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Influence of social-normative information on the modeling of food-related decisions

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ABSTRACT

Social modeling is a powerful influence on people's food intake: When there is a clear and consistent norm, people eat more when eating with someone who eats a lot and eat less when eating with someone who eats only a little. In three studies, the present research examined how clear versus ambiguous social-normative information influences the modeling of food-related decisions. Using a novel online decision-making paradigm, female participants (total $N = 1042$) were provided with information about how many cookies previous participants had supposedly selected (no information was provided in the control condition), and then decided how many cookies they would choose for a snack. When there was a clear and consistent norm, the typical social modeling effect was observed. When there was a small number of "dissenters" whose responses conflicted with the norm set by the majority, participants' cookie selection still conformed to the behaviour of the majority (Studies 1 and 2). It was only when the behaviour of the previous participants was highly ambiguous that participants behaved as if they had been given no normative information (Study 3). By demonstrating that, except in extreme cases, people use the available information to discern a social norm that influences their behaviour, these findings highlight the power of social norms related to food-related decisions.

1. Introduction

Social norms are potent drivers of individuals' thoughts, feelings, and behaviour. From the classic work of Latané and Darley on the "Bystander Effect" (Latané & Darley, 1970) to more recent work showing the influence of social norms on energy conservation (Schultz et al., 2018), social norms have been shown to influence behaviour across a variety of domains. One domain in which social norms have a particularly powerful influence is eating behaviour. People frequently eat their meals in the presence of others, and many social situations involve food, thus creating many opportunities for one's food intake to be influenced by the behaviour of others. Given the health implications of one's food intake, understanding the potential impact of social norms on eating behaviour is particularly important.

1.1. Modeling of food intake

There are a variety of different ways in which the behaviour of others (or even their mere presence) can influence one's eating behaviour (see Herman et al., 2019), but some of the most robust evidence is for social modeling – the tendency for individuals to eat an amount that is similar to that of their eating companions. Specifically, individuals tend to eat more when eating with someone who eats a lot and eat less when eating with someone who eats only a little (Vartanian et al., 2015). A meta-analysis of studies examining modeling of food intake found a large overall modeling effect ($r = 0.39$; Vartanian et al., 2015).

Social modeling of food intake has been demonstrated in correlational and experimental studies. For example, when a pair of unacquainted participants watched a video together while snacking on bite-size pieces of pizza, there was a high degree of correspondence between the number of pizza pieces eaten by each of the individuals in the pair (Herman et al., 2005). In the earliest experimental demonstration of the modeling of food intake, Nisbett and Storms (1974) recruited participants for a study under the guise of a "taste test," which required them to taste and rate some crackers. In the control condition, participants completed the task alone and were provided with no social-normative information. Participants in the two experimental conditions ate alongside an experimental confederate who was instructed to eat either

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a lot (20 crackers) or a little (1 cracker). Participants who ate alongside a high-intake experimental confederate ate more than did participants who ate alone, and participants who were paired with a low-intake confederate ate less.

The robustness of the modeling effect is further demonstrated by the fact that modeling can be observed under a variety of conditions. For example, modeling has been observed during meals (Hermans, Larsen, et al., 2012) and with healthy snacks and unhealthy snacks (Hermans et al., 2009; Vartanian et al., 2013), and has been demonstrated in children (Bevelander et al., 2012; Salvy et al., 2008) as well as in adults (e.g., Rosenthal & McSweeney, 1979). The power of modeling is perhaps best demonstrated by research showing that modeling can override physiological drivers of eating. One study found that even participants who were food-deprived for up to 24 h ate minimally when they were paired with an experimental confederate who was instructed to eat very little (Goldman et al., 1991). Another study demonstrated that the magnitude of the suppression caused by a low-intake norm was on par with consuming a full meal-replacement shake prior to taking part in the taste test (Vartanian et al., 2017).

As with other domains of normative influence, the actual presence of another person does not appear to be needed for modeling to occur. The early work of Cialdini and colleagues demonstrated that leaving litter on the ground of a carpark was enough to establish a behavioural norm (i.e., an indication of what other people typically do), which then influenced people's own littering behaviour (Cialdini et al., 1990). Similarly, modeling of food intake has been observed in research using a so-called remote-confederate design. In these studies, the co-eating model is replaced by a written indication of the alleged food intake of 10 bogus prior participants. Participants in these studies eat more when the previous participants set a high norm than when they set a low norm (e.g., Roth et al., 2001). Other approaches to remotely presenting normative information (such as via a video or social-media presentation of the confederate) have likewise shown that participants eat more when the remote confederate eats a lot and eat less when the confederate eats only a little (Bevelander et al., 2013; Hermans, Salvy, et al., 2012). A meta-analytic review showed that the magnitude of the modeling effect was identical regardless of whether the social model was present or remote (Vartanian et al., 2015).

Modeling of food intake has been explained from a normative perspective positing that, because the appropriate amount of food to eat in social situations is often unclear, people use the behaviour of others as a guide to determine how much they should eat (Herman et al., 2003). The Theory of Normal Eating (Herman et al., 2019) further maintains that individuals are motivated to maximise their intake of highly palatable food without eating "excessively," and that excess is determined relative to what others are eating. In this sense, an eating companion provides an upper limit for how much food is appropriate to eat. If the companion eats very little, then the upper limit is set low, and one's own food intake will be correspondingly inhibited. If, however, the companion eats a lot, then the upper limit is set high, and one may eat freely without being concerned about exceeding the established norm of appropriate intake. The available evidence suggests that individuals are more likely to inhibit their food intake when eating with someone who eats minimally than they are to overindulge when their eating companion eats a lot: A meta-analytic review of the social modeling of food intake found a stronger inhibition effect ($d = 0.47$) than augmentation effect ($d = 0.29$) (Vartanian et al., 2015). The observed asymmetry in modeling provides support for the view that one's eating companion establishes an upper limit of acceptable food intake. That is, one ought not exceed the limit set by others, but one does not necessarily need to reach the limit, and may indeed eat less than that upper limit.

1.2. Clear versus ambiguous social norms

To date, almost all modeling studies have used a clear and consistent norm for both the high- and low-intake conditions. In studies with a live model, the food intake of the model is fixed to a specific amount (e.g., 1 cracker or 20 crackers) and is invariant across participants within a condition. Even the remote-confederate design typically maintains a narrow range of values within a particular condition. For example, participants might be led to believe that the 10 (bogus) previous participants in these studies had eaten between 3 and 5 bite-sized cookies (with a mean of 4) in the low-norm condition, and between 13 and 15 bite-sized cookies (with a mean of 14) in the high-norm condition. These studies leave unexplored the question of how ambiguous social norms might influence people's food intake behaviour.

The early work of Solomon Asch (1955) provides insight into one approach that can be used to examine how clear versus ambiguous norms influence behaviour. The most well-known finding from this research is that naïve participants who are exposed to a consistent (or what Asch called unanimous) incorrect judgment by fellow "participants" (actually experimental confederates) will often provide the same obviously incorrect response. Although Asch's early studies focused on people's behaviour when there was a consistent norm, his subsequent research examined how people behave when exposed to ambiguous (or non-unanimous, in Asch's terms) social-normative information. That is, he examined whether introducing a single dissenting individual, whose response deviated from the norm set by the majority, would influence naïve participants' responses. In these studies, when one of the confederates broke from the group and gave the correct response (which agreed with the participants' perception), conformity to the group dropped substantially, presumably because participants felt free to behave as they wanted to (i.e., give the correct response) (Asch, 1955).

