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Christopher Gustafson

Eliana Zeballos

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The effect of presenting relative calorie information on calories ordered

Christopher R. Gustafson[a,*], Eliana Zeballos[b]

[a] Department of Agricultural Economics, University of Nebraska-Lincoln, 314A Filley Hall, Lincoln, NE, 68583, USA
[b] USDA Economic Research Service, Food Economic Division, Washington, D.C, USA

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ABSTRACT

In this research, we tested the effect of a novel method of presenting calorie information—highlighting relative differences in calories among ingredients. We conducted an online hypothetical food choice experiment where 633 participants selected the ingredients for a sandwich from five categories: meat/protein, cheese, spread/dressing, bread, and vegetables. Each participant was randomly assigned to one of four calorie information conditions: 1) a condition in which no information about calories was provided, 2) a condition in which calorie information was provided for each ingredient, 3) a condition in which calorie information was presented relative to the highest calorie item, and 4) a condition in which calorie information was presented relative to the lowest calorie item. Participants in the high- and low-calorie reference conditions ordered between 32 and 36 fewer calories per sandwich than participants in the no-calorie information control condition ($p \leq 0.04$). Calories ordered by participants in the per-item calorie condition were not significantly different than the control. Presenting relative calorie or other nutritional information to make health-related trade-offs more salient may guide consumers to make healthier choices.

1. Introduction

Over the past five decades, an increasingly large proportion of the US population has been affected by overweight and obesity—a trend seen in countries throughout the world (GBD 2015 Obesity Collaborators, 2017; Centers for Disease Control and Prevention (CDC), 2019; Hales, Fryar, Carroll, Freedman, & Ogden, 2018). Having a body mass index (BMI) in the overweight ($25 \leq \text{BMI} < 30$) and obese ($\text{BMI} \geq 30$) range is linked to poorer health outcomes—including a higher probability of developing non-communicable diseases, such as type-2 diabetes, cancer, and heart disease (Preston, Vierboom, & Stokes, 2018)—and has become a leading cause of death in the US (Centers for Disease Control and Prevention (CDC), 2019) as well as contributing to millions of deaths globally (GBD 2015 Obesity Collaborators, 2017). High BMI impacts the economy as well. It is estimated to cost the US economy $150 billion per year in direct costs (in 2008 dollars) and $3–6 billion annually in indirect costs (Cawley, 2004; Trogdon, Finkelstein, Hylands, Dellea, & Kamal-Bahl, 2008; Finkelstein, Trogdon, Cohen, & Dietz, 2009 Sep-Oct). The direct costs of high BMI include higher healthcare expenses, while indirect economic costs include higher rates of absenteeism—missing days of work—and presenteeism, which refers to a reduction in workers' productivity at work due to poorer health (Cawley, 2015). High BMI may also affect quality of life measures through stigma, diminished self-esteem, higher rates of depression, and poorer physical health, though quality of life is affected differently depending on an individual's sex, ethnicity, and other individual characteristics (Wee, Davis, Chiodi, Huskey, & Hamel, 2015).

High BMI results from a long-term tendency to consume more energy than the individual expends. An important determinant of net energy balance, diet has been targeted as a prime opportunity for behavior change that could lead to a reduction in BMI. To encourage behavior change in food purchasing and consumption practices, policymakers have focused heavily on policies that mandate the provision of nutrition information, which individuals could use to make more informed food choices and improve the quality of their diets. This strategy—providing nutritional information—was implemented with packaged food products over 25 years ago in the US, and has been widely adopted and tested, with recent research testing the efficacy of various front-of-package labeling systems in countries throughout the world (Talati, Egnell, Hercberg, Julia, & Pettigrew, 2019).

In response to increasing consumption of food away from home (FAFH) in the US, this approach has recently been extended to restaurants and other FAFH settings. US residents consume around 33% of daily calories away from home and foods consumed away from home tend to be higher in fat and sodium and to contain less of important nutrients, such as fiber and calcium (USDA ERS, 2012; Todd, 2017). On

* Corresponding author.
E-mail addresses: cgustafson6@unl.edu (C.R. Gustafson), eliana.zeballos@gmail.com (E. Zeballos).

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May 7, 2018, specific rules of the Affordable Care Act (ACA) went into effect that require restaurants and other retail outlets selling prepared foods that have at least 20 locations to post the calorie content of foods and provide other nutritional information at the request of consumers (ACA Section 4205 [March 2010]).

Many places across the US, including New York City and King County, Washington—home to Seattle, had adopted rules similar to the ACA's restaurant nutrition information over the previous decade, allowing researchers to study the effect of calorie information on food choices in FAFH settings before implementation of the restaurant labeling rule. While some studies of restaurant calorie labeling find significant, but small reductions in calories ordered (Bassett, Dumanovsky, Huang et al., 2008; Wisdom, Downs, & Loewenstein, 2010; Bollinger, Leslie, & Sorensen, 2011; Ellison, Lusk, & Davis, 2013), others find no change (Cantor, Torres, Abrams, & Elbel, 2015; Elbel, Kersh, Brescoll, & Dixon, 2009; Finkelstein, Strombotne, Chan, & Krieger, 2011; Tandon et al., 2011). Meta-analyses of FAFH calorie labeling do not suggest that providing calorie information leads diners to choose lower calorie foods (Kiszko, Martinez, Abrams, & Elbel, 2014; Sinclair, Cooper, & Mansfield, 2014; Long, Tobias, Cradock, Batchelder, & Gortmaker, 2015; Littlewood, Lourenço, Iversen, & Hansen, 2016; VanEpps, Roberto, Park, Economos, & Bleich, 2016; Bleich et al., 2017; Cantu-Jungles, McCormack, Slaven, Slebodnik, & Eicher-Miller, 2017).

