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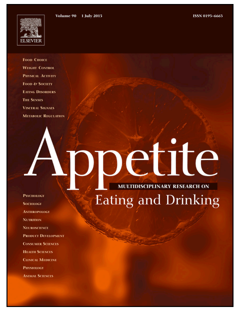

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Does exposure to socially endorsed food images on social media influence food intake?

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Abstract

Social norms can influence the consumption of high and low energy-dense (HED/LED) snack foods. Such norms could be communicated via social media, however, there is little experimental research investigating this possibility. This laboratory study aimed to investigate the acute effect of socially endorsed social media posts on participants' eating behaviour. Healthy women students (n = 169; mean age = 20.9; mean BMI = 23.3) were assigned to either a HED, LED or control condition, where they viewed three types of images (HED foods, LED foods and interior design as control), but only one type was socially endorsed (e.g. in the control condition, only interior design images were socially endorsed). Participants completed questionnaires and were also provided a snack buffet of grapes and cookies. One-way ANOVA revealed a significant main effect of condition on participants' relative consumption of grapes (percentage of grapes consumed out of total food intake), for both grams and calories consumed (both ps < .05). Follow-up t-tests revealed that participants consumed a larger proportion of grapes (grams and calories) in the LED condition vs HED condition (all ps < .05), and a larger proportion of calories from grapes in the LED compared to control condition (p <.05). These findings suggest that exposure to socially endorsed images of LED food on social media could nudge people to consume more of, and derive more calories from these foods in place of HED foods. Further research is required to examine the potential application of these findings**.**

Keywords: social norms, social media, healthy eating, food consumption

1. Background [1]

Consumption of fruit and vegetables is associated with various health benefits, such as decreased risk of cancer and cardiovascular mortality, as well as increased well-being (Oyebode, Gordon-Dseagu, Walker & Mindell, 2014). Additionally, a diet high in fruit and vegetables and low in sugary and fatty foods is also likely to help prevent obesity (World Health Organization, 2019). However, according to the Health Survey for England (2018), only 28% of adults across all age ranges consume the recommended 5 portions a day. While interventions, such as the '5 a day' programme in the UK, have attempted to encourage fruit and vegetable consumption through health education and advertising campaigns (World Health Organization, 2003), success has been limited (Rekhy & McConchie, 2014). Thus, in order to help prevent these non-communicable diseases, it is necessary to continue to explore innovative ways of nudging food choices and consumption towards healthier options.

One possible option for interventions is to utilise social influences, such as exposure to social norms; implicit rules that communicate how others typically behave. According to Cialdini's theory (1998), social norms may be used as a form of normative social influence, whereby norms are adhered to because they are viewed as socially approved of or accepted (Cialdini & Goldstein, 2004; Cialdini & Trost, 1998; Deutsch & Gerard, 1955), or as a form of informational social influence, whereby the norm communicates appropriate behaviour when it is not clear what to do (Cialdini & Trost, 1998; see Higgs 2015 for a review). Indeed, normative information about the typical behaviour of others has been found to increase healthy behaviours such as stair climbing (Slaunwhite, Smith, Fleming & Fabrigar, 2009) and decrease risky behaviours such as drink driving (Neighbors, Larimer & Lewis, 2004; Perkins,

[1] LED = low energy-dense foods, typically nutritious foods high in water content and low in fat (e.g. fruits and vegetables like grapes, strawberries, cucumber); HED = high energy-dense foods, typically less nutritious and high in fat and/or sugar and low in water content (snacks such as biscuits, crisps etc).

Linkenbach, Lewis & Neighbors, 2010), suggesting that exposure to social norms can be used to nudge health-related behaviour.

More recently, exposure to social norms has been demonstrated to affect eating behaviour. For example, asking participants about their perceptions of what close others eat has been shown to predict participants' own food and beverage consumption (Ball, Jeffery, Abbot, McNaughton & Crawford, 2010; Pelletier, Graham & Laska, 2014), as well as the type of food consumed (Hawkins, Farrow & Thomas, 2020). Further, perceived peer norms have been shown to predict young adults' consumption of high calorific foods (Robinson, Ottens & Hermans, 2016), as well as their intake of fruit and vegetables (Lally, Bartle & Wardle, 2011). Additionally, norms conveyed implicitly, via environmental cues, such as leaving snack wrappers to indicate the choices of others, have resulted in participants matching to the norm and consuming and choosing the same as what they believe others typically ate, making both 'healthy' and 'unhealthy' food choices as a result (Burgur et al., 2010; Prinsen, de Ridder & de Vet 2013). This suggests that perceived social norms can predict food consumption and choice even when others are not present, and that these effects also occur when norms are presented implicitly.

This work has been expanded on by experimental studies, in which exposure to a descriptive social norm message, suggesting that others eat plenty of fruit and vegetables, increased participants' subsequent consumption of low energy-dense (LED) foods and decreased consumption of high energy-dense (HED) foods (Robinson, Fleming & Higgs, 2014). This has also been replicated in field studies, in university and workplace canteens, where norms have increased the consumption of vegetables with meals (Mollen, Rimal, Ruter & Kok, 2013; Thomas et al., 2017; Collins et al., 2019). Additionally, there is also evidence that social norms conveying how much others like vegetables (a liking norm; i.e. a social norm conveying what the majority like) can encourage healthy eating, above and beyond descriptive social norm messages (Thomas, Liu, Robinson, Aveyard, Herman & Higgs, 2016), however, there is little work exploring how norms interact with the hedonic evaluation of food, and whether social norms that convey liking consistently exert a superior effect on consumption.