In the context of eating behavior, only one study to date has examined how people respond to ambiguous norms (Leone et al., 2007). In contrast to the clear norms typically used in remote-confederate studies, this study used an ambiguous-norm condition in which the information provided to participants indicated that the behaviour of previous participants was quite varied, with the number of cookies allegedly eaten by past participants ranging from 4 to 14. This study found that the pattern of consumption for participants in the ambiguous-norm condition was similar to the behaviour of participants in the no-norm control condition. Based on these findings, the authors concluded that ambiguous norms might be functionally equivalent to there being no norm at all.

In sum, people will generally adhere to a clear social norm, even if that clear norm deviates from how they otherwise might behave. However, when the norms are more ambiguous, it appears that people are essentially freed from these normative constraints, allowing them to behave as they typically would (in the absence of social-norm information). Further research is needed to support this conclusion in the context of food-related decisions.

1.3. The present research

The aim of the present research was to develop a better understanding of how clear versus ambiguous social-normative information influences people's food-related decisions. Across three studies, two different approaches were used to examine the effect of varying degrees of ambiguity in social-normative information on food-related decisions. Previous research has demonstrated that decisions regarding food selection that are made prior to a meal ("pre-meal decisions") are a key determinant of how much someone will eat (Fay et al., 2011), and thus it is useful to understand how social-normative information influences these decisions.

In all three studies, participants were provided with information about the number of cookies that previous participants supposedly selected, and then indicated how many cookies they themselves would choose for a snack. Study 1 used an Asch-like paradigm in which participants were exposed to either a clear norm or slightly ambiguous information, which consisted of a majority norm along with two dissenters who deviated from the norm. Study 2 and 3 used an even more

ambiguous norm to further examine the influence of clear versus ambiguous social-normative information on food-related decisions. Examining how people's food-related decisions are influenced by ambiguous social-normative information will provide a more accurate parallel to the type of social-normative information that people are exposed to in real eating contexts.

2. Study 1

Study 1 built on previous research by examining the impact of clear norms (when all group members behave in a consistent way) versus slightly ambiguous norms (when there are some dissenters who behave in a way that diverges from the group norm) on food selection. Participants took part in an online study in which they were exposed to one of four experimental conditions (low-norm [LN], high-norm [HN], low-majority/high-dissenters [LMHD; which consisted of a low-norm majority along with two high-norm dissenters] or high-majority/low-dissenters [HMLD; which consisted of a high-norm majority along with two low-norm dissenters]) in which they observed the snacking decisions supposedly made by previous participants in the study. A no-norm (NN) control condition was also included in which participants were not given any information about prior participants' snacking decisions.

Consistent with previous modeling studies, we hypothesised that participants in the low-norm condition would select fewer cookies for a snack than would participants in the no-norm condition, and that participants in the high-norm condition would select more cookies than would participants in the low-norm condition, but possibly no more than participants in the no-norm condition. We also tentatively predicted that, if the behaviour of others sets an upper limit for appropriate selection (as suggested by the Theory of Normal Eating), then the presence of dissenters should allow participants to respond more freely, in which case they should select more cookies in both the low-majority/high-dissenters condition and the high-majority/low-dissenters condition than in the low-norm condition, but not necessarily more than in the no-norm condition.

Another aim of Study 1 was to investigate whether social models influence food-related decisions by providing a norm of appropriate selection. Previous research has shown that perceived appropriateness mediates the relationship between norm condition and food intake (Vartanian et al., 2013). Thus, it was hypothesised that perceptions of the appropriate number of cookies to select would mediate the effect of condition on the number of cookies selected. For all studies, all measures, manipulations, and exclusions are disclosed, as well as the method of determining the final sample size. No additional data were collected after an initial data analysis.

2.1. Method

2.1.1. Participants

Participants were 499 women who were recruited through Prolific Academic. Only female participants were recruited to allow for more direct comparisons to previous behavioural modelling research, which has largely been limited to female participants only. Previous research on modelling of food intake has found an overall large effect ($r = 0.39$; Vartanian et al., 2015). However, given the novelty of the paradigm being used, and the fact that we were asking about food decisions rather than actual intake, we powered the study to detect a small-to-medium effect. A sensitivity analysis using G*Power showed that, with power set at 0.80 and $\alpha = 0.05$, we would have a sample size sufficient to detect an effect size of $d = 0.32$ or $f = 0.16$ (Faul et al., 2009). Participants' mean age was 22.0 years ($SD = 2.19$; range = 18–25) and their mean body mass index (BMI; kg/m^2) was 23.73 ($SD = 5.89$; range 14.37–56.12). With regard to ethnicity, 80.2% identified as Caucasian, 9.3% identified as Asian, 2.2% identified as Black, 0.4% identified as Middle Eastern, and 7.9% identified as "Other". All participants received £0.75 for completing the study. This study was approved by the university's ethics committee.

2.1.2. Remote-confederate manipulation

The present study used a novel "remote-confederate" manipulation that merged the typical remote-confederate task used in the eating literature with aspects of Asch's conformity-task design, all presented in an online format. Participants in the experimental conditions saw an animation depicting 10 alleged past participants taking turns selecting the number of cookies that they would like to eat for a snack (see Fig. 1 for sample images). Following previous research (Roth et al., 2001; Vartanian et al., 2013), the cookie selection displayed in the low-norm condition ranged from 3 to 5 cookies (with a mean of 4), and the cookie selection displayed in the high-norm condition ranged from 13 to 15 cookies (with a mean of 14). The low-majority/high-dissenters (LMHD) condition included eight previous participants whose food selection was in the low-norm range and two previous participants whose food selection was in the high-norm range. This pattern was reversed for the high-majority/low-dissenters (HMLD) condition. After viewing the animation, participants were signalled that it was their turn to make a selection. Participants in the no-norm control condition did not receive any information about the cookie selection of previous participants and proceeded straight to the cookie-selection task.

2.1.3. Measures

Mood and hunger measure. Participants were asked to indicate how hungry they were on a scale ranging from 0 to 100, and this measure was examined as a potential covariate. Participants were also asked to indicate how calm, tired, preoccupied, and stressed they felt on scales ranging from 0 to 100. Given that data for these studies were collected during the height of the COVID-19 lockdown, the mood measures were included to control for any possible effects of mood on cookie selection.

Cookie selection. To assess the critical dependent variable, participants responded to the question, "How many cookies do you think you would eat?" This item was rated using a sliding scale ranging from 0 to 30 cookies. The high upper limit was selected to avoid a possible ceiling effect in the high-norm conditions.

Selection estimates. As a manipulation check, participants were asked to indicate how many cookies other participants in the study had selected, on average. This item was rated using a sliding scale ranging from 0 to 30 cookies.

