

**Menu design approaches to promote sustainable vegetarian food choices when dining out**

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# Menu design approaches to promote sustainable vegetarian food choices when dining out

## Abstract

Shifting dietary choices towards vegetarian food is an urgent challenge given the environmental impact of livestock production and imminent need to reduce global greenhouse gas (GHG) emissions. Previous research has proven the value of low cost, scalable menu design interventions to influence food choices, without the need for large-scale educational campaigns. Here, we present two online randomized control trials to determine the effectiveness of two menu design approaches to nudge participants' food choices away from meat and towards vegetarian dishes. In study one we explore the impact of vegetarian items availability on choice. Participants were allocated to menus in which 75%, 50% or 25% of items were vegetarian. We show that meat eaters were significantly more likely to choose a vegetarian meal when presented with a menu with 75% vegetarian items, but not when half (50%) were vegetarian. This finding highlights that saturating the choice environment is required to promote vegetarian food. In study two, we explore the impact of vegetarian symbols (V) to determine if these are used by meat eaters as exclusion decision filters, as is seen in previous work with menus containing 'vegetarian' dish sections. Here we show that placement of V symbols, to either the left or right of a dish label, has no impact on choice. These studies provide insights into how the environmental footprint of the food service sector can potentially be reduced using easy and scalable menu design approaches.

## Key Words

Behaviour change; Sustainability; Food choice; Diet; Climate change

## 1.Introduction

### 1.1 The climate impact of food choices

The 2015 Paris Agreement aims to keep global temperature rises below 1.5° to avoid the worse consequences of climate change (UNFCCC, 2020). In order to achieve this, countries around the world must rapidly reduce their greenhouse gas (GHG) emissions, especially within sectors that contribute most to national footprints. The food system is one such sector, with estimates showing that production, processing, distribution, preparation and consumption of food accounts for around 25–30% of all global GHG emissions (Poore & Nemeck, 2018; Crippa, Solazzo, Guizzardi et al., 2021; UNEP, 2020).

Moreover, further analyses shows that, even if GHG emissions from all other sectors were immediately curbed, the impact of the food system alone, if unchallenged, would prevent achievement of Paris Agreement targets (Clark et al., 2020). This situation is further compounded by population growth, projected to reach around 10 billion people by 2050.

Therefore, it is essential to find ways to feed approximately one third more people while simultaneously preventing agricultural expansion into virgin forests and reducing GHG emissions. This will require more efficient means of both producing and consuming food (Willett et al., 2019).

### 1.2 Ruminant meat and sustainable diets

Particularly problematic from the perspective of diet efficiency is over-consumption of meat from ruminant animals (i.e. beef, goats and lamb). Ruminant meat is far more resource intensive to produce than vegetarian food. For example, per unit of edible protein, producing beef emits around 20 times more GHG emissions than non-animal sources such as beans, peas and lentils (Ranganathan, Vennard, Waite, Lipinski, Searchinger et al., 2016).

While a wide range of different and promising approaches to improve the efficiency of ruminant meat production exist, these do not negate the need for a global shift in dietary choice towards eating less

meat. For example, the EAT Lancet consortium have recommended that, for optimal individual and planetary health, consumption of animal- products must be capped at 98 g of red meat and 203 g of poultry per person per week (Willett et al., 2019), with plant-based foods constituting the majority of the diet.

Given that meat is integral to many cuisines across the world, a crucial question remains as to how exactly we achieve this move to more vegetarian diets? As many years of research and practice in the health domain indicates, eating habits tend to be hard to

change. For example, numerous campaigns have been launched worldwide to tackle over- consumption of calories leading to overweight and obesity (Walls, Peeters, Proietto, & McNeil, 2011), yet prevalence continues to rise (Malik, Willet, & Hu, 2020).

### 1.3 Nudging food choices

Efforts to change dietary choices have tended to focus on educating individuals about associated risks, often via population campaigns or targeted programs directed at 'high risk' groups (Stead et al., 2019). Recently, however, research has been directed towards the role of the decision context on food choices (Abrahamse, 2020; Wansink & Love, 2014). More commonly known as 'nudging', these interventions involve modifying the way in which a choice is presented, known as the 'choice architecture', in dining establishments or food retail. Promisingly, these approaches have shown some efficacy at changing food choices (Van- denbroele, Vermeir, Geuens, Slabbinck, & Van Kerckhove, 2020), often without consumer awareness that their decisions have been influenced (Rust et al., 2020). Examples include modifying the default food offering (i.e. Campbell Arvai, Arvai, & Kalof, 2014), limiting access to the sale of certain food items, redesigning menus (i.e. Feldman, Su, Mahadevan, Brusca, & Hartwell, 2014) , labelling products with symbols, signs or language (i.e Wansink, Painter, & Van Ittersum, 2001), and altering the placement of food products (i.e Dayan & Bar-Hillel, 2011).

### 1.4 Availability of vegetarian options

Considering nudges to promote sustainable dietary choices, one intervention that has been shown to work well in real-life dining contexts is increasing the availability of vegetarian foods. Examples include adding more vegetarian dishes to menus or buffets, or presenting vegetarian dishes in ways to appear more numerous or abundant (i.e. separating salad ingredients into multiple separate bowls rather than mixing them together in one) (Friis et al., 2017).

Recent research conducted in a university canteen in the United Kingdom showed that doubling the number of vegetarian items on sale (from one to two items on a four-item menu) led to a 62% (range of 40.8%–78.8%) increase in the number of diners choosing these options (Garnett, Balmford, Sandbrook, Pilling, & Marteau, 2019). A second study in a restaurant based in the Netherlands demonstrated that replacing three meat dishes with vegetarian alternatives, and modifying the portion size of meat in a fourth dish, led to a 113% increase in the amount of vegetables consumed and 4% reduction in amount of meat consumed (Reinders, Lieshout, Pot, Neufinger et al., 2020). Similarly, an older campus-based restaurant study found that offering diners a default vegetarian menu, with meat available on a separate menu displayed 3.5m away, significantly increased the

probability that vegetarian meals were chosen compared to when diners received a regular menu (Campbell Arvai et al., 2014).