This research contributes to a literature examining the effect of varying the presentation of health information—including through the use of simple graphics and listing choices in order of health attributes, such as calories—on food choices. Previous research finds that graphical labeling systems that summarize health information, such as traffic light labeling systems, increase the identification and choice of healthy foods in many cases (Feunekes, Gortemaker, Willems, Lion, & van den Kommer, 2008; Thorndike, Riis, Sonnenberg, & Levy, 2014, 2012; VanEpps, Downs, & Loewenstein, 2016). These graphical systems are used both in packaged food retail and restaurants. Another approach, which has been studied in the context of FAFH, has been to structure the provision of nutritional information to make it easier to identify, for example, low-calorie items by listing options in order based on calorie content (Downs, Wisdom, & Loewenstein, 2015; Policastro, Smith, & Chapman, 2017). Results from these studies have been mixed. While Downs et al. (2015) show find that items listed in order of calorie content reduces calories ordered (while simply providing calorie information does not), Policastro et al. (2017) find that structuring food lists in order of calorie information does not lead to changes in calories ordered, although other attributes—such as fiber and sodium—do improve. One important difference between these two studies was that calorie information was not provided to participants in the research reported in Policastro et al. (2017), while it was in Downs et al. (2015).

Presenting information in a way that highlights the nutritional tradeoffs in food items may prompt consideration of health when making a decision, which has been found to promote healthier choices (Hare, Malmaud, & Rangel, 2011). A significant percentage of consumers are willing to downsize the quantity of food they receive to in order to reduce their consumption of calories (Schwartz, Riis, Elbel, & Ariely, 2012). A few recent studies suggest that the presentation of information influences choices even when the content of the information is fundamentally the same. A natural experiment at a sandwich counter in a national supermarket chain compared calories ordered when calorie information was provided at the per-item versus per-ingredient level (Gustafson & Zeballos, 2018). Findings show that providing per-ingredient calorie information—which may highlight ways the consumer could reduce caloric intake by forgoing specific ingredients rather than making a wholesale change in food item—-resulted in a significant decrease in the average number of calories ordered, while per-item calorie labeling did not (Gustafson & Zeballos, 2018). Another study examined providing a real-time updating summation of calories ordered to individuals relative to a per-item calorie information condition in a sequential food choice setting (Gustafson & Zeballos, 2019). Results suggest exposure to updating calorie information leads to fewer calories ordered by making individuals accurately account for the calories in items selected in early choices, resulting in the selection of lower calorie items in later choices.

In this article, we report a test of a novel calorie labeling format in an online build-your-own sandwich choice task. The calorie presentation examined in this research is intended to facilitate comparison of the calorie content of sandwich ingredients by presenting the relative differences in calories contained in each ingredient available in five ingredient categories: meat/protein, cheese, spread/dressing, bread, and vegetables, contributing to a growing literature on information and labeling-based approaches to reduce the number of calories individuals consume. We highlight tradeoffs in the numbers of calories contained in different items by displaying calorie information relative to the highest calorie item in one condition, and the lowest calorie in the other.

While we focus on a sandwich choice exercise, we view this approach as applicable to any FAFH setting. In particular, the adoption of electronic, online, or app-based ordering options by many chain restaurants, such as McDonald's (www.mcdonalds.com), could facilitate the presentation of relative calorie information.

2. Materials and methods

2.1. Participants

We generated the data for this research in a hypothetical sandwich ingredient choice task and survey implemented online. Individuals, recruited from the Amazon Mechanical Turk (mTurk) worker pool, completed the research between April 24, 2018 and May 3, 2018. Participants first completed the sandwich experiment, followed by a survey collecting demographic information. Respondents were required to be at least 19 years of age, to be residents of the United States, and were only allowed to complete the survey once. Participants received a $3.00 payment for completing the survey. The Institutional Review Board of the University of Nebraska-Lincoln approved the research (IRB protocol # 20171017580EX). All participants provided written informed consent before participating in the research.

2.2. Experimental conditions

In the sandwich experiment, participants chose the ingredients for a sandwich, selecting one ingredient from each of five categories: meat/protein, cheese, spread/dressing, bread, and vegetable. They could also select "I would not add any of these" if they did not want to add any of the available ingredients in a category. Participants were instructed to imagine they were going to eat the sandwich after completing the choice task.

