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Title

Menu Engineering to Encourage Sustainable Food Choices when Dining Out: An Online Trial of Priced-Based Decoys

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Abstract

Menu-based 'nudges' hold promise as effective ways to encourage a shift away from ruminant meat and towards more environmentally friendly plant-based options when dining out. One example of a menu-based nudge is including an inferior 'decoy' option to existing items on menus. Decoys have been shown to influence decision-making in other domains (e.g. Lichters, Bengart, Sarstedt, & Vogt, 2017), but have yet to be used to promote sustainable food choices. Two online randomized controlled trials tested whether the addition of higher priced 'decoy' vegetarian options to menus influenced the number of diners choosing a 'target' vegetarian option. Adjusted Generalized Estimating Equations on data from four menu conditions showed no main effect of intervention group in study 1 (decoy absent vs. decoy present; odds ratio (OR) 1.08 (95% Confidence Interval (CI) 0.45 to 2.57). Replicating the trial in study 2 across seven menu conditions and testing a more expensive decoy also showed no main effect of the intervention (decoy absent vs. decoy present; OR 0.68 (95% CI 0.41 to 1.12). Further analyses revealed that our price-based decoy strategy (a £30% price increase) did not significantly influence the numbers who chose the inferior decoy dish, potentially due to the fact that dish choices were purely hypothetical. Further research is now needed to clarify which attributes of a dish (e.g. taste, portion size, signature ingredients etc.) are optimal candidates for use as decoys and testing these in real world choice contexts.

Key Words: Sustainable diets; Environment; Food choice; Behaviour change; Menu design; Randomized controlled trial

Declarations of interest*:* none

Abbreviations

OR - Odds ratio

CI - Confidence Interval

GHG - Greenhouse Gas Emission

GEE – Generalized Estimating Equations

Introduction

Sustainable Food Choices and Dining Out

Current estimates suggest that food production is responsible for around 30% of global greenhouse gas emissions (GHGs), approximately 70% of the world's freshwater use and around 40% of the world's land use – figures that are expected to rise with projected population growth of up to 10 billion people by 2050 (Willett et al., 2019). The least sustainable food source is meat, in particular, meat from ruminant animals (cows, sheep and goats). Compared to common plant-based alternatives like pulses and legumes, ruminant meat emits approximately 20 times more GHGs per unit of edible protein. While white meat is more resource-efficient than red, producing it still emits approximately three times more GHGs than plant-based foods (Ranganathan et al., 2016; Searchinger et al., 2018). Together, these statistics indicate that current levels of meat consumption, especially in established economies like the United Kingdom (UK), are untenable.

As a result, it is widely recognized that a large-scale shift away from the overconsumption of meat and towards a more plant-based diet is now needed if we are to succeed in sustainably feeding a growing global population (Nemecek & Poore, 2018). To achieve this goal, changes are required from multiple actors across a range of sectors that are involved in the production and sale of food, including the food service industry. Taking the UK as an example, data from 2017-18 show that expenditure on dining out is around £219bn per annum (approximately £40 per person per week)(Office for National Statistics, 2019b), with diners more likely to consume meat when eating out than at home (Office for National Statistics, 2019a). These facts emphasize the need for more research to identify effective behaviour change interventions that can be implemented in food service settings to encourage diners to choose more plant-based options and eat less ruminant meat.

Menu Engineering Nudges

'Nudges' are one promising category of behaviour change intervention for use in this context. A nudge involves redesigning the 'choice architecture' or micro-environment in which decisions are made to asymmetrically promote a desired behaviour (Thaler & Sunstein, 2008). Underpinned by dual-process theories of decision-making, nudges target the automatic processes that are understood to exert a greater influence over many behaviours than more rational and reflective thought (Hollands, Marteau, & Fletcher, 2016).

Within food service settings, a range of nudges have already been tested and proven effective at influencing which foods diners buy (Vecchio & Cavallo, 2019; Hollands et al., 2015; Arno & Thomas, 2016; Cadario & Chandon, 2017; Kraak, Englund, Misyak, & Serrano, 2017). Of these, menu-based nudges (or 'menu engineering') are a subcategory of interest given that they are cheap and relatively easy to implement by food service providers. Menu-engineering involves making changes to the placement, order, labelling or descriptions of items listed on food menus and is grounded in research that shows even small changes of this kind can increase sales of healthier or more profitable menu items (Ozdemir & Caliskan, 2015; Cohen & Babey, 2012).

Nudging Sustainable Food Choices

Less well researched, however, are menu-based nudges to encourage more sustainable food choices and, specifically, those promoting a shift away from ruminant meat and towards more plant-based dishes. Where studies have been conducted on this topic, interventions tend to include either presenting diners with information on the environmental footprint of meals (Brunner, Kurz, Bryngelsson, & Hedenus, 2018; Osman & Thornton, 2019), changing the order of items on menus (Gravert & Kurz, 2019; Kurz, 2018; Bacon & Krpan, 2018), or modifying dish descriptions to selectively highlight the benefits of meat-free options (Bacon, Wise, Attwood, & Vennard, 2018; Vennard, Park, & Attwood, 2018). These studies are beginning to demonstrate the power that menu-based nudges can have on sustainable choice-making when dining out, and imply that other, similar interventions may prove effective when used in this context.

The Decoy Effect

One menu-based nudge that we will investigate in the current study is known as the 'decoy effect' (otherwise described as 'asymmetric dominance'). The decoy effect refers to the observation that an individual's preference between two items is influenced by context and can be modified through the addition of a third item that is similar, but slightly inferior to one of the existing items (Kaptein, Van Emden, & Iannuzzi, 2016). For example, a diner may prefer dish A on a menu over dish B initially. Decoy theory hypothesizes that adding a third dish C, which is similar to B, but slightly inferior on key choice attributes (e.g. taste, cost, appearance), will actually boost sales of dish B, as diners shift their preferences towards this option after viewing the inferior decoy dish C. A number of explanations have been proposed for why this effect occurs (Huber, Payne, & Puto, 1982), including the observation that

the addition of a decoy makes the target either seem the more attractive or safer option in comparison (Carroll & Vallen, 2014).

Introducing decoys has already proven successful in encouraging behaviour change across a range of behaviors, including uptake of health screenings from specific hospital sites (Stoffel, Yang, Vlaev, & von Wagner, 2019) and on alcohol purchasing in pub settings (Monk, Qureshi, Leatherbarrow, & Hughes, 2016). In relation to food choice, decoys have been studied in the context of encouraging healthier food purchases, with research showing that smaller portion decoys and decoys based on calorie content labelling can all influence food choice (Carroll & Vallen, 2014).

In addition, decoys are already widely used by food retailers and service providers. Real life examples include the use of portion-size decoys on the menus of global coffee chains to encourage consumers to purchase larger beverage sizes, within cinemas to encourage larger popcorn purchases and in high-end dining establishments to encourage greater expenditure on wine (National Geographic, 2019; Insider, 2014; Times, 2009).

The Decoy Effect and Sustainable Food Choices

The current study represents the first proof-of-concept trial to test whether the decoy effect can encourage diners to move away from selecting meat-based items and towards more sustainable plant-based alternatives when choosing between options listed on food menus. For this study, we chose to use a price-based decoy strategy (e.g. inclusion of a higher priced dish) given that cost is one leading determinant of food choice (Hoek, Pearson, James, Lawrence, & Friel, 2017). Price also permits us a 'clean' test of the decoy effect as higher prices for equivalent goods are generally recognized as disadvantageous. Constructing decoys on other attributes such as flavor, perceived quality or featured ingredients is a more subjective alternative strategy that requires knowledge of the specific preferences of each diner (French, 2003; Huber, Payne, & Puto, 2014).

