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Effects of calorie labelling and contextual factors on hypothetical coffee shop menu choices

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ABSTRACT

This study examined the effects of calorie labelling and two key contextual factors (reflective motivation and habits) on the calorie content of hypothetical coffee-shop menu choices. In one exploratory ($n = 70$) and one pre-registered ($n = 300$) laboratory study (Studies 1 and 2 respectively), participants viewed a hypothetical calorie-labelled or non calorie-labelled menuboard and selected their preferred item(s). Coffee shop drinking habits were measured using the Self-Report Habit Index, and reflective motivation (relating to calorie intake) was assessed with three items asking about watching weight, eating healthily, and reading calorie labels. In Study 2, participants also estimated calories contained in a subset of the menuboard drinks. Results of both studies showed that labelling did not significantly affect the total calorie content of items selected. However, in Study 2, as predicted, there was a trend toward moderation by reflective motivation ($p = .056$) with less motivated participants showing relatively greater calorie selection when exposed to labelling. Participants with weaker habits took longer to select items ($p = .002$) but, contrary to predictions, were not more influenced by labelling. Higher reflective motivation was associated with selecting fewer calories ($p = .002$), correctly recalling the presence/absence of labelling ($p = .016$) and better estimating calorie content ($p < .001$). Overall, participants significantly underestimated calories in higher calorie drinks but overestimated calories in lower calorie drinks. The results highlight the importance of contextual factors such as habits and reflective motivation for obesity interventions and are relevant for the UK's introduction of selective mandatory calorie labelling. In some instances, labelling may actually increase intake among those less motivated by health and weight concerns, but further research is needed to substantiate this concern.

1. General introduction

To help combat rising levels of obesity, some governments have mandated that retailers serving foods and drinks display calorie information. For example, in the USA, all chain restaurants with 20 or more locations are required by law to include calorie information on their menus. This became enforceable in 2018 though some US cities, counties and states had already passed their own legislation prior to this (Zlatevska, Neeumann & Dubelaar, 2018). A similar approach is being used in parts of Australia and Canada (Wellard-Cole et al., 2017; Moghimi & Wiktorowicz, 2019). In the UK, the government has also committed to the introduction of mandatory calorie labelling for businesses with more than 250 employees (DHSC, 2020).

The rationale behind the legislation tends to be two-fold. The first is that it prompts businesses to reformulate their products and menus to reduce their calorie content and provide a greater range of lower calorie options (Hawkes et al., 2015; Theis & Adams, 2019; Zlatevska, Neumann, & Dubelaar, 2018). The second is that the labelling provides the consumer with the information they need to enable them to make healthier choices (DHSC, 2020). This latter line of reasoning is supported by the fact that people often underestimate the numbers of calories contained in foods served outside the home (Bollinger, Leslie, & Sorensen, 2011; Petimar et al., 2019; Robertson & Lunn, 2020). Others have also suggested that calorie labelling may work by reminding the consumer about the importance of calories at the point at which they are making their choice (Bollinger et al., 2011).

However, evidence for the effects of calorie labelling on consumer behaviour has been mixed. A 2018 meta-analysis of three real-world randomised controlled trials of calorie labelling on restaurant menus showed a significant reduction of 47 kcal in energy purchased (an

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estimated reduction of 7.8%), though the authors rated the quality of evidence for these three studies as low (Crockett et al., 2018). The authors also conducted a meta-analysis of eight laboratory studies which showed a non-significant reduction in energy consumption of 50 kcal when foods were calorie labelled, but again the quality of evidence was rated as low. Another 2018 meta-analysis, that also included hypothetical as well as real choices, concluded that calorie labelling led to a reduction of 27 kcal in items selected (Zlatevska et al., 2018). More recently, four studies looking at hypothetical food purchases among US and UK participants found no overall effects of restaurant menu labelling on the total energy content of foods selected (Marty, Jones, & Robinson, 2020; Marty, Reed, Jones, & Robinson, 2021). Three real-world studies also found no effects of menu labelling on food purchased at a US fast-food restaurant chain (Petimar, Ramirez et al., 2019) or in UK worksite cafeterias (Vasiljevic et al., 2018; 2019). By contrast, another real-world study of three US fast-food restaurant chains found that menu labelling was associated with a significant reduction of 60 kcal (4%) per transaction, though this effect diminished over the course of the following year (Petimar, Zhang et al., 2019). In Ireland, a study examining real food choices made in a laboratory setting found that menu labelling reduced both the total number of calories ordered (by 93 kcal, 11%) and consumed (by 184 kcal; Robertson & Lunn, 2020).

These divergent results underscore the fact that the effects of any intervention will vary depending on factors relating to both the intervention context and the individual (Hawkes et al., 2015). A full understanding of these moderating factors is essential to ensure that interventions are both targeted and tailored to maximise their effects, as well as avoid inadvertently worsening health inequalities. Although there has been limited exploration of potential moderators of calorie labelling interventions (Crockett et al., 2018), a number of possible factors have emerged. For example, there is evidence to suggest labelling may be more effective for females, for those from higher socioeconomic backgrounds, and for those with excess weight (Bollinger et al., 2011; Feng & Fox, 2018; Marty, Reed, Jones and Robinson, under review; Petimar, Zhang et al., 2019; Sarink et al., 2016; Zlatevska et al., 2018). Effects may also be stronger at table-service restaurants and lunch-time meals (Bleich et al., 2017; Zlatevska et al., 2018). Additionally, effects may vary depending on label format and placement (Robertson & Lunn, 2020).