A crucial and growing intersection for social norms and eating behaviour is social media. In the current digital age, use of social media platforms has increased dramatically, with the UK Office of National Statistics (2019) reporting that 68% of the population used social networking sites, rising to 91% of 25-34 year olds and 98% of 16-24 year olds. Sites such as Facebook and Instagram are among the top five most popular social networking sites worldwide (Statista, 2021) and host an abundance of food posts, particularly of HED foods (Barre, Cronin & Thompson, 2016; Holmberg, Chaplin, Hillman & Berg, 2016). With its focus on image sharing, a recent study reported that out of 1000 images on Instagram, up to 70% were images of HED food and only 21% of LED foods (Holmberg et al., 2016), making it an ideal platform to study how these images may affect our own eating behaviour. Further, many food posts also include certain social contexts, such as eating with friends or in restaurants and so posts may communicate norms around foods relating to context (Qutteina, Hallez, Mennes, De Backer & Smits, 2019).

In addition, sites such as Instagram enable sharing of pictures, as well as possible social validation functions, such as liking and commenting on these, which also communicates social endorsement. Some evidence has found that these social validation methods have no effects on credibility and persuasiveness of content (Hamshaw, Barnett & Lucas, 2018). However, this was used for those gathering information on food hypersensitivities and so this may be different for more generalised groups and social media usage. For instance, food adverts on Instagram with a medium or high number of likes (1000 - >10,000) were rated and engaged with more by adolescents, suggesting that others' explicit liking of foods on posts and the social functions these platforms offer, may influence behaviour (Lutfaeli et al., 2020). Further, it has been found that personal norms and subjective norms (what others think I should do) affected how users interacted with adverts on Facebook via likes and comments (Kim, Lee & Yoon, 2015). More specifically, we have also previously found that different perceived norms about Facebook users' eating habits predict self-reported food consumption of LED and HED foods differentially (Hawkins, Farrow & Thomas, 2020) with descriptive norms predicting consumption of healthier foods. Social media therefore provides a new method of communicating norms about eating; our online social networks suggest what others eat, through pictures (descriptive norms), as well as what others enjoy eating via likes on social media posts (liking norms). Thus, it may be possible to take advantage of social validation methods to examine whether advocating certain foods can encourage healthier choices. Indeed, priming a descriptive social norm has been found to encourage users' attitude for creating food posts of healthy rather than indulgent foods (Coary & Poor, 2016), but no research to date has considered how experimentally manipulating social endorsement on social media can influence our actual food consumption.

One study has considered whether social media can affect the portion size of HED snack food consumption (Sharps, Hetherington, Blundill-Birtill, Rolls & Evans, 2019), however further research is required to investigate the effect of social norms conveyed via social media on actual consumption of LED and HED foods. As social validation appears to be key in how social norms online may work (Guadagno & Cialdini, 2013; Harrow et al., 2018; Latfaeli et al., 2020), research investigating whether altering the numbers of likes can affect actual food consumption is important in determining if and how social media may affect our eating behaviour.

Therefore, the present study aimed to test whether socially endorsed images of LED foods, HED foods, and interior design (as a control), in the style of Instagram posts, affected how much and what participants chose to consume. It was hypothesised that those who viewed socially endorsed images of LED foods (compared to control or HED foods) would consume more grapes, whereas those viewing socially endorsed HED foods (compared to control or LED foods) would consume more cookies.

2. Methods

2.1 Participants

Participants were undergraduate and postgraduate students, with a mean age of 20.9 years (SD = 4.02) and were recruited via posters or through the Aston University Psychology research participation system, where undergraduate students take part in research, as part of their course. An opportunistic sample of two hundred and two women from Aston University (Birmingham, UK) consented to taking part, however due to exclusions (see sample size section), only 169 were included in analyses. Participation was in exchange for course credits, or entry into a prize draw to win a £50 Amazon voucher. Ethical approval was granted by Aston University Life and Health Sciences Ethics Committee (#1263) and carried out in accordance with the ethical standards of the 1975 Declaration of Helsinki, as revised in 1983. Informed consent was obtained from all participants. Data collection took part from April 2018 – February 2019.

2.2 Sample size

Sample size was determined via power analysis (G-Power 3.1.9.2); to achieve significant main effects, with power set at 0.80, $\alpha = 0.05$ and $f = 0.25$, a minimum of 159 participants were required. We intended to recruit higher than this number to account for incomplete data provided by participants.

From the 202 participants who consented and took part, 33 were excluded, or their data removed due to: a current or previous history of eating disorders, food allergies or diabetes, were not aged 18-65, had eaten in the 2 hours before the study, were smokers (as this can impact taste/appetite), did not consume any food from the buffet, or correctly guessed the aims of the study. Only women were used in this study, as they are more likely to be affected by social influences than men (Robinson, 2015). Hence, 169 women successfully completed the entire study and were included in all analyses (control condition n = 57; LED condition n= 54; HED condition n= 58).

2.3 Design

A between-subjects design was used, with one factor: socially endorsed image, consisting of three levels: Control images (interior design), LED food images and HED food images. All participants were exposed to all images, but in their condition, the specific image set that was ‘socially endorsed’ had substantially more ‘likes’ (e.g. a participant in the control condition, saw all three sets of images, however, the control images appeared to have disproportionately more ‘likes’). For good experimental control, all participants were shown all images so that they had the same experience apart from the manipulation and so that it was possible to make inferences about the effect of number of likes, unconfounded by exposure to different images. The dependent variables included: participants’ total food intake (in grams and calories) and relative consumption of LED food (proportion of LED food consumed out of total intake) in both grams and calories.

2.4 Materials

The experiment was conducted using the online survey platform Qualtrics and comprised a series of questionnaires, along with the experimentally manipulated images, and a food buffet, presented in the order below:

Lifestyle Questionnaire: this included questions regarding age, gender, previous and current history of eating disorders, as well as questions about what participants had eaten prior to the study, to measure sample characteristics and exclude participants based on study criteria (e.g. smokers; Thomas et al., 2016).