This research is promising as it shows that preferences can be influenced via relatively minor modifications to the way in which a choice is presented, without the need to educate or consciously persuade individuals to alter their behavior. However, despite these initial positive findings, research is yet to determine exactly how much meat availability needs to decrease in order for this approach to produce the desired effect. For example, in the university canteen study noted above, meat options were decreased by 33% (Garnett et al., 2019), while in the

Netherlands restaurant study, three meat dishes were replaced by vegetarian dishes in a buffet, although we are not told what proportion of the total dishes on offer this represents (Reinders, Lieshout, Pot, Neufinger et al., 2020).

This question has important practical significance, as knowing exactly how much meat to remove from menus would give useful, pragmatic guidance for retailers and food service operators. For example, to what extent do menus need to substitute meat to vegetarian dishes? Given that diners tend to consume more meat when eating out (Horgan, Scalco, Craig, Whybrow, & Macdiarmid, 2019), reducing the number of meat options may have important implications for profitability or customer retention, and hence, may limit operator willingness to adopt this approach. As such, it would be useful for restaurants to have guidance on the minimum viable reduction in meat availability required to elicit a significant shift in consumer choice towards more sustainable vegetarian options.

## 1.5 Labelling of vegetarian options

A similarly pragmatic question that remains unanswered regards labelling of vegetarian options. To date, these have tended to be indicated by 'vegan' or 'vegetarian' labels on menus, signs or packaging. This approach is beginning to also receive interest for its potential to influence consumer food choices (Vlaeminck, Jiang, & Vranken, 2014; Tobi et al., 2019).

One intriguing finding in existing literature is the fact that overtly indicating options are 'vegetarian' or 'free from meat' seems to reduce the numbers of diners willing to purchase them (Bacon & Krpan, 2018; Krpan & Houtsma, 2020). For example, an online menu study found that separating vegetarian items into their own dedicated and labelled 'vegetarian' section more than halved the odds they were chosen (Bacon & Krpan, 2018). This finding was replicated in a separate online study also demonstrating that a designated 'vegetarian' menu section (versus an environmental or social designation, or no designation) was the least effective approach to promoting vegetarian dishes (Krpan & Houtsma, 2020). In this study, authors suggested that the apparent choice-inhibiting effect of vegetarian labelling owed to this framing leading consumers to believe that vegetarian dishes were less enjoyable, and were used by meat-eaters as exclusionary

criteria when scanning menus. While it should be noted that both studies used hypothetical food choices and not real-world behaviours, [Piernas et al. \(2021\)](#) explored the influence of moving vegetarian products to meat aisles in supermarkets on real purchasing decisions. This study found that integrating these products increased sales of meat-free products, yet did not significantly reduce sales of meat products, although this may not apply to restaurant dining where the total number of products on offer may be more restricted.

The implications of this research presents a quandary for food service providers wishing to label vegetarian options without alienating their customer base; how can meat-free options be highlighted for those consumers who want to easily identify them, and also comply with allergen labelling requirements, whilst not inadvertently discouraging meat-eaters to select more vegetarian options?

Thus far, one approach routinely used in many dining and retail establishments is the inclusion of 'V' symbols to denote either vegetarian or vegan options. However, no research has yet been conducted to understand whether symbols also reduce the likelihood of these items being selected by consumers. A recent calorie labelling study measured the influence label placement has on dish choices. The results showed that only calorie labels presented before dish titles, but not after, encouraged less calorific food choices. This result was shown to be the case using participants from both the US (who read left to right) and Israel (who read right to left) ([Dallas, Liu, & Ubel, 2019](#)). This finding has yet to be replicated in the context of climate labelling and such research would provide food operators insight into optimal placement of vegetarian symbols to avoid deterring vegetarian food choices.

## 1.6 Research Questions

In this study, we present findings from two separate online randomized controlled trials exploring the influence of vegetarian food availability and vegetarian labelling on choice. These two distinct areas are united by the direct, practical guidance they offer; the first study will help to provide the food service sector with guidance on how to redesign their menu to encourage vegetarian choices, and the second on how to communicate about these options on menus in a way that will appeal to meat-eaters. In study one, we test a range of menus with different ratios of vegetarian: meat dishes to address the question of how much of a menu needs to be vegetarian to encourage diners to shift away from choosing meat? In study two we test the role that placement of 'V' symbols on menus play in influencing food choice, answering the question of whether placement of the symbol before or after dish titles influences the number of diners choosing vegetarian items? The goal of both studies is to give practical guidance on the use of these nudge approaches to food service providers wishing to promote more vegetarian options.

## **Study 1: Availability of vegetarian menu options**

### **2.1 Materials and Methods**

#### **2.1.1 Study design**

This online randomized controlled trial was delivered via Qualtrics. Participants were randomly allocated to one of three conditions that presented them with a series of menus with different availability of vegetarian and meat dishes – a meat: vegetarian ratio of (a) 2:6 (75% vegetarian menu); (b) 4:4 (50% vegetarian menu); and (c) 6:2 (25% vegetarian menu). Within each condition participants viewed five mock menus that reflected the types of offerings available in popular restaurant chains in the UK (e.g. a burger menu, a brunch menu, a deli-style sandwich menu, a pub-style lunch menu, and an Italian food menu). The order in which each of these menus were presented was randomized across participants.

#### **2.1.2. Participants**

Participants were recruited via the online recruitment platform Prolific (<https://www.prolific.co/>) and received an incentive of £1.50 to undertake the study. Eligibility criteria included English speaking, UK residents aged over 18. Participant recruitment was stratified according to age categories (age brackets 18–24, 25–45, 46–64, 65+) and gender (male, female). We excluded participants who self-identified as following a pescatarian, vegetarian or vegan diet prior to data analysis. These exclusions were made via a post-task dietary questionnaire, rather than pre-screening, to avoid dietary questions priming vegetarian food choices in the subsequent experiment.

Sample size was informed by a prior power calculation reported in [Attwood, Chesworth, and Parkin \(2020\)](#), a previous study that we undertook to explore the influence of price on vegetarian food choices using a similar research protocol ([Attwood et al., 2020](#)). Criteria for this calculation were based on prior research ([Vennard, Park, & Attwood, 2018](#)), and aimed to detect a minimum 7% shift in numbers choosing vegetarian menu items between intervention and control groups, at a significance level of 0.05, with power of 80% and assuming a two-tailed hypothesis. The results of this calculation recommended N = 156 participants per menu condition (i.e. N = 468 total). Data collection occurred during April 2020, and we note that eventual recruitment was underpowered due to early cessation because of COVID-19 related limitations.