In the current studies, we extended previous research by using a hypothetical setting to examine the effects of calorie labelling in university coffee shops. In other words, outlets where the majority of sales are hot drinks rather than food. This is an important extension for several reasons. First, coffee shops represent one of the fastest growing sectors of the food service industry (Statista, 2021) and whilst some drinks (such as teas and black coffees) contain relatively few calories, other dairy-based, sweetened drinks contain considerably more (Starbucks, 2021). This, together with the fact that calories consumed in liquid form have weaker effects on satiation (Stribiţcaia, Evans, Gibbons, Blundell, & Sarkar, 2020), means coffee shops represent an important context within which people may regularly consume excess calories. Second, there is also evidence that whilst consumers may underestimate calories in foods, they may overestimate calories in drinks (Bollinger et al., 2011). As such, labelling that corrects this misperception could, in principle, lead people to compensate by increasing the number of calories purchased.

Two studies have specifically examined calorie labelling in coffee shops. An interrupted time series analysis conducted in the USA between 2008 and 2009 in the Starbucks chain found evidence that menu labelling led to a reduction in calories per transaction from 247 kcal to 232 kcal (6%). However, this change was the result of consumers changing their food rather than beverage choices (Bollinger et al., 2011). Another randomised controlled trial of labelling in a UK academic-hospital coffee shop likewise showed a significant reduction in purchases of high-calorie snacks but a non-significant reduction in purchases of high-calorie drinks. However, in this study calories were displayed on a separate sign rather than on a menu with prices (Allan, Johnston, & Campbell, 2015).

We also extended previous research by examining the moderating effects of two key contextual factors; habits and reflective motivation. Habits refer to a process in which encountering a specific situational cue triggers an impulse to enact a response due to cue-response associations learned through repeated performance (Gardner, 2015). In a choice scenario, habits may influence behaviour by leading to the automatic selection of one option from an array of alternatives (referred to as habitual selection or habitual instigation; Gardner, Phillips, & Judah, 2016). Eating behaviours have been shown to be influenced by habits (Verhoeven, Adriaanse, Evers, & de Ridder, 2012) and this may be especially the case for hot drinks consumed outside the home since they may be purchased frequently in similar settings. These types of habitual choices may be associated with reduced attention toward relevant information. For example, Verplanken, Aarts, and Van Knippenberg (1997) conducted a series of studies in which participants were asked to decide how to get to a particular destination. Those with stronger travel mode habits (such as use of a car) accessed less information about the journey before making their selection. Thus, in a similar manner, those with strong hot drinks purchasing habits may be less likely to attend to, and be influenced by, calorie labelling. As such, calorie labelling in coffee shops could have little effect on consumer behaviour. Nevertheless, effects could emerge over a longer period of time as younger people, who have yet to form strong habits, start to frequent coffee shops.

Reflective motivation refers to conscious brain processes, such as conscious goals, evaluations and decision making, that energise and direct behaviour (Michie, Van Stralen & West, 2011). As such, we would also expect reflective motivation to moderate the effects of calorie labelling interventions, with reduced calorie selection occurring among those who were motivated to limit their calorie intake.

2. Study 1 introduction

Study 1 was an exploratory study in which we examined the effects of both habits and reflective motivation to limit calorie intake on hypothetical purchases from a university coffee shop menu. Two key food choice motivations are weight control and healthy eating (Steptoe, Pollard, & Wardle, 1995). Given links between calorie intake and weight gain, as well as the increased calorie density of foods high in less healthy fats and sugars (Butland et al., 2007), we would expect those who are more concerned with weight control and healthy eating to be more motivated to limit their calorie intake. Thus, our measure of reflective motivation was designed to capture both these food choice motivations. We anticipated that participants who viewed the calorie labelled menu would select lower calorie items, with these effects being stronger among those with weaker habits and with higher reflective motivation to limit calorie intake.

3. Study 1 methods

3.1. Participants

A total of 70 participants (59 females, 11 males) aged 18–23 years ($M = 19.27$, $SD = 1.20$) were recruited for the study. The majority of these ($n = 61$) were first-year undergraduate students who responded to an online advertisement for research into 'coffee shop drinks choices' and took part in exchange for course credit. A smaller proportion ($n = 9$) were recruited via word of mouth and did not receive any incentives. The ethnic backgrounds of participants were Asian (64%), White (27%), Black (7%) and Mixed (1%) and 71% had English as their first language. The study received ethics approval from the City, University of London Psychology Department Research Ethics Committee.

3.2. Menu boards

All participants viewed a menuboard, displayed on a computer screen, that listed a range of items from a university coffee shop menu. These consisted of eight different coffees, two teas, and three hot chocolates, each in up to three different sizes. There were also two food items (croissant and Belgian chocolate brownie). Prices were displayed to the right of each item, under the corresponding size where relevant. In the calorie group the calorie content of each item was also displayed below the price in slightly smaller font; these values were drawn from information provided by a coffee shop franchise (Starbucks, 2021).

3.3. Measures

3.3.1. Drink selection

Before viewing the menuboard, participants were asked to imagine they were visiting a university coffee shop to buy a hot drink and to use the computer mouse to select their chosen item(s). The menuboard was then displayed. Items were highlighted when selected and could also be deselected. The item(s) selected were recorded as well as the length of time it took to select each item.