In this study, we use the highest or lowest calorie item in each ingredient category as a reference point and present the calories embodied in the other items within the ingredient category as the number of fewer or additional calories, respectively, with respect to the reference point. The two relative conditions we examine are the maximum calorie item, or "Max Ref," condition and the minimum calorie item, or "Min Ref," condition. We compare the calories ordered in a hypothetical sandwich choice exercise in these two conditions to the number of calories ordered under two control conditions: a no-calorie information condition ("No Info") and a scenario in which participants see the total number of calories ("Calorie Info") contained in each available ingredient (Gustafson & Zeballos, 2019). When these data were collected (April 24, 2018–May 3, 2018), the ACA restaurant calorie labeling requirement had not yet gone into effect, making a no-calorie information control a relevant informational condition for our participants. In fact, many FAFH decisions continue to be made without access to calorie or other nutritional information: while food retail outlets with 20 or more locations must display calorie information, outlets with fewer than 20 locations are not required to provide this information. The Calorie Info

Table 1
Presentation of calorie information (from highest to lowest calorie items) for ingredients in conditions with calorie information.

Ingredients	Calorie Info	Max Ref	Min Ref
Meat/protein			
Bacon	254	254	+164
Salami	230	−24	+140
Roast Beef	207	−47	+117
Roast turkey	180	−74	+90
Ham	178	−76	+88
Prosciutto	140	−114	+50
Tofu	90	−164	90
Cheese			
Cheddar	115	115	+79
Colby	112	−3	+77
Swiss	111	−4	+76
American	104	−11	+68
Provolone	98	−17	+62
Mozzarella	85	−30	+49
Light American	36	−79	36
Spread/dressing			
Mayonnaise	188	188	+182
Olive oil	119	−69	+113
Light mayo.	71	−117	+65
Italian dressing	35	−153	+29
Balsamic vinegar	14	−174	+8
Dijon mustard	10	−178	+4
Yellow mustard	6	−182	6
Bread			
Croissant	406	406	+184
Sourdough	319	−87	+97
Multigrain	265	−141	+43
Ciabatta	263	−143	+41
Bagel	250	−156	+28
Marble Rye	233	−173	+11
Gluten-free	222	−184	222
Vegetables			
Avocado	47	47	+44
Red onion	11	−36	+8
Red pepper	8	−39	+5
Spinach	7	−40	+4
Tomato	5	−42	+2
Lettuce	4	−43	+1
Cucumber	3	−44	3

Source: Sandwich choice experiment.

condition represents the post-May 7, 2018 default informational scenario at prepared food retail outlets with 20 or more locations.

Participants were randomly assigned to one of the four calorie labeling conditions: 1) No Info; 2) "Calorie Info"; 3) Max Ref; and 4) Min Ref. In each of the conditions, participants had to actively select an ingredient (or the "none of these" option) in each ingredient category. Table 1 displays the ingredients offered in each category; it also shows how calorie information was presented in each condition. In the *No Info* condition, participants viewed only the list of items in each category that they could add to the sandwich; no calorie information was provided. In *Calorie Info*, participants saw the number of calories that each item would add to the sandwich. Next, *Max Ref* condition takes the highest calorie item as a reference point, and it displayed the full calorie amount for the highest calorie item in each ingredient category and presented the calorie savings that would result from choosing any other ingredient instead of the highest calorie item, for every other item in the same category. Finally, *Min Ref* condition uses the lowest calorie item as a reference point, and it displayed the full calorie amount for the lowest calorie item in each ingredient category and showed the calories that would be added by choosing any other ingredient for all ingredients in the same category.

The instructions preceding the choice task explained how calorie information would be provided in each condition. For the *Calorie Info* condition the instructions read, "Imagine you want to eat a sandwich, and you have the following list of ingredients available to build the sandwich. Please select the ingredients that you want to add to your sandwich. You may only choose one ingredient per food category. Simply click on the box next to the ingredient to select an ingredient. The number of calories that each ingredient will add to the sandwich is presented in parentheses behind the ingredient." Instructions in other conditions that presented calorie information explained how calorie information would be presented and how to interpret the information (instructions for other conditions are provided in an online appendix). A screenshot of the meat/protein choice in the *Min Ref* condition is presented in Fig. 1.

Participants could select at most one item from each category, reflecting a common practice at many sandwich restaurants, but could also select "I would not add any of these" if they did not want to add any of the options in a given category. The order of the ingredients within an ingredient category were randomized for each individual to avoid order effects, with the exception of the reference item, which was presented first. We used the United States Department of Agriculture Food Composition Database (United States Department of Agriculture Agricultural Research Service, 2018 United States Department of Agriculture Agricultural Research Service. USDA Food Composition Database 2018. Available online: . Accessed March 19, 2018Crossref Partial Au1 ATL) to populate calorie information for each item for the amount of each ingredient used in build-your-own sandwiches offered at the sandwich counter of a national chain of food retailers (Gustafson & Zeballos, 2018).

The ingredient categories were displayed in the same order for every participant, which corresponded to the order of categories in Table 1. Finally, participants completed a survey containing demographic questions and self-reported anthropometric measures—each participant's height and weight—for calculating body mass index (BMI).

