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Comparing the impact of feedback on excess calories and physical activity calorie equivalent (PACE) information on consumer behaviour in an online hypothetical restaurant setting

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ABSTRACT

Information provision interventions to improve nutrition in the out-of-home food sector include providing calorie information at point of choice. Supplementary approaches also include providing feedback on physical activity calorie equivalent information (PACE) and/or the extent to which food orders exceed calorie guidelines. However, minimal research has compared the impact these different supplementary approaches have on consumer behaviour. Our aims were to compare the effects of feedback on excess calories ordered, different types of PACE related feedback on decisions to change orders, calories purchased, and calories ordered in a hypothetical online restaurant setting. In an online randomised controlled trial participants (N = 1546) were allocated to receive a restaurant menu with (i) no calorie information on individual menu items, but overall feedback on excess calories ordered (>600 kcals); (ii) calorie information on individual items and feedback on excess calories; (iii) calorie information on individual items and non-specific PACE feedback; (iv) calorie information and personalised PACE feedback based on individual body weight. Outcomes were number of calories ordered after any feedback, and any decision to change items selected after receiving feedback. Receiving feedback on excess calories or exercise required to burn excess calories did not significantly impact the total number of calories purchased. There was some evidence to suggest that presence of feedback on total excess calories without previously seeing the calorie content of individual menu items increased likelihood of participants changing their order. Overall, these findings suggest limited evidence that information provision of feedback on excess calories in different forms has an impact on consumer behaviour in a hypothetical setting.

1. Introduction

Eating food prepared out of home (OOH) is becoming more common in the UK. Recent estimates suggest approximately 60 % of the UK population eat food from takeaways, restaurants or cafés at least once per week. Food consumed out of the home contributes to approximately 11 % of total energy intake within the UK (Garbutt et al., 2025). This eating pattern contributes substantially to typical energy intake, as food prepared, and eaten OOH is often highly calorific. For instance, estimates of over 13,000 possible main meals available in UK chain restaurants found only 9 % met public health recommendations for calorie content of lunch/evening meals (<600 kcals: Robinson et al., 2018), with the average main meal containing 977 calories (similar estimates have been reported across other countries (Roberts et al., 2018)). The estimated energy content of supplements to a main meal such as starters, sides and desserts (Muc et al., 2019), as well as food consumed on-the-go (e.g. snacks purchased from supermarkets and coffee shops: Marty et al., 2021) is also often high in energy. Consistent with these observations, increased frequency of OOH eating is associated with poor diet, weight gain, and prevalence of overweight or obesity (Bes-Rastrollo et al., 2010; Bezerra et al., 2012; Kant et al., 2015).

In order to reduce the impact of over-eating via OOH consumption and improve population health, a number of information provision interventions, focused on nutrition labelling, have been developed for the OOH eating sector. Two related approaches are calorie labelling and physical activity calorie equivalent (PACE) labelling. Calorie labelling

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requires the number of calories in individual food/drink items to be provided per portion, usually at point-of-choice, such as on a menu-board or food displays (Kaur et al., 2022). Multiple experimental and field studies have examined the effects of calorie labels on food choice and consumption, and a recent updated Cochrane review demonstrated that the presence of calorie information leads to a modest 1.8 % reduction in calories selected, and 5.9 % consumed (Clarke et al., 2025). In England, mandatory calorie labelling for large businesses in the OOH food sector came into force in April 2022. However, a recent evaluation of the impact of this policy found the introduction of calorie information in large businesses did not significantly impact purchasing or consumption behaviour (Polden et al., 2025). A potential factor impeding the effectiveness of calorie labelling is the poor understanding of calories for individuals' typical nutritional needs, and the relationship between exercise and energy balance (Bleich & Pollack, 2010). Indeed, researchers have suggested that, alone, labelling may not be effective because (i) simply providing 'the number of calories' is hard to understand and interpret (Iris et al., 2023), (ii) calorie counting is burdensome and can be overwhelming (Guth, 2018), and (iii) many individuals do not notice displayed calorie information (Polden et al., 2025).