3.3.2. Reflective motivation for limiting calorie intake

This measure was designed to capture two key food choice motivations; weight control and healthy eating (Steptoe et al., 1995). These were reflected in two items that asked participants to rate the extent to which they agreed or disagreed with the following statements: *It is important to me to watch my weight*; *It is important to me to eat a healthy diet*. To increase the specificity of the measure, we also included an additional item: *I always read calorie labels on food and drink products*. Participants rated all three items on a 7-point scale, anchored by *Strongly disagree* and *Strongly agree* and these were summed to produce a total score from 3 to 21. Across both studies 1 and 2, this measure showed good internal reliability (with Cronbach's alphas of 0.73 and 0.71 respectively) as well as evidence of criterion validity (with both studies showing negative relationships with total calories selected).

3.3.3. Dieting status

This question asked participants to indicate whether or not they were currently dieting to lose weight. Dieting to lose weight usually means reducing calorie intake and can therefore be viewed as an indirect measure of motivation to limit calorie intake. However, if relatively small numbers of participants indicate they are dieting, this can lead to underpowered analyses. As such, this question was included as a secondary measure of reflective motivation only.

3.3.4. Habits

These were assessed using the Self-Report Habits Index (Verplanken & Orbell, 2003); participants indicated the extent to which they agreed with 12 statements relating to *Buying a hot drink from one of the university coffee shops*. For example, *Buying a hot drink from one of the university coffee shops is something I do automatically*. Each item was rated on a scale from 1 (*Strongly disagree*) to 7 (*Strongly agree*) and the questionnaire was scored by computing the total of the 12 items. Cronbach's alpha was 0.92 in the current study.

3.3.5. Body mass index (BMI)

Weight and height (without a coat, shoes or items in pockets) were measured by the researcher for the calculation of BMI, using medical grade weighing scales and height measure.

3.4. Procedure

A randomisation sequence was prepared by the first author using a 1:1 allocation ratio, a block size of 2 and stratification by gender. This sequence was used to assign participants to the calorie and no calorie groups upon arrival at the laboratory. Participants, but not researchers, were blind to group allocation. Participants were first seated in front of the computer's LCD display, which incorporated an eye tracker, and completed an eye-tracking calibration procedure. However, due to calibration difficulties across the sample these data were not used and are not reported here. Participants then completed the drink selection task and a second eye-tracking calibration procedure before being given a questionnaire pack where they reported on their age, gender, ethnic origin and first language, and completed the measures of reflective motivation and habits. Participants also provided estimates of calories contained in a subset of nine different drinks from the menuboard, but these are not reported here. Finally, the researcher measured their weight and height.

4. Study 1 results

4.1. Data screening

One participant (1%) from the no calorie group failed to select any items so was not included in the main analyses. All other participants selected a drink first and 30 participants (43%) also selected a croissant and/or brownie. Where participants selected more than one drink (n = 17, 24%) we included only the first drink selected since we assumed additional drinks may have been selected for friends. Two participants (3%) declined to say whether or not they were dieting and 12 (17%) declined to have their BMI measured. Mean total calorie content of items selected showed a bimodal distribution whilst habits showed a positive skew.

4.2. Participant characteristics

As shown in Table 1, participants were well-matched across the two conditions in terms of both demographic and psychological variables.

4.3. Exploratory analyses

Mean total calorie content of items selected was 502 (SD = 289) in the calorie condition and 473 (SD = 285) in the no calorie condition. Because this variable showed a bimodal distribution, a series of hierarchical bootstrap linear regression models (with 2000 bootstrap resamples) were used to explore effects. Calorie condition and dieting were each coded as 1, no calorie condition and not dieting as 0. Simple regressions showed no effects of condition ($b = 29$, $SE\ B = 68$, $\beta = 0.05$, $p = .68$), motivation ($b = -17$, $SE\ B = 9$, $\beta = -0.21$, $p = .08$), dieting ($b = -81$, $SE\ B = 80$, $\beta = -0.12$, $p = .32$) or BMI ($b = 2$, $SE\ B = 9$, $\beta = 0.03$, $p = .80$) on the total calorie content of items selected. For interaction effects, condition and the variable of interest were entered at step 1

Table 1
Characteristics of study participants as a function of condition.

Characteristic	Calorie (n = 35)	No calorie (n = 35)
Percentage females	83%	86%
Percentage White/Percentage Asian	23%/63%	31%/66%
Percentage first language English	74%	69%
Age in years (*M, SD*)	19 (1)	19 (1)
BMI (*M, SD*)[a]	22.01 (3.31)	23.48 (5.37)
Percentage dieting to lose weight[b]	29%	20%
Importance of watching weight on a scale of 1–7 (*M, SD*)	5 (2)	5 (2)
Importance of eating a healthy diet on a scale of 1–7 (*M, SD*)	5 (1)	5 (1)
Extent to which read calorie labels on a scale of 1–7 (*M, SD*)	3 (1)	3 (2)
Strength of habit on a scale of 12–84 (*M, SD*)	25 (14)	29 (14)

[a] n = 27 (calorie) and n = 31 (no calorie).
[b] n = 34 (calorie) and n = 34 (no calorie).