2.3. Statistical analysis

We analyze the data on the primary outcome of interest—the total number of calories ordered—using summary statistics, t-tests, and linear regression analysis. We additionally analyze demographic data and the pattern of ingredients ordered using chi-square tests. We first examine the similarity of the sample of respondents across the four conditions by testing for differences in the demographic and anthropometric variables across the four conditions with a chi-square test (for categorical variables) and pairwise *t*-test using the Bonferroni Correction for multiple comparisons (for numeric variables). Next, we examine mean differences in calories selected per condition using t-tests. We then conduct a series of linear regressions that add increasing control variables to evaluate the stability of parameter estimates for the condition variables, which are the focus of the research. In the first analysis, we regress the total number of calories ordered on condition variables only. We use *No Info* as the reference category and include variables for *Calorie Info*, *Max Ref*, and *Min Ref*. The second regression adds a binary variable for participants who were overweight or obese, *OverObese,* based on categorization of each individual's BMI. The third regression adds demographic variables, including *Female* (=1 if yes, 0 otherwise), *Age* (in years), *Income* (in $1000s), and *Education* (years). In the regressions, we log-transform the income variable, *Ln Income*, to account for skewness in the data. Finally, we examine the distribution of ingredient choices per ingredient category across the four conditions using a chi-square test to examine whether choice patterns change with the introduction of reference-based information. Data were analyzed using R (R Core Team, 2018). We consider p-values < 0.05 to be

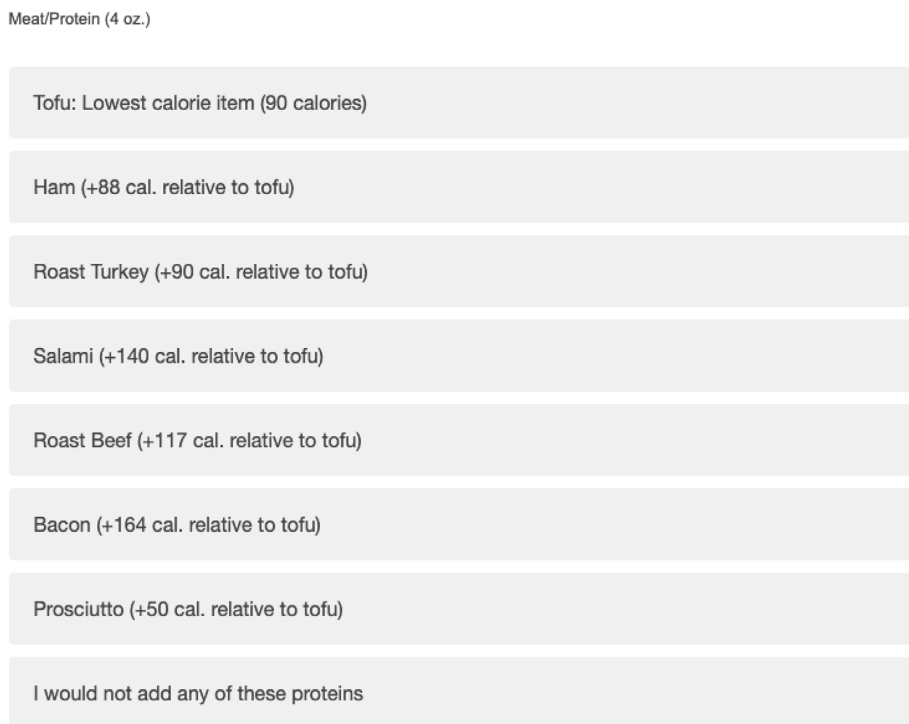

Fig. 1. Screenshot of the presentation of the meat/protein ingredient choice in the Min Ref condition.

statistically significant.

3. Results

We received surveys on sandwich choices from 686 individuals (out of 708 surveys that were initiated). An additional 53 participants did not provide responses to all survey questions used in the analysis. These participants were omitted from the analysis so that the sample of participants is stable across all analyses—however, the significance of the results do not change if all participants who reached the end of the survey are included. The final sample used in the analysis includes 633 participants. Table 2 presents summary statistics of demographic variables for the final sample (n = 633) and by condition. Chi-square tests of differences in proportions and pairwise t-tests of differences in mean values of participant characteristics in the different calorie labeling conditions identify only one significant difference across conditions for this set of variables. The proportion of overweight or obese individuals differs across conditions, with higher proportions of overweight or obese individuals in the Min Ref and Calorie Info conditions than in the Control and Max Ref conditions. We find no other significant differences in demographic variables among conditions. However, given the significant difference in Overweight/Obese and variation across conditions among the other variables, we control for the effect of these variables across conditions on calorie ordering in the sandwich choice task in our regressions to avoid confounding.

Fig. 2 displays the mean number of calories ordered in each condition. The mean number of calories ordered is 650.7 (*No Info*), 642.6 (*Calorie Info*), 615.7 (*Max Ref*), and 618.5 (*Min Ref*). The mean calories ordered in *Max Ref* and *No Info* are significantly different (p = 0.03) as are the differences in means between *Min Ref* and *No Info* (p = 0.02). The number of calories ordered in the *Max Ref* condition is 35 calories fewer than the *No Info* condition, representing a slightly more than five percent reduction (−5.4%; 95% CI [-1.9%, −8.9%]), while the calories ordered in the *Min Ref* condition are 32 calories fewer, or just under five percent lower (−4.95%; 95% CI [-1.5%, −8.4%]) than in *No Info*. These percentage changes were calculated by taking the difference between mean calories in the Max Ref (Min Ref) condition and the No Info condition divided by the number of calories in the No Info condition.

We use linear regression analysis to control for differences in participant characteristics across conditions in the analysis of total calories ordered. Table 3 presents results from the linear regression analyses. Relative to the omitted *No Info* condition, participants in the two reference conditions, *Max Ref* and *Min Ref*, consistently select

Table 2
Summary statistics of characteristics of participants in an online experiment about calorie labeling format with hypothetical sandwich choices.