The Current Studies

In the current studies we aimed to test, firstly, if the *inclusion of a higher priced vegetarian decoy option on a menu influences the number of participants who select a 'target' vegetarian option that is available at a base price?* Secondly, if the *inclusion of the same higher-priced decoy option influences the number of participants who chose a 'competitor' meat option that is also available at base price*? These research questions will allow us to determine if inclusion of a higher priced vegetarian decoy option is an effective strategy to promote plant-based menu choices. It will also allow us to examine whether an

increase in numbers choosing the target vegetarian option results from either a between-category shift away from the meat choice (which is the intended effect) or from a within-category shift away from one vegetarian option to another (e.g. a movement away from the decoy and towards the target vegetarian option, which would have no benefit for the environment). We present the findings from two independent online studies. Study 1 involved an initial pilot trial, while study 2 replicated the same methodology using a larger sample, a wider range of menu conditions and a more expensive decoy option.

Study 1

Study Design

We employed an online randomized controlled trial, delivered via Qualtrics. This trial used a repeated measures design, where each of our participants viewed a series of four online menus – a burger menu, a curry menu, a brunch menu and a salad menu. For each type of menu, participants were randomly allocated to either a control (decoy absent) or intervention (decoy present) group. The order in which menus were presented to participants, and the order of the options listed on each menu, were randomized to prevent order effects .

Participants

Participants were recruited using convenience sampling from a participant pool at the University of Westminster. There was no inducement for the students to participant in the study (i.e. they did not have to participant in order to pass a module). The students were invited to participate (amongst a number of other studies going on at the University) via an online portal, where participation is voluntary and is incentivized by receiving virtual credits. Virtual credits can be used to gain access to the research participant portal (i.e. for students to post their own research studies). Eligibility criteria included English speaking, UK residents, aged over 18 years. Given that this study aimed to test the impact of a menu-based decoy strategy on shifting food choices away from meat, we screened out any participants who reported adhering to a vegetarian, vegan or pescatarian diet prior to data analysis. These exclusions were made on the basis of a post-task dietary questionnaire rather than pre-screening as we did not want prior dietary questionnaires to prime choices during the subsequent experiment.

We conducted a power calculation prior to recruitment to determine how many participants were needed to detect a shift in choices away from meat and towards the vegetarian option of a similar magnitude to that observed in existing menu engineering studies (Vennard et al., 2018). Given no accepted method for computing statistical power for binary logistic GEE models using available software (Guo, Logan, Glueck, & Muller, 2013), we chose to use G*Power to determine the number of participants required in each menu condition separately, based on the following criteria: to detect a minimum 7% shift in numbers choosing the vegetarian option between intervention and control group, at a significance level of 0.05, with power of 80% and assuming a two-tailed hypothesis. The results of this calculation indicated that a minimum of N=156 participants were required per menu condition.

Intervention

For each of our four menu conditions, participants were asked to make a choice between three dishes presented to them – a 'competitor' meat option, a 'target' vegetarian option and a 'decoy' vegetarian option. Appendix 1 shows the dish options that each participant saw. Menus were constructed based on meals served by local restaurant chains. The target and decoy vegetarian options listed on these menus were all suitable for someone following a lacto-ovo vegetarian diet. We endeavored to match all dishes in terms of the number of ingredients and degree of descriptive language used in the dish title and subtitle, while still ensuring that the experimental stimuli would still appear realistic.

Participants in the control group were exposed to all three options at the same base price, whilst participants in the intervention group were instead shown the decoy vegetarian option listed at a price point £2 more expensive than the other options on the menu. The competitor meat and target vegetarian dish were otherwise matched on price. Three dishes were chosen in line with previous research into decoy effects (Carroll & Vallen, 2014), allowing us to isolate the effect of including a decoy option on the choice between the two remaining options.

188

189 ***Procedure and Measures***

190 This study was approved by Westminster University Ethics Committee in line with the Declaration of
191 Helsinki. Upon entry into the online platform, participants were provided with a description of the
192 experimental task and gave informed consent. Participants were then provided with the following
193 instructions prior to seeing each of the four menus *"Please consider the menu on the following page.*
194 *Imagine you are in a restaurant; please select which dish you would be most likely to order".* To make
195 their choice between the three dishes, participants clicked on their desired option, following which they
196 were directed to the subsequent menu.

197 Following this, participants were asked to fill out demographic and dietary questions relating to their
198 age (in 10 year age brackets), gender (male or female), time since eating their last meal (Less than an
199 hour/ 1-2 hours/ 2-3 hours/ 4-5 hours/ 5hours+), usual diet (Vegan/ Lacto-ovo vegetarian/ Pescatarian/
200 Includes meat and dairy products/ Other (please specify)), current hunger levels (scale from 1 Not at all
201 – 10 Extremely hungry), a measure of past behavior (whether their last meal contained meat -Yes or
202 No) and typical frequency that they dined out-of-home (Monthly/ Less than monthly/ Fortnightly/ Once
203 per week/ 2-3 times per week/ Every day). These measures were included to capture some of the
204 variables known to influence food choice, to add to covariate adjusted analyses; demographic variables
205 of age and gender have both been shown to influence attitudes and practices towards meat
206 consumption (Neff, Edwards, Palmer et al., 2018). Hunger underpins the physiological drive to eat, while
207 our measure of past behavior allows us to control for the influence of prior meat consumption on dish
208 choice. Lastly, measuring frequency of eating out-of-home permits us to control for the extent to which
209 participants are usually exposed to selecting and ordering food from menus. Existing research indicates
210 that individuals tend to choose less healthy options and more meat when eating out-of-home, an effect
211 that may plausibly differ by frequency of consumption or familiarity with the types of dishes presented
212 here as experimental stimuli (Lachat, Nago, Verstraeten et al. 2011).

213 ***Outcomes***

214 The primary outcome in this study was choice of target vegetarian option, represented in our analyses
215 as a dichotomous variable reflecting whether the dish was chosen (1) versus not chosen (0). The
216 secondary outcome of interest was choice of the competitor meat option, again represented as a
217 dichotomous variable reflecting whether this option (1) or any others (0) were chosen. Additionally, we

also measured choice of the decoy vegetarian option, primarily for the purposes of checking whether participants perceived the decoy as the inferior choice (i.e. an experimental manipulation check).

Analysis

To determine the effect of intervention on our primary and secondary outcomes, we ran two separate Generalized Estimating Equations (GEE) using statistical package IBM SPSS statistics version 25. GEE is an extension of the general linear model to allow for inclusion of data collected from a repeated measures or panel design, where the same participant is measured at more than one endpoint. In this study, the repeated measures element was the fact that each participant made dish choices across four sequential menus. GEE accounts for the fact that multiple data points collected from the same participant are non-independent by including participant ID as a 'subject' variable and menu type as a 'within subjects' variable in the final statistical model. Our GEE models were binary logistic models, with dish choice as the outcome and group (intervention versus control), menu type (the four conditions), and the interaction between these variables as predictors. All models were adjusted for demographic and diet related covariates that were found to significantly predict dish choice ($p<0.05$) in prior binary logistic regression analyses (for either the primary or secondary outcome across at least three of the menu conditions). These analyses were conducted for each menu separately. We kept these control variables consistent across all GEE analyses to ensure comparability between models.

Study 1 Results

Study Sample

A total of 194 participants were recruited into this study. N = 47 participants were excluded from analyses as post-task questionnaires indicated that these individuals followed non-meat diets, or they failed to complete the experimental task. The final study sample thus consisted of N = 147 participants. As each participant viewed all four menus, the final total number of data points included in analyses was 598. See Table 1 for sample characteristics.