### 2.1.3. Intervention

For each menu in the three conditions, participants were asked to make a choice between eight dishes presented in two columns of four. Vegetarian dishes were all suitable for someone following a lacto-ovo vegetarian diet. The vegetarian and meat items were presented in fixed positions across all menu types (as seen in [Fig. 1](#)), to ensure that vegetarian and meat dishes were equally represented in the top two rows of the menu to control for the known influence of edge item positioning on choice ([Kim, Hwang, Park, Lee, & Park, 2018](#)). Dishes listed on menus were priced similarly to their UK retail value, with meat and vegetarian options matched on price with the exception of one slightly higher priced meat option (>£2). This decision was made to ensure that menus appeared realistic while keeping the price variation within a range that has previously been shown to exert no influence on choice ([Attwood et al., 2020](#)). The dishes used in each condition are listed in supplementary materials 1.

### 2.1.4. Procedures and measures

The study was approved by the Westminster University Ethics Committee in line with the Declaration of Helsinki. Upon entry to the online platform, participants were provided with a description of the experimental task and gave informed consent. The primary outcome in this study was dish choice, represented as a dichotomous variable reflecting whether the dish chosen was vegetarian (1) or not (0). Prior to seeing each menu, participants were told to “Please consider the menu on the following page. We would like you to imagine you are in a restaurant and to select which dish you would be most likely to order”. To highlight their choice, participants clicked on their desired option, and were then directed to the next menu.

Following this choice task, participants completed a series of demographic and dietary questions. These included age, gender (male/ female/other), BMI, usual diet (vegan/lacto-ovo vegetarian/pescatarian/Includes meat and dairy products/Other), current hunger levels (1- not at all - 10 extremely hungry), past behavior (whether their last meal contained meat: Yes/No) and the typical frequency that they dined out-of-home (Less than monthly/Monthly/Fortnightly/Once per week/ 2–3 times per week/Every day). Questions relating to the participants’ perception of vegetarian food choice were also included, for example whether participants thought vegetarian options are for specific types of people and not for other eaters (from 0- strongly agree to 7- strongly disagree) and whether vegetarian foods are environmentally friendly (0- strongly agree to 7- strongly disagree). These measures were included to capture some of the variables known to influence food choice (for co-variate adjusted analyses) based on previous research using a similar paradigm ([Attwood et al., 2020](#)) and that which has shown age, gender ([Neff et al., 2018](#)) and past eating behaviour predict meat consumption ([Saba & Di Natale, 1998](#)). An attention check question was also included.



**Figure 1: Example menu for each availability condition in study 1:** Participants were randomly allocated to one of three conditions, which differ according to the proportions of meat and vegetarian dishes. They were either allocated to a menu where A) 75% of the dishes were meat and 25% vegetarian B) 50% of the dishes were meat and 50% vegetarian of C) 25% of the dishes were meat and 75% were vegetarian.

A)	B)	C)
<div> <div>THE CORNER CAFE</div> <div> <div>EGGS FLORENTINE £8.45</div> <div>Spinach, poached eggs, hollandaise on grilled ciabatta</div> </div> <div> <div>EGGS BENEDICT £8.45</div> <div>Roasted ham, poached eggs, hollandaise on grilled ciabatta</div> </div> <div> <div>MEXICAN FRITTERS £9.45</div> <div>Sweetcorn fritters, chorizo, poached eggs &amp; guacamole</div> </div> <div> <div>GARDEN BREAKFAST £9.45</div> <div>Poached eggs, hash browns, smashed avocado, roasted plum tomatoes, mushrooms &amp; toast</div> </div> <div> <div>THE BREAKFAST STACK £8.45</div> <div>Sausage &amp; chorizo baked beans on a grilled bagel with two poached free range eggs</div> </div> <div> <div>THE ALL AMERICAN £9.95</div> <div>Pancakes, streaky bacon, sausage, home-style potatoes &amp; maple syrup</div> </div> <div> <div>PANCAKES &amp; BACON £9.45</div> <div>Topped with streaky bacon and maple syrup</div> </div> <div> <div>THE FULL ENGLISH £10.95</div> <div>Fried eggs, Cumberland sausage, smoked bacon, roasted plum tomatoes &amp; toast</div> </div> </div>	<div> <div>THE CORNER CAFE</div> <div> <div>EGGS FLORENTINE £8.45</div> <div>Spinach, poached eggs, hollandaise on grilled ciabatta</div> </div> <div> <div>EGGS BENEDICT £8.45</div> <div>Roasted ham, poached eggs, hollandaise on grilled ciabatta</div> </div> <div> <div>MEXICAN FRITTERS £9.45</div> <div>Sweetcorn fritters, chorizo, poached eggs &amp; guacamole</div> </div> <div> <div>GARDEN BREAKFAST £9.45</div> <div>Poached eggs, hash browns, smashed avocado, roasted plum tomatoes, mushrooms &amp; toast</div> </div> <div> <div>THE BREAKFAST STACK £8.45</div> <div>Sausage &amp; chorizo baked beans on a grilled bagel with two poached free range eggs</div> </div> <div> <div>SHAKSHUKA CLASSIC £9.95</div> <div>Baked eggs with, onion, pepper &amp; tomato sauce, harissa hollandaise &amp; pita</div> </div> <div> <div>BUTTERMILK PANCAKES £9.45</div> <div>Topped with banana, blueberries &amp; maple syrup</div> </div> <div> <div>THE FULL ENGLISH £10.95</div> <div>Fried eggs, Cumberland sausage, smoked bacon, roasted plum tomatoes &amp; toast</div> </div> </div>	<div> <div>THE CORNER CAFE</div> <div> <div>EGGS FLORENTINE £8.45</div> <div>Spinach, poached eggs, hollandaise on grilled ciabatta</div> </div> <div> <div>EGGS BENEDICT £8.45</div> <div>Roasted ham, poached eggs, hollandaise on grilled ciabatta</div> </div> <div> <div>MEXICAN FRITTERS £9.45</div> <div>Sweetcorn fritters, chorizo, poached eggs &amp; guacamole</div> </div> <div> <div>GARDEN BREAKFAST £9.45</div> <div>Poached eggs, hash browns, smashed avocado, roasted plum tomatoes, mushrooms &amp; toast</div> </div> <div> <div>THE BREAKFAST STACK £8.45</div> <div>Baked beans on a grilled bagel with two poached free range eggs</div> </div> <div> <div>SHAKSHUKA CLASSIC £9.95</div> <div>Baked eggs with, onion, pepper &amp; tomato sauce, harissa hollandaise &amp; pita</div> </div> <div> <div>BUTTERMILK PANCAKES £9.45</div> <div>Topped with banana, blueberries &amp; maple syrup</div> </div> <div> <div>MEDITERRANEAN BREAKFAST £10.95</div> <div>Poached eggs, grilled aubergine, red peppers, plum tomatoes &amp; toast</div> </div> </div>