whilst the interaction term was entered at step 2. These showed a trend toward an interaction with habits ($b = -10$, $SE\ B = 5$, $\beta = -0.58$, $p = .056$[1]) but no interactions with motivation ($b = 25$, $SE\ B = 19$, $\beta = -0.62$, $p = .16$), dieting ($b = -26$, $SE\ B = 158$, $\beta = -0.03$, $p = .85$) or BMI ($b = -21$, $SE\ B = 23$, $\beta = -0.83$, $p = .34$). To explore the interaction with habits, a median split was applied to the habits variable to allow for two separate bootstrap regression models. In the weak habits group, calorie labelling was associated with a non-significant increase in total calorie content ($b = 137$, $SE\ B = 101$, $\beta = 0.24$, $p = .19$) whilst in the strong habits group calorie labelling was associated with a smaller, non-significant decrease in total calorie content ($b = -96$, $SE\ B = 102$, $\beta = -0.17$, $p = .34$). Further exploration with simple slopes analysis showed a similar pattern; at the 16th percentile for habits, calorie labelling showed a non-significant positive relationship with calories selected ($b = 172$, 95% CI [−22, 365]; $t = 1.77$. $p = .08$) whilst at the 84th percentile, it showed a non-significant negative relationship with calories selected ($b = -129$, 95% CI [−334, 76]; $t = 1.26$. $p = .21$). No statistically significant transition points were identified using the Johnson-Neyman technique (Hayes, 2013). Finally, Pearson's correlation with bootstrapping showed a non-significant negative correlation between habits and time taken to make the first drink selection ($r = -0.14$, $p = .24$).

5. Interim discussion

Contrary to our initial expectations, the total calorie content of items selected was not lower among those who had viewed the calorie menu, and those with weaker habits selected items that were (non-significantly) higher rather than lower in calories. Some research suggests that younger adults' food choices may be heavily influenced by factors such as taste, hunger satisfaction, or value for money (Brennan et al., 2020; Lems, Hilverda, Broerse, Dedding, 2018; see also; van der Heijden, Molder, Jager & Mulder, 2021, p. 105135). As such, we speculated that they may use calories as a marker for these which could result in calorie labelling *increasing* the calorie content of items selected.

6. Study 2 introduction

To follow up on the findings from Study 1, in Study 2 we collected data from a larger sample with hypotheses, methods and analyses that were pre-registered at https://osf.io/cj3qb. In light of findings from Study 1, we predicted that only those with weaker habits would show an effect of calorie labelling on behaviour and that here it would lead to the selection of higher-calorie items. Because habits can lead to a neglect of related information (Verplanken et al., 1997), we also predicted that those with stronger habits would be more likely to misreport seeing calorie information or report being unsure of whether there had been calorie information. Additionally, we predicted that there would be a negative correlation between habit strength and the length of time taken to make a selection.

In relation to reflective motivation, we predicted that those with higher reflective motivation for limiting calorie intake would be more likely to select items with a lower calorie content. We also predicted an interaction between calorie labelling and reflective motivation, with those with higher reflective motivation, who were exposed to calorie labels, selecting items with the lowest calorie content. Additionally, we predicted that those with lower reflective motivation would be more likely to misreport seeing calorie information or report being unsure of whether the menu had been calorie labelled, as this information would be less salient for this subgroup.

We also included several additional questions for the purpose of exploratory analyses. Previous research suggests that, outside the home, consumers tend to underestimate calories in foods but may overestimate calories in drinks (Bollinger et al., 2011; Petimar, Ramirez et al., 2019). Thus, we included questions to assess participants' accuracy at estimating the calorie content of a subset of drinks from the menuboard. These questions were also included to explore the suggestion that calorie labelling may help correct misperceptions around the calorie content of drinks served outside the home (Bollinger et al., 2011). Additionally, we included questions to explore the extent to which participants use hot drinks as a substitute for a meal. Given the increasing popularity of coffee shops (Statista, 2021), this may represent a growing trend that could have a detrimental effect on diet quality.

7. Study 2 methods

7.1. Sample size calculation

Using data collected in Study 1, we calculated that 270 participants would be needed to achieve 80% power to detect a significant effect of condition among participants with weak habits. This was based on a median split of the habit variable, the use of bootstrap regression, and the anticipation of both an effect size ($\beta = .24$) and distributional properties equivalent to those observed for the low-habit group from Study 1.

7.2. Participants

Because participants were recruited by several researchers simultaneously, it was not possible to stop recruitment at exactly 270 and the final sample comprised 300 participants (191 females, 108 males, 1 other) aged 18–58 years ($M = 21$, $SD = 5$), 82% of whom had English as a first language. Participants were recruited from November 2018 to February 2020 via flyers handed out around the university campus as well as a university online advertisement. They took part in exchange for course credit or 5 pounds sterling (approximately 7 US dollars). The study received ethics approval from the City, University of London Psychology Department Research Ethics Committee.

7.3. Menuboards

The menuboards consisted of an image of a local university coffee shop menuboard but with listings that had been edited in photoshop. These comprised eight different coffees, two teas and three hot chocolates each in up to three different sizes. There were also six food items: croissant, flapjack, Belgian chocolate brownie, blueberry muffin, triple chocolate muffin, banana. Prices were displayed to the right of each item, under the corresponding size where relevant. In the calorie group the calorie content of each item was displayed to the right of the price, in the same size font; these values were drawn from information provided by the local university coffee shop franchise.