Perceived appropriateness. To assess participants' perceptions of how many cookies were appropriate to select, participants were asked, "How many cookies was an appropriate number to select in this situation?" This item was rated using a sliding scale ranging from 0 to 30 cookies.

Demographics. Participants reported their gender, age, height, weight, and ethnicity. Each participant's BMI was calculated on the basis of their self-reported height and weight.

Additional measures. Three measures were included for exploratory purposes but are not included in this paper: The Restraint Scale (Herman & Polivy, 1980) and a measure of perceived food-related deprivation (Timmerman & Gregg, 2003) were included as potential moderators, but did not yield any significant interactions, and thus are not discussed further. Participants were also asked to indicate the extent to which several factors (e.g., their emotional state, how much they generally like cookies, and how much other people in the study ate) influenced their cookie selection. However, these questions are unrelated to the aims of this paper and are therefore not discussed.

2.1.4. Procedure

Participants signed up to take part in a study about "snacking decisions." After providing informed consent, participants completed the state mood and hunger measure. Participants were then informed that the purpose of the study was to gain insight from potential customers prior to launching a new product. To begin the task, participants were

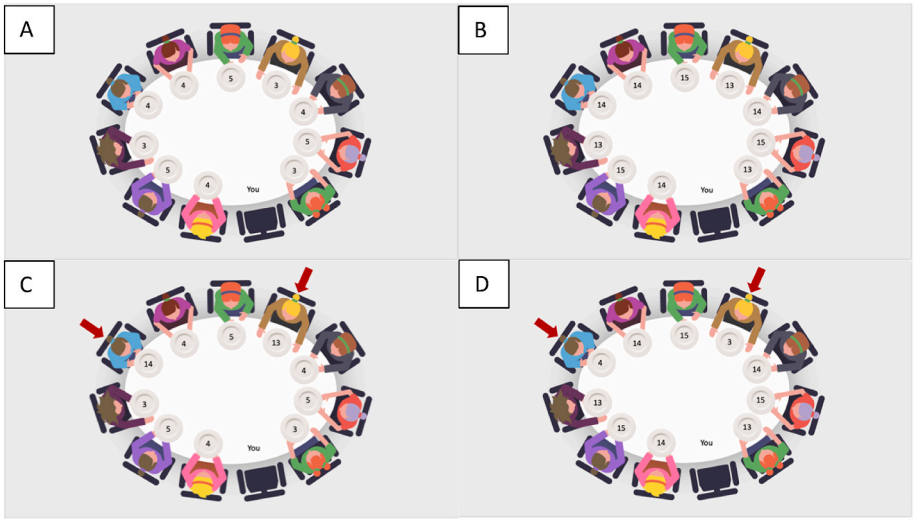

Fig. 1. Sample Animation Images for all Norm Conditions (Study 1) *Note.* The images above are the final images in the sequence that participants viewed for the low-norm (A), high-norm (B), low-majority/high-dissenters (C) and high-majority/low-dissenters conditions (D). The plates displaying the number of cookies selected by "previous participants" started with the participant on the left of the empty seat labelled "You" and moved in a clockwise direction around the table, with each plate appearing one at a time. The red arrows in images C and D refer to the dissenters (these arrows were not visible to participants during the experiment).

first asked to imagine that they were trying a new, bite-size chocolate chip cookie. To enhance the vividness with which participants could imagine eating the cookie, they were shown an image of a bite-size chocolate chip cookie and provided the following description: "*This cookie is bite-size so it can be eaten in one mouthful. With twice the number of chocolate chips, this cookie is extra chocolatey and has been slow-baked to give it a crunchy, golden exterior with a chewy and moist interior.*" Participants were then randomly assigned to one of the five normative-information conditions. All participants, except for those in the no-norm control condition, viewed a brief slideshow depicting 10 alleged past participants taking turns selecting the number of cookies that they would like to eat. After the alleged past participants had selected their cookies, the graphic depicted an empty seat marked "You" to indicate that it was the participant's turn to select their cookies. After watching the animation relevant to their assigned condition, participants indicated how many cookies they would choose. They then responded to the manipulation check, appropriateness question, and demographic questions.

2.1.5. Statistical Analyses

Data were screened for statistical outliers using the interquartile range method (Hoaglin & Iglewicz, 1987). There were outliers on the main outcome variable (i.e., cookie selection; $n = 5$), all from the low-majority/high-dissenters (LMHD) condition. The main analyses are conducted without these outliers, but the analyses were also conducted with the outliers included, and any differences are noted in a footnote. All analyses were conducted using IBM SPSS Statistics (Version 27). Results were considered statistically significant if two-tailed p-values were <.05 and if confidence intervals did not include zero.

Individual one-way ANOVAs were conducted to ensure that there were no significant between-group differences on any of the individual difference variables (age, BMI, hunger, and mood measures) and to verify that the information about prior participants' behaviour was communicated effectively. All pairwise comparisons were conducted with Bonferroni-corrected contrasts.

A one-way ANOVA was used to test the main hypotheses regarding the mean number of cookies selected in each norm condition. There was significant heterogeneity for the main outcome variable. However, previous research has shown that, regardless of the total sample size and variance ratio, for five groups with equal sample size, an F-test is robust in 100% of cases (Blanca et al., 2018). All pairwise comparisons were conducted with Bonferroni-corrected contrasts. Several individual difference variables (BMI, age, hunger, and mood) were examined as potential covariates. Participants' BMI ($r[492] = 0.13$, $p = .004$), hunger level ($r[493] = 0.19$, $p < .001$), and tiredness ratings ($r[493] = 0.12$, $p = .010$) were significantly correlated with cookie selection. However, re-running the analysis with these variables included as covariates did not change the pattern of results, and thus they are not discussed further.

Finally, a mediation analysis was conducted using the PROCESS macro (Model 4; Hayes, 2018) to determine whether participants' perceptions of appropriate selection mediated any differences between conditions in the number of cookies selected. This specific causal model was chosen based on prior theory (Herman et al., 2003, 2019) and empirical research (e.g., Vartanian et al., 2013). Because the independent variable is multi-categorical, effect coding was used to compare each norm condition to the control condition. PROCESS uses a non-parametric bootstrapping procedure involving resampling and replacement to generate confidence intervals for the indirect effect. In the present study, the confidence intervals that were generated were based on 10,000 bootstrap samples. The indirect effect is considered to be significant if the confidence interval does not include zero.

2.2. Results

2.2.1. Preliminary analyses

Individual one-way ANOVAs revealed that there were no differences between conditions on any of the demographic/baseline variables (age, BMI, hunger, and mood measures), for all tests, $F < 1.80$, $p > .130$, $\eta_p^2 < .02$.

2.2.2. Manipulation check

A one-way ANOVA on participants' estimates regarding the number of cookies selected by other participants confirmed the effectiveness of the manipulation, $F(4, 489) = 105.91$, $p < .001$, $\eta_p^2 = .46$. Pairwise contrasts showed that estimates for all conditions were significantly different from one another ($ps < .001$, $ds > 0.68$), except that the no-norm condition did not differ from the high-majority/low-dissenters condition ($p = .563$, $d = 0.22$). See Table 1 for descriptive statistics.