	Pooled n = 633	No Info n = 156	Calorie Info n = 162	Max Ref n = 161	Min Ref n = 154
Female (1 = yes)	53%	56%	52%	58%	45%
Age (yrs.)[a]	37.1 ± 11.0	38.3 ± 11.5	38.5 ± 12.0	35.7 ± 9.9	35.9 ± 10.5
Income ($1000s)[a]	53.5 ± 36.5	56.8 ± 38.8	50.8 ± 35.7	54.2 ± 37.3	52.1 ± 33.9
Education (yrs.)[a]	14.8 ± 1.7	14.9 ± 1.7	14.7 ± 1.7	15.0 ± 1.8	14.7 ± 1.7
Overweight/Obese[b] (1 = yes)	58%	51%	59%	53%	69%

Source: Survey data from hypothetical sandwich choice survey conducted with Amazon Mechanical Turk.
Notes: The authors used the chi-square test for differences in proportions and pairwise t-tests using the Bonferroni Correction for multiple comparisons of continuous variables to examine differences in variables across conditions.
[a] Statistics reported are means and standard deviations.
[b] The chi-square test of the proportion of overweight/obese participants across conditions was significant with a p-value = 0.02.

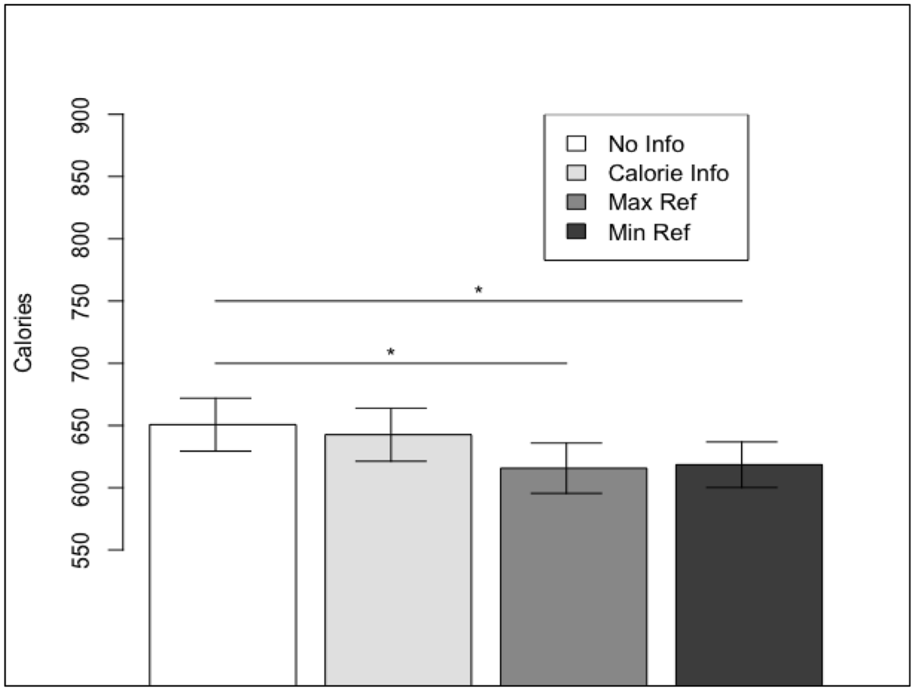

Fig. 2. Mean calories selected with 95 percent confidence intervals in hypothetical sandwich choice under different calorie labeling information conditions. Significant differences ($p < 0.05$) are indicated with an asterisk (*).

significantly fewer calories ($p < 0.04$). Across the three regressions, we estimate that participants in the *Max Ref* condition make choices that result in between 35.0 (95% CI [6.3, 63.9]) and 36.2 (95% CI [7.4, 65.0]) fewer calories than participants in the *No Info* condition. All estimates of *Max Ref* are significant at $p < 0.04$. The estimates are similar for *Min Ref*, ranging between 32.2 (95% CI [3.1, 61.3]) and 36.6 (95% CI [7.2, 66.0]) fewer calories than the *No Info* condition (all p-values are $p < 0.03$). Calorie information alone (in the *Calorie Info* condition) does not have a statistically significant effect on calories selected relative to the *No Info* condition. None of the demographic variables are estimated to have a significant effect on calories selected in the regressions.

Next, we examine how the ingredients selected vary across labeling conditions. The percentage of participants that selected an item in each condition is presented in Table 4. There is a general pattern of the distribution of choices in the *Max Ref* and *Min Ref* conditions having more mid-to low-calorie items chosen than in the *No Info* condition for every ingredient category except vegetables, though the modal ingredient selected is the same across conditions in four out of five ingredient categories.

Significant differences ($p < 0.05$) among conditions were found in the categories Cheese, Spread/dressing, and Bread. In each case the Max Ref and Min Ref conditions show a pattern of choices suggesting that participants exposed to that information presentation select mid or low-calorie items in lieu of the highest calorie items, resulting in a significant overall decrease in calories ordered. In the meat/protein ingredient category, nearly 40 percent of choices in the No Info condition were items with more than 200 calories. In Max Ref, the percentage of ingredients with more than 200 calories chosen was 33.7, while in Min Ref, it was only 25.5 percent. The percentage of choices in the 150–200 calorie range and below 150 calories were similar or higher in the Max Ref and Min Ref conditions than the No Info condition. The percentage of choices in the 150–200 calorie range were nearly identical in Max Ref (51.7 percent) and No Info (51.5 percent),

Table 3
Linear regression of calories ordered in a hypothetical sandwich choice on calorie labeling condition, weight status, and demographic variables.