The majority of participants were female (N=89, 60.5%), with the modal age group 45-54 years (29.9%), and just under a third of the sample aged under 35 years (31.2%). The largest category for self-reported frequency of dining out was at least fortnightly (N = 45, 30.6%). At the time of the study, over half the sample reported having eaten their last meal within the preceding hour (N = 53, 36.1%), with an average hunger score of 4.29 (Standard Deviation; SD = 2.41) out of 10. Two thirds of the sample reported that their last meal included meat (N = 89, 60.5%).

248 ***Table 1: Study 1 Sample Characteristics***

Characteristic	***N(%) or Mean(SD)***
Gender (Male)	*58 (39.5%)*
Age (Years)	
18-24	21 (14.3%)
25-34	25 (17.0%)
35-44	22 (15.0%)
45-54	44 (29.9%)
55-64	27 (18.4%)
65+	8 (5.4%)
Time Since Last Meal	
less than an hour	53 (36.1%)
1-2 hours	26 (17.7%)
2-3 hours	32 (21.8%)
4-5 hours	13 (8.8%)
5hours+	23 (15.6%)
Current Hunger level (10-point scale)	4.29 (2.41)
Frequency of eating out-of-home	
Less than monthly	41 (27.9%)
Monthly	15 (10.2%)
Fortnightly	45 (30.6%)
Once per week	29 (19.7%)
2-3 times per week	14 (9.5%)
Every day	3 (2.0%)
Last Meal Contained Meat	89 (60.5%)

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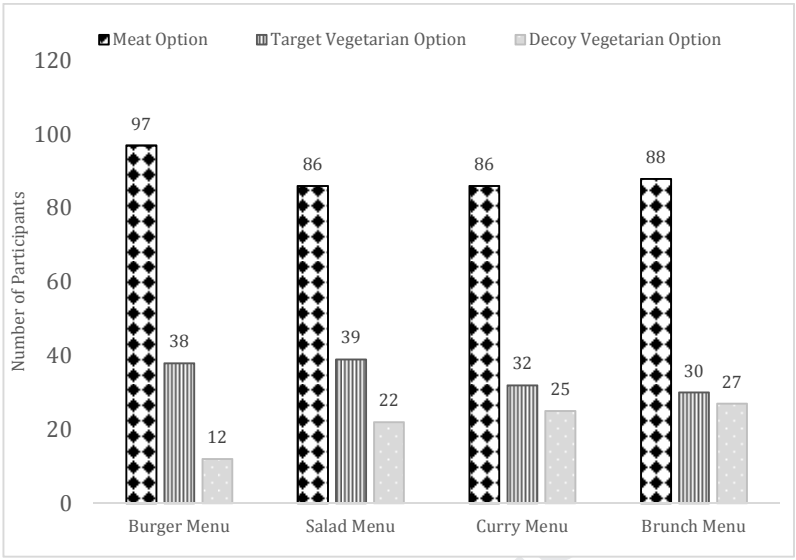
250

251 Figure 1 presents dish choices (number of participants choosing the competitor meat option, the target
252 vegetarian option or the decoy vegetarian option) by menu condition. This figure shows that the most
253 popular dish was the meat option, followed by the target vegetarian option and lastly, the decoy
254 vegetarian option. To note, individuals who claimed to be following a lacto-ovo vegetarian diet (N = 15)
255 and who would have chosen either of the two vegetarian options are excluded from these totals.

256

Figure 1: number of participants choosing each dish option in study 1, by menu



Experimental Manipulation Check

To determine if the higher-priced decoy deterred diners, we compared the number of diners selecting the decoy dish in the intervention group (where it is priced higher than the target vegetarian option) versus in the control group (where it is available at base price). Binary logistic GEE analyses were conducted on the outcome variable of choice of the decoy vegetarian option, with intervention group, menu condition (dummy coded contrasts with brunch as the reference group given greatest popularity of this dish in those who selected the decoy, as shown in figure 1) and an interaction between group and menu condition as predictors in the model. Participant ID was added as an additional 'subject variable' to control for the repeated measures element in the study design.

Results of this analysis indicate no significant main effect of group (decoy absent (control group) versus decoy present (intervention group); OR 0.50, 95% CI 0.22 to 1.15; $p = 0.1$), nor a significant menu by group interaction (all ORs for interaction terms crossed the null value of 1; non-significant at $p<0.05$). This analysis did, however, reveal a main effect of menu condition. Compared to the brunch menu, those who saw the burger menu were significantly less likely to choose the decoy dish (OR 0.35, 95% CI (0.13 to 0.93); $p=0.04$), while we found an OR that approached significance for the comparison between the brunch and salad menus (OR 0.50, 95% CI 0.24 to 1.04; $p = 0.07$). Overall, these results also indicate that participants who saw the higher priced vegetarian decoy option in the experimental condition were

not less likely to select this dish, across all menus aggregated and for each menu individually, than those who saw the decoy option at price parity to the target vegetarian option on the menu.

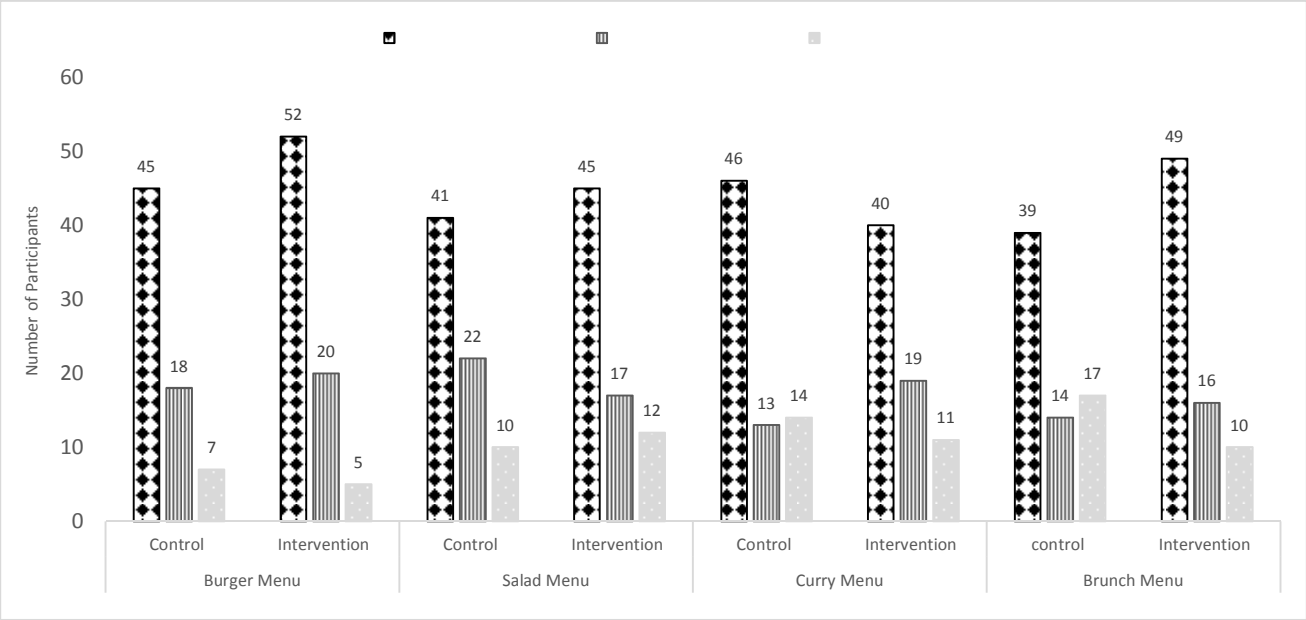
Main Analyses

Next, we ran two further GEE analyses for our primary outcome of choice of the target vegetarian option, and for our secondary outcome of choice of the competitor meat option. Similar to the analysis outlined above, the outcomes in these models were dichotomous dummy coded variables ('1' chose the target vegetarian or meat dish, '0' chose any alternative dish), predicted by group, menu condition and the interaction between these variables, in addition to inclusion of participant ID to account for the repeated nature of dish choice across menus. We also controlled for four covariates in these models – participant gender, age, whether the last meal that a participant ate contained meat and the frequency with which they would normally eat out-of-home.