2.2.3. Cookie selection

There was a significant effect of norm condition on the number of cookies selected, $F(4, 489) = 32.95$, $p < .001$, $\eta_p^2 = .21$ (see Table 1 for descriptive statistics). As predicted, participants in the low-norm condition selected fewer cookies on average than did participants in the high-norm and no-norm conditions ($ps < .001$, $ds > 1.10$). The number of cookies selected by participants in the no-norm condition and high-norm condition did not differ significantly ($p > .999$, $d = 0.02$). Participants in the low-majority/high-dissenters condition selected significantly fewer cookies than did participants in the no-norm condition ($p < .001$, $d = 0.87$) and in both of the high-norm conditions ($ps < .001$, $ds >$

Table 1
Mean estimate of prior participants' cookie selection and mean number of cookies selected by participants as a function of norm condition (Study 1).

Norm Condition	Estimate of Prior Participants' Selection		Number of Cookies Selected	
	M	*SD*	*M*	*SD*
Low-norm	4.39[a]	1.10	4.82[a]	2.17
Low-majority/high-dissenters	7.15[b]	2.98	6.22[a]	2.78
No-norm	10.06[c]	5.36	10.53[b]	7.03
High-majority/low-dissenters	10.94[c]	2.78	9.12[b]	4.17
High-norm	12.88[d]	2.53	10.65[b]	4.97

Note. Means within a column with different superscripts are significantly different at $p < .05$.

0.82), but did not differ significantly from the selections made by participants in the low-norm condition ($p = .320$, $d = 0.57$).[1] There were no significant differences between the selections made by participants in the high-majority/low-dissenters condition compared to those made by participants in the no-norm ($p = .292$, $d = 0.25$) or high-norm ($p = .181$, $d = 0.34$) conditions.

Variability analyses. Although there were no significant differences in the mean number of cookies selected by participants in the low-norm and low-majority/high-dissenters conditions (or by participants in the high-norm and high-majority/low-dissenters conditions), as noted in the Statistical Analyses section, there was significant heterogeneity of variance for the overall ANOVA. Therefore, post-hoc follow-up analyses were conducted to examine whether the variability in responses differed between the clear-norm conditions and their dissenter counterparts. Levene's tests indicated that the degree of variability was greater in the low-majority/high-dissenters condition than in the low-norm condition, $F(1,198) = 6.47$, $p = .012$. However, there was no significant difference in the degree of variability in the high-norm and high-majority/low-dissenters conditions, $F(1,198) = 3.52$, $p = .062$.

2.2.4. Mediation by perceived appropriateness

As predicted, in each of the conditions, the effect of norm condition on cookie selection was explained by perceived appropriateness. That is, for each contrast, there was a significant indirect path from norm condition through appropriateness to cookie selection. (see Table 2 for indirect effects estimates).

2.3. Discussion

Consistent with previous research on modeling of food intake, participants selected fewer cookies in the low-norm condition than in the no-norm condition, whereas participants in the high-norm condition did not select more cookies than did those in the no-norm condition. Contrary to prediction, participants in the dissenter conditions also followed the behaviour of the majority; that is, the mean cookie selection for participants in the dissenter conditions did not differ from their clear-norm (no dissenters) counterparts. Nonetheless, participants' cookie selections were more variable in the dissenter conditions (although this was not significant for the high-majority/low-dissenters), suggesting that ambiguity in the social norm information weakened the perceived strength of the norm. Study 2 further examined the impact of ambiguity by (a) directly assessing perceptions of the group norm and (b) examining the effect of highly ambiguous social-normative information.

Table 2
Indirect effects of perceived appropriateness on the number of cookies selected (Study 1).

Comparison	Point estimate	SE	95% CI
Control vs. low-norm	−1.80	0.24	[-2.30, −1.35]
Control vs. low-majority/high-dissenters	−0.89	0.22	[-1.34, −0.48]
Control vs. high-majority/low-dissenters	0.64	0.22	[0.22, 1.07]
Control vs. high-norm	1.63	0.29	[1.09, 2.24]

[1] When outliers were included in the analyses, the difference between the low-majority/high-dissenters (LMHD) condition and the low-norm (LN) condition was significant ($p = .019$), but the LMHD group was still significantly lower than was the NN group ($p < .001$).

3. Study 2

To further examine the effects of ambiguous normative information on food-related decisions and perceptions of the norm, Study 2 again included the low-majority/high-dissenters condition along with the standard low-norm, high-norm, and no-norm conditions. Rather than inferring perception of the group norm, however, participants were directly asked about their perceptions of the norm (i.e., how many cookies *most other participants* had selected). We predicted that participants in the low-majority/high-dissenter condition would be less likely than participants in the low-norm condition to perceive a clear group norm.

Study 2 also included additional conditions that had the same mean number of cookies selected by prior participants as the low-majority/high-dissenters condition (i.e., $M = 7$), but that differed in terms of the range of previous participants' cookie selections: an ambiguous-norm (AMB) condition that consisted of a wider range of values (2–15 cookies); and a moderate-norm (MOD) condition that had a narrow range of values around the mean of 7 (6–8 cookies). We predicted that the perception of the group norm would be weaker in the AMB condition than in the MOD condition. If the perception of the norm in the ambiguous-norm condition is so weak that it is effectively interpreted as if there is no norm (cf. Leone et al., 2007), then we might predict that cookie selection in the ambiguous-norm condition would be greater than it would be in the moderate-norm condition, and perhaps no different than the no-norm control condition.

3.1. Method

3.1.1. Participants

Participants were 310 women who were recruited via Prolific Academic. As in Study 1, we powered this study to detect a small-to-medium effect. A sensitivity analysis using G*Power showed that, with power set at 0.80 and $\alpha = 0.05$, we would have a sample size sufficient to detect an effect size of $d = 0.42$ or $f = 0.21$ (Faul et al., 2009). Participants' mean age was 21.8 years ($SD = 2.15$; range = 18–25) and their mean BMI was 23.37 ($SD = 5.06$; range 15.43–55.10). With regard to ethnicity, 89.1% identified as Caucasian, 5.0% identified as Asian, 2.3% identified as Black, 2.0% identified as Mixed, and 1.7% identified as "Other". All participants received £0.75 for completing the study. This study was approved by the university's ethics committee.

3.1.2. Remote-confederate manipulation

Study 2 used the same type of remote-confederate manipulation as Study 1. Participants in the no-norm condition did not receive any information about the selections made by previous participants. As in Study 1, the low-norm condition showed that previous participants had selected between 3 and 5 cookies (with a mean of 4), the high-norm condition showed that previous participants had selected between 13 and 15 cookies (with a mean of 14), and the low-majority/high-dissenters condition showed eight participants whose cookie selection was in the low-norm range and two past participants whose cookie selection was in the high-norm range (with a mean of 7). The two additional conditions also had a mean of 7 cookies selected but differed in the spread of values: the ambiguous-norm condition showed that

previous participants had selected between 2 and 15 (with a mean of 7), and the moderate-norm condition showed that previous participants had selected between 6 and 8 cookies (with a mean of 7). Sample images for the two new conditions are shown in Fig. 2.