Physical activity calorie equivalence (PACE) information extends calorie labelling by providing an interpretation of the calories as the amount of physical activity required to 'burn off' energy content of food items consumed. For instance, '*the calories in this chocolate bar require 50 min of walking to burn off*' (see Daley et al., 2023). Given calorie contents are poorly estimated by the general public (Polden et al., 2025), PACE information has been proposed as a useful alternative to help understand energy requirements and balance, when making purchase and consumption decisions. Individual studies have demonstrated that presentation of PACE information in either minutes of exercise or miles of walking effectively reduces calories selected, compared to the absence of information (Dowray et al., 2013). A recent meta-analysis of 14 studies demonstrated that PACE information is associated with a reduction of approximately 103 [95 % CI: 48 to 159] calories selected when compared to no labelling (A. J. Daley et al., 2020). However, PACE labelling and calorie labelling only were not significantly different for the number of calories selected (reduction of 67 [95 % CI: −28 to 163] calories, see also (Seyedhamzeh et al., 2018)).

There are multiple gaps in the evidence base which warrant further investigation. First, much of the experimental research presents calorie and PACE information related to individual menu items such as snack foods and beverages, rather than meals (e.g., (Masic et al., 2017). Some studies have applied calorie and/or PACE to restaurant meal items but did not find any evidence they affect ordering behaviour (Droms Hatch, 2015; Oh et al., 2021; Platkin et al., 2014). A small number of studies have also included a 'calorie counter' for total calories ordered, but evidence for the effectiveness on reducing ordering is equivocal (VanEpps et al., 2021; Tanasache et al., 2025). However, when calorie or PACE information has been applied to meals, it does not account for typical energy guidelines/requirements and is applied to total calories of the meal (Dowray et al., 2013), rather than 'excessive calories' – i.e., calories in excess of public health calorie guidance. Furthermore, there have been no studies to our knowledge that have examined the extent to which presenting feedback on total calories selected or PACE information result in consumers changing behaviour at the point of order/-purchase (i.e., changing original order in response to feedback). Finally, PACE information is often based on an 'average' adult (~70kgs/160 pounds) and qualitative reports suggest individuals may not find this personally applicable (Swartz et al., 2013), which may reduce its effectiveness. Researchers have suggested that ' … *it may be useful to provide PACE information to account for variation in individual characteristics, for example according to both a high and lower body weight*' (Daley & Bleich, 2021, p. 3). As such, personalised PACE information may be more effective, and recent systematic reviews support the greater effectiveness of nutrition advice with a personalised component (Jinnette et al., 2021).

Therefore, the aim of this study was to compare different methods of PACE information (non-specific PACE information based on the average adult's body weight (~70 kgs) and personalised PACE based on participants' body weight) and calorie information against no calorie information in a hypothetical online restaurant design. We applied calorie and PACE feedback to 'excess' calories only, based on UK public health guidance of 600 calories per evening meal. Our a-priori pre-registered hypotheses (see https://osf.io/482bg/registrations) were that,

H1a. Calorie information and feedback on excess calories would reduce calories ordered compared to No calorie information and feedback on excess calories;

H1b. PACE feedback would reduce calories ordered compared to feedback on excess calories only;

H1c. Personalised PACE feedback (related to the individual's body weight) would reduce calories ordered compared to non-specific (related to average body weight) PACE feedback;

H2a-c. We expected the same pattern of findings when examining whether people would change their order in response to feedback on excess calories / PACE.

2. Methods

2.1. Participants

Participants were recruited from the local community and the crowdsourcing platform Prolific (Palan and Schitter, 2018). Inclusion criteria were aged 18+, with no current or historical diagnosis of an eating disorder, a resident of the UK, fluent English speaker, and can complete the study on a laptop or desktop. We excluded individuals who were taking part in a fast or other restrictive eating for religious reasons, and who were currently dieting for other reasons, including vegan and vegetarian diets, in line with our previous studies (Jones, Gough, & Robinson, 2024; Marty et al., 2020). We used prolific demographic screeners to obtain a sample closely representative of the UK population, but also to ensure high quality data (approval rates >95 %).

Our a-priori power calculation required a sample size of 1,520, which would power us to detect a main effect in an ANOVA with 99 % power, and to detect small (d = .20) between group contrasts (specifically between non-specific and personalised PACE with 80 % power). We chose a small effect as something that might be theoretically or practically meaningful, in the absence of any existing information. One-thousand, five-hundred and forty-six participants completed the study. The final sample had a mean age of 42.26 years (Standard Deviation: 16.70: min = 18, max = 81), with average BMI = 27.67 (Standard Deviation = 8.44: N = 36 (2.4 %) underweight, N = 651 (43.7 %) normal weight, N = 436 (29.2 %) overweight, N = 369 (24.7 %) with obesity). These demographics are reflective of the UK population (National Health Service [NHS], 2022; Office for National Statistics, 2021). Full breakdown of participant demographics, split by experimental group, can be seen in Table 1.

