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Does social-norm messaging influence expected satiety and ideal portion-size selection?

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ABSTRACT

A person's perception of how long a food will stave off hunger (expected satiety) and the ideal amount to consume (ideal portion size) are both influenced by food-to-mealtime norms. Here, we examine whether social norms can modulate this effect, in three experimental studies. In study 1 ($n = 235$) participants were exposed to a social norm suggesting most people enjoyed consuming pasta for breakfast. There was a main effect of food-to-mealtime congruence for expected satiety and ideal portion size ($p < 0.001$) – participants selected a smaller portion of pasta for breakfast (vs. lunch) – but there were no other main effects/interactions ($p \geq 0.15$). Study 2 ($n = 200$) followed the same approach as study 1, but sought to examine whether the typical volume of food consumed at breakfast and lunch needed to be controlled. Again, there was a main effect of congruence (the same pattern) ($p \leq 0.02$) but no other main effects/interactions ($p \geq 0.73$). Study 3 ($n = 208$) followed the same approach as study 2, but the social-norm message was changed to suggest that most people who eat pasta for breakfast found it effectively reduced their hunger. Again, there was a main effect of congruence (the same pattern) ($p < 0.001$) but no other main effects/interaction ($p \geq 0.26$). These studies provide further evidence for the food-to-mealtime effect, but do not provide any evidence that a single, simple social-norm statement can modulate expected satiety or ideal portion size, or interact with the food-to-mealtime effect.

1. Introduction

Expected satiety can be defined as the perception, before consumption, of a food's ability to stave off hunger for a period of time (Brunstrom, 2011). At a typical mealtime, research has shown that the portion size selected by an individual to stave off hunger for a given period is highly correlated with the portion size that the individual would consider as 'ideal' in the same moment (Wilkinson et al., 2012). These findings suggest that pre-meal expectations about the satiating ability of a food weigh heavily on the decision-making process about which food to select and in what quantity.

That said, research has shown that satiety perceptions differ when food is presented in an unusual (vs. usual) context. For example, when a typical lunch food (e.g., pasta) is presented at breakfast time (an incongruous mealtime), a smaller portion size is selected (1) to stave off hunger until their next meal, and (2) as an ideal portion, compared to when it is presented at a congruous mealtime (e.g., lunchtime) (McLeod, James, Brunstrom, & Witcomb, 2020; McLeod, James, & Witcomb, 2022). When also considering the literature showing that food is eaten slower (with less consumed) in an unusual context (McLeod, James, & Witcomb, 2020a), overall there is sufficient evidence to suggest that when food is presented in an unusual context people perceive (and eat) food differently and may consider other factors (i.e., more than expected satiety) in selecting an ideal portion size.

It is important to understand the psychological mechanisms underpinning the change in eating behaviours in unusual contexts as it has been hypothesised that eating foods in unusual contexts may present a novel opportunity to support various health outcomes, such as losing weight or increasing vegetable intake. Although evidence suggests that a change in 'implicit satiety driver' (beliefs, expectations or goals about when to stop eating that occur without conscious reflection) may underpin eating behaviour changes between usual and unusual contexts (McLeod, James, & Witcomb, 2022), the variable evidence suggests other possible mechanisms should be explored. In this regard, it is possible that social norms may affect eating behaviours observed in unusual contexts. For instance, individuals may deem it to be more socially acceptable to select a smaller portion size when presented with an incongruous food-to-mealtime context.

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Extensive research has been undertaken to examine the role of social-norm messaging in positively influencing eating behaviour, as information describing the behaviour of others (e.g., conveying what the majority of people do, or approve of) has been shown to influence people's own behaviour (Higgs, Liu, Collins, & Thomas, 2019). For example, across two laboratory-based studies, exposure to a single, simple, social-norm message stating that students consumed more vegetables (or fruit and vegetables) than one might realise, led to participants immediately consuming more vegetables (or fruit and vegetables; Robinson, Harris, Thomas, Aveyard, & Higgs, 2013). Conversely, exposure to a single, simple, social-norm message suggesting that students consumed less junk food that one might realise, led to participants immediately consuming less high-calorie snack food (Robinson et al., 2013), and there is evidence to suggest that the effects of such manipulations can persist beyond the initial exposure (Stok, Verkooijen, de Ridder, de Wit, & de Vet, 2014; Thomas et al., 2016). These food-based social-normative messages have also been demonstrated to have an effect in real-world settings. For instance, Thomas et al. (2017) placed a poster in work restaurants, with the simple normative message "Most people here choose to eat vegetables with their lunch", which led to a significant increase in the percentage of customers purchasing a meal with vegetables. Further, normative influence also appears to extend to portion size, where a single exposure to a social-norm message (e.g., "according to research, x% of women find this portion appropriate") has been demonstrated to blunt the potency of the portion-size effect (Versluis & Papies, 2016).

It is plausible that knowledge or perceptions about social norms may influence the portion size selected in usual vs. unusual contexts, as food-to-mealtimes norms are formed through associative learning that is influenced by an individual's social environment (McLeod, James, & Witcomb, 2020b). For example, the social norms that start to be learned from as young as two years old (Nguyen, 2007) about which contexts it is considered normative behaviour to consume particular foods are highly dependent on the normative beliefs and behaviour of the parents and caregivers who support the child's feeding throughout childhood (McLeod, Haycraft, & Daley, 2022). Food-to-mealtime norms continue to be cemented, unlearned, or adjusted across the lifespan, through repetition and reinforcement across all strata presented in the socio-ecological model (Bronfenbrenner, 1992). What is not clear is whether social norms play a significant role in influencing the ideal portion selected in a given context, and the portion size selected to stave off hunger. If social norms do indeed play a significant role, then manipulating information about social norms (i.e., norms pertaining to the acceptability of consuming a food in an incongruent context) could potentially modulate the effect of congruence on portion-size selections. However, this has not been explored previously.