3.1.3. Measures

Study 2 included the same measures used in Study 1 for state mood and hunger, cookie selection, estimates of prior participants' selection (the manipulation check), perceived appropriateness, and demographics. Study 2 also included an additional question to further assess the influence of variability on participants' perceptions of a norm. For this question, participants were asked to indicate how many cookies they thought *most other* participants in the study had selected. Response options included: *0–2*, *3–5*, *6–8*, *9–11*, *12–15*, *16–18*, *19+*, and "*I don't know*". Participants selected a range rather than a specific value because, in the remote-confederate design, the "other participants" do not select a single, specific value but rather select values within a narrow range around a particular mean. As in Study 1, the Restraint Scale was included for exploratory purposes as a potential moderator, but there were no significant interactions, so this measure is not discussed further.

3.1.4. Procedure

The procedure was the same as in Study 1: Participants first completed the cookie-selection task, then participants responded to the manipulation check, answered the norm-perception question, reported their perceptions of the appropriateness norm, and responded to the demographic questions.

3.1.5. Statistical Analyses

Data were screened for statistical outliers using the same method as in Study 1. There were seven outliers on the main outcome variable (cookie selection): low-norm condition, $n = 4$; high-norm condition, $n = 1$; low-majority/high-dissenters condition, $n = 1$; and moderate- norm condition, $n = 1$. As in Study 1, the analyses were also conducted with the outliers included, and any differences are mentioned in a footnote in the Results section.

Individual one-way ANOVAs were conducted to ensure that there were no significant differences between conditions on any individual-difference variables (age, BMI, hunger, and mood measures) and to verify that the information about prior participants' behaviour was communicated effectively. Pairwise comparisons were conducted with Bonferroni-corrected contrasts.

A one-way ANOVA with Bonferroni correction on pairwise comparisons was used to test the effect of norm condition on the mean number of cookies selected. Several individual-difference variables (age, BMI, hunger, and mood) were examined as potential covariates. Only participants' hunger ($r[299] = 0.23$, $p < .001$) was significantly correlated with cookie selection. Re-running the analysis including hunger as a covariate did not change the pattern of results and thus is not discussed further.

To further understand the effect of clear versus ambiguous social information on participants' perceptions of the norm, we examined the proportion of participants selecting the norm that was relevant to their assigned condition. First, the proportion of participants in each of the clear-norm conditions who selected the relevant range was examined to determine whether the majority of participants accurately identified the norm. Next, chi-square analyses were used to compare the proportion of participants in the low-norm versus low-majority/high-dissenters conditions who identified the relevant norm (i.e., the 3–5 cookie range). Finally, we identified the modal response in the ambiguous-norm and moderate-norm conditions, and chi-square analysis was used to compare the proportion of participants in the ambiguous-norm and moderate-norm conditions identifying the modal response in those conditions.

As in Study 1, and consistent with prior theory (Herman et al., 2003, 2019) and empirical research (e.g., Vartanian et al., 2013), the role of perceived appropriateness was tested using the PROCESS macro for SPSS (model 4; Hayes, 2018) to examine whether perceived appropriateness mediated the relationship between norm condition and the number of cookies selected. Effect coding was used to compare each norm condition to the control condition.

3.2. Results

3.2.1. Preliminary analyses

Individual one-way ANOVAs revealed that there were no differences between conditions on any of the demographic or baseline variables (age, BMI, hunger, and mood measures) for all tests, $F < 2.01$, $p > .077$, $\eta_p^2 < .04$.

3.2.2. Manipulation check

The effectiveness of the manipulation was confirmed by a one-way ANOVA on participants' estimates regarding the mean number of cookies selected by other participants, $F(5, 297) = 43.27$, $p < .001$, $\eta_p^2 = .42$ (see Table 3 for descriptive statistics). Most notably, the estimates for participants in the low-majority/high-dissenters and ambiguous-norm conditions did not differ from the estimates given by participants in the moderate-norm condition (both $ps > .999$, $ds < 0.26$).

Table 3
Mean estimate of prior participants' cookie selection and mean number of cookies selected by participants as a function of norm condition (Study 2).

Norm Condition	Estimate of Prior Participants' Selection		Number of Cookies Selected	
	M	*SD*	*M*	*SD*
Low-norm	4.74^{a}	1.19	4.94^{a}	1.82
Low-majority/high-dissenters	7.71^{b}	3.36	$7.25^{a,b}$	4.38
Moderate-norm	7.14^{b}	1.28	7.61^{b}	3.77
No-norm	9.50^{c}	4.29	10.58^{c}	7.33
Ambiguous-norm	7.49^{b}	2.77	$7.08^{a,b}$	3.43
High-norm	12.59^{d}	2.59	10.45^{c}	4.05

Note. Means within a column with different superscripts are significantly different at $p < .05$.

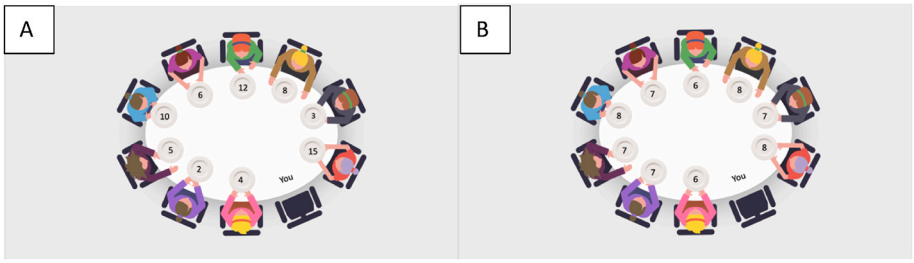

Fig. 2. Sample Animation Images for Ambiguous-norm and Moderate-norm Conditions (Study 2) *Note.* These are the final images in the sequence that participants viewed for the ambiguous norm (A) and moderate-norm conditions (B).

3.2.3. Cookie selection

There was a significant effect of norm condition on the number of cookies selected, $F(5, 297) = 11.65$, $p < .001$, $\eta_p^2 = .16$ (see Table 3 for descriptive statistics). Participants in the low-norm condition selected significantly fewer cookies than did participants in the no-norm and high-norm conditions ($ps < .001$, $ds > 1.19$); the number of cookies selected by participants in the no-norm condition and high-norm condition did not differ significantly ($p > .999$, $d = 0.02$). Participants in the low-majority/high-dissenters condition selected somewhat more cookies than did participants in the low-norm condition, but this difference was not statistically significant when applying the Bonferroni correction ($p = .166$, $d = 0.73$). Finally, participants in the ambiguous-norm condition selected significantly fewer cookies than did participants in the no-norm condition ($p = .001$, $d = 0.65$), but did not differ significantly from participants in the moderate-norm condition ($p > .999$, $d = 0.15$).

3.2.4. Perceptions of the group norm

The majority of participants in the low-norm (83.0%), moderate-norm (86.3%), and high-norm (72.5%) conditions selected the range that was relevant to their assigned condition, confirming that they perceived these clear norms. Participants in the low-majority/high-dissenters condition did identify the relevant norm (i.e., 3–5 cookies; 54.9%), but less frequently than did participants in the low-norm condition, χ^2 (1, $N = 98$) = 8.92, $p = .003$. In the ambiguous-norm condition, the modal response was the 6–8 cookies range, which was selected by 60.8% of participants, suggesting that they did identify a "norm" despite the spread of values. However, the proportion of participants in the ambiguous-norm condition selecting this norm was lower than it was for those in the moderate-norm condition, χ^2 (1, $N = 102$) = 8.51, $p = .004$.