2.2. Materials

2.2.1. Online restaurant task (Jones, Gough, & Robinson, 2024)

The online restaurant paradigm was similar to our previous work examining the presence vs absence of calorie labels. Participants were presented with a restaurant home page in which they could choose from starters, mains, desserts and drinks, by clicking one of four images (see online supplementary materials). In the middle of the home page the participants were informed of the number of each dish they had ordered (e.g. 1 starter, 1 main, 0 dessert). Menu items, descriptions, prices and calorie information were based on popular UK restaurant menus with small changes to avoid any familiarity (e.g. changes to descriptions and price). There were 8 options for starters (calorie range 247–764), 8 for

Table 1
Demographic information split by experimental groups.

	Calorie (no labell)	Calorie (labelling)	Non-specific PACE	Personalised PACE
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Age	43.24 (16.52)	42.04 (16.34)	42.91 (16.68)	40.96 (17.00)
Eq. Income (£)	30,756 (26,705)	28,459 (20,331)	27,865 (26,539)	30,090 (26,155)
BMI	28.10 (8.69)	27.30 (8.25)	27.95 (8.29)	27.33 (8.52)
Dietary Restraint	2.35 (1.50)	2.22 (1.43)	2.41 (1.61)	2.50 (1.52)
Shape Evaluation	3.22 (1.98)	3.11 (1.88)	3.35 (1.99)	3.31 (2.02)
Body Dissatisfaction	3.54 (1.96)	3.53 (1.89)	3.63 (2.02)	3.62 (2.04)
Motives (healthy food)	5.12 (1.34)	5.00 (1.28)	5.00 (1.28)	5.08 (1.33)
Motives (weight control)	4.42 (1.54)	4.23 (1.53)	4.30 (1.58)	4.84 (1.53)
	N (%)	N (%)	N (%)	N (%)
Gender: Male	185 (25.8 %)	186 (26.0 %)	175 (24.3 %)	169 (23.9 %)
Gender: Female	208 (25.2 %)	211 (25.6 %)	205 (24.9 %)	199 (24.3 %)
Education: Below Degree	186 (25.9 %)	195 (27.2 %)	171 (23.8 %)	166 (23.1 %)
Education: Degree +	210 (25.4 %)	204 (24.6 %)	210 (25.4 %)	204 (24.6 %)
Eating out: Weekly	90 (27.8 %)	93 (28.7 %)	87 (26.9 %)	54 (16.6 %)
Eating out: Less than	306 (24.8 %)	316 (25.7 %)	294 (23.9 %)	316 (25.6 %)

Legend: BMI = Body mass index.

Table 2
Number of participants in each experimental group who decided to change order following feedback.

	Did not change order	Changed order
Calorie feedback (no labelling)	296 (74.8 %)	100 (25.2 %)
Calorie feedback (item labelling)	355 (89.0 %)	44 (11.0 %)
Non-Specific PACE (item labelling)	305 (80.1 %)	76 (19.9 %)
Personalised PACE (item labelling)	306 (82.7 %)	64 (17.3 %)

mains (calorie range 544–980), 4 for desserts (calorie range 387–761), 22 for soft drinks (calorie range 0–423), and 43 alcoholic drinks (calorie range 70–634). For a visualisation of the task and full list of menu options see supplementary materials (Supplementary Fig. 1, and Supplementary Table 1).

Participants could select as many options as they liked and were asked to confirm each selection ('Are you sure you would like to order this?'). Once completed, participants navigated back to the home page to see the number of items/dishes they ordered and then clicked to place their order. Following completion of the order, participants were given feedback on excess calories/PACE based on their experimental group (see Procedure), and given the opportunity to change their order or not ('Would you like to change your order? Yes/No'). Participants were only permitted to change their order once.

2.2.2. *Brief eating disorder examination questionnaire (Jenkins & Davey, 2020)*

The Brief Eating Disorder examination questionnaire is a 7-item Likert style questionnaire which assesses three factors (dietary restraint, body dissatisfaction, shape/weight overevaluation), with items such as 'Has your weight influenced how you think about (judge) yourself as a person?'). The subscales had good internal reliability (~Ω = .89).