Therefore, the aim was to explore whether a social-norm manipulation (e.g., suggesting that most people enjoyed eating cheese and tomato pasta at breakfast time), would influence the effect of food-to-mealtime congruence on expected satiety and ideal portion size. It was hypothesised that: (1) there would be a main effect of message, whereby those exposed to the social-norm message would select a larger portion (to stave off hunger, and as their ideal portion size), versus those presented with a control message; (2) there would be a main effect of congruence, whereby exposure to the food at a congruent mealtime would lead to the selection of a larger portion (to stave off hunger, and as their ideal portion size), than at an incongruous mealtime, and; (3) there would be a significant message-by-congruence interaction, whereby the effect of meal incongruence would be blunted by the social-norm message. These hypotheses were explored across three separate studies, with each subsequent study implementing minor amends to the methods in order to undertake a rigorous and comprehensive test of these hypotheses.

2. Study 1 - methods

2.1. Participants

Participants were eligible to take part in the study if they were at least 18 years of age and were regular breakfast eaters (defined as "someone who eats food within 2 h of waking at least five days a week"; Clayton & James, 2016). Participants were not eligible if they currently lived outside the UK and/or had a diagnosed eating disorder, a history of gastric, digestive, metabolic, cardiovascular or renal disease, diabetes, photosensitive epilepsy, allergies or intolerances to dairy, gluten or tomato, or followed a vegan diet. All participants provided informed consent before taking part in the study which was granted ethical approval by the Loughborough University Ethics Review Sub-Committee (2020-1237-169). Participants were recruited via the Aston University Research Participation Scheme and via advertising on social media – the software configuration for the Participation Scheme meant that, for those participants recruited via this avenue, participants would only be able to complete one of the three studies presented in this paper. Participant recruitment was undertaken at a different institution to where ethical approval was granted in order to use the large participant pool available at JMT's institution. The use of external ethical approval was reviewed and permitted by Aston University. All participants were entered into a prize draw to win one of two £50 Amazon vouchers to compensate them for their time. For participants recruited via the Research Participation Scheme, they also received course credit for taking part.

2.1.1. Sample size

Sample size was estimated by conducting an *a priori* calculation for the message-by-congruence interaction term (hypothesis 3) of the main statistical analysis used to test all three hypotheses (mixed 2 × 2 ANOVA). This indicated that a small effect size (Cohen's d = 0.2) would be detected with an alpha of 0.05, 80% power, sphericity assumed and repeated measures correlation at 0.5, if 200 participants were recruited. A small effect size was chosen in order to identify subtle but meaningful differences that may have practical real-world significance.

2.2. Design

A mixed-design was used, whereby the between-subjects independent variable was message (social norm vs. control), the within-subjects independent variable was food-to-mealtime congruence (incongruent [breakfast] vs. congruent [lunch]), and the dependent variables were (1) expected satiety and (2) ideal portion size. The study was deployed online via Qualtrics (qualtrics.com). Upon clicking the Qualtrics link, participants were automatically randomly allocated to one of two surveys via a simple randomisation process facilitated by Qualtrics' in-built randomisation algorithm. Both surveys were identical apart from the message presented to the participants (see 'Message manipulation' section).

2.3. Measures

2.3.1. Participant characteristics

Participants indicated their age in years, their sex assigned at birth (female, male, prefer not to say, prefer to self-describe), their height (metres or feet and inches) and weight (kilograms or stone and pounds). All height data was converted into metres and all weight data into kilograms – with manual assessments undertaken to ensure reported height/weight were plausible values – before body-mass index (BMI; kg/m^2) was calculated subsequently by the researchers. The IP address of the responder was collected automatically by Qualtrics to allow for data exclusion from further analysis (see 'Data analysis'). Participants also responded to the questions of the Three-Factor Eating Questionnaire (TFEQ; Stunkard & Messick, 1985) measuring eating-related restraint to

further characterise the sample.

2.3.2. Subjective appetite and food reward

Participants indicated their current subjective appetite by responding to the questions: "how 1) hungry, and 2) full are you right now?" and 3) "how strong is your desire to eat right now?". Participants responded to each question via individual visual-analogue scales (VAS; digital horizontal sliders presented on Qualtrics) by placing the marker on a line where the left-hand anchor stated 'not at all' and the right-hand anchor stated 'extremely'. Subsequently, a composite appetite score was calculated – (hunger + (100-fullness) + desire to eat)/3 – and used in subsequent statistical analyses, as implemented in previous studies (e.g., McLeod et al., 2020a; Monsivais, Perrigue, & Drewnowski, 2007; Perrigue, Monsivais, & Drewnowski, 2009, 2015). This multivariate measure triangulated on different factors of appetite, allowing participants to reflect on different subjective aspects of meal initiation and readiness to eat (Rogers & Brunstrom, 2016).

Using similar horizontal sliders, participants also responded to two further questions in relation to subjective 1) liking of, and 2) desire to eat the test food (liking: "how much do you like the taste of this food"; desire to eat: "how much do you want to eat this food right now?"). Above these two questions, participants were presented with an image of a 340 g portion of cheese and tomato pasta (referred to as 'pasta' herein) to refer to when answering the questions.

