ESRI

Working Paper No. 615

February 2019

The effect of spatial position of calorie information on choice, consumption and attention

Deirdre A. Robertson[ab*], Pete Lunn[ac]

Abstract: *We report a "lab-in-the-field" experiment designed to test the impact of posting calories on menus. The study adds substantially to previous work by testing different spatial arrangements of price and calorie information. Choices were real, not hypothetical, and participants were unaware that their lunch choice was part of a study, even though their eye-movements were being tracked. Participants exposed to calorie information ordered 93 fewer calories (11%) relative to a control group. The impact was strongest when calorie information was presented on menus just to the right of the price, in an equivalent font. The difference in number of calories consumed was greater still. These effects were mediated by knowledge of the amount of calories in the meal, implying that calorie posting led to more informed decision making. There was no impact on enjoyment of the meal. Eye-tracking data suggested that this arrangement altered the decision process such that greater decision weight was given to calorie content.*

Acknowledgements*: This research was funded by the Department of Health. The authors would like to thank the other members of the Behavioural Research Unit for their input in designing and conducting the study. We also thank audiences at an ESRI internal seminar, the Irish Annual Economics and Psychology Conference, the Behavioural and Experimental Economics of Food Consumption workshop and the Department of Health Research Services Unit for feedback and comments.*

**Corresponding Author: deirdre.robertson@esri.ie*

a. Economic and Social Research Institute, Dublin
b. Department of Psychology, Trinity College Dublin
c. Department of Economics, Trinity College Dublin

1. Introduction

Small and seemingly inconsequential daily decisions can have a cumulatively large impact on health. Choosing one calorie-dense meal over a calorie-light meal is unlikely to have any major repercussions for an individual, but repeating this pattern over time increases the likelihood of overweight, obesity and associated health conditions. Obesity-associated health conditions include non-communicable diseases such as cardiovascular disease, diabetes and cancer, which are now the leading cause of death worldwide (Roth et al., 2018).

This paper presents an experimental study that tested whether different formats of calorie posting on menus have differential effects on what people order and eat. The main experimental manipulations were different spatial arrangements of the price and calorie information. We hypothesised that differences in the spatial positioning of calories on menus might contribute to previous mixed results on the effectiveness of calorie posting. We first outline this previous research and how our hypotheses were generated, before describing the experiment in detail.

1.1. The Obesity Epidemic and Modifiable Behaviours

The global obesity epidemic has been attributed to a combination of genetic, environmental and behavioural factors. Individual risk factors include gene-environment interactions, the microbiome, family lifestyles, low levels of physical activity, medication usage and diet (Hruby & Hu, 2015). Societal factors are also thought to play a role including increasing wealth, larger portion sizes, technological innovations that have led to an increased availability of and reliance on processed food and the replacement of food cooked at home with ready-made food purchased and eaten outside of the home (Cutler, Glaeser, & Shapiro, 2003; Hruby & Hu, 2015; Littlewood, Lourenço, Iversen, & Hansen, 2016). Overall, modifiable behaviours are some of the biggest contributors to obesity, non-communicable diseases and, as a result, to life lost (Hruby & Hu, 2015; Newton et al., 2015).

The link between the amount of calories consumed and eaten outside the home could be attributed to individuals' gaps in knowledge – misunderstanding either the content of ready-made food or recommended nutritional intake – and/or to behavioural patterns driven by factors other than knowledge. One study in the United States found that adults, adolescents and school children underestimated the calorie content of fast food meals by an average of 175 calories (Block et al., 2013). Yet despite many educational public health campaigns exploration of the relationship between individuals' nutritional knowledge and dietary intake seems to be relatively limited (Spronk, Kullen, Burdon, & O'Connor, 2014). A recent systematic review found a positive but only small association between nutritional understanding and diet (Spronk et al., 2014). This is not surprising from a psychological perspective given the well-established gap between attitudes, intentions and behaviours. In a striking example of this the authors of a longitudinal study on overweight children informed parents in writing of their child's weight relative to a healthy weight and provided information on the health risks associated with overweight and obesity as well as information on healthy lifestyles and local health and leisure services. Although 72% of parents reported an intention to change behaviour this was not associated with actual behaviour change when followed up six months later (Park et al., 2014).

The intention-behaviour gap can be explained by failures of self-control, planning, habits and competing incentives. Models of behaviour change suggest that behaviour is influenced not just by knowledge and motivation but also by the availability of that knowledge in the time and place at which it can be used (e.g. Behavioural Insights Team (2014), Michie, van Stralen, and West (2011)). The retail environment presents an opportunity to provide nutritional information at the source of purchase and, sometimes, consumption. This is most commonly done in the form of nutritional labelling.

1.2. Nutritional Labelling and Menu Labelling

Nutritional labels provide information about the nutritional content of food or drink to consumers. Nutritional labels displaying information on fat, saturated fat, carbohydrate, total sugars, protein and fat are mandatory on most pre-packaged foods in the European Union. Menu labelling refers to nutritional information provided on non-packaged foods on menus. Menu labels present nutritional information to consumers at the point of both choice and, frequently, consumption. In principle, therefore, they may have a different impact to nutritional labels on food bought for later consumption. Menu labels are mandatory in the United States and voluntary in other countries, including the United Kingdom and the Republic of Ireland. Where labelling is voluntary, however, only a small proportion of vendors have taken it up (Geaney et al., 2015; Littlewood et al., 2016). Yet a global survey of consumers found that 80% of respondents are in favour of menu labelling in at least some locations (Nielsen, 2012). What remains unclear from the literature is whether this information is useful to consumers and whether it has an impact on choice.

Since 2016 there have been at least six large-scale reviews on nutritional labelling, including one Cochrane systematic review (Crockett et al., 2018; Fernandes et al., 2016; Hillier-Brown et al., 2017; Littlewood et al., 2016; Sacco, Lillico, Chen, & Hobin, 2017; Sarink et al., 2016). Some reviews combine evidence for nutritional labelling on pre-packaged foods and on menus. Here we use the term nutritional labelling as an umbrella term to refer to any nutritional labelling on food and menu labelling to refer to nutritional labelling on menus. On balance, labels on menus appear to have some effect on dietary behaviours. The Cochrane review concluded that menu labelling would lead to an average reduction in purchase and consumption per meal of about 8% (Crockett et al., 2018). Littlewood et al. (2016) restricted their analysis to papers published after 2012 on the rationale that consumers have become more aware of and accepting of menu labelling and calculated an average reduction of 77kcals ordered and 100kcals consumed where menu labelling was present. However, there is substantial variability across studies and the common message from all reviews is that the quality of existing studies is mixed, with many displaying low quality, bias and a lack of experimental control.

The format and information provided on menu labels also varies widely. Some of the formats that have been tested include:

- Simple presentation of calories or kilojoules in number format
- Number format with categories (low, medium, high) indicated by colour
- A summary traffic light system (colours red, orange or green without further information beside each item on menu)
- An informational traffic light system (colours red, orange or green for each nutrient in a dish)
- Guideline daily amounts of nutrients or calories
- Health symbols (e.g. healthy heart or keyhole symbol)

- Qualitative descriptions of healthiness of food (e.g. “this is a lower fat option”)
- Physical activity estimates of minutes to walk/run to burn off items

This range in presentation formats makes summarising the impact on consumers difficult, particularly as even broad categories (e.g. a traffic light system) differ between studies.

From the above range of formats, the literature reviews that have collected format information and assessed differences seem to suggest that traffic light systems are more effective at influencing purchase and consumption than simple numeric information (Fernandes et al., 2016; Littlewood et al., 2016). One hypothesis is that colour is salient which drives attention and therefore influences subsequent choice (Becker, Bello, Sundar, Peltier, & Bix, 2015; Bialkova et al., 2014; Crosetto, Muller, & Ruffieux, 2016; Reale & Flint, 2016). This is a plausible hypothesis given the large body of behavioural science research indicating that the salience of information influences the weight placed on it. As Taylor and Thompson (1982) defined it “salience refers to the phenomenon that when one's attention is differentially directed to one portion of the environment rather than to others, the information contained in that portion will receive disproportionate weighting in subsequent judgments.” The comparative saliency of the colour on nutritional labels compared to the surrounding environment may be one reason why they appear to have a greater influence on choice than monochrome labels. Nevertheless there are also counter-arguments to the use of traffic light labels namely that they involve categorising nutritional information and imposing boundaries on what determines a high (red) vs. medium (amber) or medium vs. low (green) choice. From an implementation perspective traffic lights necessitate the use of colour on menus where it may not already exist. It is possible that at an applied level traffic light labelling may impose a greater regulatory burden on menu labelling policy than there is appetite for. As the mechanism by which traffic light information is thought to influence healthier choice is due to the salience of the label, however, then we can consider whether there are other formats that may also increase salience without imposing colour or categorisation. One such method that has not yet been explored and that may be relevant is the spatial position of nutritional information.

1.3. Format and Salience

There is evidence from related research that the spatial arrangement of information can alter how it is processed in decision making. Work in non-food ingredient labelling has shown that changing the format of information to make it easier to search can improve comprehension and attention (Yazar, Seimyr, Novak, White, & Lidén, 2014). Studies on front-of-packaging nutritional labels have found that consumers spend 30% more time viewing labels that are placed in the centre of their visual field and that label components at the top of a label are viewed more than components in the centre of it (Graham, Orquin, & Visschers, 2012). In a more extreme illustration of the point a recent field trial found large effects on the sales of calorie-dense muffins compared to calorie-light scones when calories were presented in a font size ten times larger than the price at the point of purchase (Nikolaou, McPartland, Demkova, & Lean, 2017). This lead the authors to conclude that where calorie labelling is introduced the information should at least be of similar prominence to the price, making the point that health warnings on other products, such as cigarettes, are often displayed on at least 30% of the packaging (Nikolaou et al., 2017). While these studies hint that position or spatial location may be important for directing attention, and therefore decision-making, we are not aware of any studies that have systematically varied the spatial location of nutritional information on menus.

Of the 28 studies included in the recent Cochrane Systematic review of the effect of nutritional labelling (Crockett et al., 2018), 13 focused on menus. We were able to find images or descriptions of 10 of these studies to ascertain the spatial position of the nutritional information. Of these 10, two had large signs above individual items and one had arrows pointing to low calorie options (Allan, Johnston, & Campbell, 2015; Dubbert, Johnson, Schlundt, & Montague, 1984). Four had nutritional information to the left of the price, one had labels above the menu items, one had labels below the menu items, one put labels to the right of the item description and another also put the label on the right but it was contained within the descriptive text (Ellison, Lusk, & Davis, 2013, 2014; Girz, Polivy, Herman, & Lee, 2011; Hammond, Goodman, Hanning, & Daniel, 2013; Harnack et al., 2008; Holmes, Serrano, Machin, Duetsch, & Davis, 2013; Platkin et al., 2014). The menus varied with the level of clutter and visual complexity, such as the additional information included and whether they included pictures with the text. None manipulated spatial position between conditions.

Only one study that we are aware of (Allan et al., 2015) considered the spatial location of nutritional information, albeit on a point-of-purchase sign rather than a menu containing prices. Lower calorie options were shown on the left of a spectrum, with higher calorie options to the right. Allan et al. hypothesised that attention would be more likely to be drawn to items on the left, as previous research has found an attentional bias for information presented in the left visual field. However, they only tested presence versus absence of the sign, not whether effects differed when the spatial position was reversed.

1.4 The Current Study

The current study was primarily motivated by two factors. First, it was designed to pre-test possible regulations. The Irish government has planned to introduce calorie information on restaurant menus (Healthy Ireland, 2016). Financial support for this research was provided by the Department of Health under the Research Programme in Healthcare Reform. Part of the design phase therefore involved meetings with Department of Health officials and sectoral stakeholders, including officers likely to enforce any new regulations. Consideration of the issues surrounding regulatory burden and enforcement led to a focus on the spatial arrangement of information and on the presence or absence of recommended daily amounts (RDAs), which either did or did not appear at the bottom of the menu in conditions where calorie information was supplied for individual menu items. Both factors had the potential to affect consumers' choices and, in the views of stakeholders, be made the subject of enforceable regulations. Also, given the desire to pre-test potentially effective interventions and the previous research on salience reviewed above, it was decided that in all conditions the calorie information should appear on the menu in the same font and at the same size as the price. Second, we wanted not only to test "what works", but to gain insights into the decision-making mechanisms behind any observed differences in choices. Since spatial locations of information on the menu were to be varied, we decided that it would be beneficial to observe the eye-movements of consumers when making choices. This presented a challenge, since we wanted decisions to be real, not hypothetical. The challenge was met by employing a "lab-in-the-field" experiment. Participants chose their lunch from a menu immediately after completing an unrelated experimental study in which their eyes were being tracked. As we discuss below, a manipulation check – in which participants were asked what they thought the aim of the study was - revealed that only one participant realised that their choice of lunch was part of the study. This is important as it illustrates that the choices participants made were real choices and unlikely to be due to experimenter demand.