For both primary and secondary analyses, we selected an independent working correlation matrix, as iterating analyses demonstrated improved goodness-of-fit according to quasi-information criterion (QIC) values compared to using an unstructured approach. Figure 2 provides an overview of the number of participants choosing each dish, by group and menu condition. Table 2 shows the results of the adjusted GEE analyses for all outcomes.

298 ***Figure 2: number of participants choosing each dish option in study 1, by menu and group***

299



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302 ***Table 2: Odds Ratios and 95% Confidence Intervals from GEE analyses, all outcomes, study 1***

	OR (95% CI)[¶]	
Group*	***Menu****	***Group X Menu***
Target Vegetarian Option		
Intervention vs. Control	*1.Salad vs. Burger*	*Group vs. 1*
1.08 (0.45 to 2.57)	1.67 (0.63 to 4.47)	0.54 (0.13 to 2.27)
	2.Salad vs Curry	*Group vs. 2*
	0.65 (0.28 to 1.54)	1.97 (0.56 to 6.96)
	3.Salad vs. Brunch	*Group vs. 3*
	0.64 (0.27 to 1.51)	1.23 (0.36 to 4.24)
Competitor Meat Option		
Intervention vs. Control	*1.Burger vs. Salad*	*Group vs. 1*
1.56 (0.63 to 3.84)	1.11 (0.48 to 2.52)	0.54 (0.15 to 1.91)
	2.Burger vs. Curry	*Group vs. 2*
	0.84 (0.38 to 1.90)	0.55 (0.15 to 1.98)
	3.Burger vs. Brunch	*Group vs. 3*
	0.97 (0.42 to 2.25)	0.99 (0.30 to 3.27)
Decoy Vegetarian Option		
Intervention vs. Control	*1.Brunch vs. Salad*	*Group vs. 1*
0.46 (0.18 to 1.21)	0.47 (0.22 to 1.00)	2.82 (0.75 to 10.70)
	2.Brunch vs. Curry	*Group vs. 2*
	0.86 (0.35 to 2.09)	1.24 (0.29 to 5.34)
	3.Brunch vs. Burger	*Group vs. 3*
	0.28 (0.10 to 0.81)	1.66 (0.30 to 9.10)

303 *For comparisons, intervention group coded 1, control group coded 0. Control group (decoy absent) is the reference group.
304 **For comparisons, reference menu coded 0, alternative menu coded 1.
305 ¶Analyses adjusted for covariates of age brackets, gender, frequency of eating out-of-home and last meal contained meat.
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307

For the primary outcome of choice of the target vegetarian option, there was no significant main effect of group (*p=0.87*, see Table 3 for the OR). For the comparison across menus, we chose the salad menu as the reference group given that this was the most popular choice among those who chose the target vegetarian option. Here, we found no significant main effect of menu condition (see Table 3; salad vs. burger menu *p = 0.31*; salad vs. curry menu *p = 0.35*; salad vs. brunch menu *p = 0.33*). We also found no significant interaction between group and menu condition for this outcome (see Table 3; all OR cross the null value of 1 or *p>0.05*).

For the secondary outcome of choice of the competitor meat option, we found no significant main effect of group (*p = 0.34*). Considering menu condition and using the burger menu as the reference group for comparisons as that this was the most popular menu among those choosing the meat option, we found no significant main effect of menu type (burger vs. salad (*p = 0.81*); burger vs. curry (*p = 0.95*); burger vs. brunch (*p = 0.84*)). Once again, we also found no significant interaction terms between group and menu condition for this secondary outcome (all OR cross the null value of 1 or *p>0.05*).

Study 1 Discussion

The results from this study do not support our initial supposition that a price-based decoy strategy can encourage diners to shift their choices away from meat and towards more environmentally friendly plant-based alternatives when selecting what to eat from food menus. Our analyses across four menu conditions showed that addition of a decoy vegetarian option, priced two pounds higher than a similar target vegetarian alternative, did not influence the numbers who selected the target vegetarian option, nor did it influence the numbers selecting the competitor meat option.

The finding that a higher priced decoy option did not influence food choice is surprising given that price or value perception is recognized as one of the main determinants of this outcome (Defra, 2016), and given existing evidence to show that the decoy effect can influence choice of other food types (Carroll & Vallen, 2014). One potential explanation for the lack of effect found in this study may be that the price differential between our decoy and target vegetarian option was not large exert an influence. As a result, we conducted a second study across a larger sample, repeating the same intervention but testing a greater price differential between the decoy and target vegetarian menu options and introducing a broader range of menus.

Study 2

Study Design

The design of study 2 replicated study 1, with the following key modifications: In study 2, participants viewed a subset of seven online menus – the four trialed in study 1 (a burger menu, curry menu, brunch menu and salad menu), plus an additional roast dinner menu, Italian menu and soup menu. Menu conditions are shown in Appendix 2. Participants were randomly allocated to either control (decoy absent) or intervention (higher priced decoy present) groups across all menus. Menu order and the order of dishes within menus were, once again, randomized. Participants viewed a total of five menus each, selected randomly from the seven available, to avoid excessive drop-out due to boredom effects.

Participants

Five hundred and forty three participants were recruited using Prolific Academic, a crowd sourced recruitment service tailored for psychological research. Participants were paid a fixed sum of £0.50 for participation. In line with study 1, participants were UK residents whose first language was English. The post-experimental exclusion of those following vegan, vegetarian and pescatarian diets consisted of N = 68, with a further N = 5 excluded due to a failure to adhere to an attention check or for non-completion of the study.

Intervention

Menu conditions were presented in the same way as for study 1, with participants asked to choose between three dishes– a 'competitor' meat option, a 'target' vegetarian option and a 'decoy' vegetarian option. Participants in the control group were exposed to all three options at the base price, whilst participants in the intervention group were shown the decoy vegetarian option listed at a price point four pounds more expensive than other options on the menu (with the exception of the soup, which is a cheaper dish, and hence a 30% price rise was applied in line with the magnitude of the price differential in remaining conditions).

Procedure and Measures

An identical procedure to study 1 was followed in study 2, with the addition of supplementary questions assessing participants' demographic characteristics and dietary habits. Specifically, we added an item measuring the factors that participants are likely to consider when making choices between items on

menus ('*What do you usually think about when choosing a meal?*', rank ordering their response options '*how healthy/expensive/tasty/filling the meal is*' or *'it is my usual option'* on a 5-point scale*)*. A measure of habitual meat eating frequency ('*how often do you eat meat*' - *Every meal/ Once a day/ 5-6 times per week/ 3-4 times per week/ 1-2 times per week/ Less than once a week/ Less than once a month*), and a question assessing perceptions of price ('*What did you think of the pricing of the dishes you chose?*' (*too expensive/about right/ too cheap*) were also added to study 2.

Outcomes

The primary outcome in study 2 was, once again, choice of the target vegetarian option and the secondary outcome was choice of the competitor meat option, both represented as dichotomous variables in analyses. An additional experimental manipulation check was also conducted with choice of the decoy vegetarian option as the outcome.

Analysis

GEE analyses were conducted following the same procedure as for study 1. The only differences were the addition of our supplementary demographic and diet related variables as covariates in adjusted models. Adjusted models included covariates that prior analyses indicated significantly predicted choice of either the primary or secondary outcome across at least three of the menu conditions. These control variables were kept consistent across all GEE analyses to ensure comparability between models.