2.2.3. *Health motives (Robinson et al., 2022)*

Participants were asked two questions related to health motives ('It is important to me that the food I eat on a typical day is healthy', and 'It is important to me that the food I eat on a typical day helps me control my weight'), on a 7-point Likert scale from 1 (Not at all important) to 7 (Very important).

2.3. *Procedure*

The experiment was hosted online via Inquisit web v.6 (Millisecond Software, Seattle, MA). Upon clicking a hyper-link, participants were taken to an information sheet and confirmed their consent. They then provided demographic information, including: age (years), gender (male, female, non-binary, other), highest completed education level completed (No formal education, GCSE/Equivalent, A-Level/Equivalent, Degree/Equivalent, Higher Degree (MSc/PhD)/Equivalent), household income and composition (to calculate equivalised household income), frequency of eating in sit-down/table service restaurants per month (Never/almost never, Less than once, Once or twice, Weekly/almost weekly, Multiple times per week), and height and weight (to calculate BMI). An explicit attention check item was included ('What planet do you live on?'), which 4 participants failed (<1 % of data). We opted to retain their data in analyses presented below as removal did not impact the findings and evidence suggests removal of individuals who fail these checks reduces generalisability (Jones, Gillespie, et al., 2024).

Following the demographic questionnaire, all participants were given information regarding an ongoing UK public health campaign called 'One You' (UK Health Security Agency, 2016). The 'One You' campaign encourages adults to consume no more than 400 calories for breakfast, 600 calories for lunch and 600 calories for dinner, alongside some healthy snacks, to aim for daily calorie intake of ~2000/2500 calories. The campaign is part of the UK government's wider obesity strategy, to help individuals be more calorie aware. No other information was presented during this time to ensure participant's attention to the 'One You' messaging. They were then asked to imagine they were eating out for dinner in a restaurant at 7pm on a Saturday evening, and to order for only themselves in the subsequent menu.

Before they ordered they were randomised to one of four experimental groups.

2.3.1. *Calorie feedback (no labelling)*

Participants were given no information about what feedback they would receive prior to seeing the menu and did not see any calorie information for the dishes on the menu. However, they received information on the number of calories they ordered in comparison with the One You campaign ('*Once you have ordered we will tell you how many calories (if any) you have ordered over the guidelines*') after their order. They received feedback such as '*You ordered 1284 calories, which is 684 calories over the 600 recommended*'.

2.3.2. *Calorie feedback (item labelling)*

All individual menu items had calorie information. Participants were told they would receive information on the number of calories they ordered in comparison with the One You campaign *before* making their order. They received the same feedback as the calorie feedback (no labelling) group above.

2.3.3. *Non-specific PACE feedback (item labelling)*

All individual menu items had calorie information. Participants were told they would receive information on the number of minutes of exercise required (if any) that the *average* person would need to do to burn off calories ordered over the guidelines ('*Once you have ordered we will provide you with some information about how much exercise the average person would need to do to burn excess calories … '*). To calculate non-specific PACE information, we used similar formulas of ~3.65 calories per minute of walking, and 12.9 per minute of running taken from previous studies (Swartz et al., 2013), based on the 'average' adult. For an order of 1284 calories the feedback would be '*You ordered a total of 1284*[1] *calories which is 684 over the 600 recommended. You would need to brisk walk for 187 min or run for 53 min to burn off the additional calories*).

2.3.4. Personalised PACE feedback (item labelling)

All individual menu items had calorie information. Participants were told they would receive information on the number of minutes exercise they would need to do based on their body weight ('*Once you have ordered we will provide you with some information about how much exercise you would need to do, based on your body weight, to burn excess calories …* '). To calculate personalised PACE information, we used the metabolic equivalent of task (Jetté et al., 1990) for walking (5) and jogging (8.8) and multiplied these by the participant's weight in kilograms to provide personalised information (e.g., a participant with a weight of 85kgs, who originally ordered 1284 calories would be informed '*You ordered a total of 1284*[1] *calories which is 684 over the 600 recommended. Based on your body weight you would need to brisk walk for 97 min or run for 55 min to burn off the additional calories*').

Following the order and calorie/PACE feedback, participants were given the opportunity to change their order, and if they decided to change their order, they were reminded of the 'One You' campaign and their menu choices were reset.