7.4. Measures

Measures of *drink selection*, *reflective motivation for reading calorie labels*, *dieting status*, *habits* and *BMI* were the same as those used in Study 1 but with a number of adjustments. In the drink selection task, the wording was adjusted so participants were asked to imagine they were visiting a coffee shop 'tomorrow' and to imagine they were buying for themselves, not other people. In the Self-Report Habits Index, the wording was adjusted to refer to a 'coffee shop' (rather than a 'university coffee shop') to try to capture a wider range of relevant instances. Ten items in the Self-Report Habit Index were also adjusted to refer to 'selecting' (rather than 'buying') a hot drink to better specify the sub-action of interest (i.e. the decision-making process; Gardner et al., 2016). Cronbach's alpha for the Self-Report Habit Index was 0.90. Additional measures are detailed below.

[1] Because the bootstrap p value was close to the borderline of conventional significance, the precision of bootstrapping was increased by requesting 15,000 re-samples.

7.4.1. Calorie estimates

Participants estimated the number of calories contained in nine of the drinks that had been displayed on the menuboard.

7.4.2. Calorie information recall

Participants indicated whether or not the menu they had seen included calorie information (*Yes, No, I'm not sure*).

7.4.3. Hunger

Participants indicated how hungry they were on a 100-point sliding scale anchored by *Not at all hungry* and *Extremely hungry*. They also reported on the number of minutes since they last ate something and till they next ate something but these data were not subsequently analysed.

7.4.4. Meal replacement

Participants were asked whether or not they had ever had a hot drink (on its own or with a snack) instead of a regular meal, and if so, approximately how often they did this (*One every three months or less; Once a month; Once a week; 2–3 times a week; Every day*). They also indicated whether they had ever justified buying a hot drink (on its own or with a snack) intending to consume less later on.

7.5. Procedure

The majority of participants (71%) were tested alone in a laboratory setting, whilst the remainder (29%) were tested seated apart in a small computer room that accommodated up to six people. To ensure noise was kept to a minimum in the computer room, instructions were provided to participants on an individual basis before they entered the room. In both settings participants were seated in front of a computer where they answered questions on gender, age and first language. The software then randomised them to the calorie or no calorie condition, stratifying by gender, and they completed the drink selection task. After submission of their choice(s) they reported on the first thing they had clicked on the menu (*The drink I chose; A food item; Something I changed my mind about then 'unclicked'; I can't remember*). They then completed the measures of reflective motivation and habits before reporting on the frequency with which they bought a hot drink from a coffee shop, the type of drink they most often bought and whether there was a drink they often bought that had not been on the menu. Following this, all participants completed measures of calorie estimates, calorie information recall, hunger and meal replacement. Participants who were tested in the laboratory setting also had their weight and height measured after completing all the other measures.

8. Study 2 results

8.1. Data screening

A total of 20 participants (7%) selected either no drink or more than one drink. We felt these instances were likely to reflect errors or misunderstandings so, as per our pre-registration, these participants were excluded from all analyses relating to drink selection. For the reflective motivation scale, three participants (1%) had missing data for two items and these missing data points were replaced with the score from the other item. Three participants in the calorie group and six in the no calorie group (3% overall) declined to indicate whether or not they were dieting to lose weight. For the Self-Report Habits Index, 10 participants had missing data for two items and one participant had missing data for one item (4% overall). These missing data points were replaced by the mean of the remaining items. Two participants (1%) had missing data for the meal replacement questions. The calorie selection, habits and reflective motivation variables all showed significant deviations from normality with Kolmogorov-Smirnov and Shapiro-Wilk tests.

8.2. Participant characteristics

Table 2 shows the characteristics of participants included in the main analyses; they were well matched across the two conditions in terms of both demographic and psychological variables.

8.3. Confirmatory analyses

8.3.1. Effects of condition and habits on calories selected

Mean total calories selected were identical ($M = 553$ kcal) in both the calorie group ($SD = 358$) and the no calorie group ($SD = 360$). Bootstrap hierarchical linear regression (with 2000 re-samples) was used to examine the interaction between habits and condition on calories selected; condition was entered at step 1, habits at step 2 and the interaction term at step 3. Contrary to predictions, results showed no interaction between condition and habits ($b = 0$, $SE\ B = 3$, $\beta = 0$, $p = 1.00$).

8.3.2. Effect of habits on recall of calorie information

A total of 184 participants (nearly 2/3) correctly remembered the absence/presence of calorie information whilst 116 (over 1/3) reported being unsure or incorrectly remembered these details. Contrary to predictions, an independent *t*-test (with bootstrapping) found no significant difference in habit strength between these two groups; $M = 51$, $SD = 16$ and $M = 51$, $SD = 15$ for correct and incorrect respectively; $t(298) = 0.35$, $p = .73$. (In a deviation from our pre-registration, we also restricted this analysis to those in the calorie condition only and found similar results; $p = .83$.)

8.3.3. Effect of habits on speed of drink selection

As predicted, bootstrap Pearson's correlation (with 2000 re-samples) showed that those with weaker habits took significantly longer to select their first item from the menu; $r = -0.19$, $p = .002$. (In a deviation from our pre-registration, we additionally restricted this analysis to the 245 participants who confirmed that the first item they clicked on was the drink they chose. This showed a significant correlation of $r = -0.19$, $p = .004$.)