Results Study 2

Study Sample

N = 452 participants completed study 2. Given that the study utilized a repeated measures design, this meant a total of 2080 observations for each of the primary and secondary analyses. Table 3 below provides a summary of the characteristics of the study 2 sample.

The majority of participants were female (N=262, 58%), although compared to study 1, this sample was slightly younger, with the modal age group of respondents 25-34 years (N =126, 27.9%). The largest category for self-reported frequency of dining out was monthly (N = 121, 26.8%). At the time of the study, participants average hunger score was 5.46 (Standard Deviation; SD = 2.40) out of 10. In terms of their last meal, 61% of the sample had eaten meat (N = 268) and approximately 65% vegetables (N=279). In total, 379 participants (83.8% of the sample) were classified as regular meat eaters, consuming meat at least three times per week or more frequently.

396 ***Table 3: Study 2 Sample Characteristics***

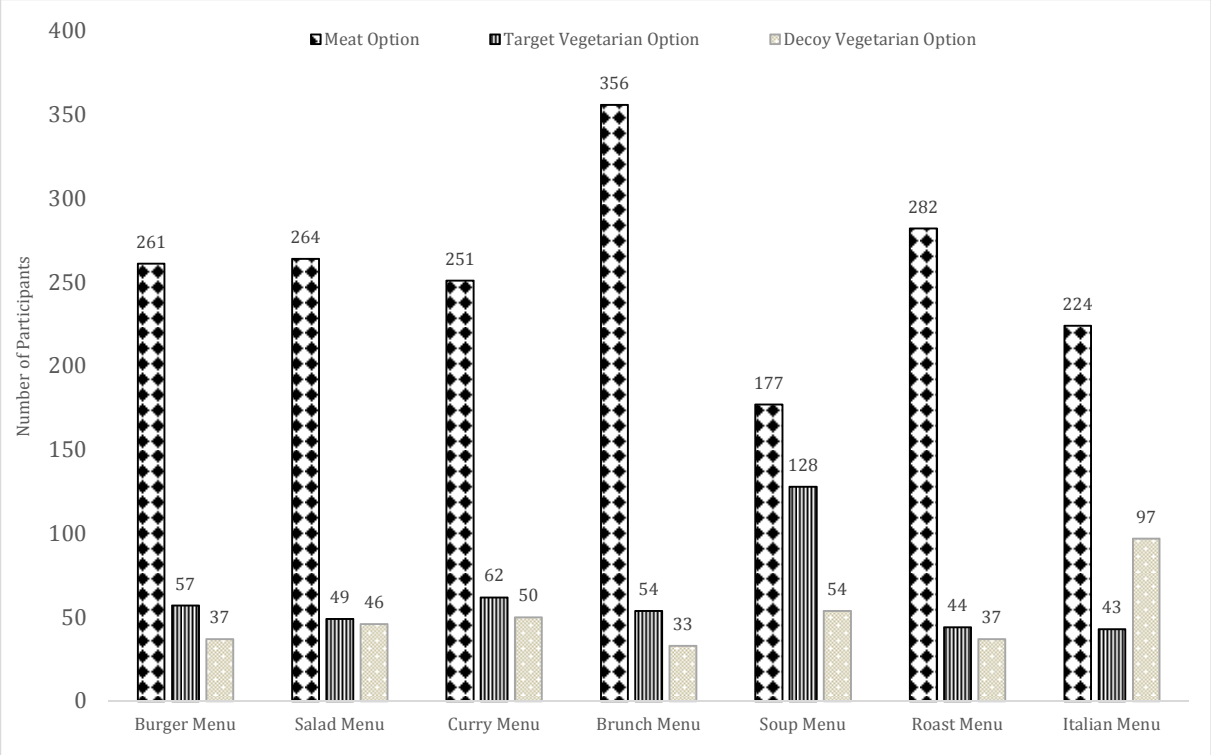
Characteristic	***N(%) or Mean(SD)***
Gender (Male)	*188 (41.6%)*
Age (Years)	
18-24	93 (20.6%)
25-34	126 (27.9%)
35-44	109 (24.1%)
45-54	66 (14.6%)
55-64	42 (9.3%)
65+	16 (3.5%)
Biggest influence on meal choice	
How healthy a meal is	47 (11.4%)
How expensive a meal is	87 (21.1%)
How tasty a meal is	222 (53.9%)
How filling a meal is	12 (2.9%)
The meal is my usual choice	44 (10.7%)
Current Hunger level (10-point scale)	5.46 (2.40)
Frequency of eating out-of-home	
Less than monthly	143 (31.6%)
Monthly	121 (26.8%)
Fortnightly	87 (19.2%)
1 to 2 times per week	82 (18.1%)
2 to 3 times per week	18 (4.0%)
everyday	1 (0.2%)
Last Meal Contained Meat	268 (61.0%)
Last Meal Contained Veg	279 (64.7%)
Typical Frequency of Meat Eating	
Every meal	33 (7.3%)
Once a day	129 (28.5%)
5-6 times per week	104 (23.0%)
3-4 times per week	113 (25.0%)
1-2 times per week	56 (12.4%)
Less than once a week	12 (2.7%)
Less than once a month	5 (1.1%)

397

398 Figure 3 presents the number of participants choosing each dish per menu condition. In study 2, the
399 most popular choice across all menus was, once again, the meat option, followed by the target
400 vegetarian option for all menus except the Italian, where the decoy dish was favored over the target.

Overall, differences in dish preferences across menus was significant (chi square statistic χ^2 = 171.95, df = 12, $p < 0.01$), due to a larger proportion of participants choosing the target vegetarian dish when viewing the soup menu and the decoy vegetarian dish when viewing the Italian menu.