After finalising their order, participants were asked to recall the name of the public health initiative ('Earlier on we provided you with some information about a public health initiative. What was the name of this initiative?) with four possible options. The majority of participants (N = 1288/83 %) correctly recalled this, and we conducted sensitivity analyses by removing participants who failed (as a proxy attention check). They were also asked whether their menu choices were influenced by the calorie and exercise labelling (Yes/No) and how this information influenced their choices ('How did this information make you feel about your choices?') which was open ended (not analysed). They were given a funnelled debrief, where they were asked to write a few sentences about what they thought the study was about. Other measures were taken around body satisfaction and dietary restraint at the end of the study as part of undergraduate research projects for teaching purposes; these are not reported here but described in the data sheet on OSF.

2.4. Data reduction and analysis

Data reduction and analyses were conducted in R/Studio using the following packages: 'tidyverse', 'janitor', 'psych', 'epitools' 'ggstatsplot'. All analysis scripts and raw data are hosted on the Open Science Framework (https://osf.io/482bg). For computing demographics, 39 participants were removed due to implausible BMI values (BMI <14 or > BMI 70: (Booth et al., 2013). To simplify demographic reporting, we grouped education as below degree level (vs degree or above) and regularity of eating out as less than once per month (vs once or greater than once per month).

In line with our pre-registration, we examined boxplots separately for each group to determine any outlying orders (N = 3). We also removed the fastest 5 % of orders on the menu task (removing 76 individuals who ordered in less than 27 s: median order time = 65 s), in line with our previous studies (Jones, Gough, & Robinson, 2024). For our primary analyses we also computed a Bayes Factor (BF10) indicating support for the alternative vs the null hypotheses.

Our primary outcomes were the final number of calories ordered after calorie/PACE feedback; and the decision to change an order based on calorie/PACE feedback. We conducted exploratory analyses on group differences in ordering behaviour prior to the groups receiving feedback, to determine whether presence of calorie labelling (item information) vs not impacted initial ordering. We also descriptively examined the magnitude of the order change in those that did change their order and examined a subset of participants who reported being influenced by calorie information. We conducted exploratory analyses where we included scores on health motives questions and the Brief eating disorders examination scale as covariates in our primary model, however this did not change any findings (models reported in supplementary online materials). Finally, we used binary logistic regression to examine whether any demographic variables (as noted in Table 1) predicted the likelihood of an individual changing their order vs not, after adjusting for experimental group.

3. Results

Participant demographics are shown in Table 1. Based on the available demographics our sample was broadly representative of the UK population.

3.1. Does feedback on excess calories/PACE influence the number of calories ordered?

An ANCOVA with the covariate of BMI demonstrated no significant main effect of group on the final number of calories ordered (F (3, 1483) = 1.46, p = .223, eta^2 = .00: see Fig. 1). Bayes factor demonstrated strong support for the null hypothesis (BF10 = .001). Removal of the covariate did not influence findings (F (3,1537) = 1.75, p = .155, eta^2 = .00). Similarly, removing participants who failed the attention check (F (3, 1471) = 1.44, p = .228, eta^2 = .00), who failed to correctly recall the name of the public health initiative (F (3, 1254) = .95, p = .415, eta^2 = .00), or who were fast orderers (F (3, 1403) = 1.24, p = .293, eta^2 = .00) did not substantially influence findings. Finally, inclusion of gender as a main effect and interaction with experimental group demonstrated that males ordered significantly more calories than females (1680 vs 1585, d = −.18 [95 % CI: −.08 to −.28], p = .048), but there was no interaction with experimental group.

3.2. Does calorie/PACE information influence the decision to change order (Table 2)?

A chi-squared test was statistically significant (X^2 (3) = 27.77, p < .001). Bonferroni pairwise comparisons were conducted to examine differences between groups. There was a significant difference between calorie feedback with vs. without item labelling (OR = 2.71 [99 % CI: 1.65 to 4.59] p < .001), indicating a significantly greater number of decisions to change the order in the no labelling, compared to the item labelling group.

There was also a significant difference between calorie feedback with item labelling and general PACE feedback (OR = .50 [99 % CI: .29 to .84], p = .005), indicating significantly fewer number of decisions to change the order in the calorie labelling group compared to the general PACE information group.