2.3.3. Expected satiety and ideal portion size

This study aimed to assess the influence of social-norm messaging on the portion size selected to stave off hunger (expected satiety). To address this aim, expected satiety was measured using the 'momentary' (rather than 'hypothetical') expected satiety method as laid out in McLeod, Mycock, et al. (2022). Therefore, as previously implemented in studies measuring momentary expected satiety and ideal portion size (e.g., McLeod et al., 2020; Wilkinson et al., 2012) participants were asked: "What portion would you select to ensure you staved off hunger until your next meal?" (expected satiety) and "What would be your ideal portion of cheese and tomato pasta to eat at [insert mealtime]?" (ideal portion size). Participants were asked to answer both questions twice; when imagining the prospective consumption of pasta at 1) breakfast time, and 2) lunch time. For both mealtimes, participants were told that they would not be able to eat anything else until the following mealtime. Participants responded to these questions in relation to expected satiety (both mealtimes) followed by ideal portion size (both mealtimes) by selecting the appropriate portion of pasta from 50 portion sizes of pasta (0–980 g) presented in sequential order (see section 2.3.4.).

2.3.4. Portion selection task

For questions pertaining to food preference and portion-size selection, participants were presented photographs of the pasta dish. Fifty photographs of the pasta were taken (by CJM), using a high-definition camera with a standard background, viewing angle and lighting in each photograph (as used in McLeod, James, & Witcomb, 2022). The portion of pasta in each photograph increased by 20 g (range: 0–980 g). These images (300 × 225 pixels) were loaded into Qualtrics and presented in collage format; that is, participants could view two adjacent columns of the pasta images that increased in portion size as participants scrolled down their computer screen. Participants selected the appropriate portion of pasta to respond to the particular question by clicking on the appropriate image. The use of an online portion selection task has been shown in previous studies to be an effective analogue tool to estimate real-world portion size selections (Embling, Lee, Price, & Wilkinson, 2021; Pink & Cheon, 2021; Wilkinson et al., 2012).

2.4. Message manipulation

The experimental manipulation included a social-norm message and asked: "Did you know that most people enjoy eating cheese and tomato pasta at breakfast time?". The norm-referent group was intentionally broad ("people") to allow the same message to be replicated across future studies and populations without limit. The specific reference to enjoyment was based on previous work, demonstrating that 'liking norms' may be a particularly potent type of social norm to expose participants to (Thomas et al., 2016). The control survey included a question asking: "Did you know that the Harry Potter book series is the best-selling book series of all time?". This question was generated so that it had a reasonably similar structure to the norm-based question, but was entirely unrelated to food. Participants were asked to response 'yes' or 'no' to the question they were presented.

2.5. Participant checks

Participants were asked three questions at the end of the survey, to: 1) ensure participants were paying attention when completing the survey; 2) assess whether participants could successfully recognise the message they were exposed to; 3) assess potential demand awareness, and; 4) potentially identify survey completion by bots. Participants were asked to 1) type the answer to the maths sum 5 + 4 in an open textbox, 2) confirm which message they were presented earlier in the survey (from four options), and 3) provide a response to what they thought was the purpose of the study.

2.6. Procedure

After clicking the link to start the survey, participants were presented with detailed information about the study before being asked to provide their consent to take part. Subsequently, all participants completed the sections of the survey in the following order: demographics, subjective appetite and food reward, social-norm (or control) message and response, expected satiety, ideal portion size, TFEQ-restraint. At the end of the survey, participants were asked the compliance check questions, before being asked to provide their email address to be entered into the prize draw. They were then thanked for their time completing the questionnaire.

2.7. Data analysis

Data Processing: Participant responses were excluded from the analysis if: (1) the participant had not completed the whole survey; (2) they incorrectly answered the compliance check questions (maths sum, message previously presented); (3) indecipherable or non-sensical data was provided for the questions requiring open-textbox answers; (4) duplicate answers were provided for open-textbox answers where the IP address was the same, or; (5) if the IP address of the survey responder was from outside the UK (identified using ipapi.co). These data-processing methods were implemented to reduce the risk of digital-bot data compromising the reliability of the dataset.

General: All data are presented as means (±SD) unless otherwise stated. Significance was accepted as $p < 0.05$ and effect sizes for the ANOVAs were presented as partial eta squared (ηp^2).

Covariates: A Spearman's Rho correlation analysis was undertaken to investigate the associations between composite subjective appetite, liking and TFEQ-restraint score with the expected satiety and ideal-portion-size selection tasks, in order to identify whether any of these factors, known to influence portion-size selection, should be added as covariates in the main analyses testing this study's hypotheses. As the expected satiety and ideal portion size tasks were both assessing portion-size selection, it was determined that a given variable would be included as a covariate in the main analysis if it correlated significantly with both measures (expected satiety and ideal portion size) at both time points (breakfast and lunch). The analysis revealed that none of the variables significantly correlated with expected satiety and ideal portion size at breakfast and lunch time; therefore, no variables were included as covariates in subsequent analyses.

Main Analysis: Two mixed ANOVAs were used to explore this study's hypotheses; that is, to investigate the effect of messaging (social norm vs. control [between groups]) on expected satiety and ideal portion size when participants selected a portion of pasta to consume at lunch time (a congruous mealtime) and at breakfast time (an incongruous mealtime) [within groups].

3. Study 1 – results

3.1. Participant characteristics

Four hundred and fifty participants started the online study. One hundred and fifty-three participants were excluded for not completing the study, 29 were removed for wrongly answering the participant check questions, 2 were removed due to a computer reporting error where no data was registered, and 31 were removed for having IP addresses outside the UK, leaving a final participant sample of 235 (females = 182, males = 51, prefer to self-describe = 1, prefer not to say = 1) with an average age of 26 ± 10 (range: 18–73) years and BMI of 24.2 ± 4.8 kg/m^2.

