visible can succeed in reducing calorie intake if low-calorie, non-main-dish choices are included in decision-making. In contrast, this trade-off can have inverse consequences in terms of more visibility of low-calorie main dish menus as well. The inventions must be applied cautiously since the effect can be dampened by this trade-off.

While education was initially believed to potentially increase health knowledge and to improve eating habits, the results showed that calorie intake was similar across participants with different education levels. This suggests that both those with a low- and high-level education can equally be nudged to reduce calorie consumption.

Policy recommendations and concerns

The ineffectiveness of visibility interventions related to overweight participants suggests that weaker interventions are not enough to change the eating behavior of this group. Stronger interventions or combined interventions should be considered to nudge the overweight group to make healthy changes. In this study, adding difficulty to ordering high-calorie food along with decreasing its visibility was able to reduce calorie intake and compensate for the calorie increase caused by ordering according to taste.

However, before scaling up policy implementations, it is vital to find out why nudges work (do not work). The compensatory effect might partly

explain why interventions that target low-calorie main dish choices are not very effective. Consumers who choose low-calorie main dishes because of the factor of visibility and convenience may add extra calories later on via side dishes, drinks, and sweets, and vice versa. Further research is still needed to understand the compensatory behaviors of the overweight population, for which this study did not produce results due to the small sample of these participants. Additionally, social interaction at restaurants might also influence and complicate compensatory behaviors. Customers who come in a group may order a variety of types of food for sharing with the group without considering calories. The study of the interrelationships in group dining that may influence compensatory behaviors is also worth exploring.

The question whether such policies would be become burdensome to restaurants if they were implemented can be answered in a quite straightforward manner. First, the implementation cost of nudging customers to make healthy food choices at real restaurants is minimal. Restaurants only need to make minor adjustments to their menus. Second, such nudging need not negatively affect their profit. To sum up, nudging consumers toward better nutrition is not difficult to implement and represents little burden to restaurants.

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