There were no significant differences between calorie feedback and no labelling and non-specific PACE (p = .557) or personalised PACE (p = .057), or between non-specific and specific PACE (p = 1.00), or between calorie feedback with labelling and personalised PACE (p = .099).

The majority of participants (94 %) who opted to change their order following calorie/PACE feedback reduced the number of calories they ordered. The average calorie reduction was −585 calories (Standard Deviation: 427). The differences between groups were descriptively very similar (Calorie feedback (no labelling) = −543 kcals; Calorie feedback (item labelling) = −565 kcals; Non-specific PACE (item labelling) = −596 kcals; Personalised PACE (item labelling) = −653 kcals).

[1] This would be an order from the menu of a starter of butterfly prawns (375 calories) and a main of steak fajitas (909 calories).

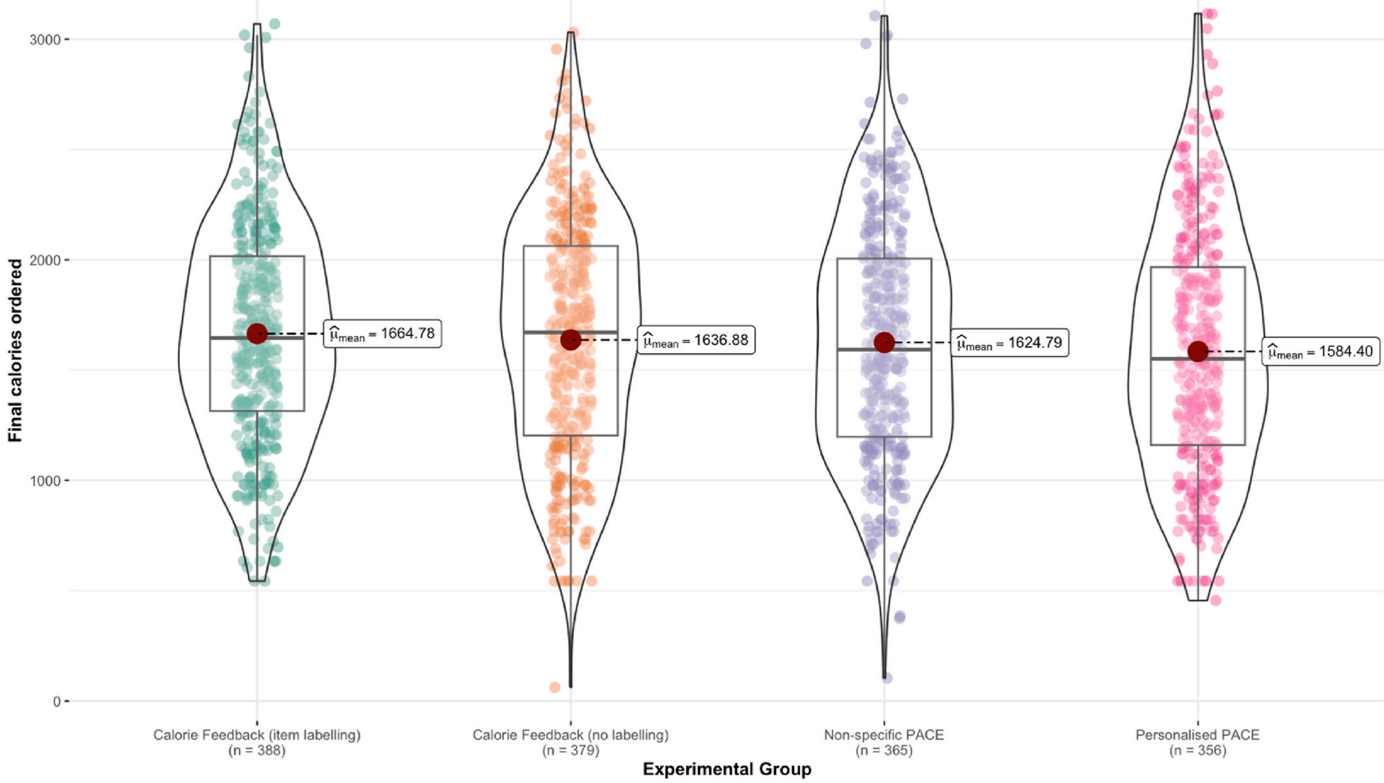

Fig. 1. Number of calories ordered following calorie information/PACE feedback, separately by experimental group.