There were 114 participants in the 'social-norm message' group (female = 91, male = 22, 1 = preferred to self-describe) and 121 participants in the control group (female = 91, male = 29, 1 = preferred not to say) (see Table 1 for each group's mean score for the demographic and subjective variables).

3.2. Main analysis: expected satiety and ideal portion size

The ANOVA results for the expected satiety data revealed a significant main effect of congruence, that is, a larger portion was selected for lunch (congruent: 511.7 ± 234.3 g) compared to breakfast (incongruent: 415.4 ± 211.5 g; $F_{(1,231)} = 83.3$, $p < 0.001$, $\eta p^2 = 0.27$ – see Fig. 1). However, there was no significant effect of message on expected satiety (social-norm group = 465.7 ± 217.2 g; control group = 461.4 ± 228.7 g; $F_{(1,231)} = 0.02$, $p = 0.88$, $\eta p^2 < 0.001$) and no significant congruence-by-message interaction (congruent: social-norm group = 508.8 ± 225.0 g, control group = 514.6 ± 243.6 g; incongruent: social-norm group = 422.6 ± 209.4 g, control group = 408.2 ± 213.7 g; $F_{(1,231)} = 0.92$, $p = 0.34$, $\eta p^2 = 0.004$).

The results for the ideal portion size data also revealed a significant main effect of congruence, that is, a larger portion was selected for lunch (congruent: 473.7 ± 220.1 g) compared to breakfast (incongruent: 355.7 ± 219.1 g; $F_{(1,232)} = 111.2$, $p < 0.001$, $\eta p^2 = 0.32$ – see Fig. 1). There was no significant effect of message (social-norm group = 431.7 ± 221.2 g; control group = 397.8 ± 217.0 g; $F_{(1,232)} = 1.65$ $p = 0.20$, $\eta p^2 = 0.007$), and there was no significant congruence-by-message interaction (congruent: social-norm group = 482.7 ± 212.6 g, control group = 464.8 ± 227.4 g; incongruent: social-norm group = 380.7 ± 229.8 g, control group = 330.7 ± 206.6 g; $F_{(1,232)} = 2.06$, $p = 0.15$, $\eta p^2 = 0.009$).

Table 1
Study 1: mean scores (±SD) for each group's demographic and subjective variables.

Variable (unit)	Social-norm group average (±SD)	Control group average (±SD)
BMI (kg/m^2)	24.4 (5.2)	24.0 (4.4)
Age (years)	26 (10)	26 (11)
Appetite[a] (mm)	42.6 (23.3)	45.8 (24.4)
Liking (mm)	70.3 (23)	70.9 (22.2)
Desire to eat (mm)	36.9 (28.6)	42.5 (29.9)
TFEQ-restraint	8.2 (4.7)	7.6 (4.6)

[a] Composite subjective appetite score.

Table 2
Study 2: mean scores (±SD) for each group's demographic and subjective variables.

Variable (unit)	Social-norm group average (±SD)	Control group average (±SD)
BMI (kg/m^2)	23.3 (4.9)	23.9 (5.2)
Age (years)	19 (2)	20 (5)
Appetite[a] (mm)	37.9 (24.7)	47.2 (25.8)
Liking (mm)	71.3 (27.4)	65.4 (28.4)
Desire to eat (mm)	38.0 (31.1)	39.1 (31.0)
TFEQ-restraint	7.5 (5.5)	7.6 (5.6)

[a] Composite subjective appetite score.

Fig. 1. Study 1: Mean (±SEM) portion-size selection (g) for expected satiety and ideal portion size for cheese and tomato pasta at breakfast time (incongruent) and lunch time (congruent).
* = Significant main effect of congruence for both expected satiety and ideal portion size (both *p*s < 0.001).

3.3. Interim discussion

The main aim of this study was to explore whether a single, simple, social-norm manipulation would influence the effect of food-to-mealtime congruence on expected satiety and ideal portion size. It was hypothesised that there would be a significant main effect of message, congruence, and a significant interaction.

The results indicate that only hypothesis two could be accepted, as participants selected a larger portion of pasta (to stave off hunger and as their ideal portion size) at the congruous (vs. incongruous) mealtime. This finding aligns with the results from the two previous studies that have investigated expected satiety and ideal portion-size selections for pasta at congruous and incongruous mealtimes (McLeod et al., 2020; McLeod, James, & Witcomb, 2022), and another study that explored energy intake, where pasta was actually consumed (McLeod et al., 2020a). That said, it is possible that this result is driven by the fact that people living in the UK typically eat more of their daily energy intake at lunch (~30–40%) compared to breakfast (~15–25%) (Betts et al., 2014; Clayton, Stensel, & James, 2016; Clayton & James, 2016, McLeod, James, & Witcomb [2020a]). That is, our participants may have selected smaller portions at breakfast not (solely) because of the effect of food-to-mealtime incongruency, but because they typically select smaller portions at breakfast anyway. However, the results from previous studies exploring the effect of food-to-mealtime congruence on expected satiety and ideal portion size provide some evidence to refute this supposition. For example, previous studies have used two foods (a

typical lunch food, e.g., pasta, and a typical breakfast food, e.g., porridge) to try and create an incongruous association at both breakfast and lunch time (e.g., McLeod, James, & Witcomb [2020a], McLeod, James, & Witcomb [2020a]). Although these studies did not find evidence that the typical breakfast foods used (e.g., porridge) were incongruous at lunch for a UK participant sample, these data did still demonstrate the effect of food-to-mealtime congruence on portion-size selection. This is because the typical breakfast food ultimately acted as a control food (as portions did not differ significantly between breakfast and lunch time) with the typical lunch food (pasta) data showing that significantly smaller portions were selected at breakfast vs lunch time. That said, to explore this study's aims rigorously, it was decided that a second study would be conducted, with a different participant sample, to explore the same hypothesis, but also aiming to control for the potentially different typical energy intakes at breakfast time and lunch time. This was important to undertake, to explore whether the acceptance of the null hypothesis for hypotheses 1 and 3, and the acceptance of hypothesis 2, can be explained by the confounding factor of typical energy intakes at breakfast and lunch.