3.2.5. Perceived appropriateness

As in Study 1, there were significant indirect effects of norm condition on the number of cookies participants selected via ratings of how much was appropriate to select for the low-norm and high-norm conditions. However, the indirect effects were not significant for the low-majority/high-dissenters, ambiguous-norm, or moderate-norm conditions (see Table 4 for indirect effects estimates).

3.3. Discussion

Study 2 further investigated the impact of ambiguous norms on people's food decisions and their perceptions of the norm. We found that ambiguous social norm information (whether two dissenters from a clear norm or an even more ambiguous norm) weakened the perceived strength of the norm. However, even in the ambiguous-norm condition, it was still the case that the majority of participants (61%) perceived a common norm (6–8 cookies, the same range as the moderate-norm condition), and the mean number of cookies selected also did not differ from the moderate-norm condition. In other words, participants did not treat this ambiguous norm condition as if they were not given a norm but rather identified what they saw as a norm despite the ambiguity. One explanation for the findings for the ambiguous-norm condition is that, although the ambigious-norm condition displayed a spread of values, most of the values (i.e., the cookie selections of 8 out of the 10 confederates) fell at, or below, the mean number of cookies selected by participants in the no-norm condition (i.e., 10). It may be, therefore, that the ambiguous norm that we used in Study 2 inadvertently conveyed the impression of a "relatively-low norm," as opposed to conveying an "ambiguous" norm as we had original intended. This issue was addressed in Study 3.

Table 4
Indirect effects of condition on the number of cookies selected via perceived appropriateness (Study 2).

Comparison	Point estimate	SE	95% CI
Control vs. low-norm	−1.26	0.29	[-1.86, −0.72]
Control vs. low-majority/high-dissenters	−0.31	0.23	[-0.79, 0.14]
Control vs. moderate-norm	−0.13	0.18	[-0.49, 0.23]
Control vs. ambiguous-norm	−0.31	0.32	[-1.02, 0.23]
Control vs. high-norm	1.97	0.49	[1.08, 2.96]

4. Study 3

In addition to the standard low-, high-, and no-norm conditions, Study 3 also included a highly-ambiguous-norm condition which had a mean of 10 cookies selected by confederates, with an equal distribution of values above and below this midpoint. That is, an equal number of confederates were shown selecting more than and fewer than 10 cookies. We hypothesised that this highly ambiguous norm would be treated as equivalent to not receiving any normative information, both in terms of cookie selection and perception of the group norm.

4.1. Method

4.1.1. Participants

Participants were 233 women who were recruited via Prolific Academic. As in the previous two studies, we powered this study to detect a small-to-medium effect. A sensitivity analysis using G*Power showed that, with power set at 0.80 and $\alpha = 0.05$, we would have a sample size sufficient to detect an effect size of $d = 0.44$ or $f = 0.22$ (Faul et al., 2009). Participants' mean age was 21.7 years ($SD = 2.05$; range = 18–25) and their mean BMI was 22.79 ($SD = 5.06$; range 15.35–46.29). With regard to ethnicity, 93.6% identified as Caucasian, 3.4% identified as Asian, 2.1% identified as Mixed, 0.4% identified as Black, and 0.4% identified as "Other". All participants received £0.75 for completing the study. This study was approved by the university's ethics committee.

4.1.2. Remote-confederate manipulation

Study 3 used the same type of remote-confederate manipulation as Studies 1 and 2. Participants in the no-norm condition did not receive any information about the selections of previous participants. As in Studies 1 and 2, the low-norm condition showed that previous participants had selected between 3 and 5 cookies (with a mean of 4), and the high-norm condition showed that previous participants had selected between 13 and 15 cookies (with a mean of 14). Building on the findings of Study 2, Study 3 included an even more variable ambiguous-norm condition which showed that previous participants had selected between 3 and 17 cookies (with a mean of 10). A sample image for the

Fig. 3. Sample Animation Image for the Ambiguous-Norm Condition (Study 3)
Note. This is the final image in the sequence that participants viewed for the ambiguous-norm condition.

ambiguous-norm condition is shown in Fig. 3.

4.1.3. Measures

Study 3 included the same measures used in Studies 1 and 2 for state mood and hunger, cookie selection, estimates of previous participant selection, perceived appropriateness, and demographics. Study 3 also included the same norm-perception question that was included in Study 2. Finally, as in Studies 1 and 2, the Restraint Scale was included for exploratory purposes as a potential moderator, but there were no significant interactions, so this measure is not discussed further.

4.1.4. Procedure

The procedure was the same as in Study 2: Participants first completed the cookie-selection task, then participants responded to the manipulation checks, the norm-perception question, reported their perceptions of the appropriateness norm, and responded to the demographic questions.

4.1.5. Statistical Analyses

Data were screened for statistical outliers using the same method as in Studies 1 and 2. There were 12 outliers on the main outcome variable (cookie selection): low-norm condition, $n = 6$; high-norm condition, $n = 1$; ambiguous-norm condition, $n = 1$; and no-norm control condition, $n = 4$. As in Studies 1 and 2, the analyses were also conducted with the outliers included, and any differences are mentioned in a footnote in the Results section.

Individual one-way ANOVAs were conducted to ensure that there were no significant differences between conditions on any individual difference variables (age, BMI, hunger, and mood measures) and to verify that the information about previous participants' behaviour was communicated effectively. Pairwise comparisons were conducted with Bonferroni-corrected contrasts.

A one-way ANOVA with Bonferroni correction on pairwise comparisons was used to test the main hypotheses regarding the mean number of cookies selected in each norm condition. Several individual difference variables (age, BMI, hunger, and mood) were examined as potential covariates, but none of these variables was significantly correlated with cookie selection, and they are therefore not discussed further.

With respect to perceptions of the norm, we first examined the proportion of participants in each of the clear-norm conditions who selected the relevant range, to confirm that they perceived these clear norms. Next, we examined the modal response in the ambiguous-norm and no-norm conditions, and chi-square analysis was used to compare the proportion of participants in the no-norm and ambiguous-norm conditions identifying the modal response in those conditions.

As in Studies 1 and 2, the role of perceived appropriateness was tested using the PROCESS macro for SPSS (model 4; Hayes, 2018) to examine whether perceived appropriateness mediated the relationship between norm condition and the number of cookies selected. Effect coding was used to compare each norm condition to the control condition.

4.2. Results

4.2.1. Preliminary analyses

Individual one-way ANOVAs revealed that there were no differences between conditions on any of the demographic or baseline variables (age, BMI, hunger, and mood measures), for all tests, $F < 1.84$, $p > .142$, $\eta_p^2 < .03$.