Visual Analogue Scales (VAS): this scale assessed baseline, post-manipulation and post-buffet mood and appetite, to assess whether these changed throughout the study and needed to be controlled for in the main analyses. The following items are included: “alertness”; “drowsiness”; “light-headedness”; “anxiety”; “happiness”; “nausea”; “sadness”; “withdrawn”; “faint”; “hunger”; “fullness”; “desire to eat” and “thirst”. Participants were asked to indicate on a scale from 0 – 100 (0 = not at all, 100 =very much) how they felt, for each item, at the present time of the study (Thomas et al., 2016). Factor analysis was carried out (see analysis section), resulting in 3 factors. Cronbach’s for all subscales ranged from .64 - .85, so in an acceptable to good range.

Social Networking Use: To assess social media usage within the sample and whether this needed to be controlled for, this scale used 9 items that assessed Instagram and other social media use, including frequency of use, the types of posts made, the accounts ‘followed’, the number of other social media accounts participants use, and how often, using a combination of 3 open ended questions (e.g. ‘Roughly how many followers do you have?’, where participants typically enter a number which was converted into the correct units) and 6 response scales (e.g. ‘How long do you typically spend on Instagram?’, with responses measured on a 5-point Likert scale; Slater, Varsani & Diedrichs, 2017). This questionnaire is yet to be validated. Cronbach's alpha for this scale was α = .48.

Instagram Task: participants were shown three sets of fictitious Instagram posts containing; 20 LED food images, 20 HED food images and 20 Control images (interior design). These were presented one at a time, in a randomised order. A VAS item was administered below each image, asking participants to rate how much they liked each one, on a scale from 0 (Not at all) to 100 (Very much). After completing the VAS they would proceed to the next image. Participants saw all 60 images, however, in order to induce a perceived norm for a particular set of images, one of these sets was 'liked' more than the other two sets of images (e.g. in the HED condition, the HED food posts appeared to receive substantially more 'likes' - see Figure 1). Images were piloted with a separate sample of participants from the same university (n=28) prior to the present study, to confirm that the images could be correctly identified as LED, HED or control images, by a significant majority of participants, which they were.

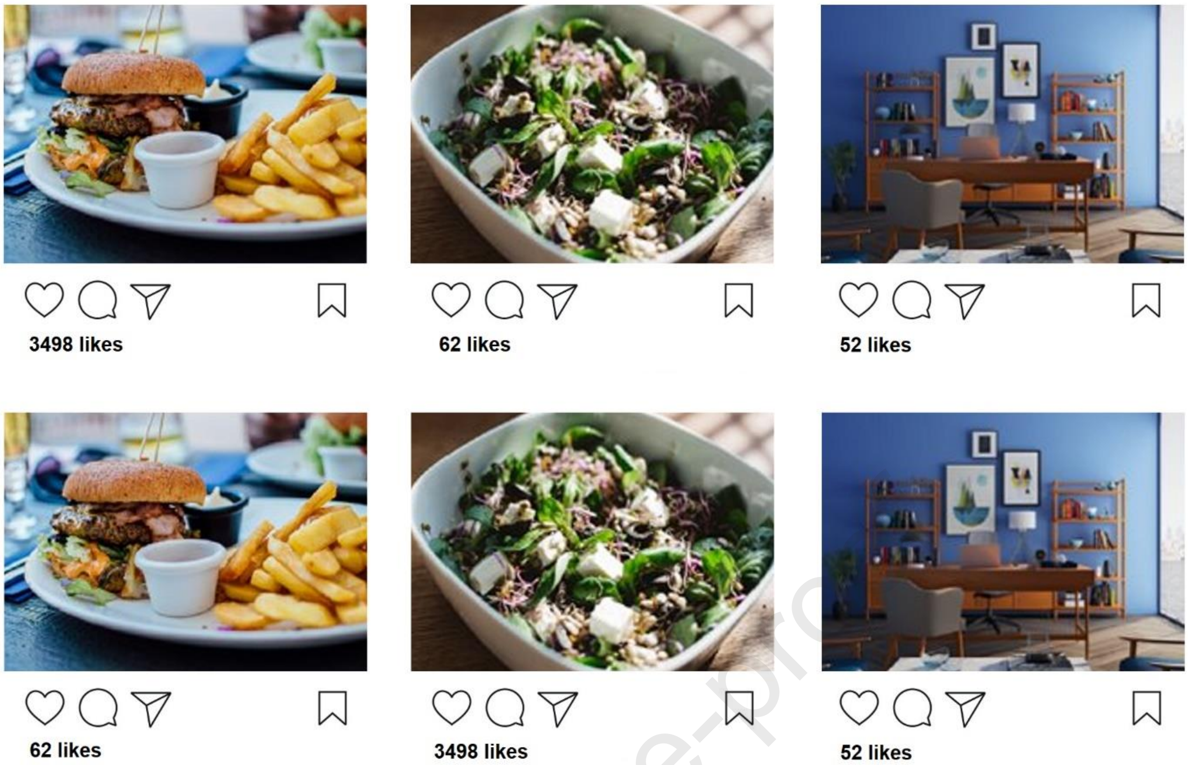

Figure 1. *Example of socially endorsed images.*

The top row illustrates how posts in the HED condition would appear to be the most 'liked' and the bottom row illustrates how posts in the LED condition would appear to be the most 'liked', by manipulating the number of 'likes'.

Images via Pexels (Creative Commons License).