4. Study 2

Study 2 aimed to explore the same aims and hypotheses as study 1 but, in addition, this study would look to understand whether typical energy intake at breakfast and lunch should be controlled for in the main statistical analyses, in order to accurately explore the impact of social-norm messaging on expected satiety and ideal portion size. Therefore, this study used the same methods, processes and (amended) ethical approval as detailed in study 1, with the addition of the typical energy intake measure, detailed below.

4.1. Study 2 – methods

4.1.1. Typical daily energy intake

Participants were asked: "How do your meals over the course of a day compare in volume of food consumed?". Participants were asked to use horizontal sliders to indicate their perception of the percentage of total daily intake that they tend to consume at breakfast, morning snack, lunch, afternoon snack, dinner and evening snack. Each eating occasion (e.g., breakfast, morning snack etc.) was allocated an individual slider which was marked with 0 as the left-hand anchor and 100 as the right-hand anchor, with equally spaced 10-unit increments in between. Participants were also informed that as regional variations exist in names given for different mealtimes, that 'lunch' meant 'a meal in the middle of the day', 'dinner' meant 'a main meal towards the end of the day' and 'snack' meant 'food consumed between main meals'. This measure was added to the survey after the subjective appetite questions and before the food reward questions, and configured so that the answers had to sum to 100%.

4.1.2. Data analysis

Covariates: as per study 1, a Spearman's Rho correlation analysis was undertaken to investigate the associations between composite subjective appetite, liking rating for the test food, and TFEQ-restraint, with the expected satiety and ideal-portion-size selection tasks. The analysis revealed that all three measures correlated with expected satiety and ideal portion size at both mealtimes (Rho $\geq$0.15, $p \leq 0.04$); therefore, composite appetite, liking and TFEQ restraint score were included as covariates in the main analysis.

The data analysis approach was the same as in study 1. However, to address concerns raised in study 1, it was anticipated that participants' reporting of their typical volume of food consumed at breakfast and lunch might need to be controlled for in the main analysis, using ANCOVA. However, a Spearman's Rho correlation analysis showed that typical volume of breakfast and lunch portions did not significantly correspond with expected satiety or ideal portion size at breakfast or lunch, respectively (Rho $\leq$0.10, $p \geq 0.15$). Therefore, descriptive statistics were reported for average typical portion sizes (Table 3) but this variable was not entered as a covariate in the main ANOVA analyses.

4.2. Study 2 – results

4.2.1. Participant characteristics

Two hundred and thirty-one participants started the online study. Seventeen participants were excluded for not completing the study, 10 were removed for wrongly answering the awareness check questions, and three were removed for having IP addresses outside the UK, leaving a final participant sample of 200 (females = 164, males = 34, prefer to self-describe = 1, prefer not to say = 1) with an average age of 20 ± 4 (range: 18–65) years and BMI of 23.6 ± 4.9 kg/m^2.

There were 97 participants in the test 'social-norm message' group (female = 82, male = 14, 1 = preferred to self-describe) and 103 participants in the control group (female = 82, male = 20, 1 = preferred not to say) (see Table 2 for each group's mean score for the demographic and subjective variables).

4.2.2. Main analysis: expected satiety and ideal portion size

The ANCOVA results for the expected satiety data revealed a significant main effect of congruence; that is, there was a significant difference in the portion selected for lunch time (congruent = 533.0 ± 239.8 g) compared to breakfast time (incongruent = 453.1 ± 228.2 g; $F_{(1,189)} = 5.26$, $p = 0.02$, $\eta p^2 = 0.027$; see Fig. 2). However, there was no significant effect of message on expected satiety (social-norm group = 488.2 ± 231.9 g; control group = 497.9 ± 236.9 g; $F_{(1,189)} = 0.11$, $p = 0.74$, $\eta p^2 = 0.001$) and no significant congruence-by-message interaction (congruent: social-norm group = 530.7 ± 236.1 g, control group = 535.3 ± 244.6 g; incongruent: social-norm group = 445.7 ± 227.8 g, control group = 460.5 ± 229.1 g; $F_{(1,189)} = 0.12$, $p = 0.73$, $\eta p^2 = 0.001$).

The results for the ideal portion size data also revealed a significant main effect of congruence; that is, a larger portion was selected for lunch time (congruent = 496.6 ± 234.7 g) compared to breakfast time (incongruent = 377.7 ± 242.0 g; $F_{(1,191)} = 6.26$, $p = 0.01$, $\eta p^2 = 0.03$ – see Fig. 2). There was no significant effect of message (social-norm group = 437.5 ± 247.3 g versus control group = 436.8 ± 230.1 g; $F_{(1,191)} = 0.001$ $p = 0.98$, $\eta p^2 < 0.001$), and there was no significant congruence-by-message interaction (congruent: social-norm group = 499.3 ± 234.2 g, control group = 493.9 ± 236.4 g; incongruent: social-norm group = 375.7 ± 260.5 g, control group = 379.8 ± 223.7 g; $F_{(1,191)} = 0.10$, $p = 0.76$, $\eta p^2 = 0.001$).