In line with Allan et al.'s theory and Graham et al. (2012)'s finding that participants paid more attention to information in the centre of their visual field, we designed an intervention to test whether nutritional information presented between the description and price (to the left of the price) would be more likely to influence food choice than nutritional information presented after the description and price (to the right of the price). As our participants are English-speaking we reasoned that they might be more likely to notice and attend to calorie information presented between the description and the price, as they would read from left to right and find it difficult to ignore the information in the middle.

We made the following hypotheses, which were registered on aspredicted.org (pre-registration number 11685) before data collection began:

1) Participants who see calories and the recommended daily allowance of calories on the menu will be more likely to look at calories on the menu, order fewer calories, consume fewer calories and be more accurate in their estimation of the number of calories in their meal and RDAs.

2) Participants who see calories on the left hand side of the price on a menu when ordering lunch, compared to participants who see calories on the right, will be more likely to look at calories on the menu, order fewer calories, consume fewer calories and be more accurate in their estimation of the number of calories in their meal and RDAs.

In addition to these directional hypotheses, given the lack of previous research on the spatial location of calorie information and the variation in spatial location across different menu formats in previous studies, any associated differences in consumer choices and behaviour would be of interest.

2. Methods

The basic design of the experiment was as follows. Participants understood that they were undertaking a series of experimental studies either side of lunchtime and that they would be given lunch. After an (unrelated) experiment during which their eyes were being tracked, participants were invited to order lunch, within a given budget, from a menu designed to look like an online ordering system. The presence of calorie information, its spatial location and the presence of the RDA information were each manipulated between participants. The experimenters recorded what was ordered, the participant's eye movements, how much they ate by weight and, later, responses to questions about how they had made their choice, satisfaction with their lunch, nutritional knowledge, and some individual background information. The study was conducted in accordance with ESRI policy on the ethical conduct of research.

2.1. Participants

Participants (N=145) were recruited by a market research company. The sample was balanced by age, gender and working status to be approximately representative of Dublin, where the study took place. Three participants declined to order lunch, leaving a total sample of 142. Mean age was 39.65 (SD = 14.41, range 18-71), 51% were male and 38% had a Bachelor's degree or higher.

2.2. Experimental Manipulation

Participants were randomly selected to see one of five menus: Control (no calories or RDA); calories left without RDA (calories to left of price with no RDA); calories left with RDA; calories right without RDA (calories to the right of the price with no RDA); and calories right with RDA (Table 1). Position of calories on menu (left vs right) and presence of RDA on menu (present vs absent) were orthogonally manipulated so that categories could be collapsed.

2.3. Measures

2.3.1. Number of calories ordered and consumed

Lunch was supplied by catering outlets close to the researchers' institute. Three outlets were chosen on the basis that they could provide calorie information for all items on their menu. The items on the menu covered sandwiches, salads, wraps, pizzas, burgers, fries, hot nachos, chips, chocolate, fruit, soft drinks, fruit juices and water.

The menu was designed to look like an internal online ordering system with three pages (see Figure 1). On the first page participants saw main courses, on the second they saw extras and drinks and on the third they saw a summary of their order and a button to confirm it. Participants could move freely between the pages as many times as they wished until they confirmed the order. All participants saw the same menu items but the order in which the items were shown on the menu was randomised. All allergen information was provided by the catering outlets and was presented underneath each of the menu options. We did not include the names of the catering outlets or any branding on the menu. Where the items had recognisable names we changed these to a simple description of the main ingredients. This was to avoid any bias due to pre-existing preferences for specific brands. Participants were made aware of the source of the food when it arrived as the catering outlets used their own branded food wrapping.

Although participants were essentially receiving a free lunch it was important for the ecological validity of the decision that they had to consider the price. Participants were told that they had been allocated €8 for lunch. This amount appeared at the bottom of the first page (i.e. "Voucher Amount: €8") and updated as items were added to the order. Main courses were all less than €8 (€5.50 to €7.85) meaning that participants could order any main course, but may or may not then be able to order a side and/or a drink. These supplementary items ranged in price from €0.50 to €2.00. Thus, participants had to trade off their preferences for different items against prices. Participants were not reimbursed if they spent less than the allocated €8, nor were they able to purchase additional items with their own money.[1] The price for each item was displayed to the far right of the page on the same horizontal line as the item description. When calories were present on the menu they appeared in a separate column either to the left of the price or to the right of the price.

The main course items were chosen to cover both vegetarian (4) and non-vegetarian (7) options. The menu contained low (5 items, 179 – 490 calories) and high calorie options (6 items, 701 – 1674 calories). Price and calories were balanced, with 2 low calorie low price options, 4 low calorie high price options, 3 high calorie low price options and 2 high calorie high price options. The price for each

[1] A coding error meant that the 9 people who ordered the chicken tikka wrap were able to spend more than €8. Seven of these participants ordered a drink or side which meant they spent between €8.79 and €9.99. These participants were spread throughout the conditions (N= 3 in control, N = 2 in calories left and N = 2 on calories right). The mean spend for the other 135 participants was €7.40 (SD = 0.65, range €5.49 - €8).

item was fixed and did not vary between participants. Sides and drinks were chosen to provide a choice of healthy and unhealthy, sweet and savoury options that ranged from 0 to 403 calories.

In the RDA condition a box appeared at the bottom of each screen containing the RDA for physically active and physically inactive men and women as per the Food Pyramid (Department of Health, 2016).

Menu item descriptions, price and calorie information were all written in black text in size 16 font of type Lucida Sans Typewriter.

We recorded the number of calories in each of the items that participants selected, whether they ordered extras or drinks and the total price of their meal. Food was weighed before being given to participants and the remains were weighed after to give an approximation of the number of calories each participant consumed.

2.3.2. Questionnaire

Manipulation Check

Participants were given a text box and asked to type in what they thought was the purpose of the studies they had been involved in. We asked this question after they had eaten lunch and before they answered any questions related to calories or their lunch choice.

Decision Information

We asked participants to answer a series of questions about their lunch decision.

They were asked how satisfied they were with their lunch, what they had viewed on the menu and what factors were important to them in making their decision.

Participants ranked how satisfied they were with their meal on a scale of 1 ("Not at all happy") to 7 ("Very happy"). Participants then ranked the factors that were important to them in choosing their lunch in order of importance. The options were taste, nutritional value, price, calorie content and hunger/lack of hunger. They also ranked what items they could remember viewing on the menu (meal name, description of food, allergen information, price and calorie information) and in what order.

Nutritional Knowledge

We asked participants to estimate the number of calories in their main course, side and drinks. We then asked them to estimate the recommended daily allowance of calories for physically active and non-physically active men and women.

Background Characteristics

Participants were asked for their age, gender, education level and whether they were vegetarian.

2.3.3. Eye Tracking

Participants were seated in front of a 1920 mm x 1080 mm computer screen connected to an EyeLink 1000 Plus (SR Research, Ontario). We used a 25mm high speed lens for remote tracking with a sampling rate of 1000 Hz and a typical accuracy of 0.25 – 0.50°. We did not use a chin rest as this would necessitate telling participants to keep their head on the chin rest while choosing their lunch which might reveal the aim of the study. Instead we enabled “remote mode” whereby participants put a bulls-eye target sticker in the centre of their forehead. The distance from target to camera was the recommended 600 mm.

We determined Areas of Interest (AOIs) for prices, calories, menu items and the RDA box. Calories and prices AOIs were non-overlapping rectangular boxes of 400 pixels (80 pixels x 50 pixels). The RDA AOI was defined as a 734 pixel x 105 pixel rectangle covering the whole area of the RDA box.

Participants were calibrated prior to beginning the first task of the study (non-food related task 1) using 13 calibration points on an off-white background that was the same shade as the menu background.

2.4. Procedure

Participants came to the researchers’ institute to take part in a series of real consumer decision making studies on weekdays between 11:30 and 14:30. An equal proportion of participants took part on each of the five weekdays. They were told in advance that they would attend for approximately 90 minutes and that they would be given a fee of €40 as well as a voucher for lunch to compensate them for their time. They were not told in advance that an additional aim of the study was to assess their lunch choices.

On arrival participants were told that there were three parts to the study with breaks in between. Participants sat in front of a computer while the experimenter explained how the eye tracker worked and set up the first task. The first task was unrelated to food and involved participants choosing between pairs of products that appeared on screen while their eye movements were tracked. This task was part of a real study for which data was being collected. The purpose of running it alongside the food choice study was to calibrate the eye tracker for each participant without revealing the aims of the current study. When participants got to the final trial in the first task the experimenter told them that they had to leave them momentarily to check on the second task and informed participants that they could order their lunch using the online system when they finished the task. The experimenter then left the room. The purpose of this was to avoid demand effects as participants chose their lunch.

Participants were randomly assigned to see one of the five menu types (Control vs. Calories on Left vs. Calories on Right and No RDA vs. RDA). Experimenters were blind to the condition participants had been assigned to. When participants reached the end of the first task they saw a screen that informed them they had finished that part of the study and could choose their lunch by clicking on the hyperlink to the online ordering system. The eye tracker remained running while participants chose their lunch.

When participants had put in their order the experimenter re-entered the room and brought them to the room where the second task was to take place. As with the first task this was a real study for which data was being collected and which was unrelated to food choice.

While participants completed this second task the experimenters ordered the food that they had chosen from the relevant catering outlet, weighed the main, sides and drink and then delivered the food to the participants. Participants were given a lunch break approximately 30 minutes after they had placed their order.

Participants were given time to eat their lunch after they had completed the second task. There was no pre-defined window for eating, participants were left alone to eat and were told that they could let the experimenter know when they were ready to continue with the third task. If the participants had not finished eating after approximately 15 minutes had elapsed the experimenter checked on them but participants were not told that they had to finish.

When participants had finished eating they were given the questionnaire that contained the manipulation check and then questions on their lunch choice and estimations of calorie amounts. When participants had finished this they were debriefed on the additional aim of the study. Participants were given a retrospective consent form and asked if they were still happy to give their consent for the experimenters to retain the data they had provided as part of the study including their lunch order. The consent form reiterated that participants were free to withdraw at any time. No participant withdrew their data at this or any stages of the study.

After participants had left the remains of their main, extras and drink were weighed again.

3. Results

Participants were randomly assigned to see one of the five menus. Of the 142 participants who ordered lunch 48 saw no calories, 24 saw calories on the left with no RDA, 24 saw calories on the left with RDA, 23 saw calories on the right with no RDA and 23 saw calories on the right with RDA.

There were no statistically significant differences in background characteristics between conditions (see Table 1).

3.1. Statistical Analyses

We carried out ordered logistic regressions to assess the difference in responses between conditions. These models test the odds of being in a higher category relative to lower categories. The coefficients in Tables 2 – 7 show the effect of each independent variable on the odds of being in a higher category. Positive coefficients indicate that the independent variable is associated with increased odds of being in a higher category while negative coefficients indicate that the independent variable is associated with decreased odds of being in a higher category. We used Wald tests for equality of coefficients to assess whether coefficients within an ordered logistic regression were statistically significantly different to each other. We used a Brant test to check that all ordered logistic regressions met the proportional odds assumption. This tests that the coefficients describe the same relationship for all levels of the dependent variable.

3.2. Manipulation Check

One participant guessed the aims of the study but all other participants were unaware that their lunch choice was part of the study until they were debriefed at the end.

3.3. Items Ordered

Participants ordered 54 different combinations of main courses, sides and drinks; no one meal combination dominated the data. The most commonly ordered main course was the chicken wrap with chips (28%) followed by the pulled chicken wrap (19%) and the burger and chips (16%). Forty-four participants ordered a side with their main course with the most popular being the chocolate bar

(40%) followed by the crisps (27%). Ninety-eight participants ordered a drink. The most popular drink was water (41%) followed by Coca Cola (37%).

3.4. Calories Ordered

We calculated calories ordered as the total number of calories in a meal including the main course, extras and drinks if ordered. The average number of calories ordered was 805 (SD = 393, range 179 – 1858). Mean calories per condition are shown in Figure 2. Participants who saw a menu with calories on it ordered an average of 93 (11%) fewer calories than those who did not see calories. They ordered fewer calories than the control group in all four conditions in which calories were displayed. However, the largest effect was for participants who saw calories on the right of the price, who ordered an average of 164 (19%) fewer calories than those who did not see calories. We had hypothesised that the spatial position of calorie information would be important and we found an effect for this but, contrary to our hypothesis, the descriptive statistics showed that it was participants who saw calories on right who ordered fewer calories compared to the control condition.