Dep. var.: Calories Ordered	1: Regression with condition variables		2: Regression with condition and weight status variables		3: Regression with condition, weight status, and demographic variables	
	Est. (SE)	p-val.	Est. (SE)	p-val.	Est. (SE)	p-val.
Intercept	650.66 (10.45)	< 0.001	647.01 (11.79)	< 0.001	592.66 (83.18)	< 0.001
Calorie Info	−8.06 (14.65)	0.58	−8.58 (14.67)	0.56	−8.32 (14.67)	0.57
Max Ref	−34.98 (14.67)	0.02	−35.09 (14.68)	0.02	−36.20 (14.70)	0.01
Min Ref	−32.17 (14.83)	0.03	−33.42 (14.95)	0.03	−36.56 (15.02)	0.02
Overweight/Obese			7.13 (10.61)	0.67	8.41 (10.62)	0.43
Female					−10.39 (10.62)	0.33
Age (in years)					−0.71 (0.48)	0.14
Ln Income					12.63 (7.16)	0.08
Edu (in years)					−3.23 (3.06)	0.30
Adj. R2	0.008		0.008		0.013	
N	633		633		633	

Source: Data from the experiment.
Note: The omitted condition to prevent multicollinearity is the No Info control condition. The estimated parameters for other conditions—Calorie Info, Max Ref, and Min Ref—are in reference to the No Info condition.

Table 4
The percentage of each ingredient selected in the hypothetical sandwich choice task in every calorie information condition and the calories that each item added.

Ingredients	Calories	No Info	Calorie Info	Max Ref	Min Ref
Meat/protein	Cal.	% Ordered	% Ordered	% Ordered	% Ordered
Bacon	254	13.5	8.2	8.1	3.5
Salami	230	5.8	5.3	7.6	5.8
Roast Beef	207	20.5	15.9	18.0	16.2
Roast turkey	180	36.3	37.6	37.2	39.9
Ham	178	15.2	20.0	14.5	21.4
Prosciutto	140	2.9	6.5	6.4	7.5
Tofu	90	3.5	4.1	5.2	4.0
None	NA	2.3	2.4	2.0	1.7
Cheese	Cal.	% Ordered	% Ordered	% Ordered	% Ordered
Cheddar	115	25.7	18.8	12.8	14.5
Colby	112	5.3	3.5	5.8	6.9
Swiss	111	18.7	17.1	16.3	18.5
American	104	5.3	8.8	16.9	8.7
Provolone	98	26.3	35.3	23.8	21.4
Mozzarella	85	7.0	7.1	10.5	17.9
Light American	36	1.8	2.9	4.7	5.2
None	NA	9.8	6.5	9.3	6.9
Spread/dressing	Cal.	% Ordered	% Ordered	% Ordered	% Ordered
Mayonnaise	188	28.7	32.4	20.9	20.8
Olive oil	119	3.5	1.8	5.8	3.5
Light mayo.	71	15.8	8.8	15.1	13.3
Italian dressing	35	2.9	9.4	6.4	5.8
Balsamic vinegar	14	5.3	4.1	8.7	7.5
Dijon mustard	10	19.9	26.5	18.0	22.0
Yellow mustard	6	11.7	5.3	16.3	14.5
None	NA	12.3	11.8	8.7	11.6
Bread	Cal.	% Ordered	% Ordered	% Ordered	% Ordered
Croissant	406	11.1	8.8	5.8	6.4
Sourdough	319	23.4	18.2	22.1	15.0
Multigrain	265	32.7	37.6	36.0	44.5
Ciabatta	263	11.7	19.4	15.1	9.8
Bagel	250	4.1	1.8	5.2	7.5
Marble Rye	233	7.6	5.3	9.3	8.7
Gluten-free	222	5.8	5.9	1.0	6.4
None	NA	3.5	2.9	5.8	1.7
Vegetables	Cal.	% Ordered	% Ordered	% Ordered	% Ordered
Avocado	47	14.0	17.1	23.8	12.7
Red onion	11	9.9	7.1	12.8	10.4
Red pepper	8	2.3	4.1	5.2	1.7
Spinach	7	12.3	11.8	6.4	16.8
Tomato	5	15.2	15.9	15.7	17.3
Lettuce	4	36.3	35.3	27.3	29.5
Cucumber	3	2.9	3.5	2.9	5.8
None	NA	7.0	5.3	5.8	5.8

Source: Sandwich choice experiment.
Note: A Pearson's chi-square test of the patterns of choices within each ingredient was conducted for each category. Significant differences ($p < 0.05$) among conditions were found for Cheese, Spread/dressing, and Bread.

but were higher in the Min Ref condition (61.3 percent). The percentage of choices of items with less than 150 calories was higher in the Max Ref (13.6 percent) and Min Ref (13.2 percent) conditions than in the No Info condition (8.7 percent).