3.3. Exploratory analyses: calories ordered prior to feedback received (individual item calorie labelling vs not)

There was no significant difference in group ordering prior to receiving any calorie/exercise-related feedback (F (1, 1482) = 3.00, p = .083, np^2 = .02). In the no item labelling group, the average number of calories ordered was 1776 (SD = 488), and in the item labelling group the average number of calories ordered was 1721 (SD = 498: d = .11 [95 % CI: .00 to .23], a relative reduction of 55 kcals (3.1 %) of calories.

3.4. Exploratory analyses: influence of calorie/PACE information

Three-hundred and seventy-seven individuals (24.9 %) reported being influenced by the calorie/PACE information, and this was significantly different across the groups (X^2 (3) = 8.25, p = .041). However, no group contrasts were significant when p-values were Bonferroni corrected (ps > .076). We included this as a between-subjects factor in our ANCOVA examining calories ordered after calorie/PACE feedback. There was a significant main effect of influence of calorie information (F (1, 1465) = 52.54 p < .001, eta^2 = .13), and individuals who reported being influenced by calorie labels (*mean* = 1292) ordered fewer calories than those who did not (*mean* = 1741, d = .91 [95 % CI: .79 to 1.03]). There was no significant interaction with group (F (3, 1465) = .39, p = .756, *eta2* = .00).

3.5. Exploratory analyses: demographic predictors of the decision to change order

Binary logistic regression demonstrated the only significant demographic predictors of changing order were the health motives variables; specifically, increased motivation to eat healthy food (OR = 1.16 [95 % CI: 1.01–1.33], p = .043) and increased motivation to control weight (OR = 1.16 [1.02 to 1.32], p = .028) were associated with greater odds of changing an order (see Supplementary Table 2).

4. Discussion

The aim of this study was to examine whether feedback on excess calories/PACE during hypothetical restaurant ordering would lead to reductions in the number of calories ordered and/or a change in ordering behaviour. We demonstrated limited evidence that these information-provision approaches led to differences in the number of calories ordered in a representative sample of UK adults, but some evidence to suggest feedback on excess calories might impact decisions to change ordering behaviours.

One potential reason for the lack of observable effects of feedback on excess calories/PACE on calories ordered is that these approaches require 'high agency' at the individual level (Kaur et al., 2022). It is possible that, at least in restaurant settings, individuals consciously ignore or resist using calorie information, as eating out is considered a treat. This is supported by qualitative evidence from public consultations on calorie labelling ("*if I am eating out, I'm doing so for the experience, the taste, the atmosphere, and I'm not doing it every single day. So I don't have any interest in how many calories are in my meal*" (Jeacle & Carter, 2023)), and social media sentiment in response to a calorie labelling policy by Public Health England ("*Calorie labels will not put me off eating unhealthy food. I eat unhealthy food because it is delicious, and I want to*" (Polden et al., 2023)). Similar points have been made elsewhere (Evans et al., 2016). This is further supported by quantitative evidence suggesting few people report using or noticing calorie labelling when present (Essman et al., 2024; Polden et al., 2025). However, it is possible that the presence of calorie or PACE information may lead to reformulation and reduction of energy content/switching to healthier options (Robinson et al., 2021), reducing the requirement of individual agency and still having a positive impact on population health.

We demonstrated some evidence for changes in ordering in response to calorie/PACE-related feedback. When individuals were informed of the number of total calories (and calories in excess of 600) they had ordered, without observing calorie information on individual meal items, they were significantly more likely to change their order than if they had this information as they were ordering. This suggests that individuals may not be very good at estimating the calorie content of individual meal items (Polden et al., 2025; Woolley & Liu, 2021), and are willing to change their behaviour once informed. In practice, the aggregation of total calories ordered would be possible to implement in many restaurants which have moved to mobile/online ordering, or food-delivery systems (Keeble et al., 2020). We also demonstrated that non-specific PACE feedback increased the likelihood of changing an order, compared to calorie-only information. However, contrary to expectations we found personalised feedback was no more effective in changing orders than general/non-specific PACE feedback (Swartz et al., 2013).

Our exploratory findings suggest that the presence of calorie information on individual items lead to a small (but non-significant) reduction in calories selected (prior to feedback) vs. absence of calorie information on items. The relative reduction (3.1 %, 55 kcals) is somewhat similar to estimates presented from recent meta-analyses (1.8 %: Clarke et al., 2025). We did demonstrate that individuals who reported being influenced by calorie labels ordered substantially fewer calories, which is perhaps unsurprising given that that individuals who choose to engage with calorie information report being more motivated by health (Jones, Gough, & Robinson, 2024). Accordingly, those in our study motived by healthy eating and eating to control weight were also more likely to change their order.