Food buffet: this was provided to participants consisting of grapes (400g/264kcal per bowl) and cookies (200g/950 kcal per bowl); the latter were broken up into 4-6 pieces each, to make it difficult for participants to monitor their intake. The two bowls were filled equally so that they were matched in terms of visual presentation. All food was purchased from Sainsbury's plc. Each food was weighed (in grams) before each testing session, using digital scales and again after each testing session, to measure how much participants had consumed of each snack after viewing the images (as used in Robinson and colleagues 2013; 2014; Thomas et al., 2016).

Three Factor Eating Questionnaire-R21 (TFEQ-R21): this included 21 items to assess 3 facets of eating style: uncontrolled eating (e.g. ‘Sometimes when I start eating, I can’t seem to stop’), cognitive restraint (e.g. ‘I don’t eat some foods because they make me fat’) and emotional eating (e.g. ‘I start to eat when I feel anxious’) and was included to account for any effects dietary behaviours may have on participants eating behaviour. Participants indicated their response on a four-point Likert-type scale (‘definitely true’, ‘mostly true’, ‘mostly false’, ‘definitely false’; Cappelleri et al., 2009). The TFEQ-21R is a widely used measure and has been validated in obese and non-obese samples demonstrating good psychometric properties (Cappelleri et al., 2009). In the current sample, the TFEQ demonstrated excellent reliability, α = .84 (uncontrolled eating subscale α = .78; cognitive restraint subscale α = .83 and emotional eating subscale α = .88).

The Usual Food and Drink Intake Questionnaire*:* measured participants’ own habitual consumption, and liking of fruit, vegetables, energy-dense snack foods and sugar sweetened beverages, using a combination of open-ended items (e.g. ‘How many serving of vegetables do you typically eat a day?’) and VAS items (e.g. on a scale from 0 (Not at all) to 100 (Very much), how much do you like eating vegetables?; Hawkins et al., 2020). This was included as part of the randomisation checks and to check whether this should be controlled for. The UFDIQ has been used widely in other peer-reviewed publications (e.g. Robinson et al. 2013; 2014; Thomas et al. 2017). It is yet to be formally validated but measures used (e.g. combining fruit and vegetable consumption) were significantly correlated ($r = .3$, $p<.001$). For use in this sample, fruit and vegetable consumption demonstrated good reliability, α = .77 and HED consumption demonstrated acceptable reliability, α = .60.

Demand and manipulation check*:* to complete the survey, participants were asked what they thought the purpose of the study was (demand check), using an open-ended response. Participants were also asked which set of images they believed had the most likes, as a manipulation check.

Height and weight*:* height (in metres) and weight (in kilograms) was recorded by the researcher using a stadiometer and digital weighing scales, in order to calculate BMI (kg/m^2).

2.5 Procedure

Participants were told that they were taking part in a study investigating the use of Instagram and Lifestyle. The true aims of the study were withheld until the end, in order not to bias behaviour. Participants were asked to attend a laboratory session and complete the majority of the study via Qualtrics on a computer. After reading a Participant Information Sheet and providing informed consent, they completed the following: Lifestyle Questionnaire, baseline VAS, UFDIQ and the social networking use questionnaire. Participants were then shown the randomised Instagram-style images, depicting the three different types of image (HED and LED foods and interior design as a control) and asked to rate how much they liked each image, one by one. They then completed the post-manipulation VAS. Two bowls of snack foods (one containing grapes, one containing cookies) were presented and participants were told that they could help themselves to these as a reward for taking part, and as a break in the study. The following measures were then administered: post-buffet VAS, TFEQ-R21 and demand awareness questionnaire. Participants' height and weight were then measured to calculate BMI and they were fully debriefed and thanked for their time. Each session took no longer than 35 minutes (see Figure 2 for an overview of the experimental time course).

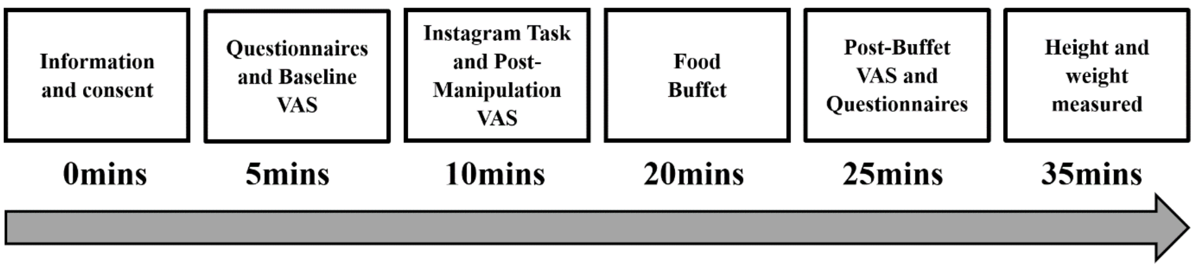

Figure 2. *Time course of key procedural elements.*

2.6 Analysis

2.6.1 Main analysis: One-way ANOVA was used to examine differences in consumption of each food (grapes and cookies, separately), and also, the relative consumption of the LED snack food (i.e. percentage of total intake that was derived from consuming grapes) between the 3 conditions. Planned t-tests were used to follow-up any significant main effects. Analyses were applied to grams consumed (to examine volume) and calories consumed (to examine the energy), separately. Finally, baseline appetite, a key variable that predicts consumption, was also controlled for in these analyses (entered as a covariate). Hypotheses were defined *a priori* before data collection, along with the above analytic strategy.

2.6.2 VAS: In order to analyse the mood and appetite data and check whether any factors should be covaried for, a principal components analysis (PCA) with Varimax rotation was carried out on the VAS items (mood and appetite). This yielded 3 factors with eigenvalues >1, which accounted for a total of 63% of the variance. Factors included 'Feeling Unwell' (alert (reverse coded), drowsy, light headedness, nausea, faint, withdrawn), 'Appetite' (hunger, thirst, full (reverse coded), desire to eat), 'Feeling Unhappy' (sad, happy (reverse coded), anxious). Once factors were identified, aggregate scores for each dimension were computed, inverting scores for items where relevant.