4.3. Interim discussion

This study found no evidence to suggest that there is an effect of social-norm message on expected satiety or ideal portion size, but there was evidence for an effect of congruence. These results support the findings from study one, while also controlling for composite appetite, liking, and TFEQ restraint score. It is interesting to note that there is no obvious reason as to why these three covariates showed significant associations with expected satiety and ideal portion size data, and thus

Table 3
Study 2: descriptive statistics of self-reported typical volume of food consumed across the day for both groups.

Mealtime	Social-norm group average (±SD)	Control group average (±SD)
Breakfast	19.1 (12.2)	18.9 (12.4)
Morning Snack	4.1 (7.1)	3.5 (4.9)
Lunch	24.9 (13.4)	24.6 (13.3)
Afternoon Snack	7.1 (7.7)	7.0 (8.3)
Dinner	37.0 (16.7)	37.4 (14.0)
Evening Snack	7.8 (8.2)	8.7 (9.3)

Fig. 2. Study 2: Mean (±SEM) portion-size selection (g) for expected satiety and ideal portion size for cheese and tomato pasta at breakfast time (incongruent) and lunch time (congruent).
* = Significant main effect of congruence for both expected satiety and ideal portion size (both *ps* ≤ 0.02).

needed to be controlled for in the main analysis, when this was not the case in study 1 where all study processes were the same.

In order to verify the rejection of these studies' hypotheses in regard to social-norm message (i.e., that those exposed to a social-norm message will select a larger portion to stave off hunger and as their ideal portion size, and that there will be a significant message-by-congruence interaction whereby the effect of meal incongruence will be blunted by the social-norm message) a further study was considered, which adjusted the social-norm message presented to participants. It was proposed that the social-norm message from studies 1 and 2 ("did you know that most people enjoy eating cheese and tomato pasta at breakfast time?") may not have been a salient message, due to the fact that the message referred to the *enjoyment* of the test food, rather than to the *satiating* abilities of the test food, with the latter better aligning with the expected satiety variable. Therefore, study 3 used the same methods, processes and (amended) ethical approval as detailed in study 2, but recruited a new participant sample and adjusted the social-norm message to refer to the test food's satiating ability, to further explore the effect of social-norm message on expected satiety and ideal portion size.

5. Study 3

5.1. Study 3 – methods

5.1.1. Message manipulation

The experimental manipulation used a social-norm message stating: "Did you know that most people who eat cheese and tomato pasta at breakfast time find it effectively reduces their hunger?" (a change from study 1 and 2's message: "Did you know that most people enjoy eating cheese and tomato pasta at breakfast time?"). As noted above, this change was implemented to draw attention to the satiating capability of the test food. It was rationalised that this would be a more potent and direct test of the utility of social norms here, by providing explicit information about the consequences of consumption (i.e., a reduction in hunger) that was directly related to the expected satiety variable. The control survey included the same control statement as the previous studies: "Did you know that the Harry Potter book series is the best-selling book series of all time?". Participants were asked to respond 'yes' or 'no' to the question they were presented.

5.1.2. Data analysis

Covariates: as in Study 2, composite subjective appetite, liking, TFEQ restraint score, and typical mealtime energy intake were analysed via a Spearman's Rho correlation against the expected satiety and ideal portion size tasks at both mealtimes. The analysis revealed that none of the variables significantly correlated with expected satiety and ideal portion size at both breakfast and lunch time; therefore, no variables were included as covariates in subsequent analyses.

5.2. Study 3 – results

5.2.1. Participant characteristics

Five hundred and ninety-five participants started the online study. One hundred and eighty-six participants were excluded for not completing the study, 92 were removed for wrongly answering the participant check questions, 16 were removed due to undecipherable or non-sensical data provided in an open textbox answer, 10 were removed where written data in an open textbox answer were duplicated and respondents had the same IP address, and 83 were removed for having IP addresses outside the UK, leaving a final participant sample of 208 (females = 174, males = 34) with an average age of 22 ± 7 (range: 18–76) years and BMI of 23.2 ± 4.2 kg/m^2.

There were 100 participants in the test 'social-norm message' group (female = 83, male = 17) and 108 participants in the control group (female = 91, male = 17) (see Table 4 for each group's mean score for the demographic and subjective variables, and Table 5 for average typical portion size scores).

5.2.2. Main analysis: expected satiety and ideal portion size

The ANOVA results for the expected satiety data revealed a significant main effect of congruence; that is, there was a significant difference in the portion selected for lunch time (congruent = 547.2 ± 235.5 g) compared to breakfast time (incongruent = 483.6 ± 216.5 g; $F_{(1,206)}$ = 17.4, $p < 0.001$, $\eta p^2 = 0.078$ – see Fig. 3). However, there was no significant effect of message on expected satiety (social-norm group = 518.6 ± 224.2 g; control group = 512.4 ± 227.9 g; $F_{(1,206)} = 0.05$, $p = 0.83$, $\eta p^2 < 0.001$), and no significant congruence-by-message interaction (congruent: social-norm group = 558.8 ± 224.5 g, control group = 535.6 ± 225.9 g; incongruent: social-norm group = 478.0 ± 202.6 g, control group = 489.3 ± 227.7 g; $F_{(1,206)} = 1.28$, $p = 0.26$, $\eta p^2 = 0.006$).