There are several limitations to this study. Although the sample was similar to the UK population in terms of average age, sex and BMI, many participants were crowdsourced and may have specific motivations for taking part (payment), which might introduce selection biases (Peer et al., 2022). The study also used hypothetical scenarios and as such has no real-world impact on actual behaviour (Klein & Hilbig, 2019). However, we observe that ordering behaviour is largely similar in terms of number of calories ordered as recent customer intercept surveys from the calorie labelling evaluation (Polden et al., 2025), and previous meta-analyses examining PACE labelling have demonstrated no difference between simulated and 'real-world' designs (Seyedhamzeh et al., 2018). Nevertheless, future research may look to investigate real world applications (and consequences), i.e., providing optional feedback on excess calories/PACE for menu orders in restaurants. Second, whilst our menu was influenced by typical UK restaurants, we did not have much variation on lower calorie/'healthier' items. As such, it is possible that participants would have found it difficult to order a meal which was in line with the 'One You' (600 calorie) recommendations, and this could have impacted the believability of the messaging. Importantly, research suggests that increased proportion of lower calorie dishes will reduce the number of calories ordered (Hollands et al., 2019). Similarly, if these dishes are presented more prominently (e.g., at the top of a menu (Edwards et al., 2025)) this will increase the likelihood they are ordered. To build on this, future research examining calorie/PACE feedback should examine the switch to healthier dishes, but also vary positioning to make healthier options more prominent. Third, we did not tailor PACE feedback based on other factors which influence metabolism, such as age and gender (Daley & Bleich, 2021). However, the impact of these factors is considerably smaller than individuals' weight. Fourth, this was an online study which may have been subject to bot-generated responses. However, this is unlikely to be an issue as we had multiple measures of careless responding (Jones, Gough, & Robinson, 2024). Nevertheless, findings should be replicated in person (e.g., in restaurants, via online ordering).

Fifth, as our primary aim was to compare different forms of feedback, we did not include a control condition who received no feedback. Whilst we found consistent evidence that a proportion of participants in each feedback condition chose to change their initial selections, in future research inclusion of a no feedback condition would now be informative as it would provide more compelling evidence on the impact that feedback vs. no feedback has on consumer behaviour. Sixth, we did not examine future compensatory behaviours, for instance if individuals planned to increase physical activity or reduce energy intake based on feedback they received. Future studies should example this, as PACE information in workplace cafeterias has been shown to increase self-reported physical activity by 13 %–26 % (Deery et al., 2019). Finally, presenting information about recommended calorie consumption prior to observing menus may have had some anchoring effect on individuals' behaviour (Furnham & Boo, 2011), and is unlikely to mimic real-world scenarios. However, we note the guidance has some similarity with the current regulations in England which require a statement on adult energy requirements presented at point-of-choice (e.g., 'adults need around 2000 kcal per day').

In conclusion, there was no difference between feedback on excess calories, non-specific PACE, and personalised PACE-related feedback on energy ordered from an online hypothetical menu. Participants who did not see calories on menu items but were provided with overall excess calorie feedback were more likely to change their order.

CRediT authorship contribution statement

Andrew Jones: Writing – original draft, Visualization, Supervision, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation. **Thomas Gough:** Writing – review & editing, Conceptualization. **Rebecca Evans:** Writing – review & editing, Conceptualization. **Amy Finlay:** Writing – review & editing. **Jay J. Duckworth:** Writing – review & editing, Conceptualization. **Sam Burton:** Writing – review & editing, Conceptualization. **Abigail K. Rose:** Writing – review & editing, Conceptualization. **Eric Robinson:** Writing – review & editing, Supervision, Conceptualization.

Consent for publication

Not applicable.

Ethics approval and consent to participate

Approved by local research Ethics Committee at Liverpool John Moores University. Informed consent was obtained from all the participants before they started the study.

Ethics statement

The research presented here was approved by the local research ethics committee (reference: PsyREC-019-2425-RR). All participants provided informed consent.

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Declaration of competing interest

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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.2025.108303.

Data availability

Data and code is shared on OSF with a link in the manuscript

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