2.6.3 Additional analysis: As planned, additional analyses were also carried out to check for possible covariates that needed to be controlled for and randomisation checks. For this, one way-ANOVA was used to investigate any differences in participant characteristics and eating styles (TFEQ) across conditions. A 3 (condition) x 3 (time: baseline, post-manipulation, post-buffet) mixed ANOVA was carried out for each VAS factor produced from the PCA (above) to investigate differences across the sample and whether any of the mood and appetite factors should be included as covariates. Chi-square analysis was used to examine baseline social media usage between the conditions as a potential covariate. Finally, a 3 (condition) x 3 (image type) mixed ANOVA was used to compare the liking ratings for the different images across the conditions, to examine if the manipulation was successful and if liking ratings of the images reflected the number of likes on the Instagram images.

3. Results

3.1 Randomisation checks

The following variables were theoretical covariates or checked to investigate differences across conditions and those that needed to be controlled for.

Participant characteristics. Participant characteristics were analysed by condition, using one-way ANOVA. There was no main effect of condition for: age, BMI, TFEQ-R 21 subscales, typical daily habitual fruit and vegetable consumption, vegetable liking and typical daily HED food consumption and liking (See Table 1).

Table 1. *Means and standard deviations for baseline characteristics for all participants and split by condition.*

Measure	All participants M (SD) *N* = 169	Control Condition M (SD) *n* = 57	LED Condition M (SD) *n* = 54	HED Condition M (SD) *n* = 58	*P* Value

Age	23.2 (4.4)	21.5 (5.1)	20.7 (2.9)	20.7 (3.8)	0.393
BMI	20.9 (4.0)	23.3 (4.4)	23.4 (3.8)	22.9 (4.9)	0.837
TFEQ-21R UC	2.4 (0.5)	2.3 (.5)	2.3 (.5)	2.4 (.6)	0.929
TFEQ-21R CR	2.1 (0.6)	2.1 (.6)	2.1 (.7)	2.0 (.6)	0.616
TFEQ-21R EE	2.0 (0.7)	1.9 (.8)	1.9 (.8)	2.1 (.7)	0.509
FV consumption	3.4 (1.8)	3.2 (1.7)	3.8 (2.1)	3.3 (1.6)	0.268
Vegetable liking	66.2 (27.0)	64.8 (30.0)	71.3 (24.6)	63.0 (26.0)	0.232
Fruit liking	81.7 (20.6)	81.3 (23.5)	87.7 (16.4)	76.4 (19.9)	0.013
HED snack consumption	1.9 (1.1)	1.8 (1.0)	1.8 (1.1)	2.1 (1.1)	0.354
HED snack liking	80.5 (20.3)	83.9 (18.1)	77.9 (24.9)	79.5 (17.3)	0.267
SSB consumption	1.1 (1.0)	1.1 (.9)	0.9 (.9)	1.4 (1.2)	0.024
SSB liking	60.7 (30.6)	62.6 (33.5)	51.3 (31.4)	67.4 (24.5)	0.016

BMI – Body Mass Index; TFEQ – Three Factor Eating Questionnaire; UC – uncontrolled eating; CR - cognitively restrained eating; EE - emotional eating; FV – fruit and vegetable; HED – High energy-dense; LED – Low energy-dense; SSB – Sugar sweetened beverage

However, there was a main effect of condition for fruit liking ($F(2) = 4.44$, $p = .013$, partial eta square = .05), whereby independent samples t-tests revealed that those in the LED condition had a higher liking of fruit than those in the HED condition ($t(110) = 3.28$, $p = .001$). There was no significant difference between the control and the LED condition or HED condition (both *ps* >.05). There was also a main effect of condition for typical daily SSB consumption ($F(2) = 3.82$, $p = .024$, partial eta squared = .05), whereby t-tests revealed that those in the LED condition habitually consumed fewer SSBs than those in the HED condition ($t(108) = -2.63$, $p = .01$) but no significant difference between the control and the LED or HED condition (*ps* >.05). Finally, for SSB liking, there was a main effect of condition ($F(2) = 4.24$, $p = .016$, partial eta squared = .02); t-tests revealed significant differences between those in the HED and LED conditions, with those in the LED condition reporting lower liking of SSBs than those in the HED condition ($t(100.1) = -3.02$, $p = .003$), but no other significant differences (both *p*s >.05 - see Table 1). Measures of SSB consumption did not significantly correlate with the dependent variables and so were not considered further (*p*s > 0.05).

Visual Analogue Scales. For VAS Feeling Unwell, a 3 x 3 ANOVA revealed that there was a main effect of time ($F(1.87) = 44.33$, $p < .001$, partial eta sq = .21). Follow up t-tests showed there were significant differences between baseline and post-buffet ($t(168) = 6.72$, $p<.001$) and post-manipulation and post-buffet ($t(184) = 8.50$, $p<.001$), with higher scores of feeling unwell reported at baseline (mean = 18.9) and post-manipulation (mean = 18.7) than post-buffet (mean = 12.9). There were no other significant differences, for time, condition or interactions (all *p*s >.05; see Table 2 below for means). VAS feeling unwell items were checked to see if they correlated with the dependent variable; they did not and so were not included in the final model.

For VAS Appetite, there was a significant main effect of time ($F(1.55) = 141.54$, $p < .001$, partial eta sq = .46). Follow up t-tests showed there were significant differences between baseline and post-manipulation ($t(168) = -8.94$, $p<.001$), post-manipulation and post buffet ($t(168) = 15.07$, $p<.001$) and baseline and post-buffet ($t(168) = 9.28$, $p<.001$), with means indicating that appetite was highest at post-manipulation (mean = 74.9) compared to baseline (mean = 66.1) or post-buffet (mean = 50.6). There were no main effects of condition or significant interactions (all *p*s >.05; see Table 2 below). As baseline appetite significantly correlated with the dependent variable and this could be an important covariate, this was controlled for in the final model as a covariate.