The results for the ideal portion size data followed a similar pattern. There was a significant main effect of congruence (congruent-lunch = 482.0 ± 238.5 g; incongruent-breakfast = 396.8 ± 237.7 g; $F_{(1,205)}$ = 30.35, $p < 0.001$, $\eta p^2 = 0.129$ – see Fig. 3), but no significant effect of message (social-norm group = 455.8 ± 241.2 g; control group = 423.0 ± 234.9 g; $F_{(1,205)} = 1.27$ $p = 0.26$, $\eta p^2 = 0.006$), and there was no significant congruence-by-message interaction (congruent: social-norm group = 496.0 ± 237.0 g, control group = 468.0 ± 238.3 g; incongruent: social-norm group = 415.6 ± 242.3 g, control group = 377.9 ± 229.9 g; $F_{(1,205)} = 0.10$, $p = 0.75$, $\eta p^2 < 0.001$).

Table 4
Study 3: mean scores (±SD) for each group's demographic and subjective variables.

Variable (unit)	Social-norm group average (±SD)	Control group average (±SD)
BMI (kg/m^2)	23.1 (4.1)	23.3 (4.3)
Age (years)	20 (4)	23 (9)
Appetite[a] (mm)	43.9 (27.4)	44.3 (23.8)
Liking (mm)	73.6 (23.8)	64.2 (26.9)
Desire to eat (mm)	41.4 (32.2)	37.3 (29.6)
TFEQ-restraint	8.1 (5.4)	7.8 (5.1)

[a] Composite subjective appetite score.

Table 5
Study 3: descriptive statistics of self-reported typical volume of food consumed across the day for both groups.

Mealtime	Social-norm group average (±SD)	Control group average (±SD)
Breakfast	20.1 (13.9)	19.6 (10.3)
Morning Snack	3.4 (7.3)	3.6 (7.5)
Lunch	25.7 (15.6)	25.8 (11.9)
Afternoon Snack	8.4 (9.3)	6.4 (6.6)
Dinner	35.1 (14.9)	37.7 (14.2)
Evening Snack	7.3 (7.6)	6.9 (6.9)

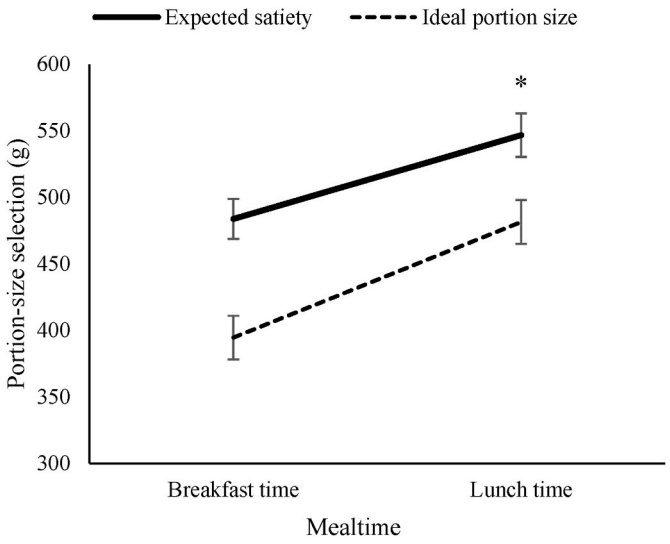

Fig. 3. Study 3: Mean (±SEM) portion-size selection (g) for expected satiety and ideal portion size for cheese and tomato pasta at breakfast time (incongruent) and lunch time (congruent).
* = Significant main effect of congruence for both expected satiety and ideal portion size (both $p < 0.001$).

6. General discussion

Across three studies, there was no evidence to suggest that a single, simple, social-norm message influences the effect of food-to-mealtime congruence on expected satiety or ideal portion size (a rejection of hypothesis 3). Similarly, there was no main effect of social-norm message on expected satiety or ideal-portion size in each study (a rejection of hypothesis 1). However, in line with previous research, in each of the three studies, there was a significant effect of congruence, whereby participants selected a larger portion of the cheese and tomato pasta dish for both the expected satiety and ideal-portion-size measures at the congruent mealtime [lunch] (an acceptance of hypothesis 2).

The consistent results across all three studies showing that food-to-mealtime congruency influenced the portion sizes selected to stave off hunger (expected satiety), and as an ideal portion, corroborates numerous previous studies (e.g., McLeod et al., 2020; McLeod, James, & Witcomb, 2022; McLeod et al., 2020a). However, given the contexts used to facilitate the food-to-mealtime congruency were breakfast and lunch, it is possible that all studies are confounded by the fact that people in the UK tend to eat a greater proportion of their daily energy intake at lunch compared to breakfast, as revealed in the results of studies 2 and 3, and in previous research (e.g., Betts et al., 2014; Clayton et al., 2016; Clayton & James, 2016). Previous studies have looked to reduce the impact of this potential confound by implementing an incongruent food-to-mealtime association at both breakfast time and lunch time (e.g., McLeod et al., 2020a). In the present study, we looked to mitigate this risk by controlling for participants' typical volume of food consumed at breakfast and lunch, as reported via visual-analogue scale. Although the data for this measure in studies 2 and 3 reflected previous findings (i.e., that more food was consumed at lunch than at breakfast), participants' reporting of their typical volume of food at breakfast and lunch did not significantly correspond with expected satiety or ideal portion size. Therefore, this factor was not controlled for in the main data analysis used in these studies. To further explore the extent to which typical portion size confounds the impact of food-to-mealtime congruency on expected satiety and ideal portion size, future research should use another method of measuring typical portion size, such as by asking participants to select a portion of food that they would typically eat at breakfast and lunch for a food that is congruent at both breakfast and lunch.