Figure 3: Number of participants choosing each dish option in study 2, by menu



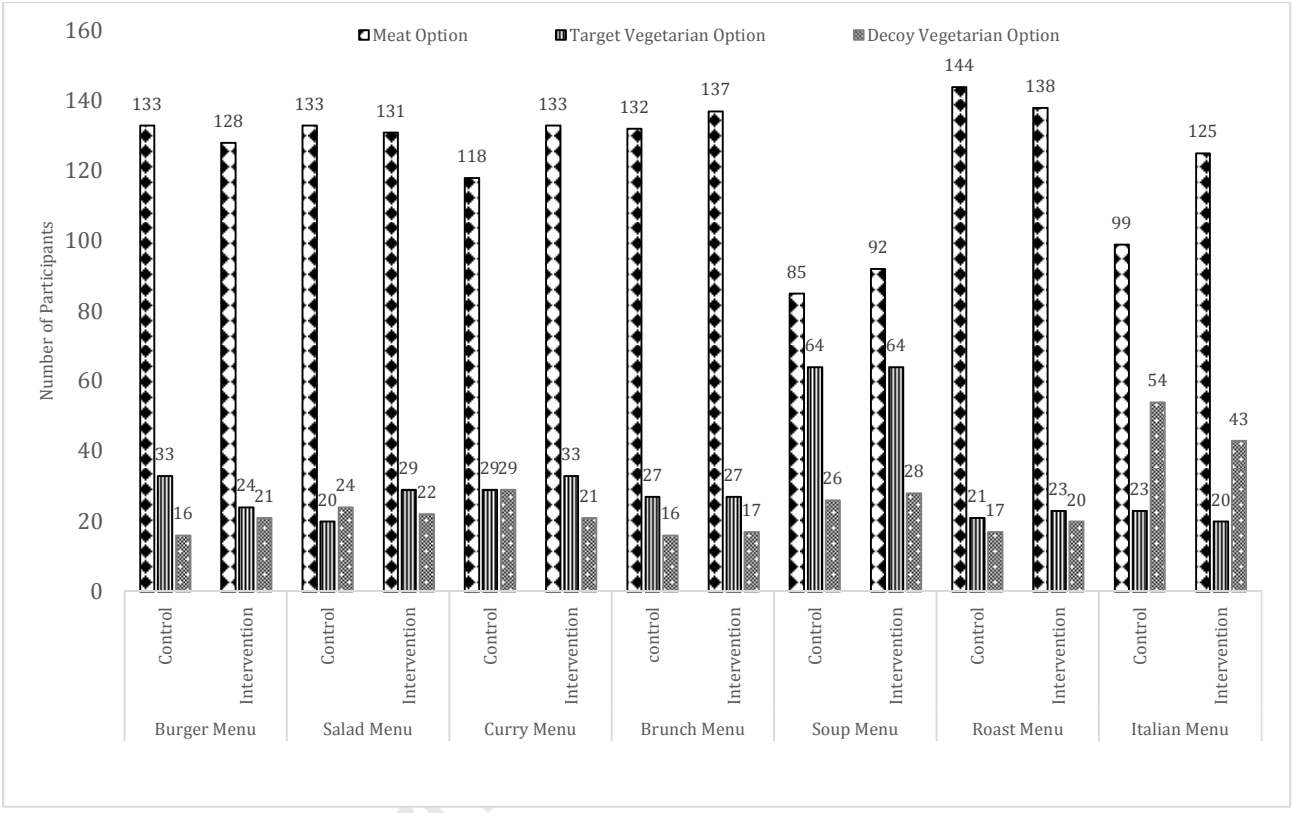
Experimental Manipulation Check

To determine if the higher priced decoy influenced dish choices in study 2, we compared the numbers of participants selecting the decoy dish in the intervention group versus the control group. As for study 1, binary logistic GEE analyses were ran with decoy vegetarian option as the main outcome variable and menu condition (with the Italian menu as the reference group given greatest popularity of this dish in those who selected the decoy) and the interaction between group and menu condition added as predictors to the model, alongside Participant ID as the 'subject variable'.

Results of this analysis approached significance ($p = 0.09$), demonstrating that there was a trend towards fewer participants choosing the decoy vegetarian dish when it was presented at a higher price point (OR 0.67, 95% CI 0.42 to 1.07). Significant differences were found in the number of participants selecting the decoy option between menu conditions, with the decoy option chosen less frequently when participants

418 viewed all other menus compared to the Italian menu as noted above (all *p < 0.01*). We also identified
419 an effect that approached significance for the interaction between menu and group, such that the decoy
420 was over twice as likely to be chosen for the Italian menu compared to the burger menu (OR 2.14, 95%
421 CI 0.92 to 4.97, *p = 0.08*).
422
423 To further determine if participants noticed the price differential between target and decoy options, we
424 compared price perceptions between the intervention and control group. Overall, there were no
425 significant difference in the number of participants who considered the dishes listed on the menus to be
426 too expensive versus priced correctly or too cheaply across conditions (χ^2 = 4,54, df = 2, *p = 0.10*). This
427 finding suggests that there were no apparent differences in participants' price perceptions, even when
428 the decoy dish was presented as four pounds higher than other options listed on the menu.
429
430 ***Main Analyses***
431 GEE analyses were run for the primary outcome of target vegetarian dish choice and for the secondary
432 outcome of competitor meat dish choice. All models were adjusted for the following variables:
433 participant gender, age, current hunger level, whether the last meal that a participant ate contained
434 meat, whether the last meal eaten contained vegetables and if the participant ranked '*how healthy a*
435 *meal is*' as a priority influence on their dish choice. Figure 4 presents the number of participants
436 choosing each dish across experimental groups and menu condition. Table 4 presents the results of
437 adjusted GEE analyses for all outcomes.
438

Figure 4: number of participants choosing each dish option in study 1, by menu and group



444 ***Table 4: Odds Ratios and 95% Confidence Intervals from GEE analyses, all outcomes, study 2***

	OR (95% CI)[¶]	
Group*	***Menu****	***Group X Menu***
Target Vegetarian Option		
Intervention vs. Control	*1.Soup vs. Curry*	*Group vs. 1*
0.68 (0.41 to 1.12)	0.31 (0.18 to 0.54)	1.34 (0.61 to 2.95)
	2.Soup vs Brunch	*Group vs. 2*
	0.29 (0.17 to 0.50)	1.24 (0.55 to 2.80)
	3.Soup vs. Salad	*Group vs. 3*
	0.19 (0.11 to 0.35)	2.16 (0.97 to 4.80)
	4. Soup vs. Burger	*Group vs. 4*
	0.29 (0.16 to 0.51)	1.14 (0.51 to 2.55)
	5. Soup vs. Roast	*Group vs. 5*
	0.21 (0.12 to 0.39)	1.22 (0.52 to 2.87)
	6. Soup vs. Italian	*Group vs. 6*
	0.21 (0.11 to 0.40)	0.88 (0.35 to 2.21)
Competitor Meat Option		
Intervention vs. Control	*1.Roast vs. Curry*	*Group vs. 1*
0.96 (0.56 to 1.65)	0.49 (0.31 to 0.79)	1.62 (0.78 to 3.38)
	2.Roast vs. Brunch	*Group vs. 2*
	0.78 (0.48 to 1.27)	1.18 (0.59 to 2.36)
	3.Roast vs. Salad	*Group vs. 3*
	0.84 (0.54 to 1.32)	0.79 (0.39 to 1.57)
	4. Roast vs. Soup	*Group vs. 4*
	0.20 (0.12 to 0.34)	1.63 (0.79 to 3.36)
	5. Roast vs. Burger	*Group vs. 5*
	0.75 (0.46 to 1.21)	*1.01 (0.48 to 2.13)*
	6. Roast vs. Italian	*Group vs. 6*
	0.33 (0.20 to 0.54)	1.70 (0.82 to 3.57)
Decoy Vegetarian Option		
Intervention vs. Control	*1.Italian vs. Curry*	*Group vs. 1*
0.73 (0.44 to 1.23)	0.45 (0.26 to 0.79)	0.69 (0.30 to 1.62)
	2.Italian vs. Brunch	*Group vs. 2*
	0.22 (0.11 to 0.43)	1.40 (0.56 to 3.66)

	3.Italian vs. Salad	*Group vs. 3*
	0.31 (0.17 to 0.57)	1.47 (0.61 to 3.56)
	4. Italian vs. Soup	*Group vs. 4*
	0.43 (0.24 to 0.76)	*1.10 (0.50 to 2.42)*
	5. Italian vs. Roast	*Group vs. 5*
	0.20 (0.10 to 0.40)	*1.85 (0.74 to 4.67)*
	6. Italian vs. Burger	*Group vs. 6*
	0.23 (0.12 to 0.45)	*2.00 (0.80 to 4.98)*

*For comparisons, intervention group coded 1, control group coded 0. Control group (decoy absent) is the reference group.

**For comparisons, reference menu coded 0, alternative menu coded 1.

¶Analyses adjusted for covariates of age brackets, gender, last meal contained meat, last meal contained vegetables, how healthy the meal is priority influence on decision making.

For the primary outcome, choice of target vegetarian option, our covariate adjusted GEE analysis found no significant main effect of group (*p=0.13*, see Table 4 for ORs). Comparing menus, with the soup menu as the reference group (given it was the most popular menu for those choosing the target vegetarian option), we found that the target vegetarian option was significantly less likely to be chosen across all remaining menus (p*<0.001* for all comparisons). There was, however, no significant group by menu interaction for our primary outcome across any of the menu conditions (ORs for all interaction terms cross the null value of 1 or *p>0.05*).