Testing the statistical significance of these effects is not straightforward, because the distribution of total calories ordered was highly non-normal and possibly tri-model (see Figure 3), with substantial differences in the variances between conditions (the range of standard deviations across the five conditions was 303 – 445). This was not anticipated. Our analysis strategy was to recode the dependent variable into three categories and to estimate ordered logistic regression models, followed by various sensitivity checks to ensure the robustness of our results. Visual inspection of the distribution implies that the distribution is not unimodal but may contain three overlapping distributions, with a first ending at 600 calories, a second covering the range 600-1500 and a third from over 1500. This first cut-off of 600 calories is in line with the most recent public health recommendations and the Cochrane review for lunchtime meals (Crockett et al., 2018; Robinson, Jones, Whitelock, Mead, & Haynes, 2018). As only a small number of participants (N=10) had ordered more than 1500 calories we instead considered the highest category of meal to be anything over 1000 calories, i.e. beyond the second peak. We then ran sensitivity checks using other analysis methods.

Three ordered logistic regressions that test the effects of menu format on number of calories ordered are shown in Table 2. Model 1 confirms that the reduction in calories ordered by the group who saw calories on the right of the price is statistically significant (p = .024) and that the reduction for those who saw calories on the left is non-significant. A Wald test for equality of coefficients between the two conditions in which calories were displayed is marginally significant ($\chi^2(1) = 3.38$, p = .066). Model 2 tests the effect of providing the RDA. The coefficient is greater for the condition in which calories were displayed and the RDA was shown at the bottom of the menu, but the effects are short of statistical significance. Model 3 compares all five conditions, although the smaller cell sizes mean some caution is required in interpretation. These analyses suggest that there is a reduction in calories ordered due to calorie labels when calories are included to the right of the price. The largest measured reduction was when the calorie label on the right of the price was accompanied by RDA information.

We conducted multiple robustness checks on these results. All models satisfy a Brant test of the proportional odds assumption, indicating that the relationship between the type of menu and the probability of ordering a meal in a higher calorie category did not differ at different levels of categories. Rerunning the analysis with 1500 calories as the higher cut point strengthens all of the above effects, but given the small number of people in the top group, we opt for the more conservative 1000 calorie cut point. Linear regressions (OLS) with total calories as a continuous dependent variable show the same pattern of results but, as expected, the assumption of normally distributed residuals does not hold. Although assignment to groups was random, we added control variables for age, gender, educational attainment and day of the week to the models. Age was the only statistically significant predictor (β = .031, se = .013, p = .016), with older adults less likely to order in the medium or high calorie ranges. The main effect for calories displayed on the right compared to the control condition remained statistically significant (β = -.69, se = .41, p = .045).

3.5. Calories Consumed

We estimated the number of calories consumed by calculating the sum of the proportion of food eaten (in grams) in each of the main, extras and drink and multiplying it by the total number of calories in each. We could not estimate the number of calories consumed for a minority of participants who took some food or drink away with them, or for whom food remains could not otherwise be recovered and weighed. Previous studies that have included this measure have told participants that for the purposes of the study they must not take any food with them. We chose not to do this to avoid revelation of the study aims and to avoid participants feeling pressured to eat or leave some food. We were nevertheless able to estimate the calories consumed in the main course for 113 participants and across all items ordered for 87 participants. Unsurprisingly, participants who took food away were more likely to have ordered an extra or drink and have ordered more calories (M = 875, SD = 390 compared to M = 760, SD = 390). Availability of the measures of calories consumed was unrelated to condition or background characteristics.

The average number of calories consumed was 551 (SD = 280, range 37 – 1550). Mean calories consumed by condition are shown in Figure 4. Participants who had calories on their menu consumed an average of 184 calories fewer than those in the control condition. As for calories ordered, we found a differential effect by the spatial positioning of calories. The difference was stronger for those who saw calories on the right. The distribution of calories consumed was non-normal and, again, visual inspection suggested it may be tri-modal (see Figure 5). We split the measure into three categories of calories consumed: low (< 400), medium (400-699) and high (>700). Three models that test for an effect of condition are shown in Table 3. Model 4 reveals a highly statistically significant effect relative to the control condition when calories were displayed on the right (p = .003). A test for equality of coefficients finds a statistically significant reduction in calories consumed also when calories were displayed on the right versus the left ($\chi^2(1)$ = 4.82, p = .028). Models 5 and 6 again separate out conditions by whether RDA information was also provided. They reveal no evidence of an additional effect of the RDA information, but confirm the stronger effect when calorie labels were displayed on the right.

All models meet the proportional odds assumption. Equivalent OLS models with a continuous dependent variable generate a similar but stronger pattern of results, but given non-normal residuals we deploy the ordinal models as our primary analysis. Repeating the analysis for calories consumed in only the main course (N = 113) generates a closely similar pattern of results. Including age, gender, educational attainment and day of the week in the model leaves the main effects unchanged. There was again a negative effect of age on calories consumed and a positive effect of Thursdays.

3.6. Nutritional Knowledge

After participants had finished eating they were asked to estimate how many calories were in their main course, sides and drinks. On average participants underestimated the calories in their main course by 193 calories (SD = 419) and the calories in their total meal by 178 calories (SD = 501). Underestimation and absolute error by condition are presented in Figure 6. Underestimation and error were lower in all four conditions in which calories were displayed. Accuracy was best when calories appeared on the right.

We split participants' estimations of total meal calories into three categories: within 100 calories of the correct answer, within 300 calories, more than 300 calories awry. Ordinal logistic regressions that test for differences by condition are shown in Table 4. Models 7 - 9 confirm that participants who saw calories on the left (p = .005) or the right (p < .001) were more accurate in estimating the number of calories in their meal compared to control. We did not find strong evidence for an additional improvement in accuracy when the RDA was also displayed. Adding background characteristics to the models does not change these main results although it reveals that men were more likely to be inaccurate (β = .922, se = .352, p = .009) and those with educational attainment to degree level were less likely to be inaccurate (β = -.952, se = .374, p = .011).

Finally we re-ran the ordered logistic regressions (Models 1 - 6) that test for the effect of condition on calories ordered and consumed, but with the inaccuracy of calorie estimation specified as an independent variable. The aim of this analysis was to test whether accuracy mediates the effect of menu type on the number of calories ordered and consumed. In other words, do calorie labels on menus influence how well consumers can estimate the number of calories in their meal and does this in turn explain why consumers order and consume fewer calories. Table 5 reproduces two of the models. Comparing to Models 1 and 4, the coefficients are greatly reduced and become non-significant, while there is a strong association between inaccuracy of calorie estimation and both dependent variables. The suggestion is that the effects of calorie posting is mediated by consumers' knowledge of the calorific content of what they order and eat.

3.7. Satisfaction

Given that calorie posting altered choices and behaviour, including how much they ate, it is important to know whether it had a negative effect on individual's enjoyment of their meal. After lunch, participants rated how happy they were with their meal on a scale of 0 (not at all happy) to 7 (very happy). The mean rating was 5.33 (SD = 1.43) and the majority of participants (71%) rated themselves as being happier than the midpoint (neither happy nor unhappy). There was no significant difference between conditions. In fact, mean ratings for all four conditions in which calories were displayed (range of means 5.26 – 5.74) were above ratings in the control (M = 5.13) condition.

3.8. Decision Making

Participants were asked to list factors that were important to them when deciding on their lunch and in what order from 1 (bottom) to 5 (top) or 0 (not factored in at all). The options were taste, nutritional value, price, calorie content and hunger/lack of hunger. The factor that received the most top ratings was taste (43%), followed by nutritional value (20%), hunger/lack of hunger (19%), price (10%) and calorie content (8%). We examined whether ranking calories as a factor in the decision differed by condition. Of 142 participants, 116 indicated that calories had at least some impact on their decision, albeit that almost one third of these ranked it as the last factor they considered. Among those who listed calories as a factor, it was ranked more highly by participants in conditions where calories were displayed (mean ranking 3.95 vs. 3.30, $Z = 2.67$, $p = .008$). There was no difference according to spatial location of the calorie information.

3.9. Recommended Daily Allowances

Participants were asked to estimate the recommended daily allowances (RDA) of calories for physically active and inactive men and women. On average participants underestimated RDAs for each of the four categories. The RDA for inactive women is 1,800 which participants in this study estimated as 1,259 (SD = 675). For active women the RDA is 2,000 but participants estimated 1,479 (SD = 759). The RDA for inactive men and active men is 2,000 and 2,500 respectively. Participants gave average estimations of 1,582 (SD = 847) and 1,847 (SD = 1,025). However the high variance and wide ranges (7 – 3,000, 10 – 3,500, 6 - 4,000 and 10 – 5,000, for inactive and active women and men respectively), with mean absolute errors of 418 to 652, indicate that participants were mostly unaware of correct RDA values.

Absolute errors by condition are shown in Figure 7. Estimated RDAs were more accurate in the conditions with displayed calories. The presence of the RDA information on the menu did not seem to have an additional effect on accuracy over and above the calorie information alone. We categorised responses into those within 500 calories, within 1000, and more than 1000 away from the true answer. Ordered logistic regressions are shown for the four estimates separately in Table 6. All coefficients are negative and at least some are statistically significant. There are no statistically significant differences between the coefficients with and without the RDA information displayed. Thus, posting the calorie content of items on menus next to the price without also including RDA estimations improved how accurately participants could estimate RDA, but putting the actual RDA at the bottom of the menu had little, if any, additional effect.

3.10. Salience of Calorie Information

We used data from the eye tracker to assess whether participants viewed calorie information, whether the format of calorie information on the menu influenced the likelihood of participants viewing it, and whether viewing the information had an impact on choice.

It is standard in eye tracking studies that the presence of thick glasses or anatomical differences interfere with eye tracking for a minority of participants. We were unable to track the eye movements of 18 participants reliably – a failure rate consistent with previous studies (e.g. Stewart, Hermens, and Matthews, 2016). As we did not restrain participants' heads while they used the eye tracker a number of participants moved their seating position when choosing their lunch, which meant that although we could track their eye movements accurately at the start of the study we could not do so when they ordered lunch. We ultimately obtained good eye tracking data for 100 participants. The tracked subsample had somewhat higher educational attainment (42% with a degree versus 27% for participants whose eyes were not tracked) and was younger (mean 37.8 versus 44.2 for missing data). Men were more prominent among those missing eye tracking data (61%), but the difference was not statistically significant.

3.10.1. Type of information viewed on full menu

Participants spent an average of 118 seconds (median = 104, SD = 63, range 41-416) viewing the menu before ordering their lunch.

Prices

All participants viewed at least one price label on the menu. Participants viewed an average of 9.56 different price labels (median = 9, SD = 4.43, range 1-20). Seventy-four (74%) participants viewed the specific price of the main course option they chose. Participants made an average of 19.7 fixations to price labels (median = 16.5, SD = 13.9, range 1-75) and spent 4.8 seconds (median = 3.7, SD = 3.7, range 0.1 – 20.4) looking at prices. Clearly, price featured prominently in most decisions.

Calories

Of the 100 participants for whom we had eye tracking data, 74 had calories displayed on the menu. Of these, only 1 did not look at any calorie information at all. These participants viewed an average of 6.3 calorie labels (median = 5.0, SD = 4.1, range 0-18). Forty-seven (64%) viewed the calories of the main course option they chose. Participants made an average of 11.9 fixations to calorie labels (median = 7.5, SD = 12.5, range = 0-70) and spent an average of 2.7 seconds (median = 1.7, SD = 3.1, range 0 – 19.1) looking at calories.

Recommended Daily Allowance

Of the 47 participants who had seen RDA on the menu we had eye tracking data on 39, of which 32 (82%) viewed the RDA information. Participants made an average of 7.7 fixations to the RDA label (median = 4.0, SD = 10.5, range 0-51) and the average amount of time spent viewing it was 1.7 seconds (median = 0.8, SD = 2.7, range = 0-12.1).

3.10.2. Differences in eye movements by condition

We had hypothesised that the spatial position of calories would influence behaviour. We hypothesised that participants would be more likely to view and spend time looking at calorie labels placed on the left of the price compared to place on the right. As all participants were English speakers who read from left to right, we had also hypothesised that participants in the calories left condition would look at calorie labels before price labels. We reasoned that the greater likelihood of looking at the calories would mean that participants in the calories left condition would be more likely to view the calories in the main course they chose.

We also hypothesised differences in how much attention would be paid to calories, but did not make a directional hypothesis for this prediction. We predicted that viewing calorie information would result in participants ordering fewer calories, eating fewer calories, greater accuracy in recall of the amount of calories in their meal and greater weight placed on calorie information in their decision. We present descriptive statistics testing these hypotheses below using parametric or non-parametric tests as appropriate. Several eye tracking variables were right-skewed and were log transformed prior to analysis to remove the skew. Of the 74 who saw calories on the menu, 35 participants saw calories on the left and 39 saw calories on the right.

Time spent viewing menu

As an initial check we compared the log of time spent viewing the menu across all five conditions using linear regression. None of the four calorie and RDA conditions differed from the control condition (β_{left} = .22 (.14), *p* = .13; $\beta_{left+RDA}$ = -.04 (.13), *p*= .74; β_{right} = -.13 (.13), *p* = .32, $\beta_{right+RDA}$ = .01 (.13), *p*= .97).