4.2.2. Manipulation check

The effectiveness of the manipulation was confirmed by a one-way ANOVA on participants' estimates regarding the mean number of cookies selected by previous participants, $F(3, 229) = 75.31$, $p < .001$, $\eta_p^2 = .50$ (see Table 5 for descriptive statistics). Participants in the low-norm condition provided significantly lower estimates than did participants in the no-norm and high-norm conditions (both $ps < .001$, $ds > 1.57$). Estimates provided by participants in the high-norm condition were significantly higher than were those provided by participants in the no-norm condition ($p < .001$, $d = 0.92$). Participants in the ambiguous-norm condition provided estimates that did not differ significantly from those provided by participants in the no-norm condition ($p > .999$, $d = 0.06$).

Table 5
Mean estimate of prior participants' cookie selection and mean number of cookies selected by participants as a function of norm condition (Study 3).

Norm Condition	Estimate of Prior Participants' Selection		Number of Cookies Selected	
	M	*SD*	*M*	*SD*
Low-norm	4.72^a	2.51	4.79^a	1.96
No-norm	10.04^b	4.24	8.61^b	4.53
Ambiguous-norm	9.82^b	2.70	8.37^b	3.71
High-norm	12.86^c	1.97	10.68^c	4.12

Note. Means within a column with different superscripts are significantly different at $p < .05$.

4.2.3. Cookie selection

There was a significant effect of norm condition on the number of cookies selected, $F(2, 229) = 25.02$, $p < .001$, $\eta_p^2 = .25$ (see Table 5 for descriptive statistics). Participants in the low-norm condition selected significantly fewer cookies than did participants in the no-norm, ambiguous-norm, and high-norm conditions ($ps < .001$, $ds > 1.17$). Participants in the no-norm condition selected significantly fewer cookies than did participants in the high-norm condition ($p = .018$, $d = 0.48$). There was no significant difference in the number of cookies selected by participants in the no-norm and ambiguous-norm conditions ($p > .999$, $d = 0.06$).[2]

4.2.4. Perceptions of the group norm

The majority of participants in the low-norm (91.2%) and high-norm (74.6%) conditions selected the range that was relevant to their condition, confirming that participants perceived a clear norm in these conditions. For participants in both the no-norm and ambiguous-norm conditions, the most commonly reported norm was the 9–11 range (26.3% and 43.3%, respectively), but the frequency with which participants in those conditions selected that "norm" was much lower than was the frequency with which participants in the clear-norm conditions selected their relevant norms. A χ^2-test comparing the proportion of participants in the ambiguous-norm and no-norm conditions who selected the 9-11-cookie range indicated the difference between groups was not statistically significant, χ^2 (1, $N = 117$) = 3.72, $p = .054$.

4.2.5. Variability analysis

To provide further support for the similarity between the ambiguous-norm and no-norm conditions, we conducted a post-hoc follow-up analysis to examine whether the variability in participants' cookie selection differed between the two conditions. Levene's test showed no significant difference in the degree of variability between the ambiguous-norm and non-norm conditions, $F(1,115) = 0.80$, $p = .374$.

4.2.6. Perceived appropriateness

There were significant indirect effects of norm condition on the number of cookies participants selected via ratings of how much was appropriate to select for the low-norm and high-norm conditions, but not for the ambiguous-norm condition (see Table 6 for indirect effects estimates).

[2] When outliers were included in the analyses, the difference between the no-norm (NN) and high-norm (HN) condition was not significant ($p = .833$).

Table 6
Indirect effects of condition on the number of cookies selected via perceived appropriateness (Study 3).

Comparison	Point estimate	SE	95% CI
Control vs. low-norm	−1.27	0.31	[-1.95, −0.73]
Control vs. ambiguous-norm	0.19	0.23	[-2.88, 0.62]
Control vs. high-norm	1.06	0.30	[0.56, 1.72]

4.3. Discussion

Study 3 showed that, when the behaviour of previous participants appeared to be highly ambiguous, participants behaved as if they had been given no normative information. This was apparent in the fact that the mean cookie selection did not differ between the ambiguous-norm condition and the no-norm condition and that the proportion of participants identifying the norm as being in the 9–11 range did not differ between the two conditions.

5. General discussion

The aim of the present research was to investigate how clear versus ambiguous social norms influence people's food-related decisions. Consistent with what is observed in laboratory-based modeling studies involving actual food intake (e.g., Vartanian et al., 2013), participants who were exposed to a clear inhibitory norm selected fewer cookies than did those who were not provided with normative information (no-norm control condition) or those who were exposed to a clear augmenting norm. Also consistent with previous research on modeling of actual food intake (Vartanian et al., 2015), the inhibitory effect of a low-intake norm was stronger than was the augmenting effect of a high-intake norm: In two of the three studies, there was no difference in the number of cookies selected for participants in the high-norm condition compared to participants in the no-norm control condition; in the third study, there was a significant augmentation effect, but it was smaller than was the inhibition effect. Finally, consistent with previous research (Vartanian et al., 2013), perceived appropriateness mediated the effect of the clear norms on participants' cookie selection.

The fact that the pattern of results for this online decision-making task mimicked so closely the data observed in laboratory studies of food intake provides evidence for the validity of the current approach to test the impact of social-normative information. That is, participants were not simply responding randomly (in which case there would have been no impact of norm condition) or reiterating the values that they saw from the previous participants (in which case we would not have observed the inhibition/augmentation asymmetry); rather, these data seem to provide a meaningful indication of how people use social-normative information in making food-related decisions.

Given that the present studies assessed the impact of social norms on food-related decisions rather than on actual food intake during an eating occasion, these findings also suggest that social norms can influence pre-meal decisions. People's pre-meal decisions are a key determinant of how much they will eat; that is, prior to a meal, most people will have determined the amount of food that they want to eat and will probably consume the selected portion in its entirety (Brunstrom & Shakeshaft, 2009; Fay et al., 2011). Taken with other research showing that people serve themselves more food in the mere anticipation of a social meal (Ruddock et al., 2021), there is now accumulating evidence that social influences on food intake can extend beyond the eating occasion itself.

5.1. Ambiguous social norm information

The current research extended previous modeling research by investigating how people behave when they are exposed to ambiguous social-normative information. In Study 1, participants were exposed to either a low-majority/high-dissenters or a high-majority/low-dissenters condition. On the basis of Asch's research demonstrating that the presence of even one dissenter can reduce conformity to the majority norm, we predicted that introducing dissenters to the group norm would reduce participants' adherence to the group norm with respect to their cookie selection, freeing participants to eat as much as they want. Contrary to predictions, however, Study 1 found that the mean number of cookies selected by participants in the dissenter conditions did not differ from the selections made by participants in the clear-norm counterpart conditions. It seems that participants in the conflicting-norm conditions were using the majority information to establish a norm, notwithstanding the presence of the dissenters. Note, however, that although there was no mean difference between the clear norm and dissenter conditions in terms of mean cookie selection, participants' cookie selections were more variable when dissenters were present compared to when they were not (at least for the low-norm conditions), suggesting that introducing some ambiguity weakened the strength of the norm.