### 2.1.5. Analysis

All analyses were undertaken using statistical package IBM SPSS statistics version 25. To determine the influence of vegetarian option availability on food choice, we ran covariate unadjusted and adjusted binary logistic Generalized Estimating Equations (GEE) models, replicating the analytic approach taken in Attwood et al. (2020). GEE models allow for analysis of data from repeated measures or panel designs by accounting for the non-independence of responses from the same participant across multiple menus. This is done by including participant ID as a ‘subject’ variable and menu type as a ‘within subjects’ variable in the final statistical model.

Dichotomized dish choice (vegetarian (1) vs. non-vegetarian (0) option selected) was the primary outcome measure. Condition was added as a predictor to the model, ran first with the 50% menu as the comparison group, and then subsequently to compare the 25% vs. 75% menus directly. Menu type (the five types of menus) was also additionally included in unadjusted models. Following this, we ran covariate adjusted models, including demographic and diet related covariates that were found to significantly predict dish choice ( $p < 0.05$ ) in prior independent binary logistic regression analyses.

## 2.2. Results

### 2.2.1. Study sample

430 individuals were recruited into study one. 78 of these individuals were excluded because they either did not eat meat as part of their normal diet (i.e. vegan, vegetarian or pescatarian, N = 76), or they had failed the attention check (N = 2 participants). This left a total sample of 352 participants, each viewing five menus, leading to 1760 observations for analysis.

Participant demographic and dietary characteristics are summarized in [Table 1](#). The sample contained slightly more males (53.4%) than females, with ages ranging from 18 to 83 years. The median age of the sample was in the mid-thirties. Participants were, on average, slightly overweight (BMI: 25.86) and had an average hunger score of 5 out of 10, indicating that they were not particularly hungry at the time of completing the task.

In terms of usual dietary behaviors, the sample ate meat frequently. On average, this was five out of seven days in the previous week, with just under 75% of participants consuming meat at their last meal. Conversely, most participants ate out infrequently, less than monthly (32%). Only 1% of the sample reported that they ate out of home on a daily basis, which may reflect the fact that data was collected during the COVID 19 pandemic as lockdown restrictions were easing in the UK.

When choosing what to eat, the most common priority in this sample was taste. Most participants rated their views towards vegetarian dishes as neutral, in that they did not strongly agree that these dishes are made for specific 'other' types of people, nor did they feel strongly about the environmental credentials of vegetarian dishes. Lastly, the vast majority (75%) of the sample rated the dishes that they were shown across the menus as priced 'about right'.

299 **Table 1: Characteristics of the sample from study one**

<b>Characteristic</b>	<b>Mean (SD) or Count (%)</b>
<b>Gender (Female)</b>	163 (46.3%)
<b>Age (years)</b>	35.17 (15.53)
<b>Current Hunger level (1-10)</b>	4.97 (2.34)
<b>Body Mass Index (kg/m<sup>2</sup>)</b>	25.86 (4.94)
<b>Dietary Variables</b>	
Last meal contained meat	262 (74.4%)
Number of days meat eaten in last week	4.94 (2.03)
Frequency of dining out-of-home	
<i>Daily</i>	4 (1.1%)
<i>2-3 times per week</i>	23 (6.5%)
<i>1-2 times per week</i>	62 (17.6%)
<i>fortnightly</i>	81 (23.0%)
<i>Monthly</i>	77 (21.9%)
<i>Less than monthly</i>	105 (29.8%)
Priority when choosing food	
<i>Health</i>	57 (16.2%)
<i>Cost</i>	40 (11.4%)
<i>Taste</i>	199 (56.5%)
<i>Filling</i>	15 (4.3 %)
<i>Usual choice</i>	41 (11.6%)
<b>Menu perceptions</b>	
Vegetarian dishes are for other people, not me	
<i>Agree or strongly agree</i>	65 (18.5%)
<i>Neutral</i>	176 (50%)
<i>Disagree or strongly disagree</i>	111 (31.5%)
Vegetarian dishes are good for the environment	
<i>Agree or strongly agree</i>	69 (19.6%)
<i>Neutral</i>	257 (73.0%)
<i>Disagree or strongly disagree</i>	26 (7.4%)
Price perceptions	
<i>Too expensive</i>	87 (24.7%)

<i>About right</i>	263 (74.7%)
<i>Too cheap</i>	2 (0.6%)

### 2.2.2. Unadjusted analysis

In unadjusted GEE models, compared to the 50% vegetarian menu, significantly more participants chose a vegetarian dish in the 75% vegetarian menu group (OR 2.58, 95% CI 1.86 to 3.57,  $p < 0.001$ ).