For the secondary outcome, choice of the competitor meat option, there was no significant main effect of group (*p = 0.89*). For the comparisons across menu conditions, the competitor meat option was significantly less likely to be chosen when participants viewed the curry menu (*p = 0.004*), soup menu (*p <0.001*) or Italian menu (*p< 0.001*) compared to the roast dinner menu (which was the menu in which the meat dish was chosen by the greatest proportion of participants). None of the interaction terms between group and menu condition were significant predictors of competitor meat choice (ORs for all interaction terms cross the null value of 1 or *p>0.05*).

Study 2 Discussion

The results of study 2 replicated those of study 1, testing a larger sample size and greater differential between decoy and base prices and a broader selection of menus. Once again, our findings provide no support for the theory that adding a decoy vegetarian option to menus encourages more diners to choose a target vegetarian dish.

This second study helps to refute one potential explanation for the lack of a significant decoy effect seen in study 1 – that the number of participants choosing the target vegetarian dish did not differ between intervention and control groups because the decoy was too similar in price to remaining menu items. The results of study 2 showed that increasing the price of decoy options to represent a 30% increase continued to have no significant influence on choice of the target vegetarian option or the competitor meat option. We do, however, note that our analysis of study 2 data show that perceptions of dish price did not differ between the experimental and control groups, suggesting that the more expensive decoy items were not necessarily perceived more negatively, and hence may not have led participants to engage in unfavorable comparisons against the target vegetarian option.

Here, we propose that the lack of effect found in study 2 may reflect the fact that meal choices in this hypothetical choice task were non-consequential (e.g. it was an online study rather than a study conducted in a real life restaurant where participants would need to spend their own money and actually consume their chosen dish). Thus, to understand whether decoy options have different or greater effects on decision making when choices have real world consequences, further research is now needed using either online experimental designs wherein participants actively purchase food items (e.g. via food delivery platforms) or studies conducted in restaurants or canteens. These studies would involve measuring true behavioral endpoints (e.g. number of vegetarian or meat dishes purchased), rather than hypothetical choices, providing a far more ecologically valid indication of whether the decoy effect can influence sustainable food choices.

In defense of the current study design, however, we note that previous online studies of menu-engineering nudges using similar protocols have been able to find sizeable, significant differences in food choice between intervention and control groups (Vennard et al., 2018). We also note that this second also helps to clarify that the lack of an effect of higher priced decoys on meal choices that was seen in study 1 was not due to inadequate power, given that study 2 recruited a far larger sample of participants.

Overall Discussion

We present two online menu studies that examine the effect of including higher priced menu items, in line with the tenets of decoy theory, both of which found no significant influence on participants' preferences for more sustainable 'target' vegetarian options compared to less sustainable 'competitor' meat options. In both these studies, viewing a third 'decoy' vegetarian dish, priced either two or four

pounds higher than remaining menu items, did not appear to lead to participants to make unfavorable comparisons against the target vegetarian dish, resulting in no significant increase in the numbers who selected this instead of the competitor meat dish.

Findings from study 2 lend support to one potential explanation for the lack of a significant decoy effect seen in study 1 – that the price differential between decoy and remaining menu items was too small to have exerted an influence on food choice. Remaining interpretations for the lack of any decoy effect seen in these two experiments include the idea that decoying is not a useful strategy to encourage more sustainable food choices (possibly due to very strong pre-existing preferences for specific dishes, particularly meat, or stronger determining influences on choice from other factors), that the decoy effect may not influence food choices in the manner hypothesized, or the fact that meal choices were non-consequential in this online trial.

One further explanation for the lack of difference in dish choices between the intervention and control group may also be that an alternative decoy strategy, focusing on attributes other than price, is needed to shift dietary preferences. For example, there may be value in considering menu-based decoys that use less appealing menu descriptions (so influencing perceptions of taste or quality; Vennard et al., 2018), decoys that are less nutritious or more calorific (Carroll & Vallen, 2014), unbranded decoys versus branded targets (Sellers-Rubio & Nicolau-Gonzalbez, 2015) or decoys that are perceived to be smaller or less filling than other menu items (Chen, 2017). We recommend further research into these strategies, but note that existing research has tended to show that the more complex the experimental stimuli used in decoy experiments (e.g. pictures and lengthy descriptions referring to multiple attributes), the less likely it is that a decoy effect will emerge (Huber et al., 2014). This is presumably because participants find it hard to recognize inferior and superior options when they are required to weigh up lots of complex information at the same time (Huber et al., 2014). Despite this, using more complex stimuli would help to make future decoy experiments more realistic (e.g. multiple menu options with variable descriptions and pricings), so enhancing the external validity of findings.

Findings in context

Decoys are an approach commonly used in the marketing and sales of food and other products, albeit rarely as a means to encourage more sustainable food choices. Where researched in relation to food choice, decoys have been shown to increase the likelihood that participants will select target products (e.g. increased sales of frozen ready meals, salad (Carroll & Vallen, 2014), baked beans (Doyle, O'Connor,

Reynolds, & Bottomley, 1999)) – findings which contradict the results of the current study. We were, however, only able to locate a single experiment that had looked at the impact of menu-based decoys on food choice specifically (rather than exploring decoys used in supermarket or other retail context). This study also found a significant effect of including an inferior decoy on target food choice, suggesting that this is an area in which further research is needed to allow for a better understanding of how, when and why menu-based decoys work and to further explore their potential for promoting more sustainable food choices.

Beyond food, a sizeable body of research has looked at the factors that may potentially moderate the decoy effect for other types of products. For example, we note the work of Huber et al (2014) who found decoys have most influence on choices in contexts where participants express no strong prior preference for one particular option over another (e.g. either the target or the competitor; Huber et al., 2014). The moderating effect of prior preference would be interesting to explore further in relation to sustainable food choices, especially given that people tend to hold very strong and consistent preferences towards meat (as demonstrated by the fact that the meat option was the most popular choice across all menus in both study 1 and 2). This ties in with existing research into the determinants of food choice and, in particular, meat intake, which shows a strong habitual component to the overconsumption of this food (Schösler, Boer, & Boersema, 2012;Rees et al., 2018).

We attempted to explore the question of whether prior preferences for meat influence the decoy effect in a series of post-hoc exploratory subgroup analyses for our primary and secondary outcomes in study 2. The aim of these analyses was to compare individuals who reported frequent (three times per week or more) versus infrequent (twice per week of less) meat consumption. Unfortunately, we were unable to run the required statistical models given too few participants choosing the target vegetarian option when the sample was split by pre-existing meat consumption habits (i.e. most habitual meat eaters chose the meat option when viewing the intervention group menus). We recommend that future research look into this issue further, in addition to exploring whether the decoy effect emerges more strongly when consumers are considering more unfamiliar or novel products that they have yet to build a preference towards. Here, one specific application may be determining if decoys influence choice of emerging alternative meat products, or cultured meat options, that are currently in development or have only recently been released to market (Slade, 2018).

We additionally note that neither of our studies found substantial differences in the numbers of participants choosing the target vegetarian option when this dish was either fully vegan (i.e. contained no animal-based products at all) as opposed to suitable for individual following a lacto-ovo vegetarian diet (i.e. contained dairy or egg based products). This outcome implies that price based decoys are not necessarily more effective at promoting dishes that differ in the extent to which they exclude animal products (and hence that differ in terms of their relative GHG footprint). Future research may usefully explore this issue further, potentially by examining whether the degree to which individuals are aware of the impact of their dietary choices on the environment, or the extent of their positive or negative perceptions of vegan or vegetarian options, moderates the effect of menu-based decoys on dish choices.

Strengths and Limitations

These are the only two studies that we are currently aware of that test the effect of including decoy items on menus to influence sustainable food choices. Our hope is that, despite showing non-significance, the addition of our findings to the literature will help stimulate others to conduct further, more extensive research into this approach. We note the importance of publishing research with null findings, both to balance potential publication biases and to allow other researchers to learn from and improve upon research methodologies that produce inconclusive results. For example, from this study, we have learnt the importance of pre-testing potential decoy strategies prior to full experimentation to ensure that participants do judge the intended decoy as inferior to the target menu item, and to consider decoying on other key attributes that influence food choice.