4. Discussion

This article provides evidence on a novel approach to calorie labeling: presenting information about the relative number of calories in each item with respect to a high or low-calorie reference item. We find that the two relative calorie conditions (*Max Ref* and *Min Ref*), which present calorie information in terms of the caloric trade-offs among different food items, result in statistically significant decreases in calories relative to the *No Info* condition (between 35.0 and 36.2 fewer calories in the *Max Ref* condition, and between 32.2 and 36.6 fewer calories in the *Min Ref* condition—a reduction in calories ordered of around five percent). The presentation of per-item calorie information—which occurred in the condition, *Calorie Info*—does not reduce the number of calories people selected, suggesting that the way in which calorie information is presented matters. These findings are robust across multiple analyses that include a variety of individual-specific variables that control for potentially confounding factors.

This work contributes to a growing literature on how the informational environment that FAFH customers face when making choices influences the healthfulness of choices. Evidence from this literature suggests that the way in which nutrition information is presented may play a key role in determining the effectiveness of the information. Liu, Roberto, Liu, and Brownell (2012) examined the effect of presenting calorie information in order from the lowest to highest calorie items—and a second condition in which low and high calorie options were highlighted using green and red text, respectively—versus a no-information condition and a condition in which calorie information was unordered. The results suggest that presenting ordered calorie information leads consumers to order fewer calories. Dallas, Liu, and Ubel (2019) studied the effect of placing calorie information before (that is, to the left of) food items on consumers' choices versus the standard approach of placing calorie information to the right and found that consumers who view calorie information before the food item order significantly fewer calories. Providing an updating account of the number of calories ordered in a sequential food choice promotes lower calorie selections in later rounds of choice by preventing underestimation of total calories selected (Gustafson & Zeballos, 2019).

This research adds to the existing literature by examining the effect of changing the presentation of calorie information on individuals' decisions about food made in a hypothetical choice context. An important effect of the *Max Ref* and *Min Ref* conditions is to allow individuals to easily discern differences in calories between two ingredients that they would normally have to calculate, which may be complicated by other demands on individuals' time and attention. Information that is easier to process has been found to facilitate identifying healthy foods when individuals face time constraints (Crosetto, Muller, & Ruffieux, 2016).

This research shares some features with an earlier study that examined whether consumption of calories could be reduced by offering diners an opportunity to reduce their calories by downsizing their order (Schwartz et al., 2012). While the study by Schwartz et al. (2012) explicitly invited customers to make this change, we explore the possibility of encouraging lower calorie choices through the presentation of calorie information itself. Previous research shows that the presentation of information can promote deeper reasoning when solving problems Hoover & Healy, 2017; Trémolière & De Neys, 2014). Altering the presentation of nutrition information to display calorie tradeoffs may likewise prompt individuals to consider the implications of those tradeoffs for their health. Prompts that focus people's attention on health when making a food decision have been shown to lead to healthier choices in both laboratory (Hare et al., 2011) and field (Gustafson, Kent, & Prate, 2018) settings, in part by speeding up the attendance to health attributes during the decision process (Lim, Penrod, Ha, Bruce, & Bruce, 2018; Sullivan, Hutcherson, Harris, & Rangel, 2015).

We selected the highest and lowest calorie items in each ingredient category to be references for the presentation of relative calorie information about other options. The examination of both reference points was motivated by the extensive literature on reference-dependent choice. Models of reference-dependent choice suggest that losses relative to the decision-maker's reference point are more influential than gains (see, e.g., Tversky & Kahneman, 1991). However, there is also research showing that when individuals are exposed to framed messaging, messages with gain frames are more effective at changing behavior than loss-framed messages (Gallagher & Updegraff, 2012). We do not find a difference between these two conditions, which may be due to the fact that the two reference items in each category—the highest calorie item in *Max Ref* and the lowest calorie item in *Min Ref*—were not necessarily the items that participants in those conditions would have chosen in the absence of calorie information. Choices of participants in the *No Info* condition support this idea. In the "Bread" category, just over 15 percent of participants in the *No Info* condition chose the highest or lowest calorie bread. Only in the "Spread/Dressing" category did the highest and lowest calorie items come close to constituting half of choices—just over 40 percent in this case—of participants' choices in *No Info*. Making the reference item specific to individuals might also increase the salience of the trade-off information presented to consumers. In this research, an individual in a reference condition whose preferred meat was turkey would have had to back-calculate the number of calories they would add or save by switching to an alternative meat/protein, which is as cognitively complex a task as calculating calorie differences from the total number of calories contained in each item. If customized relative calorie information is more salient, our results may provide a conservative estimate of the effect of framing calorie information. Additionally, the differences in *Max Ref* and *Min Ref* conditions may have been more pronounced had the calorie information highlighted changes in ingredients away from the participants' preferred ingredients.

While we find differences in the ingredients selected across conditions, there are notable similarities in patterns of ingredients chosen among the conditions. Even without the explicit provision of calorie information, many individuals will have a sense of the relative healthfulness of different items, which they may use in making their choices (Stewart, Hyman, & Dong, 2014). If one's estimates are accurate enough, receiving calorie counts for each item will not change an individual's choices because the count does not truly add information. For less precise estimates, access to information can provide more precision in understanding calorie tradeoffs between ingredients, which may have led some participants to substitute one ingredient for another. Choices made by participants who largely had accurate knowledge of the relative calories contained in ingredients available, but with some imprecision could explain the statistically significant estimates of the two conditions but the low adjusted R2 observed in the regressions reported in Table 3.