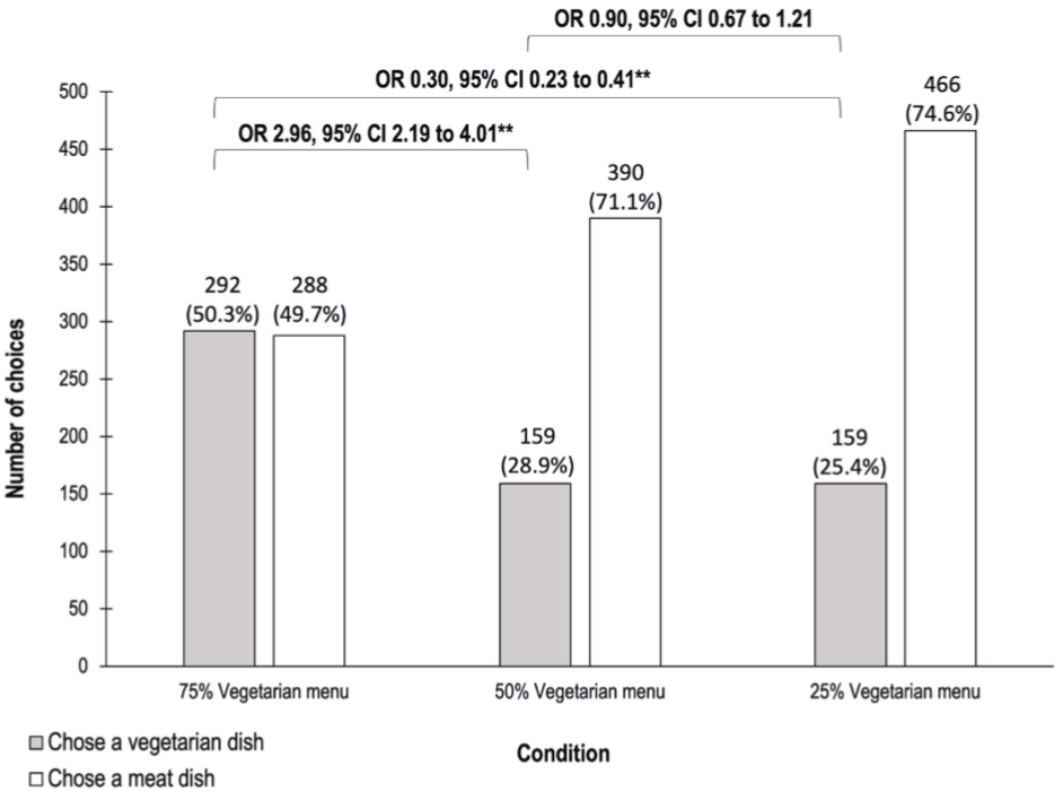
However, there were no significant differences in the number of participants who chose a vegetarian dish in the 25% vegetarian menu condition (OR 0.84, 0.61 to 1.15,  $p = 0.263$ ). When repeating the analysis by comparing the two experimental groups directly, this showed significantly fewer vegetarian dishes were chosen in the 25% vegetarian menu than the 75% vegetarian menu condition (OR 0.32, 95% CI 0.24 to 0.44,  $p < 0.001$ ).

### 2.2.3. Adjusted analysis

Analyses were re-run as fully adjusted models, adding demographic and dietary related variables found to predict dish choice in prior analyses. Menu type, gender, last meal contained meat, the number of days that meat was eaten in the last week, frequency of eating out-of-home, a variable summarizing top priorities when choosing food and a variable measuring the perception that vegetarian dishes are for specific types of 'other' people were entered into the model.

In this fully adjusted model, once again, there was no significant difference in the number of participants who chose vegetarian dishes in the 25% vegetarian menu group compared to the 50% vegetarian menu group (OR 0.90, 95% CI 0.67 to 1.21,  $p = 0.48$ ) (see [Fig. 2](#)). However, significantly more participants chose vegetarian dishes in the 75% vegetarian menu group compared to the 50% menu group (OR 2.96, 95% CI 2.19 to 4.01,  $p < 0.001$ ). Repeating the adjusted analysis by comparing the two experimental groups directly also showed significantly fewer vegetarian dishes were chosen in the 25% vegetarian menu than in the 75% menu group (OR 0.30, 95% CI 0.23 to 0.41,  $p < 0.001$ ).

**Figure 2: Dish choice by condition in study 1:** The results show that significantly more participants chose vegetarian dishes in the 75% vegetarian menu group, when compared to the 50% menu, and the 25% vegetarian menu condition. \* $p < 0.05$ , \*\* $p < 0.001$ .



### **3. Study 2: Labelling of vegetarian menu options**

#### **3.1. Material and methods**

##### **3.1.1. Study design**

Study two also used an online randomized controlled design delivered via Qualtrics. Here, participants were randomly allocated to one of three conditions; where menus were presented with the vegetarian symbol (V) to (a) the left (V Left), or (b) the right (V Right) of the dish name, or (c) a control condition where vegetarian items were not highlighted by V symbols. Within each condition, participants viewed a total of eight mock menus, the five included in study one (e.g. a burger menu, a brunch menu, a deli-style sandwich menu, a pub-style lunch menu, and an Italian food menu), plus three further menus (a salad menu, a mezze style menu and an Indian food menu). Given that participant fatigue was not a problem in the previous study, these additional menus were added to observe choice across a larger number of scenarios. The order in which menus were presented was randomized across participants. Participants were asked to make a choice between eight dishes per menu, three of which were always vegetarian options. This proportion of meat to vegetarian options was chosen to reflect the typical ratio found in national UK restaurant chains. The vegetarian and meat items were, once again, presented in fixed positions across all menus to control for the effect of item positioning on choice.

##### **3.1.2. Participants**

Participants were recruited via an online recruitment platform (Prolific <https://www.prolific.co/>), receiving an incentive of £1.50 for completing the study. Eligibility and exclusion criteria was identical as for study one, and we based our sample size requirements on the power calculation detailed above. Data collection occurred during June 2020, recruitment was, again, underpowered due to cessation due to COVID- 19.