Looking at calorie labels

In a linear regression with the log of the number of fixations on calorie labels as the dependent variable there was no difference between the conditions with calories displayed on the left or right (β = .14, se = .22, *p* = .52). Nor was there a difference in the log of dwell time on calorie labels between conditions (β = .11, se = .24, *p* = .65). There was no statistically significant difference between the number of calorie labels viewed when calories were on the right (mean = 4.64, SD = 3.12) compared to the left (mean = 3.80, SD = 2.90), Z = -1.18, *p* = .24.

However, variation in the above measures might be mainly driven by differences in the total looking time at the menu, or the number of options entertained. A better measure, therefore, is the number of calorie labels viewed as a proportion of prices viewed, which gives an indication of the likelihood that the participant looked at the calorie label of an option being considered, regardless of how many options they entertained. When calories were placed on the left, participants viewed an average of around two-thirds of the number of calorie labels compared to price labels (M = 0.69, SD = 0.69). When calories were displayed on the right, participants viewed almost equal numbers of calorie and price labels (M = 0.98, SD = 0.69). A Mann-Whitney test shows this difference to be statistically significant (*Z* = -2.45, *p* = .01). This pattern is also evident in Figure 8 which shows a colour-coded heat map of the duration of dwell time on all menu items. The same effect was seen for the amount of time spent looking at calories compared to price labels for the main courses (*Z* = -2.12, *p* = .03). The pattern was also similar for the proportion of calorie labels to prices viewed and time spent viewing them across the whole menu, but these differences were short of statistical significance which may be due to less power given the smaller subsample of participants who ordered from the extras and drinks menu.

Fixations to specific calorie labels

When calories were displayed on the right, descriptive statistics suggested that slightly more participants viewed the calorie label of the main course they chose (67%) than when calories were displayed on the left (60%), but this difference was not statistically significant ($\chi^2(1)$ = 0.35, *p* = .55). With calories on the left, participants viewed a range of main course calorie labels that had, on average, higher calorie content (M = 697, SD = 161) than with calories on the right (M = 599, SD = 156). This difference was statistically significant (*Z* = 2.34, *p* = .02). There was little difference in the range of calorie labels viewed (M_{left} = 852.44, SD_{left} = 532.21; M_{right} = 807.51, SD_{right} = 547.17), *Z* = 0.20, *p* = .84. Rather, the lowest calorie label viewed when calories were on the right was smaller than the lowest calorie label viewed when they were on the left (M = 285, SD = 143 versus M = 355, SD = 178; *Z* = 2.02, *p* = .04). Overall, this pattern of results might indicate that when calories were on the right, participants were more likely to search for a lower calorie option to compare during their decision-making process.

We looked at whether participants viewed calorie or price labels first. With calories on the left, participants were slightly more likely to view calories before prices (51%), while with calories on the right they were more likely to view prices before calories (69%) (χ^2= 3.27, *p* = .07). We also tested what was looked at last when participants viewed the main course menu for the last time. Participants were more likely to look at prices last (66%), but there was no difference between conditions. For the extras menu, 96% of participants looked at the prices last.

3.10.3. Association between eye movements and food choice

We tested the hypothesis that participants who made more fixations to calories would order fewer calories, would consume fewer calories, would be more accurate in recalling how many calories were in their meal and would give greater decision weight to calories. Many of the eye tracking variables are highly correlated, so we used number of fixations to calories on the main course page as the main independent variable to test these hypotheses and then checked robustness by testing other eye tracking measures. We chose fixations as the main independent variable as number of fixations to labels have previously been shown to mediate the relationship between nutrition label presentation and choice (Bialkova et al., 2014).

Results of ordered logistic regressions are shown in Table 7. Despite the reduced sample size (and hence statistical power) relative to the main analysis, all estimated coefficients are in the hypothesised direction and three of the four tests reveal a statistically significant relationship – only the effect on calories consumed is non-significant, although the estimated coefficient is similar to that for calories ordered. The association between the number of fixations to calories and being more accurate in estimations of meal calories was particularly strong. We found similar relationships for the number of calorie labels participants looked at and how long they had spent looking at calorie labels.

4. Discussion

We tested whether presenting calorie information on menus has an influence on food choice, intake, knowledge and attention. We also tested whether the spatial location of calorie information on a menu matters. Across all outcome variables we found that when calorie information was displayed on menus at the time of ordering consumers ordered fewer calories, consumed fewer calories, were more knowledgeable about the number of calories in their meal, allocated attention to calorie information and reported being more likely to weight calories as a factor in their decision. While these findings were consistent with our main hypothesis, the spatial location effect was contrary to that hypothesised. There was a consistent pattern across variables illustrating that the effect of calorie labelling was stronger when calories were presented immediately to the right of the price. In the following sections we relate these findings to previous results, discuss potential explanations and note some limitations of the study.

4.1. Relationship to previous findings

The literature on menu labelling has found mixed results with some studies reporting no effects and others reporting within-person differences as large as a 200 calorie reduction in meals when calorie information is present on menus (e.g. Littlewood et al., 2016; Platkin et al., 2014). Overall, we found an average reduction relative to the control group of 93 calories ordered (11%) and 184 calories consumed (28%) when calories were on the menu. This is somewhat higher than that latest Cochrane estimates of an 8% reduction (Crockett et al., 2018), while other reviews have estimated a reduction of 78 calories ordered and 100 calories consumed (Littlewood et al., 2016). The Cochrane estimate was based on an average lunch of 600 calories, while the average calories ordered for lunch in this study was 866. The latter figure is not excessive, because the options in this study were representative of the menus of popular local restaurant chains. Moreover, a recent large scale review of similar chains in the U.K. found that lunch and dinner meals contain an average of 977 calories (Robinson et al., 2018). It is also possible that the range of calories on the menu is important and this too differs between different studies. Other possible factors behind the large effect size we recorded are that the calorie label in all conditions was immediately adjacent to the price, written in the same font and presented at the same size. This would not be the case in most previous studies. Of course, the present study differed from previous ones in multiple other ways too.

The fact that simply manipulating whether the calorie label was just to the left or just to the right of the price has such a substantial impact offers potential insight here. As far as we are aware, no other study has undertaken similar tests of whether the spatial location of calorie labels matters. We revisited the menus used in some of the studies collated in the latest review (Crockett et al., 2018) and found that the spatial position of labels varied widely. Thus, a consistent reading of our results is that the spatial location of calorie labels makes a difference to consumers' choices and that placing it prominently and immediately to the right of the price generates a larger effect than has standardly been observed. Since this is the first study to directly manipulate position in this way, the effect needs to be replicated. Note, however, that the effect is consistent across all outcome variables, including eye movement data, indicating that random choice is unlikely to explain it; when calories were displayed to the right of the price the decision process was significantly altered.

Previous research on pre-packaged food labels has found that attention mediates the effect of nutrition labels on choice (Bialkova et al., 2014). In that study, participants made more fixations to nutritional labels that were colour-coded and this predicted the likelihood of the food being chosen. We did not find differences in fixation numbers or dwell time when calorie labels were on the left versus the right, but we did find evidence that the type of information viewed differed between conditions. When calories appeared on the right, participants tended to view lower calorie labels and to divide their attention more equally between calories and price, compared to when calories appeared on the left. We also found that participants who spent more time viewing calorie information were more accurate in their estimations of the calories in their meal and reported giving a greater weight to calories in their final decision, although it is not clear what the direction of this effect is. These findings all support the view that attentional processes play a role in the impact of calories labels, at least as proxied by eye movements and the ability to recall the number of calories accurately. The relationship may be more complex than a simple link between viewing time and decision weight, however. Our findings perhaps suggest that when attention is paid to calorie information it alters the ongoing decision process.

4.2. Right-side advantage

Why was there an advantage to placing the labels on the right of the price? We had hypothesised that participants who saw calorie information closer to the centre of the menu, on the left of the price, would be more likely to attend to it and to weigh it in their decision. A previous study on nutritional labels on pre-packaged food found that labels presented in the centre of the package were more likely to be looked at (Graham et al., 2012). Another study on calorie labelling on menus put low calorie options to the left and high calorie options to the right on the basis that people display subtle attentional biases to information in the left visual field (Allan et al., 2015). We offer two suggestions below as to what might lie behind the right-side advantage.

Right Visual Field Advantage for Text

Allan et al. (2015) did not test the effect of spatial location, but suggested that one reason for their findings was an attentional bias to the left of the visual field, where low calorie options were placed. One difference between ours and Allan et al.'s study is that they used pictures of low calorie options while we used text, in the form of a calorie label. While there is some evidence that images presented in the left visual field are more closely associated with activation of attention networks in the brain, there is also evidence that words presented in the right visual field are processed more quickly and accurately than those presented in the left visual field (e.g. Jordan and Paterson, 2009; Nicholls and Wood, 1998). It is possible that participants in our experiment processed calorie information faster and more accurately when it was in the right visual field, improving the accuracy of estimations and, hence, reducing calories ordered and consumed. This could also explain why we didn't see differences in number of fixations or time spent looking at calorie information, which need not be strongly correlated with processing the information. The finding that placing the calorie label on the right altered the balance between looking at calorie and price information is less obviously consistent with this account, however.

Attributes Order

Another possibility is that displaying calories to the right of the price fitted in with the sequence in which participants tend to make food choices. Participants are used to weighing up the attractiveness of food descriptions against prices, so it is plausible that the normal sequence of the decision is to check the food that is on offer and then to check its price. By putting calories to the right of the price we may have retained the natural order of this decision and provided an additional factor that could be used as a final check on whether this was the option that participants wanted. In keeping with this possibility, when calorie labels were on the left participants were more likely to view calories before prices while the opposite was true when calories were on the right. However, over the course of the decision as a whole, when calories were on the right participants had a more even balance between looking at calorie and price information and looking at lower calorie options. Thus, the sequence of the decision process may have led them to search the calorie information more, even though they looked at the calorie information later than participants for whom calories were on the left. Previous eye tracking research has generally shown that participants are more likely to choose the last option viewed, even when this is externally manipulated (e.g. Ghaffari and Fiedler, 2018). Similarly, since calorie labels were more often viewed after prices and descriptions when on the right, then participants may have been more influenced by them in this condition.

4.3. Strength and Limitations

The strength of this study is that it combined experimental control with ecological validity and the ability to study the decision process via eye tracking. Only one consumer realised that their lunch choice was part of the study, thereby removing experimenter demand from choices. Our menus looked like an online ordering system and the food selected was from typical catering outlets in the city centre meaning they were the type of menus that consumers are likely to be familiar with. They included a large range of options in terms of both taste and calories. Price had to be factored into the choice, enhancing ecological validity, although participants did not have to hand over money. Finally, we collected data on a large number of outcome variables including choice, consumption, accuracy of perceptions and eye movements, allowing us to assess consistency of effects across all of these.

There are also, of course, some limitations to the study. Our lab-in-the-field study was designed to track eye movements and required data to be collected one participant at a time rather than in groups, as would be possible in a standard field trial. It took 2-3 months to collect the data and the resulting sample may not have conferred sufficient statistical power to detect some interesting effects. We collected eye tracking data on 100 participants – a large sample by the standard of eye-tracking studies, but not field studies on food choice. Some loss of data was necessary to avoid revealing the study aims. Moreover, we could not use the dependent variable as a continuous variable as originally envisaged.

The context could, potentially, have changed some participants' eating habits. It is possible that as the lunch was free to participants that they may not have ordered what they might normally. The €8 limit on what they ordered aimed to counteract this and, in fact, a large proportion of participants could have spent more money than they did (37% spent less than €7.50). The items on the menu covered a large range of calories (179 – 1674). These were real options taken from nearby chain catering outlets and so are representative of the items that consumers see on menus. However it is possible that consumers may not see as wide a range of calories within individual outlets. This may reduce the size of the effect in an individual outlet but it is unlikely to explain the differential effects of spatial position of calorie information on decisions. We tried to make the online ordering system as realistic as possible, but this too could have induced different decisions. These trade-offs were necessary in order to test the main mechanism hypothesised – the location of calories on the menu – in an experimentally controlled environment. Future research could assess the main effect of spatial location in a field trial. Finally, we did not track participants' consumption after they left. It is possible that those who consumed less in the study ate more later, although studies that have tracked post consumption have not seen this trend (Roberto, Larsen, Agnew, Baik, & Brownell, 2010).

4.4. Policy Implications and Conclusions

There is a trend towards calorie labelling on menus. They are now mandatory in the United States. At the time of writing, the U.K. and Republic of Ireland are committed to introducing them (Department of Health and Social Care, 2018; Healthy Ireland, 2016). Public health estimates are that adults consume an average of 200 calories more than recommended daily allowances per day (Public Health England, 2018). Coupled with figures such as the recent finding that the average number of calories in lunch and dinner meals in restaurant chains is 977 per meal, policymakers have looked to menu labelling as a means of providing greater transparency to consumers about the calorie content of their food (Robinson et al., 2018).