8.3.4. Main and moderating effects of reflective motivation on calories selected

We also used bootstrap hierarchical linear regression (with 2000 re-samples) to test predictions relating to reflective motivation; motivation was entered at step 1, condition at step 2 and the interaction term at step 3. As predicted, the higher a person's motivation, the fewer the calories they selected ($b = -18$, $SE\ B = 6$, $\beta = -0.20$, $p = .002$). In line with

Table 2
Characteristics of study participants as a function of condition.

Characteristic	Calorie (n = 141)	No calorie (n = 139)
Percentage females	65%	64%
Percentage first language English[a]	85%	77%
Age in years (*M, SD*)	22 (6)	21 (5)
Percentage dieting to lose weight[b]	33%	31%
Importance of watching weight on a scale of 1–7 (*M, SD*)[c]	5 (2)	5 (2)
Importance of eating a healthy diet on a scale of 1–7 (*M, SD*)[c]	5 (1)	5 (1)
Extent to which read calorie labels on a scale of 1–7 (*M, SD*)[c]	3 (2)	3 (2)
Strength of habit on a scale of 12–84 (*M, SD*)	52 (15)	51 (16)
Hunger on a scale of 0–100 (*M, SD*)[d]	39 (27)	40 (28)

[a] $n = 140$ (calorie) and $n = 138$ (no calorie).
[b] $n = 138$ (calorie) and $n = 133$ (no calorie).
[c] $n = 137, 138, 136$ respectively (no calorie) for the three reflective motivation items.
[d] $n = 138$ (no calorie) for hunger.

predictions, there was also a trend toward a significant interaction between motivation and condition ($b = -21$, $SE\ B = 11$, $\beta = -0.43$, $p = .056$[2]). To explore this, we used a median split on motivation and conducted two post-hoc bootstrap regression models where we regressed calorie selection on condition. In the high motivation group, participants who saw calorie labels selected items with fewer calories ($b = -64$, $SE\ B = 60$, $\beta = -0.09$, $p = .29$) whereas the reverse was true for those in the low motivation group ($b = 82$, $SE\ B = 63$, $\beta = 0.16$, $p = .175$). However, neither of these models were statistically significant. Further exploration with simple slopes analysis similarly showed that at the 84th percentile of motivation, calorie labelling showed a non-significant decrease in calories selected ($b = -89$, 95% CI [−216, 37]; $t = 1.39$. $p = .17$) whilst at the 16th percentile, calorie labelling showed a non-significant increase in calories selected ($b = 99$, 95% CI [−24, 221]; $t = 1.59$. $p = .11$). No statistically significant transition points were identified using the Johnson-Neyman technique (Hayes, 2013).

8.3.5. Effect of reflective motivation on recall of calorie information

As predicted, participants who correctly remembered the absence/presence of calorie labelling were higher in reflective motivation compared to those who incorrectly remembered these details or reported being unsure; $M = 14$, $SD = 4$ and $M = 13$, $SD = 4$ for correct and incorrect respectively; $t(298) = 2.52$, $p = .016$. (In a deviation from our pre-registration, we also restricted this analysis to those in the calorie condition only and found equivalent results; $p = .010$.)

8.4. Further exploratory analyses relating to calorie selection

8.4.1. Moderating effects of reflective motivation on calories selected across the whole data set

The bootstrap regression exploring reflective motivation was repeated using data from both Study 1 and Study 2 combined ($n = 349$) and this showed a significant interaction between motivation and condition ($b = -22$, $SE\ B = 10$, $\beta = -0.45$, $p = .023$). Using a median split on motivation, two further regression models showed that those who were lower in motivation selected significantly more calories when exposed to calorie labelling ($b = 127$, $SE\ B = 59$, $\beta = 0.18$, $p = .038$) whilst there was no evidence for an effect of calorie labelling among those who were higher in motivation ($b = -63$, $SE\ B = 48$, $\beta = 0.09$, $p = .18$). Similarly, the Johnson-Neyman technique (Hayes, 2013) indicated that calorie labelling significantly increased the number of calories selected when participants' score for motivation was below 8.9; this represented 13% of the sample (45 participants).

8.4.2. Main and moderating effects of gender, age, dieting status, BMI and hunger on calorie selected

BMI data were collected for 179 participants in Study 2 and ranged from 15.13 to 47.65 ($M = 23.44$, $SD = 4.91$). For gender, one individual selected 'Other' and was excluded from analysis of gender effects. A series of bootstrap linear regression models were used to explore effects of gender, age, dieting status, BMI and hunger on calorie selection. Male and dieting were coded as 1 and female and not dieting as 0. Simple regressions showed no effects of gender ($b = -17$, $SE\ B = 43$, $\beta = -0.02$, $p = .69$), dieting ($b = -15$, $SE\ B = 47$, $\beta = -0.02$, $p = .74$), BMI ($b = 4$, $SE\ B = 6$, $\beta = 0.06$, $p = .52$) or hunger ($b = 1$, $SE\ B = 1$, $\beta = 0.10$, $p = .13$) on the total calorie content of items selected. However, those who were older selected significantly fewer calories ($b = -7$, $SE\ B = 3$, $\beta = -0.12$, $p = .007$).