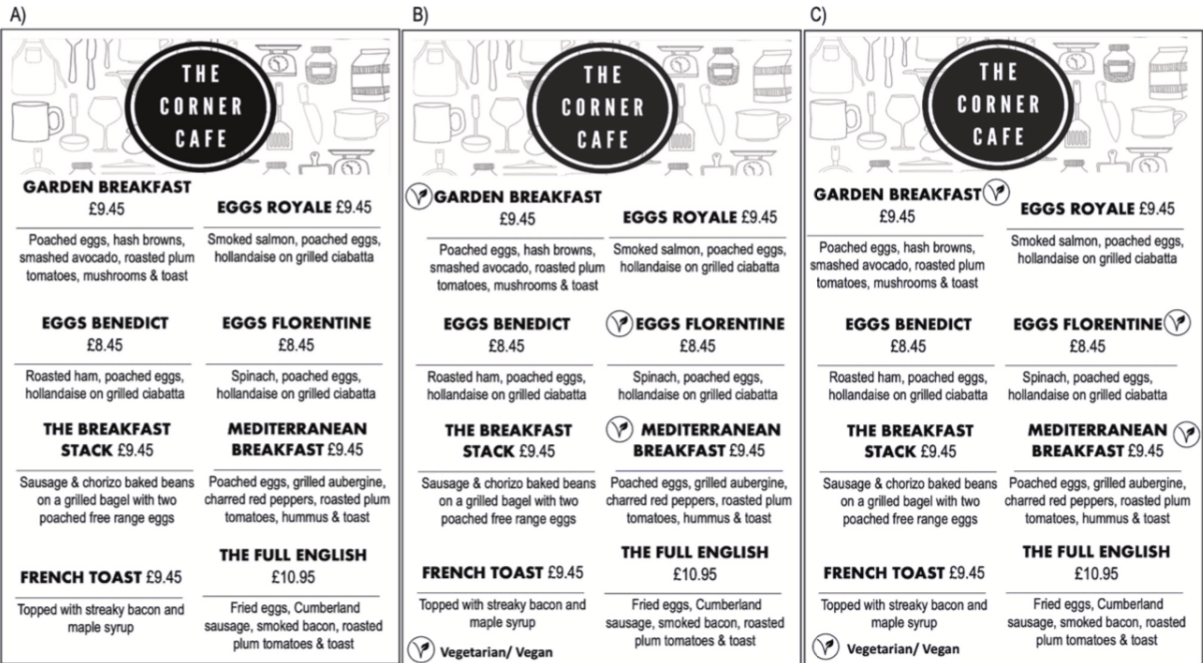
##### **3.1.3. Intervention**

In study two, participants in the intervention groups were exposed to menus with V symbols inserted either to the left or to the right of the dish name, while control group participants were exposed to the same menus with no V symbols. The V symbol design was taken from the EU endorsed registered symbol for labelling vegan and vegetarian products (<https://www.v-label.eu/en>). Fig. 3 shows an example menu across all three conditions. A list of the dishes included in each condition are listed in supplementary materials 2.

368

369 **Figure 3: Example menu for each labelling condition in study 2** Example menu for  
370 each labelling condition in study 2: Participants were allocated to either a A) control  
371 condition with no V symbols, B) an experimental condition where the V symbols denoting  
372 vegetarian food were place to the left of the dish label or C) to the right of the dish label.

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#### **3.1.4. Procedure and measures**

The procedure for study two directly replicated that used in study one. Participants who gave informed consent were required to select their preferred choices from the different menus, followed by a demographic questionnaire.

#### **3.1.5. Analysis**

Unadjusted and adjusted GEE models were once again run using IBM SPSS statistics version 25. Similar to study one, dichotomized dish choice (vegetarian (1) vs. non-vegetarian (0) option selected) was the primary outcome measure, with condition and menu type added to unadjusted models as predictor variables. We first compared both V Left and V Right conditions to the control group, and then re-ran the models to compare these two experimental conditions directly. Adjusted models were then run, to include demographic and diet related covariates that were found to significantly predict dish choice ( $p < 0.05$ ) in prior independent binary logistic regression analyses.

## 3.2. Results

### 3.2.1. Study sample

424 individuals were included in study two analysis, following exclusion of 82 participants who self-reported omitting meat from their diets (e.g. vegan, vegetarian, pescatarian) and 3 participants who failed the attention check. As participants viewed eight menus each, they together contributed 3388 observations to the analysis.

Participant demographic and dietary characteristics are summarized in [Table 2](#). The sample contained slightly more males (53.1%) than females, with ages ranging from 18 to 82 years. The sample average age was just under 40 years. On average, participants were slightly overweight (mean BMI: 26) and reported an average hunger score just below the middle of the scale (4.77) at the time of testing.

The sample ate out relatively infrequently, with the majority (31.8%) eating out monthly or less than monthly, and only 0.2% of the sample eating out of home on a daily basis. In terms of meat consumption, meat was eaten, on average, on just under four days in the last week. Approximately three quarters of participants reported that they had eaten meat at their last meal, although we note data collection occurred during the Covid 19 pandemic period in the UK.

When choosing what to eat, the most common priority was taste, with just over 60% rating this as their leading choice driver. On average, the sample did not strongly agree with the statement that vegetarian dishes are made for specific 'other' types of people (mean score 4.99 out of 7), and agreed somewhat with the statement that vegetarian dishes are good for the environment (mean score 3.29 out of 7). Lastly, the vast majority of the sample (84%) rated the dishes that they were shown across the menus as priced 'about right'.

418 **Table 2: Characteristics of sample from study two (N = 424)**

<b>Characteristic</b>	<b>Mean(SD) or Count (%)</b>
<b>Gender (Female)</b>	199 (46.9%)
<b>Age (years)</b>	39.1 (16.21)
<b>Current Hunger level (1-10)</b>	4.77 (2.33)
<b>Body Mass Index (kg/m<sup>2</sup>)</b>	26.04 (4.9)
<b>Dietary Variables</b>	
Last meal contained meat	315 (74.3%)
Number of days meat eaten in last week	3.86 (2.75)
Frequency of dining out-of-home	
<i>Daily</i>	1 (0.2%)
<i>2-3 times per week</i>	17 (4.0%)
<i>1-2 times per week</i>	72 (16.7%)
<i>fortnightly</i>	83 (19.6%)
<i>Monthly</i>	117 (27.6%)
<i>Less than monthly</i>	135 (31.8%)
Priority when choosing food	
<i>Health</i>	46 (10.8%)
<i>Cost</i>	48 (11.3%)
<i>Taste</i>	259 (61.1%)
<i>Filling</i>	13 (3.1 %)
<i>Usual choice</i>	58 (13.7%)
<b>Menu perceptions</b>	
Vegetarian dishes are for other people, not me	
<i>Agree or strongly agree</i>	27 (6.3%)
<i>Neutral</i>	189 (44.6%)
<i>Disagree or strongly disagree</i>	208 (49.1%)
Vegetarian dishes are good for the environment	
<i>Agree or strongly agree</i>	62 (14.7%)
<i>Neutral</i>	322 (75.8%)
<i>Disagree or strongly disagree</i>	40 (9.5%)
Price perceptions	
<i>Too expensive</i>	68 (16.0%)