The study presented here, combined with the body of previous evidence, suggests that calorie labelling on menus has the potential to reduce calorific intake. However, our results also sound a note of caution: the effectiveness of labels is a more complex issue than it appears. We find relatively large differences in behaviour depending merely on the spatial location on the menu. Where calorie information is smaller, embedded within text, or placed in a different location, it may have little or no effect on choices. This is an important consideration. Policymakers may wish to avoid excessive regulatory burdens, but they may need to include specifications about content, size, colour and position within relevant regulations. Our findings, coupled with previous research, imply a need to make the specific format of calorie information a focus of policy development and further research.

The obesity crisis is driven by a combination of individual and societal factors. There is no quick-fix solution. Yet providing consumers with nutritional information at the point when they can use it to make a decision may be one means of changing individual behaviour. Promisingly, our study suggests that the accuracy with which consumers estimate calories in their meal may mediate the relationship between calorie labelling and intake. This has important and encouraging implications for policy, as it suggests that consumers who were influenced by calorie labels made a more informed choice. Calorie labelling may also lead to a provider response, whereby industry leaders alter the calorific content of the meals they produce. Previous studies have found that such changes can lessen calorie intake without reducing enjoyment (Sharma, Wagle, Sucher, & Bugwadia, 2011; Stubenitsky, Aaron, Catt, & Mela, 2000). Our study also found no reduction in satisfaction with the meal when calorie labels were present.

Solutions to the obesity crisis will require collaboration between sectors, across government, industry and the individual. Reducing calorific intake is vital to tackle obesity. We conclude that a promising way to reduce calorie intake is to present calorie labels on menus and that, importantly, the spatial location of these labels may strongly influence the likelihood of the success.

References

Allan, J. L., Johnston, M., & Campbell, N. (2015). Snack purchasing is healthier when the cognitive demands of choice are reduced: A randomized controlled trial. *Health Psychology, 34*(7), 750-755. doi: 10.1037/hea0000173

Becker, M. W., Bello, N. M., Sundar, R. P., Peltier, C., & Bix, L. (2015). Front of pack labels enhance attention to nutrition information in novel and commercial brands. *Food policy, 56*, 76-86.

Behavioural Insights Team. (2014). *EAST: Four simple ways to apply behavioural insights*.

Bialkova, S., Grunert, K. G., Juhl, H. J., Wasowicz-Kirylo, G., Stysko-Kunkowska, M., & van Trijp, H. C. (2014). Attention mediates the effect of nutrition label information on consumers' choice. Evidence from a choice experiment involving eye-tracking. *Appetite, 76*, 66-75.

Block, J. P., Condon, S. K., Kleinman, K., Mullen, J., Linakis, S., Rifas-Shiman, S., & Gillman, M. W. (2013). Consumers' estimation of calorie content at fast food restaurants: cross sectional observational study. [10.1136/bmj.f2907]. *BMJ : British Medical Journal, 346*.

Cawley, J., Susskind, A., & Willage, B. (2018). *The Impact of Information Disclosure on Consumer Behavior: Evidence from a Randomized Field Experiment of Calorie Labels on Restaurant Menus*: National Bureau of Economic Research.

Crockett, R. A., King, S. E., Marteau, T. M., Prevost, A. T., Bignardi, G., Roberts, N. W., . . . Jebb, S. A. (2018). Nutritional labelling for healthier food or non-alcoholic drink purchasing and consumption. *Cochrane Database of Systematic Reviews*(2). doi: 10.1002/14651858.CD009315.pub2

Crosetto, P., Muller, L., & Ruffieux, B. (2016). Helping consumers with a front-of-pack label: Numbers or colors?: Experimental comparison between Guideline Daily Amount and Traffic Light in a diet-building exercise. *Journal of Economic Psychology, 55*, 30-50.

Cutler, D. M., Glaeser, E. L., & Shapiro, J. M. (2003). Why Have Americans Become More Obese? *Journal of Economic Perspectives, 17*(3), 93-118. doi: doi: 10.1257/089533003769204371

Department of Health. (2016). The Food Pyramid Retrieved 13/12/2018, from https://www.safefood.eu/SafeFood/media/SafeFoodLibrary/Documents/Healthy%20Eating/A3_Healthy_Ireland_Food-Pyramid-Poster_Health_Professionals_Educators_Version.pdf

Department of Health and Social Care. (2018). *Consultation on mandating calorie labelling in the out-of-home sector*. Retrieved from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/751529/consultation-on-calorie-labelling-outside-of-the-home.pdf

Dubbert, P. M., Johnson, W. G., Schlundt, D. G., & Montague, N. W. (1984). The influence of caloric information on cafeteria food choices. *Journal of Applied Behavior Analysis, 17*(1), 85-92. doi: 10.1901/jaba.1984.17-85

Ellison, B., Lusk, J. L., & Davis, D. (2013). Looking at the label and beyond: the effects of calorie labels, health consciousness, and demographics on caloric intake in restaurants. [journal article]. *International Journal of Behavioral Nutrition and Physical Activity, 10*(1), 21. doi: 10.1186/1479-5868-10-21

Ellison, B., Lusk, J. L., & Davis, D. (2014). THE IMPACT OF RESTAURANT CALORIE LABELS ON FOOD CHOICE: RESULTS FROM A FIELD EXPERIMENT. *Economic Inquiry, 52*(2), 666-681. doi: 10.1111/ecin.12069

Fernandes, A. C., Oliveira, R. C., Proença, R. P., Curioni, C. C., Rodrigues, V. M., & Fiates, G. M. (2016). Influence of menu labeling on food choices in real-life settings: a systematic review. *Nutrition reviews, 74*(8), 534-548.

Geaney, F., Kelly, C., Scotto Di Marrazzo, J., Gilgan, L., McCarthy, M., & Perry, I. J. (2015). *Evaluation of the uptake of voluntary calorie posting on menus in Ireland*. Dublin.

Ghaffari, M., & Fiedler, S. (2018). The power of attention: using eye gaze to predict other-regarding and moral choices. *Psychological Science, 29*(11), 1878-1889.

Girz, L., Polivy, J., Herman, C. P., & Lee, H. (2011). The effects of calorie information on food selection and intake. [Original Article]. *International Journal Of Obesity, 36*, 1340. doi: 10.1038/ijo.2011.135

Graham, D. J., Orquin, J. L., & Visschers, V. H. (2012). Eye tracking and nutrition label use: A review of the literature and recommendations for label enhancement. *Food policy, 37*(4), 378-382.

Hammond, D., Goodman, S., Hanning, R., & Daniel, S. (2013). A randomized trial of calorie labeling on menus. *Preventive medicine, 57*(6), 860-866. doi: https://doi.org/10.1016/j.ypmed.2013.09.020

Harnack, L. J., French, S. A., Oakes, J. M., Story, M. T., Jeffery, R. W., & Rydell, S. A. (2008). Effects of calorie labeling and value size pricing on fast food meal choices: results from an experimental trial. *The international journal of behavioral nutrition and physical activity, 5*, 63-63. doi: 10.1186/1479-5868-5-63

Healthy Ireland. (2016). *A Healthy Weight For Ireland: Obesity Policy and Action Plan*. Dublin: Government Stationery office.

Hillier-Brown, F., Summerbell, C., Moore, H., Routen, A., Lake, A., Adams, J., . . . Adamson, A. (2017). The impact of interventions to promote healthier ready-to-eat meals (to eat in, to take away or to be delivered) sold by specific food outlets open to the general public: a systematic review. *Obesity Reviews, 18*(2), 227-246.

Holmes, A. S., Serrano, E. L., Machin, J. E., Duetsch, T., & Davis, G. C. (2013). Effect of different children's menu labeling designs on family purchases. *Appetite, 62*, 198-202. doi: https://doi.org/10.1016/j.appet.2012.05.029

Hruby, A., & Hu, F. B. (2015). The Epidemiology of Obesity: A Big Picture. *PharmacoEconomics, 33*(7), 673-689. doi: 10.1007/s40273-014-0243-x

Jordan, T. R., & Paterson, K. B. (2009). Re-evaluating split-fovea processing in word recognition: A critical assessment of recent research. *Neuropsychologia, 47*(12), 2341-2353.

Littlewood, J. A., Lourenço, S., Iversen, C. L., & Hansen, G. L. (2016). Menu labelling is effective in reducing energy ordered and consumed: a systematic review and meta-analysis of recent studies. *Public health nutrition, 19*(12), 2106-2121.

Michie, S., van Stralen, M. M., & West, R. (2011). The behaviour change wheel: a new method for characterising and designing behaviour change interventions. *Implementation science : IS, 6*, 42-42. doi: 10.1186/1748-5908-6-42

Newton, J. N., Briggs, A. D. M., Murray, C. J. L., Dicker, D., Foreman, K. J., Wang, H., . . . Davis, A. C. J. (2015). Changes in health in England, with analysis by English regions and areas of deprivation, 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013. *The Lancet, 386*(10010), 2257-2274. doi: 10.1016/s0140-6736(15)00195-6

Nicholls, M. E., & Wood, A. G. (1998). The contribution of attention to the right visual field advantage for word recognition. *Brain and Cognition, 38*(3), 339-357.

Nielsen. (2012). *A Nielsen Report: Battle of the Bulge and Nutrition Labels: Healthy Eating Trends Around the World*.

Nikolaou, C. K., McPartland, M., Demkova, L., & Lean, M. E. (2017). Supersize the label: The effect of prominent calorie labeling on sales. *Nutrition, 35*, 112-113.

Park, M. H., Falconer, C. L., Croker, H., Saxena, S., Kessel, A. S., Viner, R. M., & Kinra, S. (2014). Predictors of health-related behaviour change in parents of overweight children in England. *Preventive medicine, 62*(100), 20-24. doi: 10.1016/j.ypmed.2014.02.002

Platkin, C., Yeh, M.-C., Hirsch, K., Wiewel, E. W., Lin, C.-Y., Tung, H.-J., & Castellanos, V. H. (2014). The effect of menu labeling with calories and exercise equivalents on food selection and consumption. *BMC obesity, 1*, 21-21. doi: 10.1186/s40608-014-0021-5

Public Health England. (2018). Calorie reduction: The scope and ambition for action, from https://www.gov.uk/government/publications/calorie-reduction-the-scope-and-ambition-for-action

Reale, S., & Flint, S. W. (2016). The impact of menu label design on visual attention, food choice and recognition: an eye tracking study. *Journal of Sensory Studies, 31*(4), 328-340.
Roberto, C. A., Larsen, P. D., Agnew, H., Baik, J., & Brownell, K. D. (2010). Evaluating the Impact of Menu Labeling on Food Choices and Intake. *American Journal of Public Health, 100*(2), 312-318. doi: 10.2105/ajph.2009.160226
Robinson, E., Jones, A., Whitelock, V., Mead, B. R., & Haynes, A. (2018). (Over)eating out at major UK restaurant chains: observational study of energy content of main meals. [10.1136/bmj.k4982]. *BMJ, 363*.
Roth, G. A., Abate, D., Abate, K. H., Abay, S. M., Abbafati, C., Abbasi, N., . . . Murray, C. J. L. (2018). Global, regional, and national age-sex-specific mortality for 282 causes of death in 195 countries and territories, 1980–2017: a systematic analysis for the Global Burden of Disease Study 2017. *The Lancet, 392*(10159), 1736-1788. doi: 10.1016/s0140-6736(18)32203-7
Sacco, J., Lillico, H. G., Chen, E., & Hobin, E. (2017). The influence of menu labelling on food choices among children and adolescents: a systematic review of the literature. *Perspectives in public health, 137*(3), 173-181.
Sarink, D., Peeters, A., Freak-Poli, R., Beauchamp, A., Woods, J., Ball, K., & Backholer, K. (2016). The impact of menu energy labelling across socioeconomic groups: A systematic review. *Appetite, 99*, 59-75.
Sharma, S., Wagle, A., Sucher, K., & Bugwadia, N. (2011). Impact of Point of Selection Nutrition Information on Meal Choices at a Table-Service Restaurant. *Journal of foodservice business research, 14*(2), 146-161. doi: 10.1080/15378020.2011.574540
Spronk, I., Kullen, C., Burdon, C., & O'Connor, H. (2014). Relationship between nutrition knowledge and dietary intake. *British Journal of Nutrition, 111*(10), 1713-1726. doi: 10.1017/s0007114514000087
Stewart, N., Hermens, F., & Matthews, W. J. (2016). Eye Movements in Risky Choice. *Journal of Behavioral Decision Making, 29*(2-3), 116-136. doi: doi:10.1002/bdm.1854
Stubenitsky, K., Aaron, J. I., Catt, S. L., & Mela, D. J. (2000). The influence of recipe modification and nutritional information on restaurant food acceptance and macronutrient intakes. *Public health nutrition, 3*(2), 201-209. doi: 10.1017/s1368980000000239
Taylor, S. E., & Thompson, S. C. (1982). Stalking the elusive "vividness" effect. *Psychological Review, 89*(2), 155-181. doi: 10.1037/0033-295x.89.2.155
Yazar, K., Seimyr, G. Ö., Novak, J. A., White, I. R., & Lidén, C. (2014). Readability of product ingredient labels can be improved by simple means: an experimental study. *Contact dermatitis, 71*(4), 233-241. doi: 10.1111/cod.12274

Table 1. Demographics by condition

	Control	Calories left no RDA	Calories left + RDA	Calories right no RDA	Calories right + RDA
Age	40.49	39.87	36.21	41.5	39.52
(SD, range)	(15.92)	(12.97)	(12.65)	(15.50)	(13.80)
	18-70	19-59	18-68	18-71	19-66
Education (% degree or higher)	28.26%	43.48%	41.67%	50%	34.78%
Male	57.45%	60.87%	37.50%	50%	43.48%
N	48	24	24	23	23

Note. Means and percentages were tested for differences across conditions. There were no statistically significant differences across conditions.