Current technologies offer the opportunity to customize calorie or other nutrition information based on individuals' initial choices in a variety of food retail—or even food at home—settings. While we look at a situation in which participants selected ingredients from different ingredient categories, the idea could be applied to other groupings of food items, such as main dishes, side dishes, and desserts, making this approach potentially applicable in any restaurant type. Employers, which have a vested interest in promoting their employees' health, that offer on-site food facilities may be particularly interested in adopting innovative approaches to promoting healthy food choices (Schröer, Haupt, & Pieper, 2014). Advances in technology have been adopted by many restaurants and food delivery services, allowing customers to order food by app, kiosk, or on a website. A digital ordering interface permits much more customization in the type of information presented, as well as how the information is presented. For instance, an app could take someone's initial choice and present how many calories could be saved by selecting a lower calorie ingredient or reducing the size of their order—a trade-off that a non-negligible portion of consumers might be willing to make. Schwartz et al. (2012) found that around one-third of diners in a field experiment accepted an offer to downsize their meals—without reducing their payment—in order to decrease the number of calories they consumed.

While we find consistently significant effects of calorie framing, our study does have some limitations. A chief limitation is that the choice task participants completed was hypothetical. Hypothetical bias has been extensively documented in economic valuation (see, e.g., Schmidt & Bijmolt, 2019), but we have not been able to find evidence of hypothetical bias when prices do not vary across options. If participants respond differently to information or other choice attributes in hypothetical and non-hypothetical situations, our results may not reflect what we would observe in a restaurant. However, there are some features of food choice that may counteract hypothetical bias. First, food choices tend to rely on habitual processes (Rangel, 2013). Processing anticipated taste information occurs quickly—faster than individuals process objective nutritional information about foods (Sullivan et al., 2015), though providing nutrition information accelerates integration of health information into decision-making (Lim et al., 2018). Prompting individuals to consider taste when making food choices results in choices that are no different from choices in a no-prompt condition, but choices when prompted to consider health do differ (Hare et al., 2011), suggesting that people quickly and naturally consider taste attributes in a way that does not occur with health attributes. Since participants were anonymous—no identifying information was collected—and completed the survey online, it is unlikely that motivations to appear responsible—a social desirability effect—or to please the researchers by intuiting and conforming to researchers' desired outcomes—researcher-demand effect—drove responses (Adams et al., 2005; Rand, 2011).

A second limitation of this study concerns the participant sample, which was drawn from workers on Amazon Mechanical Turk (mTurk). Though researchers have found that responses to demographic questions tend to be accurate (Rand, 2011), samples drawn from mTurk workers are unlikely to be representative of the overall US population. Samples drawn from mTurk tend to be younger and better educated than the US population (Simons & Chabris, 2012). Concerns have also been raised about the behavioral responses of mTurk samples (Goodman, Cryder, & Cheema, 2012). In a study comparing measures of personality characteristics, financial preferences, and general consumption behavior of a sample of mTurk respondents with those of students and the general public, researchers found that the choices made by the mTurk sample were more closely aligned with choices made by students. Though this study did not examine food choices, it found that the mTurk sample—and the student sample—were more likely to exhibit present-biased preferences—meaning that they are more likely give up a larger, delayed gain for a smaller, more temporally proximate gain if the smaller reward is to be received immediately, but not if both rewards are delayed—in the financial domain, which other research has established increases the likelihood that one is obese (Ikeda, Kang, & Ohtake, 2010). Finally, concerns have recently been raised about the quality of the responses obtained from mTurk. We used multiple approaches to ensure that participants were attending to questions. First, we removed incomplete surveys from the dataset. We also included a simple mathematical question in the survey to ensure that respondents were paying attention and eliminated participants who did not answer the question correctly. Lastly, we removed participants who completed the survey in under 2.5 min.

One area that future research could address is that we examine only one instance of food choice, while obesity results from a long-term imbalance in calories consumed and expended. Maintaining behavior change with respect to diet and exercise is a clear barrier to weight loss for many people. Without sustained behavior change, the study findings would not result in a meaningful change in weight status. However, in addition to providing a way to increase the salience of relative calorie information—by tailoring it to the individual's food consumption habits, for instance, technology may also present opportunities to sustain behavior change (Orji & Moffatt, 2018).

Future research should replicate this design within a real, incentivized choice setting and a more carefully targeted population. Extending the research to examine customized calorie or nutritional framing would provide important evidence about the effect of the salience of framed information on choices. This research could also examine the possibility of using calorie information framing to guide individuals to make less caloric choices by asymmetrically highlighting only items that would result in reducing the number of calories they order (and not presenting the number of calories they would add by choosing a more caloric item). Integration with personal technology—phone apps, for instance—would also provide data on the longer-term impacts of the presentation of relative calorie information on behavior.

We examine the effect of the framing of calorie information using reference items. The results show that presenting framed calorie information can guide people to order significantly fewer calories overall, resulting in an approximately 5 percent decrease in calories ordered. Given the increase in the percentage of the US population—as well as many other parts of the world—experiencing diet-related health problems, it is important to thoroughly consider options to encourage individuals to make healthier, lower-calorie food choices.

Declaration of competing interest

None.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.appet.2020.104727.

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