<i>About right</i>	355 (83.7%)
<i>Too cheap</i>	1 (0.2%)

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### 3.2.2. Unadjusted analysis

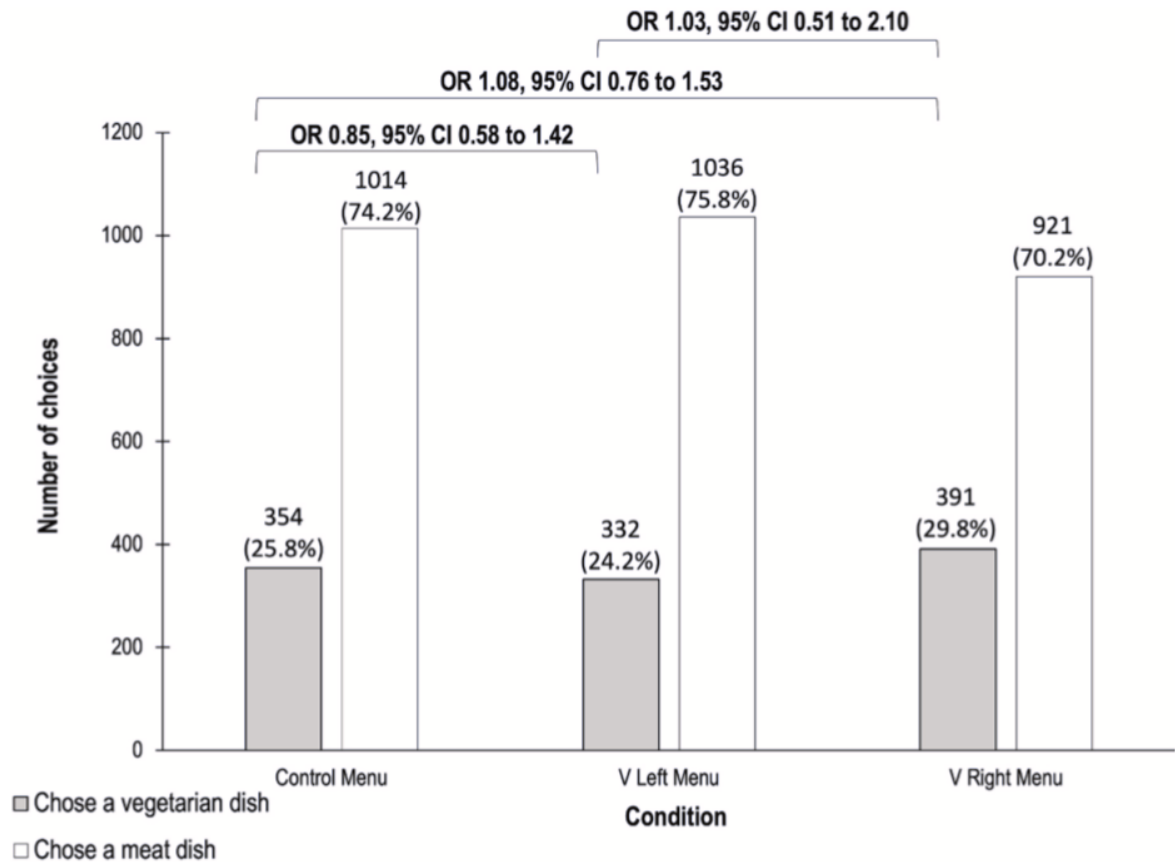
In unadjusted GEE models, compared to the control group, there were no significant differences in the numbers of participants choosing a vegetarian dish in either the V left group (OR 0.65, 95% CI 0.36 to 1.21,  $p = 0.17$ ) or the V right group (OR 0.65, 95% CI 0.35 to 1.21,  $p = 0.17$ ). There was also no significant difference in the numbers choosing a vegetarian dish when comparing the two experimental groups directly (V right vs. V left: OR 0.99, 95% CI 0.52 to 1.92,  $p = 0.998$ ).

### 3.2.3. Adjusted analysis

Analyses were re-run as fully adjusted GEE models, adding demographic and dietary related variables that prior analyses indicated were significant predictors of dish choice. These included; gender, BMI, health as the highest priority when choosing food, perception that vegetarian dishes are for specific types of 'other' people, last meal contained meat, the number of days in the last week in which meat was eaten and menu type.

In this fully adjusted model, once again, experimental group assignment had no significant impact on dish choice. Compared to the control group, the number of participants choosing a vegetarian option across all menus did not differ significantly in the V left group (OR 0.85, 95% CI 0.58 to 1.23,  $p = 0.38$ ) nor in the V right group (OR 1.08, 95% CI 0.76 to 1.53,  $p = 0.67$ ). Repeating this adjusted analysis comparing the two experimental groups directly showed no significant differences between conditions (OR V right vs. V left OR 1.03, 95% CI 0.51 to 2.10,  $p = 0.93$ ) (Figure 4).

**Fig. 4. Dish choice by condition in study 2:** There were no significant differences in vegetarian dish choice when V symbols were included on menus. \* $p < 0.05$  \*\* $p < 0.001$ .



## 4. Discussion

### 4.1. Summary of findings

This paper presents findings from two online studies that explored whether easy and scalable menu re-design approaches could shift food choices towards more sustainable vegetarian options. In study one, we examined whether the ratio of meat to vegetarian options on menus influenced participants' choices by comparing a predominantly meat-based menu (25% vegetarian dishes), a predominantly vegetarian menu (75% vegetarian dishes) and a menu offering parity between meat and vegetarian choices. Our results show that, although non-vegetarian consumers prefer meat dishes overall, their preferences are influenced by the choice context. Significantly more participants selected vegetarian dishes when these made up the majority of the menu (in the 75% vegetarian menu condition), compared to when these dishes were scarce (in the 25% vegetarian menu condition) or offered at the same frequency as meat. Hence, the findings of this study suggest that the availability of vegetarian dishes should largely exceed that of meat dishes to create large-scale shifts towards more sustainable food items.