Table 2. Ordered logistic models showing the effect of condition on the level of calories ordered

Dependent Variable: Calories ordered expressed as an ordinal variable of low, medium or high.	(1)	(2)	(3)
Calories left	-.05 (.38)		
Calories right	-.77 (.39)*		
Calories no RDA		-.25 (.38)	
Carlories + RDA		-.54 (.39)	
Calories left no RDA			.15 (.46)
Calories left + RDA			-.27 (.47)
Calories right no RDA			-.68 (.47)
Calories right + RDA			-.87 (.49)*
N	142	142	142

*$p < .05$, **$p < .01$, *** $p < .001$. All tests are one-tailed.

Note. This table shows three models that breakdown the experimental manipulation in three different ways. The first column shows the effect of seeing calories on the left (with or without RDA) or calories on the right (with or without RDA) compared to control. The second column shows the effect of seeing calories (left or right) without RDA or calories (left or right) with RDA compared to control. The third column shows the effect of seeing each of the four experimental menu types compared to control. Numbers shown are coefficients with standard errors in brackets.

Table 3. Ordered logistic models showing effect of condition on number of calories consumed.

Dependent Variable: Calories consumed expressed as an ordinal variable of low, medium or high.	(4)	(5)	(6)
Calories left	-.28 (.49)		
Calories right	-1.42 (.51)**		
Calories no RDA		-.98 (.52)*	
Carlories + RDA		-.72 (.47)	
Calories left no RDA			-.24 (.63)
Calories left + RDA			-.31 (.59)
Calories right no RDA			-1.91 (.70)***
Calories right + RDA			-1.13 (.58)*
N	87	87	87

*$p < .05$, **$p < .01$, *** $p < .001$. All tests are one-tailed.

Note. This table shows three models that breakdown the experimental manipulation in three different ways. The first column shows the effect of seeing calories on the left (with or without RDA) or calories on the right (with or without RDA) compared to control. The second column shows the effect of seeing calories (left or right) without RDA or calories (left or right) with RDA compared to control. The third column shows the effect of seeing each of the four experimental menu types compared to control. Numbers shown are coefficients with standard errors in brackets.

Table 4. Ordered logistic models showing effect of condition on error in estimating calories in meal

Dependent Variable: Accuracy of estimation defined as correct within 100 calories, within 300 calories or by > 300.	(7)	(8)	(9)
Calories left	-1.03 (.39)**		
Calories right	-1.38 (.39)***		
Calories no RDA		-1.28 (.40)***	
Carlories + RDA		-1.13 (.39)***	
Calories left no RDA			-.84 (.48)*
Calories left + RDA			-1.24 (.48)*
Calories right no RDA			-1.76 (.50)***
Calories right + RDA			-1.04 (.47)**
N	142	142	142

*$p < .05$, **$p < .01$, *** $p < .001$. All tests are one-tailed.

Note. This table shows three models that breakdown the experimental manipulation in three different ways. The first column shows the effect of seeing calories on the left (with or without RDA) or calories on the right (with or without RDA) compared to control. The second column shows the effect of seeing calories (left or right) without RDA or calories (left or right) with RDA compared to control. The third column shows the effect of seeing each of the four experimental menu types compared to control. Numbers shown are coefficients with standard errors in brackets.

Table 5. Ordered logistic models showing accuracy of calorie estimations as a mediator in the relationship between calories right condition and calories ordered and consumed.

Dependent Variable: Calories ordered and consumed expressed as an ordinal variable of low, medium or high.	Calories Ordered	Calories Consumed
Calories left	.39 (.40)	.35 (.55)
Calories right	-.23 (.42)	-.71 (.56)
Accuracy within 300 calories	.75 (.44)	.68 (.56)
Accuracy out by > 300 calories	2.11 (.44)***	1.85 (.57)***
N	142	87

*$p < .05$, **$p < .01$, *** $p < .001$. All tests are one-tailed.

Note. This table shows the effect of seeing calories on the left (with or without RDA) or calories on the right (with or without RDA) compared to control and accuracy within 300 calories or accuracy out by more than 300 calories compared to being accurate within 100 calories. Numbers shown are coefficients with standard errors in brackets.

Table 6. Ordered logistic models showing accuracy of RDA calorie estimations by condition.

Dependent Variable: Accuracy of calorie estimation expressed as an ordinal variable as correct within 500 calories, correct within 1000 calories or incorrect by > 1000 calories.	PA Male	Non-PA Male	PA Female	Non-PA Female
Calories (left or right) no RDA	-.68 (.40)*	-.50 (.42)	-.74 (.42)*	-.54 (.40)
Calories (left or right) with RDA	-.89 (.41)*	-.69 (.43)†	-.67 (.41)†	-.47 (.40)
N	142	142	142	142

† $p = .054$, *$p < .05$, **$p < .01$, *** $p < .001$. All tests are one-tailed.

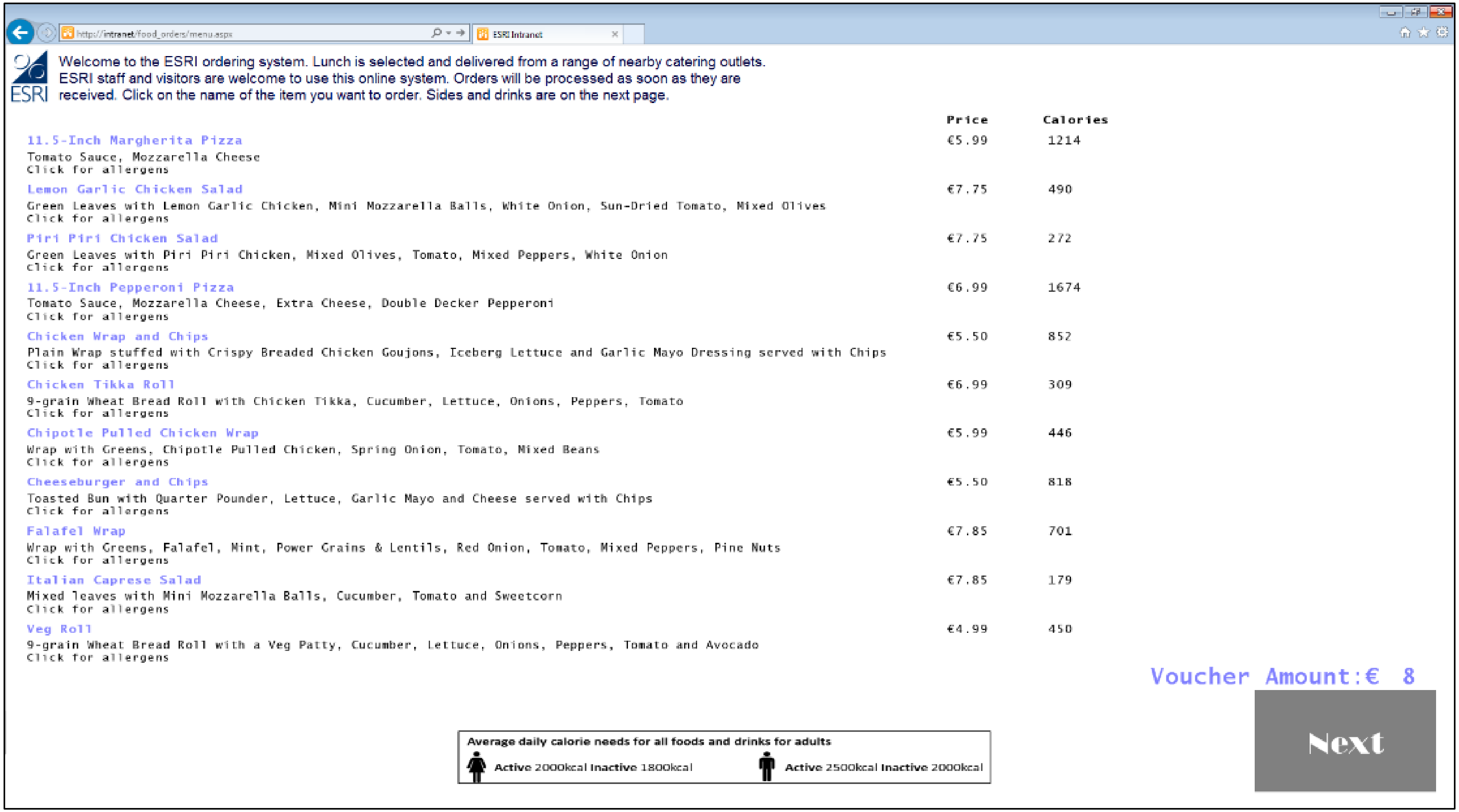
Note. This table shows the effect of seeing calories (left or right) without RDA or calories (left or right) with RDA compared to control. Numbers shown are coefficients with standard errors in brackets.

Table 7. Ordered logistic models showing relationship between number of fixations to labels and calories ordered, consumed, estimated and weighted.

DV: Likelihood of being in a medium or high category	Calories Ordered	Calories Consumed	Accuracy of Calories Estimated	Calories Weighting
Fixations to calorie labels	-.41 (.25)*	-.39 (.33)	-.67 (.25)***	.59 (.23)**
N	74	45	74	74

Note. For calories ordered, consumed and estimated higher categories indicate more calories ordered, consumed and greater inaccuracy in estimations. Calories weighting describes the weight that participants reported they gave to calorie information in their decision. Higher scores indicate a higher weighting. Numbers shown are coefficients with standard errors in brackets.
p* < .05, ***p* < .01, * *p* < .001. All test are one-tailed.

Figure 1. Screenshots of each of the three pages of the menu that participants in the Calories Right condition saw.



http://intranet/food_orders/menu.aspx ESRI Intranet

ESRI

Welcome to the ESRI ordering system. Lunch is selected and delivered from a range of nearby catering outlets. ESRI staff and visitors are welcome to use this online system. Orders will be processed as soon as they are received. Click on the name of the item you want to order. Sides and drinks are on the next page.

	Price	Calories
11.5-Inch Margherita Pizza Tomato Sauce, Mozzarella Cheese Click for allergens	€5.99	1214
Lemon Garlic Chicken Salad Green Leaves with Lemon Garlic Chicken, Mini Mozzarella Balls, White Onion, Sun-Dried Tomato, Mixed Olives Click for allergens	€7.75	490
Piri Piri Chicken Salad Green Leaves with Piri Piri Chicken, Mixed Olives, Tomato, Mixed Peppers, White Onion Click for allergens	€7.75	272
11.5-Inch Pepperoni Pizza Tomato Sauce, Mozzarella Cheese, Extra Cheese, Double Decker Pepperoni Click for allergens	€6.99	1674
Chicken Wrap and Chips Plain Wrap stuffed with Crispy Breaded Chicken Goujons, Iceberg Lettuce and Garlic Mayo Dressing served with Chips Click for allergens	€5.50	852
Chicken Tikka Roll 9-grain Wheat Bread Roll with Chicken Tikka, Cucumber, Lettuce, Onions, Peppers, Tomato Click for allergens	€6.99	309
Chipotle Pulled Chicken Wrap Wrap with Greens, Chipotle Pulled Chicken, Spring Onion, Tomato, Mixed Beans Click for allergens	€5.99	446
Cheeseburger and Chips Toasted Bun with Quarter Pounder, Lettuce, Garlic Mayo and Cheese served with Chips Click for allergens	€5.50	818
Falafel Wrap Wrap with Greens, Falafel, Mint, Power Grains & Lentils, Red Onion, Tomato, Mixed Peppers, Pine Nuts Click for allergens	€7.85	701
Italian Caprese Salad Mixed leaves with Mini Mozzarella Balls, Cucumber, Tomato and Sweetcorn Click for allergens	€7.85	179
Veg Roll 9-grain Wheat Bread Roll with a Veg Patty, Cucumber, Lettuce, Onions, Peppers, Tomato and Avocado Click for allergens	€4.99	450