Finally, for VAS Feeling Unhappy, there was a significant main effect of time ($F(1.8) = 34.35$, $p < .001$, partial eta sq = .17). Follow up t-tests showed there were significant differences between baseline and post-buffet ($t(168) = 6.87$, $p<.001$) and post-manipulation and post-buffet ($t(168) = 7.71$, $p<.001$), with participants reporting higher average scores for unhappiness at baseline (mean = 21.18) and post manipulation (mean = 20.30), compared to post-buffet (mean = 15.9). There were no other significant differences, main effects or interactions (all ps>.05; see Table 2 below). VAS feeling unhappy items were not significantly correlated with the outcome measures and so not included any other analyses.

Table 2. *Means and standard deviations for mood and appetite scores, split by time and condition.*

VAS Factor	Control Condition M (SD)	LED Condition M (SD)	HED Condition M (SD)
Feeling unwell			
Baseline	15.9 (16.8)	19.7 (16.7)	20.9 (16.5)
Post-manipulation	15.1 (16.4)	19.1 (14.4)	21.9 (17.4)
Post-buffet	9.9 (14.0)	12.9 (12.7)	15.8 (14.6)
Appetite			
Baseline	68.7 (22.3)	66.7 (19.7)	62.8 (20.3)
Post-manipulation	75.5 (23.3)	76.1 (18.4)	73.3 (19.9)
Post-buffet	52.3 (22.1)	51.8 (21.7)	47.9 (21.1)
Feeling Unhappy			
Baseline	19.6 (15.8)	21.7 (14.1)	22.3 (17.5)
Post-manipulation	18.6 (15.9)	20.3 (14.9)	21.9 (15.2)
Post-buffet	14.7 (14.5)	16.0 (14.4)	17.2 (14.5)

HED – High energy-dense; LED – Low energy-dense;

Social media use. The percentage of participants who used Instagram was not significantly different between the control and LED condition, ($X(1) = .59$, $p = .44$; 93% vs. 97%), LED and HED condition ($X(1) = 2.42$, $p = .12$; 97% vs. 90%) or control and HED condition ($X(1) = .70$, $p = .40$; 93% vs. 90%) and so not considered further as a covariate. The modal response for time spent on Instagram was between 31 and 60 minutes per day (32% of participants); the modal frequency of posting was once a month (45% of participants); the modal picture content was selfies/group selfies (56% of participants). The average number of accounts followed was 389 (SD = 379.6), average number of followers was 463 (SD = 523.7), and on average participants had 2 (SD = .99) other social media accounts.

Instagram Task VAS Liking ratings. To check whether the manipulation and randomisation was successful and if the liking ratings corresponded with the number of likes for each condition, liking ratings for the three types of images were compared across conditions. There was a significant main effect of the type of image ($F(2) = 13.5$, $p < .001$, partial eta sq = .08), with follow up t-tests revealing there were significant differences in average liking ratings between the control and HED socially endorsed images ($t(168) = -4.85$, $p < .001$) and the LED and HED food socially endorsed images ($t(168) = -4.14$, $p < .001$), with the HED images (mean = 63.8) rated as most liked, compared to the LED (mean = 56.9) and control (mean = 55.4). There was no other significant differences and no other significant main effects of condition or significant interactions (all *p*s >.05; See Table 3).

Table 3. *Means and standard deviations for liking rating for each image type split by condition.*

Image Type	Control Condition M (SD)	LED Condition M (SD)	HED Condition M (SD)
Control Image (interior design)	57.5 (15.8)	52.8 (15.3)	55.8 (15.5)
LED Food Image	56.7 (15.9)	58.1 (16.5)	56.0 (15.1)
HED Food Image	67.2 (14.5)	59.6 (20.3)	64.4 (14.5)

HED – High energy-dense; LED – Low energy-dense;

3.2 Main analysis: Food consumed

One-way ANOVA, controlling for baseline appetite, revealed that there was no main effect of condition for grape consumption in grams ($F(2) = 1.67$, $p = .19$, eta sq = .02), or calories ($F(2) = 1.67$, $p = .19$, eta sq = .02), or for consumption of cookies in grams ($F(2) = 1.34$, $p = .27$, eta sq = .02). or calories ($F(2) = 1.34$, $p = .27$, eta sq = .02; see Table 4 for means). However, for participants' relative consumption of grapes in grams, there was a significant main effect of condition ($F(2) = 3.22$, $p = .04$, partial eta squared = .04). Planned comparisons revealed that those in the LED condition consumed a higher proportion of grapes compared to cookies, than those in the HED condition ($p = .02$), but there was no significant difference in relative consumption between those in the control and LED condition ($p = .14$), or the control and HED conditions ($p = .29$). There was also a significant difference in relative consumption of grapes in calories ($F(2) = 3.1$, $p = .048$, partial eta squared = .04), whereby those in the LED condition consumed more calories from grapes than those in the control condition ($p = .036$) and the HED condition ($p = .048$), however, there was no significant difference between the HED and control conditions (p =.84; see Figure 3).