To explore whether the above variables moderated the effects of calorie labelling, condition (calorie = 1, no calorie = 0) and the interaction term between condition and the variable of interest were entered into steps 2 and 3 respectively of the above models. These showed no interactions with gender ($b = 49$, $SE\ B = 90$, $\beta = 0.05$, $p = .58$), age ($b = 6$, $SE\ B = 7$, $\beta = -0.20$, $p = .30$) dieting ($b = -32$, $SE\ B = 93$, $\beta = -0.03$, $p = .74$), BMI ($b = -9$, $SE\ B = 13$, $\beta = -0.30$, $p = .47$) or hunger ($b = 2$, $SE\ B = 2$, $\beta = 0.16$, $p = .20$).

8.4.3. Comparisons with the Self-Report Behavioural Automaticity Index

Following Gardner, Abraham, Lally, and de Bruijn (2012), we also used data from Study 2 to look at whether a 4-item subscale of the SRHI, the Self-Report Behavioural Automaticity Index (SRBAI), might better capture the cognitive component of habits we were most interested in. This subscale showed a Cronbach's alpha of .83 and, like the SHRI, was negatively correlated with time taken to select the first item ($r = -0.21$, $p = .001$). However, repeating confirmatory analyses using the SRBAI in place of the SRHI did not alter the pattern of any effects.

8.5. Exploratory analysis of calorie estimates, drink/food selection and meal replacement

8.5.1. Accuracy of calorie estimates

Table 3 shows the actual calories contained in nine drinks together with the mean estimates provided by participants in the calorie and no calorie conditions in Study 2. The drinks are arranged in order of ascending calorie content and show that, on average, participants tended to overestimate the calorie content of low-calorie drinks, such as espresso, tea and americano, but underestimate the calorie content of high calorie drinks, such as mocha and hot chocolate.

Mean estimate accuracy across the nine drinks was computed for each participant using the (unsigned) difference between their estimates and the actual drink calorie content. Spearman's correlations showed estimation accuracy was significantly higher among those who were older ($n = 300$, $r = -0.21$, $p < .001$), had a higher BMI ($n = 179$, $r = -0.25$, $p = .001$) and were more motivated ($n = 300$, $r = -0.24$, $p < .001$). A Mann-Whitney test also showed that those who reported dieting to lose weight were significantly more accurate than those who were not dieting ($n = 291$, $Mdn = 101$ and 112 respectively, $U = 10644$, $p = .032$). However, Mann-Whitney tests showed no significant differences in accuracy between participants in the calorie versus no calorie conditions ($n = 300$, $Mdn = 105$ and 111 respectively, $U = 10132$, $p = .14$) or between males and females ($n = 299$, $Mdn = 106$ and 110 respectively, $U = 10338$, $p = .97$).

8.5.2. Food and drink selection

In Study 2, the highest calorie drinks (hot chocolates and mochas) were selected by 51% of participants whilst the lowest calorie drinks (americanos, aspressos, macchiatos, ristrettos and teas) were selected by 19% of participants. A total of 56% of participants selected food. Of the 121 participants who selected one of the highest calorie drinks, 61% also selected food, while of the 52 participants who selected one of the lowest

Table 3
Calories contained in a range of different drinks and calorie content estimated by participants in the calorie (n = 150) and No calorie (n = 150) conditions.

Small drink with whole milk	Calories	Mean (*95% CI*) estimated calories: calorie condition	Mean (*95% CI*) estimated calories: no calorie condition
Espresso (single)	3	103 (78, 128)	102 (79, 126)
Tea with milk (12oz)	10	123 (102, 143)	123 (106, 139)
Americano (12oz)	27	136 (108, 165)	117 (101, 133)
Cappuccino (12oz)	163	177 (150, 204)	162 (145, 179)
Flat white (9oz)	196	153 (132, 175)	146 (128, 163)
Latte (12oz)	201	176 (154, 198)	182 (154, 210)
Mocha (12oz)	301	204 (176, 233)	191 (169, 212)
Hot chocolate (12 oz)	319	240 (211, 268)	246 (203, 288)
Hot chocolate with whipped cream and marshmallows (12oz)	466	344 (268, 421)	342 (273, 410)

[2] Because the bootstrap p value was close to the borderline of conventional significance, the precision of bootstrapping was increased by requesting 15,000 re-samples.

calorie drinks, 48% also selected food, $x^2(1) = 2.54$, $p = .11$. These proportions were similar when data were restricted to those in the calorie condition only; of the 63 participants who chose one of the highest calorie drinks, 65% also selected food, while of the 27 participants who chose one of the lowest calorie drinks, 48% also selected food, $x^2(1) = 2.26$, $p = .13$.

8.5.3. Meal replacement

A total of 71% of participants in Study 2 reported having previously had a hot drink (on its own or with a snack) instead of a regular meal, with 5% of participants reporting doing this on a daily basis, 13% 2–3 times a week and 21% once a week. A total of 40% of participants indicated that they had previously justified buying a hot drink (on its own or with a snack) by intending to consume less later on.

8.6. Protocol deviations

In the pre-registration we stated that where more than one drink was selected, we would include only the first drink selected. However, since the data did not allow us to identify the first item selected, we instead excluded these participants. We additionally excluded the five participants who failed to select a drink; a participant response we had not anticipated.

9. General discussion

The current studies found no overall effects of coffee shop menu-board calorie labelling on the calorie content of hypothetical items selected. This contrasts with previous reviews that have shown a small reduction in calorie selection with menu labelling (Crockett et al., 2018; Zlatevska et al., 2018). One reason for this difference may be because, unlike previous studies, the present studies examined effects in hypothetical outlets where most items were hot drinks rather than foods.