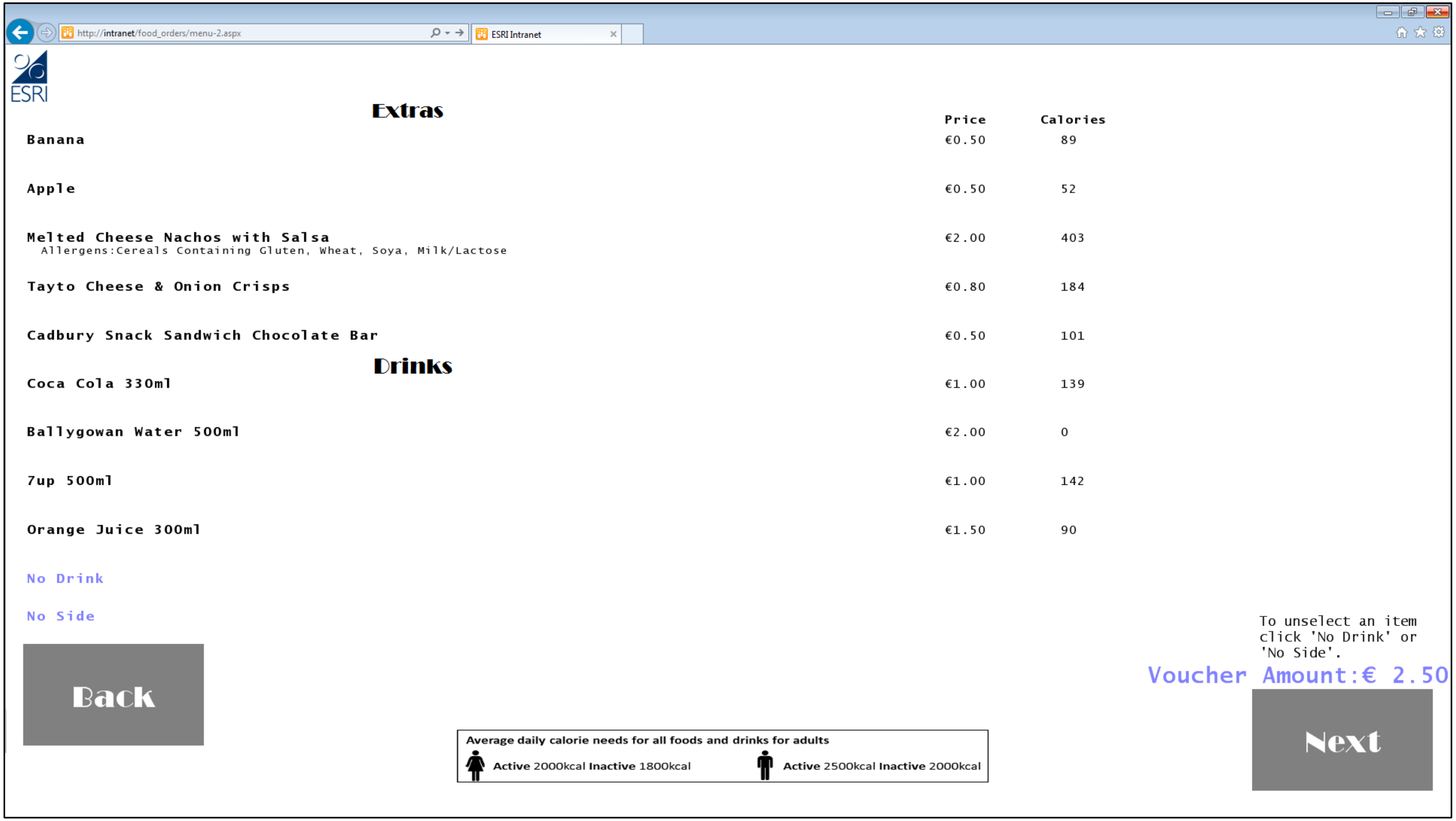
Voucher Amount:€ 8

Average daily calorie needs for all foods and drinks for adults

Active 2000kcal Inactive 1800kcal

Active 2500kcal Inactive 2000kcal

Next


http://intranet/food_orders/menu-2.aspx
ESRI Intranet
ESRI
Extras
Price
Calories
Banana €0.50 89
Apple €0.50 52
Melted Cheese Nachos with Salsa €2.00 403
Allergens:Cereals Containing Gluten, Wheat, Soya, Milk/Lactose
Tayto Cheese & Onion Crisps €0.80 184
Cadbury Snack Sandwich Chocolate Bar €0.50 101
Drinks
Coca Cola 330ml €1.00 139
Ballygowan Water 500ml €2.00 0
7up 500ml €1.00 142
Orange Juice 300ml €1.50 90
No Drink
No Side
To unselect an item click 'No Drink' or 'No Side'.
Voucher Amount:€ 2.50
Back
Average daily calorie needs for all foods and drinks for adults
Active 2000kcal Inactive 1800kcal
Active 2500kcal Inactive 2000kcal
Next

http://intranet/food_orders/confirmation.aspx

ESRI Intranet

ESRI

Order Details

Main:

Chicken Wrap and Chips €5.50

Side:

Apple €0.50

Drink:

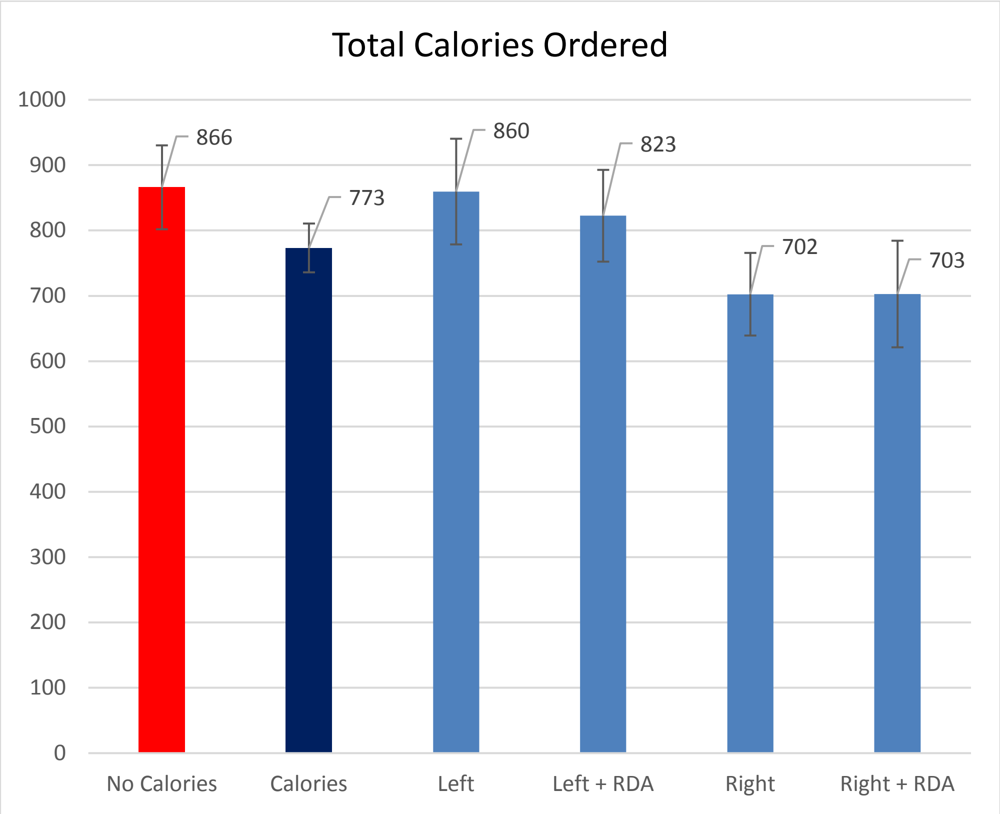
7up 500ml €1.00

Total:	€7.00
Voucher Discount:	-€8.00
Amount Due:	€ 0

Back

Next

Figure 2. Total calories in the meals that participants ordered by condition



Note. The second bar is an average of the four bars that follow it. Error bars represent standard errors.