Table 4. *Means and standard error for grape and cookie consumption and relative consumption split by condition.*

Food consumed	Control Condition M (SE)	LED Condition M (SE)	HED Condition M (SE)
Grape consumption (grams)	79.0 (9.1)	101.9 (9.3)	84.9 (9.0)
Cookie consumption (grams)	21.0 (3.4)	19.9 (3.5)	27.2 (3.3)
Grape consumption (kcal)	52.2 (6.0)	67.3 (6.2)	56.0 (5.9)
Cookie consumption (kcal)	103.7 (16.6)	98.3 (17.0)	134.1 (16.5)
Percentage of grapes consumed (grams)	74.9 (3.4)	81.1 (3.4)	68.9 (3.3)
Percentage of grapes consumed (kcal)	42.8 (4.2)	54.3 (4.3)	40.1 (4.2)

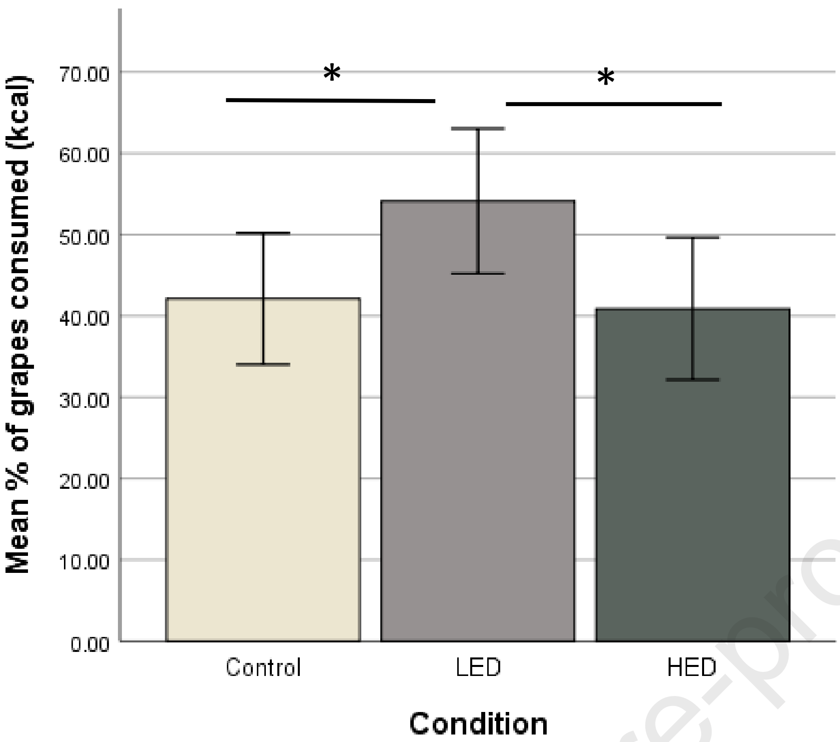

Figure 3. Mean percentage of grape consumption in calories (kcal) for control, low energy-dense (LED) and high energy-dense (HED) socially endorsed images (error bars indicate standard deviations). * $p < 0.05$

4. Discussion

This study aimed to investigate whether socially endorsed images, in the style of the social media site Instagram, affected the amount and proportion of grapes and cookies consumed by participants. After first checking to see if the randomisation was successful and examining potential covariates, baseline appetite was controlled for as part of the main analysis. Although the three types of socially endorsed images did not significantly affect participants' individual consumption of grapes and cookies, viewing socially endorsed images of LED foods (versus HED foods) led to participants consuming a higher proportion of grapes compared to cookies, in grams. Further, viewing the socially endorsed images of LED foods (versus both the HED foods and the control images) led to participants consuming a higher proportion of grapes compared to cookies, as calories. These findings suggest that exposure to socially endorsed LED food images may contribute to healthy eating, by nudging individuals to select and consume larger portions of LED food (such as grapes) relative to HED food (such as cookies).

These findings broadly support previous research on the effects of norms on eating behaviour, whereby exposure to social norm messages promote the consumption of fruit and vegetables (Robinson et al., 2014; Stok, de Ridder, de Vet & de Wit, 2014; Thomas et al., 2017). Importantly, exposure to the socially endorsed LED food images in this study was associated with a 12% and 14% shift towards consuming grapes (versus cookies) compared to the control and HED conditions, respectively. These are sizeable shifts in consumption, and if achieved at each meal, over time, could potentially produce sizeable effects on dietary nutrition and health. Interestingly, the effect of socially endorsed LED food images was observed for the proportions of food consumed, rather than individual consumption of each food. This may be an artefact of effect size, given that there was a small effect for consumption of each food in isolation, but this increased to a medium effect size when the foods were examined together (i.e. grapes consumed as a percentage of the total of both foods consumed). Thus, it may be that with a larger sample size, it would be possible to detect effects for each food, individually. Despite this, Robinson and colleagues (2013; 2014) also demonstrated that exposure to social norm messages nudged people to consume a higher proportion of LED compared to HED foods. While it is possible to examine the effect of healthy eating nudges on individual foods, it may be preferable to consider the relative contribution of foods consumed at a test meal. Further, the proportion of a meal consumed as nutritious low energy-dense calories is a useful outcome measure from a health perspective, as there is value in participants substituting a less nutritious energy-dense food with a more nutritious low energy-dense food.

We also observed that exposure to socially endorsed HED food images was not associated with participants consuming a significantly larger proportion of cookies (versus grapes) compared to the control condition. This is at odds with our hypothesis that these would enhance cookie consumption. However, a possible explanation is provided by the theory that being exposed to a norm corrects a misperception, which then leads to us matching the norm (Perkins, 2002). For example, if we think the majority consume lots of alcohol, but are then shown that the majority do not do this, our misperception is corrected, and our behaviour shifts to match the norm (Perkins, 2002). In the present study, it may be that there was no misperception to correct. Given that recent research has revealed that around 70% of food-related social media posts feature “unhealthy” food (Barre et al., 2016; Holmberg et al., 2016), it is quite possible that the socially endorsed HED condition *matched* participant perceptions and expectations, and hence, produced no effect. Conversely, as “healthy” food posts appear to be a minority (Barre et al., 2016; Holmberg et al., 2016), this may explain why the socially endorsed LED condition was effective, as it may have altered misperceptions of norms regarding healthy eating, though this was not examined here. Interestingly, the socially endorsed HED food images were the most liked by participants, however, proportionately more grams of grapes were consumed versus cookies (i.e. the pattern of liking does not match the proportion of grams consumed). However, a greater proportion of calories were consumed overall from cookies than grapes, which might suggest that the liking is aligned with energy content (and palatability of the food), rather than grams consumed (i.e. volume). This may also demonstrate that these social norms may influence and alter behaviour in a way that is in contrast to personal likes and attitudes. Of course, these kinds of effects could also be moderated by other social aspects, such as social desirability, as participants wished to act in line with the correct norm around LED foods and fit in (Boyd & Ellison, 2007) but it does suggest the powerful effects that social norms may have.