The lack of an effect of, or interaction with, the social-norm message is surprising, given the substantial body of evidence demonstrating that single, simple, messages can influence the consumption of a variety of foods, in a variety of contexts (e.g., Robinson et al., 2013, 2014; Stok et al., 2014; Thomas et al., 2016, 2017; Versluis & Papies, 2016); however, there are a range of possible explanations. Firstly, our thoughts of what constitutes an appropriate meal for a given mealtime, our expectations of satiety, and our ideal portion sizes, are formed over the course of our lives, and are embedded in our beliefs, attitudes and behaviour. Hence, it may be that they are particularly resilient to acute exposure to a social-norm message. For instance, it may take more than a single message to influence them, it may require a more potent exposure to a social norm (e.g., the presence of others at a dining table with us, where a majority select food in front of us), or the incongruency of the food (pasta) and the mealtime (breakfast) may have been too extreme to have had an impact via a simple, single social-norm message. Relatedly, it might be that the effects of the norm are more likely to be expressed when there are consequences for the individual, such as when they are provided with actual food to consume (regardless of how the norm is exposed to the participant). More prosaically, it is also plausible that the normative manipulations here were not optimal. For instance, the social-norm messages in the present study referred to "most people"; however, there is evidence to suggest that being demographically similar to and/or identifying with the norm-referent group in the social-norm message can improve its effectiveness. For instance, Stok et al. (2014) tested a social norm manipulation with student participants from Utrecht University, where norms either suggested that a minority or majority consumed "sufficient vegetables". Crucially, here, they referred to Utrecht University students as the norm-referent group in their social norm messages (e.g., "a full 73 per cent of Utrecht university students eat sufficient vegetables") and they also measured the participants' strength of identification with the norm-referent group. The results revealed that the effect of the normative manipulation on intentions to consume vegetables (the outcome variable), was partly mediated by identification with the norm-referent group. Hence, in the case of our current studies, the effectiveness of our messages may have been limited by not referring to and/or recruiting a more specific or salient referent group (e.g., a national identity, such as "people in Britain" as per Liu, Thomas, & Higgs, 2019). In addition, it is also possible that the messages were not believed by participants. For instance, participants might not have accepted the general premise of people consuming pasta for breakfast, and thus, not believed the social norm messages on that basis. Alternatively, it is possible that the term 'most' was not sufficiently clear or persuasive. For example, some studies using normative messages report specific percentages that clearly indicate a substantial majority (e.g., "Although, a lot of people aren't aware, 80% of students actually like vegetables a lot" – from Thomas et al., 2016). This may be more effective than referring to "most people", which could indicate a simple majority of 51%, or 100% of a referent group engaging in a given behaviour. Thus, while it is entirely possible that the food-to-mealtime effects on expected satiety and ideal portion size are not affected by exposure to social norms, further work is required to test this more robustly, increasing the believability and relatability of the

social-norm message and including a manipulation check to understand participants' views of the message used.

The prevalence of findings across multiple studies showing the effect of food-to-mealtime congruency on various eating-behaviour-related variables adds to the compelling argument for considering real-world application to weight-management strategies for these experimental findings – see McLeod, James, and Witcomb (2022) for further discussion on this point. However, the null findings reported in this paper provide key, novel information for researchers exploring the impact of social-norm messaging. Although food-to-mealtime associations are formed through social interactions, the robustness of these learned associations means that social-norm messages attempting to influence consumer food choice and portion-size selection may either be ineffective or should better align with the target demographic's identity and/or motivations. With previous research demonstrating the power of social-norm messaging on nudging consumer behaviour, and considering the potential benefits of eating foods in unusual contexts, further exploration via controlled research studies is warranted.

A significant strength of this paper is that it presents three experimental studies with adequate sample sizes and similar analytical procedures, building on the findings of each study in turn, to explore the same hypotheses. Each study also planned to control for a variety of potential confounds to produce a reliable dataset. This process therefore presents significant evidence for the acceptance/rejection of the proposed hypotheses, as the studies' findings all aligned. Limitations of the studies are, firstly, that the variable aiming to assess typical food portion sizes at breakfast and lunch was not associated with expected satiety or ideal portion sizes, meaning that controlling for this variable in the congruency analyses was not undertaken. Future work should consider a different measurement (as suggested above) to ensure this variable is not confounding the effect of congruence, or indeed social-norm messaging. Another limitation is the demographic characteristics of our participants. Although sample sizes were adequate, participants were mainly young adults within the 'healthy' BMI range (18.5–24.9 kg/m^2), and no further demographic information (e.g., ethnicity, socio-economic status) was collected. Future work should ensure participant diversity in order to understand the generalisability of the findings.

In conclusion, while these three experimental studies found more evidence to support the hypothesis that food-to-mealtime congruency influences expected satiety and ideal portion size, there was no evidence to suggest that the social-norm messages used in these studies can modulate this relationship. This work adds to the theoretical underpinning of food selection and energy intake, by reinforcing the role of food-to-mealtime congruency, and the robustness of this learned association. Future work should further explore the validity of using social-norm messaging to influence food-to-mealtime congruency, and the extent to which manipulating food-to-mealtime congruency in real-world eating environments influences daily energy intake.

Ethical statements

Participants provided informed consent before starting the study and ethical approval was obtained from the Ethics Review Sub-Committee (Loughborough University) (2020-1237-169).

CRediT authorship contribution statement

C.J. McLeod: Conceptualization, Formal analysis, Investigation, Methodology, Project administration, Visualization, Writing – original draft, Writing – review & editing. **J.M. Thomas:** Conceptualization, Formal analysis, Investigation, Methodology, Project administration, Visualization, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors have no conflicts of interest to declare.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.appet.2023.107157.

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