Figure 3. Distribution of total calories ordered

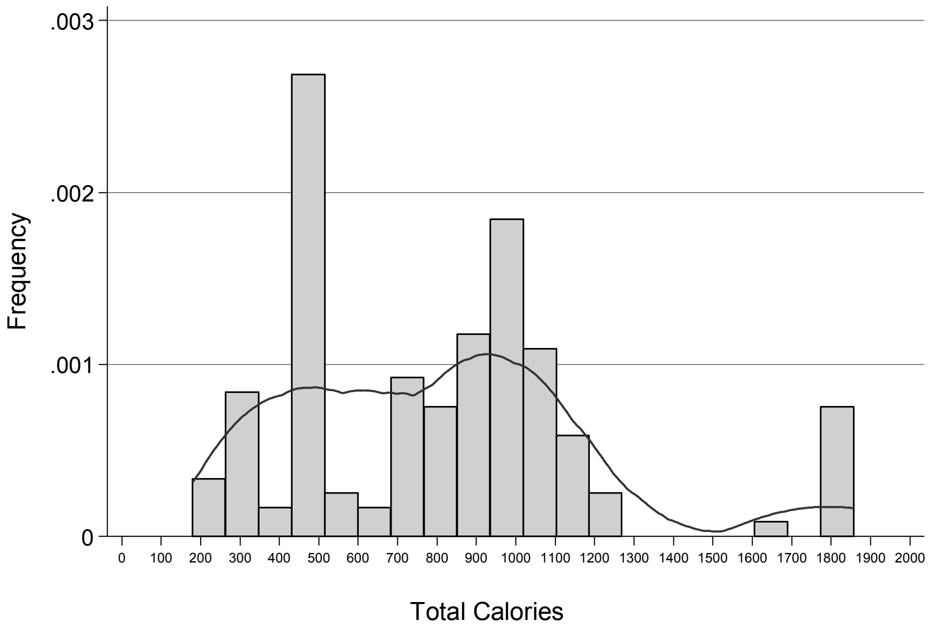


Figure 4. Total calories in the meals that participants consumed by condition

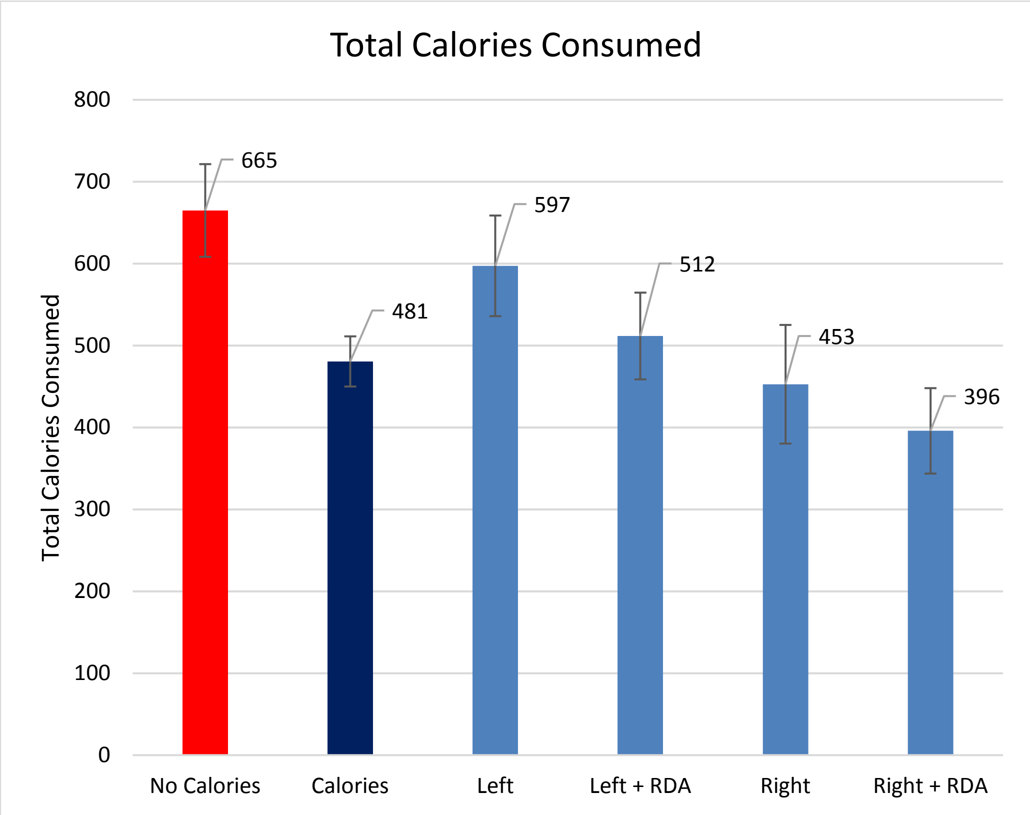


Figure 5. Distribution of total calories consumed

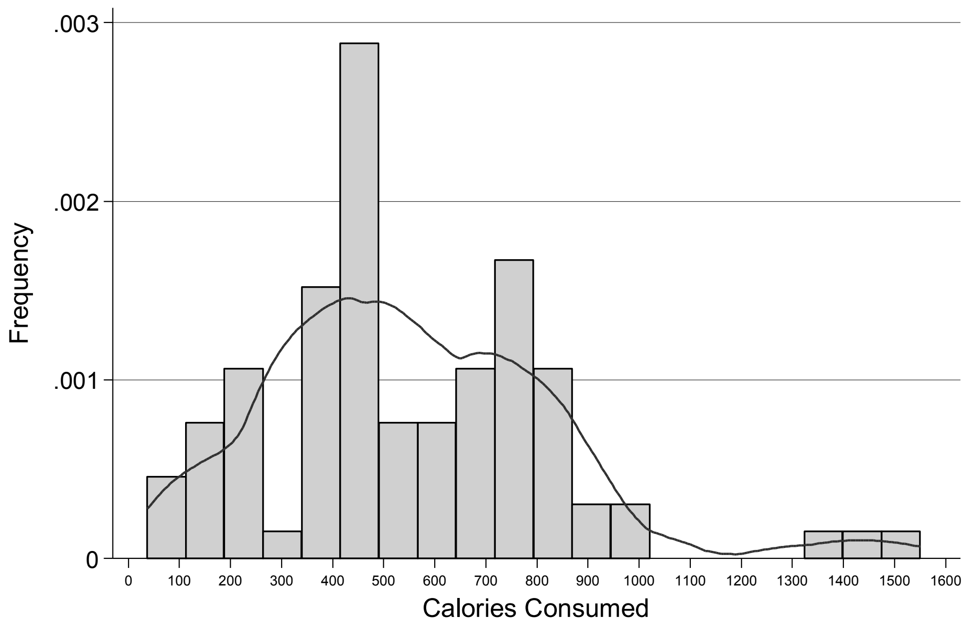
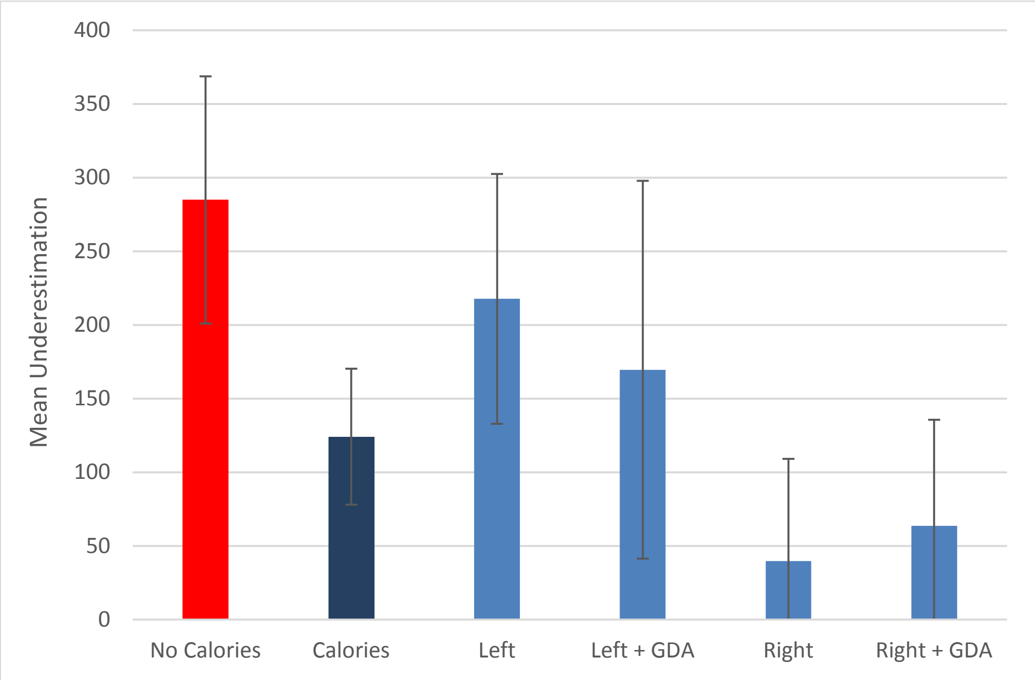


Figure 6. Mean difference in estimation of calories in meal to actual calories in meal by condition



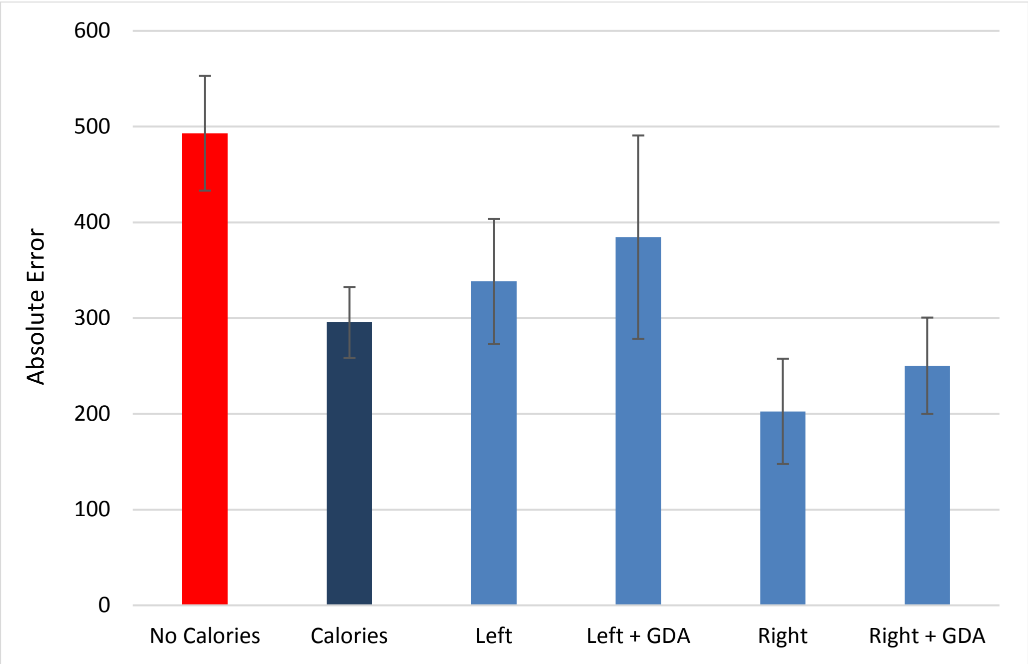


Figure 7. Mean difference in absolute error of estimates for RDA by condition

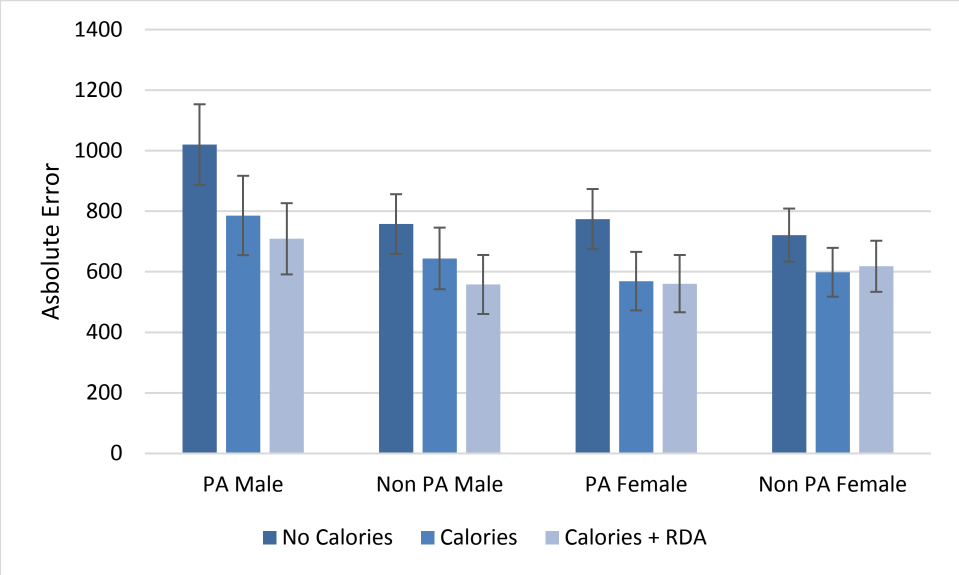
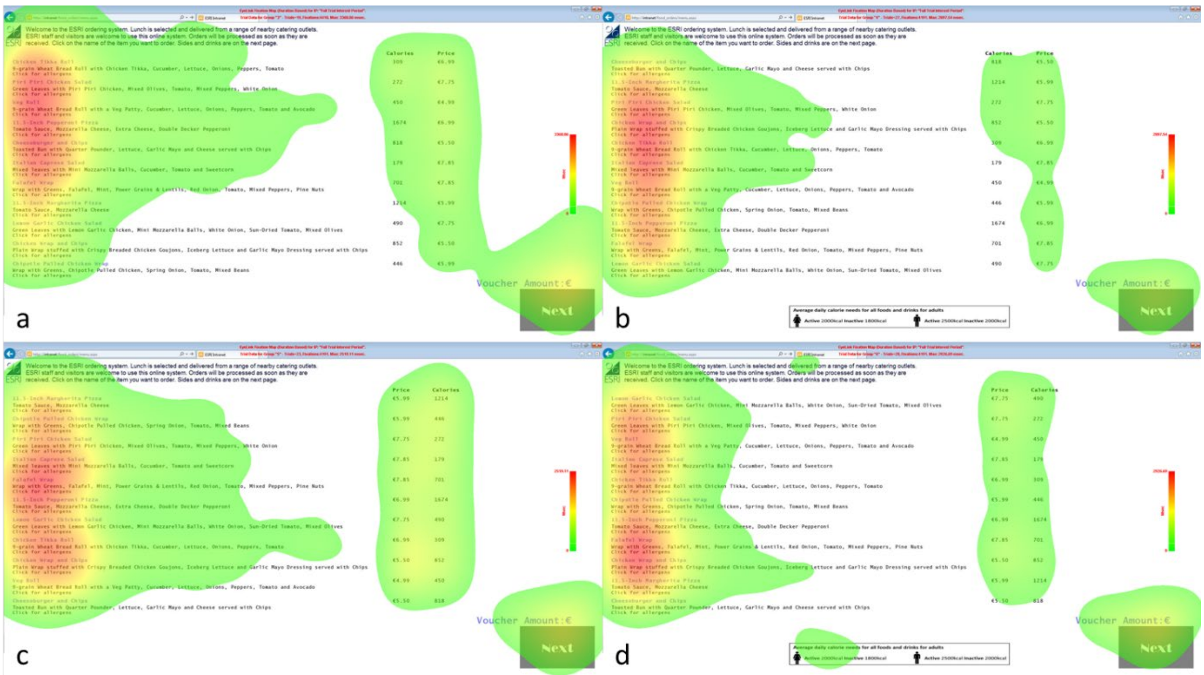


Figure 8. Fixation heat maps showing average time spent viewing elements on the menu by condition.



Note. Letters refer to conditions: a = calories left without RDA; b = calories left with RDA; c = calories right without RDA; d = calories right with RDA.

Year	Number	Title/Author(s)
2019		
	614	The determinants of SME capital structure across the lifecycle *Maria Martinez-Cillero, Martina Lawless, Conor O'Toole*
	612	Can official advice improve mortgage-holders' perceptions of switching? An experimental investigation *Shane Timmons, Martina Barjaková, Terence J. McElvaney and Pete Lunn*
	611	Underestimation of money growth and pensions: Experimental investigations *Féidhlim P. McGowan, Pete Lunn, Deirdre A. Robertson*
	610	Housing Assistance Payment: Potential impacts on financial incentives to work *Barra Roantree, Mark Regan, Tim Callan, Michael Savage and John R. Walsh*
	609	Predicting farms' noncompliance with regulations on nitrate pollution *Pete Lunn, Seán Lyons and Martin Murphy*
2018		
	608	How openness to trade rescued the Irish economy *Kieran McQuinn, Petros Varthalitis*
	607	Senior cycle review: Analysis of discussion in schools on the purpose of senior cycle education in Ireland *Joanne Banks, Selina McCoy, Emer Smyth*
	606	LNG and gas storage optimisation and valuation: Lessons from the integrated Irish and UK markets *Mel T. Devine, Marianna Russo*
	605	The profitability of energy storage in European electricity markets *Petr Spodniak, Valentin Bertsch, Mel Devine*
	604	The framing of options for retirement: Experimental tests for policy *Féidhlim McGowan, Pete Lunn, Deirdre Robertson*
	603	The impacts of demand response participation in capacity markets *Muireann Á. Lynch, Sheila Nolan, Mel T. Devine, Mark O'Malley*
	602	Review of the Irish and international literature on health and social care unit cost methodology *Richard Whyte, Conor Keegan, Aoife Brick, Maev-Ann Wren*
	601	An examination of activity in public and private hospitals in Ireland, 2015 *Conor Keegan, Aoife Brick, Maev-Ann Wren*
	600	Using angling logbook data to inform fishery management decisions *Gianluca Grilli, John Curtis and Stephen Hynes*

For earlier Working Papers see http://ww.esri.ie