Limitations of this work include limited external validity, given that food choices were hypothetical and we were presenting participants with just three options to choose from. Whilst this process did ensure that we could clearly isolate the effect of the experimental manipulation, it is somewhat different from the context in which food choices are made in real life restaurants, where multiple options are available on menus and where diners need to spend their own money when making their selection. We also acknowledge that food choices are influenced by a broad array of factors beyond menu design alone (Bisogni, Madore, Blake, 2006), indicating that future research would benefit from measuring a wider selection of additional demographic and dietary variables to add as covariates into statistical models. We attempted to address this fact through inclusion of additional covariates in study 2, but recognize that these variables represent only a small percentage of known influences on food choice. Given that it is unlikely that all potentially relevant influences on food choice can be measured in a study of this kind,

we emphasize the value of fully randomizing participants to experimental groups and sufficient sample sizes to ensure that both measured and unmeasured variables do not bias the results.

Conclusions

These two studies tested whether a menu-based behavioural nudge could influence sustainable food using online experimental trials. We found no evidence that inclusion of higher priced vegetarian decoys led to increased selection of a target vegetarian options on food menus - an outcome that would have succeeded in reducing the environmental footprint of a diner's meal. The vegetarian decoys tested in these two trials also had no effect on selection of the remaining meat-based option on the menu. Together, these findings indicate that further research is now needed to help us understand which elements make an effective menu-based decoy and to test if this effect is observable in experimental tasks where choices are consequential. We recommend further menu-engineering nudge research - considering decoys in addition to a broader range of 'nudge' techniques such as priming, defaults or modifying the number and variety of menu items - is now be conducted to generate learnings into how best to encourage consumers to shift their food choices towards more environmentally options using techniques that will plausibly be taken up by food service providers.

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744 ***Appendix 1: Dish options for each menu type trialed in study 1***

Dish Option (£control/*£intervention*)	**Burger Menu**	**Salad Menu**	**Curry Menu**	**Brunch Menu**
Target Vegetarian Option	Falafel Burger Falafel burger with hummus, relish and salad £8.95	Avocado Salad Avocado, tomatoes, quinoa and chickpeas & lemon juice on a bed of herby salad. Served with balsamic dressing and olive oil £12.95	Aubergine, Lentil and Chickpea Dhal With coriander and toasted almonds. Served with grilled flatbread £13.95	Vegetarian Breakfast Poached free range eggs, potato hash browns, smashed avocado, roasted plum tomatoes, mushrooms and toast £10.95
Meat Option	Classic Cheese Burger Beef burger with house mayo, relish and salad £8.95	Steak Salad Sliced steak fillet, tomatoes, red onion and herby leaves on a bed of cos lettuce. Served with balsamic vinegar dressing and black pepper £12.95	Green Thai Chicken Curry With sugar snap peas, red peppers, spring onions and chilli. Served with rice £13.95	Traditional English Breakfast Fried free range eggs, Cumberland sausage, smoked streaky bacon, roasted plum tomatoes, mushrooms and toast £10.95
Decoy Vegetarian Option	Classic Veggie Burger Bean burger with house mayo, relish and salad £8.95/ ***£10.95***	Superfood Salad Sweet potato, roasted peppers, tomatoes, red onion on a bed of mixed leaves. Served with pesto and lemon vinaigrette £12.95/ ***£14.95***	Butternut Squash, Turmeric and Coconut Stew With kale, red peppers and onions. Served with rice. £13.95/ ***£15.95***	Mediterranean Breakfast Poached free range eggs, smoky aubergine salad, charred red peppers, roasted plum tomatoes, hummus and toast £10.95/ ***£12.95***

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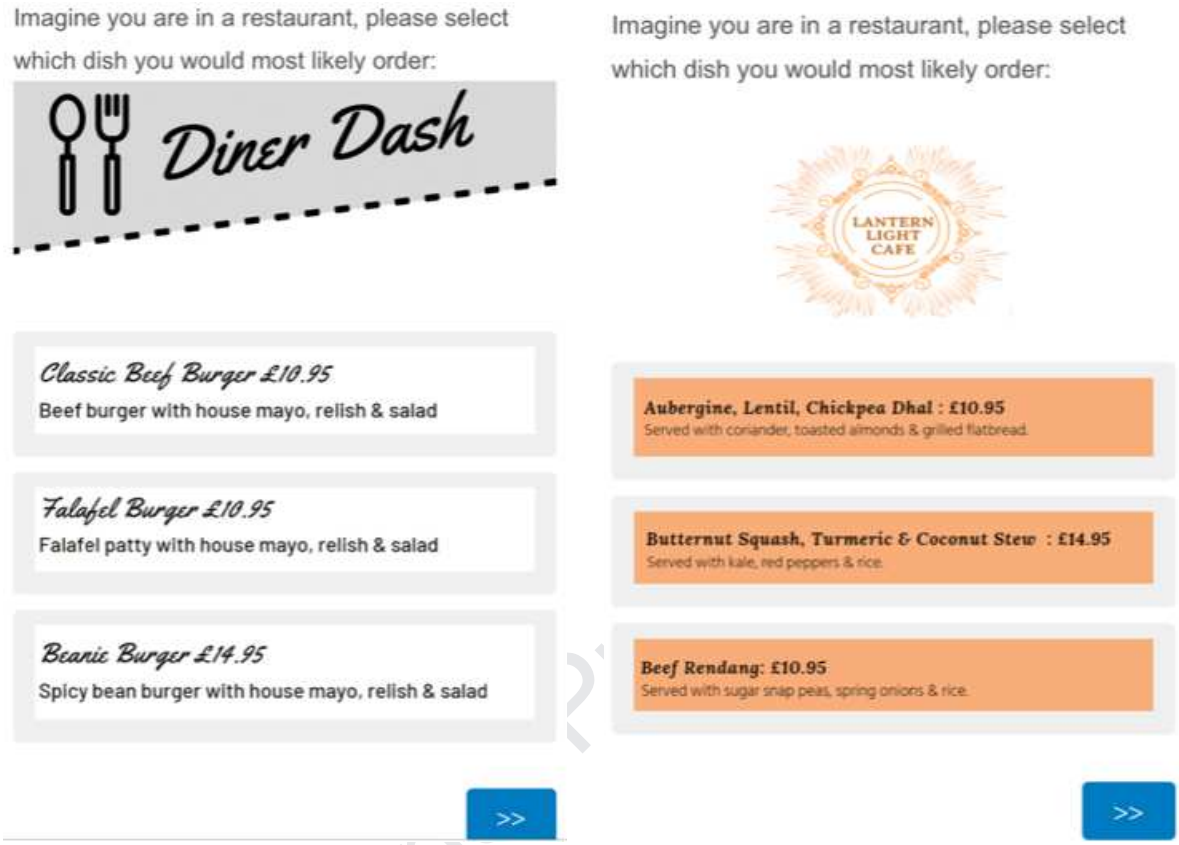
747 ***Appendix 2: Dish options for each menu type trialed in study 2****



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749 *2a. Intervention condition for the burger menu* *2b. Intervention condition for the curry menu*

750 **Screens were identical for all control conditions, with all prices listed as the same base lowest price*

2c. Intervention condition for the breakfast menu *2d. Intervention condition for the Italian menu*

**Screens were identical for all control conditions, with all prices listed as the same base lowest price*

2e. Intervention condition for the roast dinner menu *2f. Intervention condition for the salad menu*

**Screens were identical for all control conditions, with all prices listed as the same base lowest price*

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760 *2f. Intervention condition for the soup menu*