In study two, we explored whether the inclusion and positioning of vegetarian 'V' symbols on menus influenced food choices. Contrary to prior research, our study found no significant influence of V symbol placement on choice compared to when vegetarian dishes were not labelled. Given that adding V symbols to menus, wherever placed, do not influence choice, these symbols may be a useful way for food service providers to meet legal requirements to communicate allergen information without inadvertently discouraging those who follow meat-based diets from choosing vegetarian options, as has previously been shown with separate vegetarian sections on menus.

### 4.2. Results in context

Overall, findings from study one contribute to growing evidence that one of the foundational approaches used to market unhealthy foods – that is, increasing product availability – also works to promote typically less popular, healthier and more sustainable options (Garnett et al., 2019). Our research also supports the broader literature indicating that 'nudge' interventions are an effective way to encourage more sustainable food choices (Rust et al., 2020), while circumventing the need for consumers to consciously agree with pro-environmental arguments regarding their diets. Instead, increased availability of vegetarian options may influence choice by setting a consumption norm (Raghoobar, Van Kleef, & De Vet, 2020) or by providing consumers with a wider

range of desirable options to choose from. Further support for the latter explanation can be inferred by comparing the composition of the menus used in the current study to previous research. For example, when we featured eight dishes per menu, >75% of the menu needed to be vegetarian to promote a significant shift in choice, whilst a prior study by Garnett et al. (2019), using four dish menus, found a significant shift in choice when 50% of options were vegetarian. Hence, diners appear to be sensitive to the total



number of meat and vegetarian options available, as well as the relative ratio of meat: vegetarian dishes.

Of further practical benefit, increasing the availability of vegetarian options on menus may offer a viable ‘middle ground’ approach for food businesses wishing to reduce their GHG footprints, but also continue to satisfy customer preferences. While default 100% vegetarian menus appear extremely effective at encouraging sustainable dish choices (Hansen, Schilling, & Malthesen, 2019), previous research shows this approach can lead to consumer backlash (Kurz, 2018) as well as increased food waste (Lombardini & Lankoski, 2013). Study one demonstrates that offering predominantly vegetarian menus can lead to a significant shift towards vegetarian dish choices without requiring full restriction of choice.

The non-significant results we found in study two contradict previous research in the domain of calorie labelling, showing no influence of ‘V’ symbols on dish choice, regardless of their position. Speculating as to why placement of calorie indicators influences diners’ choices, but vegetarian labelling does not, we tentatively suggest that vegetarian labelling may be less salient. V symbols have been present on menus for many years, used internationally since 1996 (<https://www.v-label.eu/en>), while calorie labelling is a comparatively newer addition, and likely one that people are more engaged with, and hence may be more inclined to notice, since the related issue of obesity is commonly discussed in the media.

Moreover, it may be the case that calorie/health information is a more relevant consideration than whether a dish is vegetarian. This is supported by study two where 12% of participants stated that they prioritized health when making food choices, whilst only 7% agreed that “vegetarian dishes are not for people like me”. In line with this Campbell Arvai et al. (2014) found that the provision of environmental information alone on menus (which highlighted that consuming less meat helped reduce environmental footprints) was not sufficient to influence preference for meat-free meals. Finally, it may also be that vegetarian labelling provides little additional information that cannot be inferred from reading the dish name. In contrast, calorie information needs to be directly provided to the consumer.

### 4.3. Strengths and Weaknesses

Here we add to a growing body of literature exploring effective approaches to promoting more sustainable choices. Both the nudges tested here – altering the availability and labelling of vegetarian dishes – are interventions that do not restrict consumer choice nor require conscious buy-in to pro-environmental arguments to work. This is a key benefit from the perspective of food businesses keen to retain customers and ensure compliance to allergen labelling regulations, yet also want to sell more sustainable options.

Both studies presented here required that participants make hypothetical food choices via online ‘mock’ menus, and we recognize that this is somewhat different from the context in which food choices are made in real life restaurants, where diners spend their own money and are often eating in social settings. In addition, the participants in our study were not actively seeking a meal at the time of testing, therefore the effects we cite here may play out differently in the real world where choices may be more driven by innate factors, such as hunger.

However, the external validity of hypothetical food choice experiments is supported by previous work showing that choices made during online menu research do predict real-life decision making when similar nudges are also tested in restaurant settings (Bacon, Wise, Attwood, & Vennard, 2018). Study one and two thus present further proof-of-concept for online

testing paradigms in the context of food choice, highlighting the relevance of online restaurant menu design interventions to real life decision making. We also acknowledge that food choices are influenced by a broad array of factors, indicating that future research would benefit from measuring a wider selection of additional demographic and dietary variables (including SES) to include as covariates in statistical models. Finally, it should be noted that our studies included fewer participants than recommended by the power calculation, this was partly due to the post hoc exclusion of those who follow vegetarian and vegan diets and also due to under recruitment.

#### 4.4. Implications

Our work adds to a growing body of literature indicating that menu design interventions can support more sustainable eating habits, yet not all approaches have equal value in their ability to shift choices. In particular, we show that the availability of vegetarian options is a strong driver of decision-making, but may only influence choice when the environment is replete with vegetarian options. This finding provides initial practical guidance, where currently there is none, to the food service sector; given that 75% of the menu was required to be vegetarian to successfully promote these options, our findings suggest that the food service may need to vastly increase the proportion of vegetarian meals on offer. More research examining this finding in a field setting is warranted, as is work to explore key parameters of vegetarian food availability, including the interaction between availability and the total number of options present, as well as other dish attributes such as meal composition or relative cost. Furthermore, future work using tighter gradations of meat to vegetarian ratios would allow a deeper understanding of where the choice tipping point occurs between a 50% and 75% vegetarian menu.

#### 5. Conclusion

Here we explore the efficacy of two menu-based nudges intended to promote vegetarian food. Our results indicate that availability of vegetarian food is a key factor when presenting options to diners in the hope of promoting more sustainable choices. We demonstrate that predominantly vegetarian menus (>75%) can lead to more vegetarian

choices in meat eaters, while still offering a small range of meat options. Furthermore, we show that unlike segregated vegetarian dish sections, vegetarian symbol labelling (V) is not used by meat eaters as an exclusion decision filter and has no impact on choice. Together these studies provide insights into how the environmental footprint of the food service sector can be reduced via scalable menu design approaches. Further field research is warranted to validate these findings in food service settings, in addition to more online work to explore other menu engineering ideas prior to full roll out in the food service sector.

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