Nevertheless, the results of Study 2 found a significant association between reflective motivation to limit calorie intake and 1) correctly remembering the presence or absence of calorie labelling, 2) more accurately estimating the calorie content of drinks and, most importantly, 3) selecting items with a lower calorie content. The results also showed a trend toward moderation by reflective motivation, with those who were less motivated showing an increase in calorie selection when exposed to calorie labelling. When data were combined across Studies 1 and 2 this effect reached statistical significance. Given the exploratory nature of this latter analysis, it would be premature to draw any firm conclusions. Nevertheless, these results serve to highlight the fact that not everyone is consciously motivated to limit their calorie intake and we cannot rule out the possibility that, in some instances, calorie labelling may increase intake among those who are more motivated by, for example, value for money, hunger satisfaction, or immediate sensory pleasure. Such effects among those who suffer from food insecurity are of particular concern given the links between food insecurity and obesity (Nettle, Andrews, & Bateson, 2017).

Taken together, these results highlight the importance of considering contextual variables when thinking about the likely effects of menu calorie labelling, in terms of the intervention context as well as the underlying habits and reflective motivation of the target population. Further research is needed to explore these variables more fully; however this could attenuate the effectiveness of the UK Government's introduction of mandatory calorie labelling for businesses with more than 250 employees and should be considered as part of any evaluation of this policy.

Exploratory analysis of calorie estimates in Study 2 were partly consistent with research carried out in the US showing that participants tend to overestimate the calorie content of drinks (Bollinger et al., 2011). However, our results also suggested that this was only the case for lower calorie drinks; for drinks that were higher in calories (mochas and hot chocolates) participants tended to underestimate their calorie content in both the calorie and non-calorie groups. Importantly, these higher calorie drinks were popular among our sample, being selected by 51% of participants. There was also no evidence to suggest that correcting misperceptions about lower calorie drinks (via calorie labelling) led to compensation by participants; specifically, there was no evidence that participants in the calorie labelled condition who selected lower calorie drinks were more likely to also select a food item.

In line with habit theory (Gardner, 2015; Verplanken & Aarts, 1999), Study 2 showed that those who reported stronger coffee shop habits were significantly faster to select a drink. However, contrary to predictions, the effects of calorie labelling were not moderated by habit strength. In Study 1 we asked participants about 'buying' a drink which is arguably ambiguous with respect to the exact behaviour that is being habitually selected (deciding to go to a coffee shop versus selecting a drink versus ordering or paying for a drink). In Study 2 we tried to reduce this ambiguity with reference to 'selecting' a drink but lost the trend toward the interaction we found in Study 1. It is possible the trend in Study 1 was spurious. However, compared to participants in Study 1, participants in Study 2 were slightly older and had slightly stronger habits so it is possible moderation effects only emerge with very weak habits. Further research with a younger population would be helpful to explore this possibility. Effects may also be more likely to emerge in real world contexts where those with stronger habits may order items without even looking at a menu.

We also found no association between habit strength and the extent to which participants accurately recalled seeing calorie information. Whilst this fails to support previous research showing a neglect of information with strong habits (Verplanken et al., 1997), it is possible our recall measure was not sufficiently sensitive to capture effects. Asking participants about the calorie content of the drink they selected might be a better test of this hypothesis. Additionally, habit theory states that stronger habits can weaken the relationship between intentions and behaviour (Gardner, Lally, & Rebar, 2020); a larger sample size would make it possible to explore three-way interactions between labelling condition, habit strength and reflective motivation.

It is important to note that participants in the current studies were predominately university students aged between 18 and 25 years. Whilst this limits the extent to which results can be generalised to the rest of the population, it also represents an important demographic in terms of menu labelling interventions; younger people are more likely to have less established habits in relation to out-of-home food and drinks purchases so promoting the development of healthier habits could help sustain healthier eating over the longer term. The fact that 71% of participants in Study 2 reported using hot drinks and snacks as meal replacements could be a cause for concern, given such items are likely to have poorer nutritional content compared to a more conventional meal.

Finally, another important limitation of the research is that it assessed hypothetical rather than real item selection. In particular, in Study 2 participants were asked to imagine they were visiting a university coffee shop 'tomorrow'. We included this to try to ensure participants were thinking about the time of day they would typically visit a coffee shop. However, it may have prompted them to engage in more conscious decision-making processes which could have reduced the extent to which their choices were influenced by impulsive processes such as hunger or desire. Field studies are needed to more confidently determine the effects of calorie labelling on purchases, though inevitably such studies make it more difficult to explore the psychological process that may moderate or mediate effects.

Author contributions

KT, KM and KY were responsible for study conceptualisation and all authors contributed to study design. KT took the lead on the development of study materials, supervised data collection, took the lead on data analysis and interpretation and wrote the first draft of the manuscript. KY contributed to the development of study materials, data

curation, data analysis and data interpretation. SF contributed to the development of study materials and to data curation. All authors contributed to the final version of the manuscript.

Ethics statement

The research received ethics approval from the City, University of London Psychology Department Research Ethics Committee: PSYETH (U/L) 17/18 20; ETH 1920-0616. All participants gave informed consent before taking part.

Author note

Stephanie Farrar is now at the School of Psychology, Glasgow University.

Study 2 was pre-registered at https://osf.io/cj3qb.

Declaration of competing interest

None.

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