One point to reflect on with the current study, is that it did not explicitly state a norm to participants and participants did not explicitly note the number of likes or guess the aims of the study. This seems to suggest that the manipulation implicitly conveyed normative information. This is similar to previous work that implied a norm via the presence of empty wrappers, signalling a particular food choice (Prinsen et al. 2013). Further, the present study did not imply a clear descriptive norm, as previous work has (Robinson et al., 2014). Instead, our manipulation conveyed that certain Instagram posts were popular and liked by a significant number of individuals. This is also conceptually similar to exposing participants to liking norms, which have also been shown to nudge healthy eating (Thomas et al., 2016). Taken together, our approach is a deviation from previous research, however, we note similar outcomes, and more importantly, our findings suggest that social media is a plausible method by which social norms are transmitted on a day-to-day basis, by posts and pictures of food that are socially endorsed. Further work exploring the precise nature of whether these norms were conveyed implicitly or explicitly is needed to understand fully how the manipulation exerted an effect.

Whilst it was beyond the scope of this study to test how communicating norms via social media compares to other routes of delivery (e.g. posters or text messages), it is possible that social media and the social functions that it facilitates provides a unique environment in which norms about food choice and consumption may be communicated. Hence, with further research, it may be possible to translate these findings into guidance for using social media, or potentially as a form of intervention delivered via social media, to nudge healthy eating in a unique, but simple and effective manner (e.g. encouraging users to follow more accounts that post images of socially endorsed LED foods). However, it may also be important to educate users on what constitutes LED foods and HED foods, so that they can successfully follow the correct accounts. This is particularly important given that LED foods appear to be less apparent on social media sites (Holmberg et al., 2016). Harnessing this knowledge could also contribute to understanding how the advertising and marketing industry impacts eating behaviour via social media (Lutfaeli et al., 2020) and add to previous literature demonstrating the effect norms have within advertising (Kim et al., 2015; Lutfaeli et al., 2020). Utilising social norms as part of interventions to correct misperceptions could be one way of harnessing this knowledge, or even having influencers communicate more about LED foods and validate each others' LED posts, rather than branded, HED foods (Holmberg et al., 2016; Kusumasondjaja & Tjiptono, 2019; Qutteina et al., 2019). However, further research is required to examine whether these acute effects persist, and can exert a long-term influence on eating behaviour, first.

Further research is also required to investigate the underlying mechanisms of how norms influence behaviour via social media and the factors – relating to social endorsement – that may amplify the effects demonstrated. Such factors may include social aspects such as social desirability, or perhaps cognitive elements, such as priming and attention to social norms, as memory and attention for unhealthy food posts have been found to be enhanced compared to healthy or control food posts (Murphy, Corcoran, Tatlow-Golden, Boyland & Rooney, 2020). Future work should look to investigate these.

To our knowledge, this research provides the first experimental evidence that social norms, communicated via social media, directly affects eating behaviour, measured objectively within laboratory settings. However, there are some limitations to this study. Firstly, while an effect was found within the controlled settings of the laboratory, we do not know whether this effect will withstand translation beyond, which limits the scope of these results. Although other social norm manipulations in the laboratory have successfully transferred to the field (Thomas et al., 2017), this remains to be tested here. In a similar vein, further work is required to understand whether genuine social media use and posts produce similar effects, also. We also note that while we demonstrate an effect with one type of fruit, this may not generalise to all fruits, or indeed other LED foods such as vegetables. Thus, further research incorporating a wider selection of foods to examine if these effects are also observed with a wider range of LED foods would be beneficial. Secondly, we note the inherent limitation of using a woman only student sample. Such samples are not unusual in eating behaviour studies, and indeed, it has been found that women are more prone to social influences around eating than men (Robinson, 2015), however, future work should examine whether the effects observed here extend to men, also. Thirdly, it may be argued that participants were simply being primed, rather than actually perceiving a norm. The former may be true if all likes were the same, however, we varied these across conditions, and showed the same images to all participants, to control for a simple priming effect. Finally, while we have observed an effect, the mechanism by which it occurred is unknown; it may be that exposure to the norms corrected a misperception here, or possibly enhanced the hedonic appraisal of the LED foods. This is presently unclear, but needs to be examined in future work, to fully understand how norms exert their effect.

5. Conclusions

This study has demonstrated that social media may implicitly affect our eating behaviour, by communicating social norms. Here, socially endorsed images of LED foods resulted in a higher proportion of grapes being consumed by participants, subsequently. This suggests that manipulating social norms through social media may be a fruitful avenue to nudge the consumption of healthy nutritious foods such as fruit and vegetables. Further work is required to explore whether it is possible to translate this work into useful guidance for using social media, or interventions delivered via social media.

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Ethical statement:

Ethical approval was granted by Aston Life and Health Sciences Ethics Committee (#1263) and carried out in accordance with the ethical standards of the 1975 Declaration of Helsinki, as revised in 1983. Informed consent was obtained from all participants.