Even greater ambiguity was added in Study 2 with the inclusion of an ambiguous-norm condition, consisting of a wider range of values (2–15 cookies). We reasoned that, if participants in the ambiguous-norm condition perceive the norm to be so weak that it is effectively interpreted as the absence of a norm (cf. Leone et al., 2007), then their cookie selection should be on par with that of participants in the no-norm control condition. Although the ambiguous norm did appear to weaken the strength of the perceived norm, it did not liberate participants from normative constraints. That is, the majority of participants in the ambiguous-norm condition did perceive a common norm (61% identified the 6-8-cookie range as the norm), and the mean number of cookies selected was no different than in the moderate-norm condition (which had a true range of 6–8 cookies) but was significantly lower than the no-norm control condition. Thus, participants appear to use the available information to derive a norm, even if the information is ambiguous. As was noted earlier, although there was a spread of values in the ambiguous-norm condition, most of the values (8 out of 10) fell at or below the mean number of cookies consumed in the no-norm condition (i.e., 10). It may be, therefore, that the ambiguous norm that we used in Study 2 inadvertently conveyed the impression of a "relatively-low norm."

The final study addressed this issue by including an ambiguous-norm condition in which the number of cookies selected by previous participants was equally distributed above and below 10. With this more extreme ambiguity, participants appeared to treat this context more or less as if they had been given no normative information. The mean cookie selection did not differ between the ambiguous-norm and no-norm conditions. Furthermore, participants in the ambiguous-norm condition and the no-norm condition had the same modal response for the "norm" (the 9-11-cookie range), but it is still the case that the majority of participants (i.e., >50%) in both of these conditions did *not* select that norm, and the proportion of participants selecting that range did not differ between conditions. Overall, when it comes to food-related decisions, it appears that people use the available information to determine a norm and adhere to that norm, unless the information is highly ambiguous.

5.2. Limitations and future directions

The present studies provided some novel insights into the impact of ambiguous social norms on food-related decisions, but there are some limitations that should be noted. First, participants were asked about hypothetical snack choices; their actual intake was not measured. Although the observed pattern for the clear norms matched the pattern observed in laboratory-based studies of food intake (e.g., Vartanian et al., 2013), and pre-consumption decisions have been shown to closely align with actual food intake (e.g., McFerran et al., 2010; Wilkinson et al., 2012), it is possible that imagining the choice one would make may differ from the actual choice one would make in real eating

contexts. For instance, in actual eating contexts, there are often additional factors such as the smell and taste of the food that might be considered. Furthermore, in the direct social environment, the pressure to follow intake norms set by one's eating companions might be heightened. Thus, it will be important for future research to test the impact of ambiguity in social norms on actual food intake.

Another limitation relates to the nature of the sample recruited for the current studies. In order to allow for comparisons to previous behavioural modeling research, the samples in the present studies were restricted to women between the ages of 18 and 25. It is possible that inconsistency in social norms could influence other groups of individuals differently, potentially limiting the generalizability of these findings. It is also possible that the characteristics of the majority group members and dissenters (e.g., gender, age), and the extent to which those characteristics align with the characteristics of the participant, could influence conformity to the group norm (cf. Abrams et al., 1990; Cruwys et al., 2012). Finally, the strength of an individuals' personal norm regarding how much to eat of a particular food (Lewis et al., 2015) could influence the extent to which that person is influenced by clear versus ambiguous norms. These would be worthwhile areas of future research.

Further investigation into the influence of clear versus ambiguous norms on the social modeling of food-related decisions is also warranted. For example, there is some evidence that the serial position of the dissenters may have an important effect on conformity. Morris et al. (1977) investigated the differential effects of a "consensus pre-empting" dissenter (i.e., a dissenting individual who occupies the first position in the response sequence) compared to a "consensus breaking" dissenter (i.e., a dissenter that occupies the fourth position in the response sequence) on conformity reduction. When the dissenter answered first, thus pre-emptively breaking consensus, it had stronger liberating effects for participants than when the dissenter answered later in the sequence. In a similar vein, the number of dissenters might be an important factor in reducing conformity. For example, as the number of dissenters increases, their perceived competence, and thus capacity to influence, increases (Nemeth et al., 1977). Future research should explore how varying the position and/or the number of dissenters influences people's food-related decisions and food intake. Furthermore, future research may wish to examine the effect of varying the variability of observed behaviour, and whether a particular threshold of variability is required to influence an individual's perception of, and conformity to, a given social norm.

6. Conclusion

The present research extended previous work by using a novel, online decision-making paradigm to examine how ambiguity in social-normative information influences the social modeling of food-related decisions. When a clear and consistent norm was apparent, the typical social modeling effect was observed. When there was a small amount of ambiguity created by introducing "dissenters" whose responses conflicted with the norm set by the majority, participants' cookie selection still conformed to the behaviour of the majority. It was only when the behaviour of previous participants' was highly ambiguous that participants behaved as if they had been given no normative information. These findings highlight the power of social norms related to food decisions by demonstrating that, except in extreme cases, people use the available information to discern a social norm that influences their behaviour.

Ethical statement

All three studies in the manuscript were approved by the university's ethics committee and all participants gave informed consent before taking part in the research.

Declaration of competing interest

None.

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References

Abrams, D., Wetherell, M., Cochrane, S., Hogg, M. A., & Turner, J. C. (1990). Knowing what to think by knowing who you are: Self-categorization and the nature of norm formation, conformity and group polarisation. *British Journal of Social Psychology, 29* (2), 97–119. https://doi.org/10.1111/j.2044-8309.1990.tb00892.x

Asch, S. E. (1955). Opinions and social pressure. *Scientific American, 193*(5), 31–35. https://doi.org/10.1038/scientificamerican1155-31

Bevelander, K. E., Anschütz, D. J., Creemers, D. H. M., Kleinjan, M., & Engels, R. C. M. E. (2013). The role of explicit and implicit self-esteem in peer modeling of palatable food intake: A study on social media interaction among youngsters. *PLoS One, 8*(8), Article e72481. https://doi.org/10.1371/journal.pone.0072481

Bevelander, K. E., Anschütz, D. J., & Engels, R. C. M. E. (2012). Social norms in food intake among normal weight and overweight children. *Appetite, 58*(3), 864–872. https://doi.org/10.1016/j.appet.2012.02.003

Blanca, M. J., Alarcón, R., Arnau, J., Bono, R., & Bendayan, R. (2018). Effect of variance ratio on ANOVA robustness: Might 1.5 be the limit? *Behavior Research Methods, 50* (3), 937–962. https://doi.org/10.3758/s13428-017-0918-2

Brunstrom, J. M., & Shakeshaft, N. G. (2009). Measuring affective (liking) and non-affective (expected satiety) determinants of portion size and food reward. *Appetite, 52*(1), 108–114. https://doi.org/10.1016/j.appet.2008.09.002

Cialdini, R. B., Reno, R. R., & Kallgren, C. A. (1990). A focus theory of normative conduct: Recycling the concept of norms to reduce littering in public places. *Journal of Personality and Social Psychology, 58*(6), 1015–1026. https://doi.org/10.1037/0022- 3514.58.6.1015

Cruwys, T., Platow, M. J., Angullia, S. A., Chang, J. M., Diler, S. E., Kirchner, J. L., Lentfer, C. E., Lim, Y. J., Quarisa, A., Tor, V. W. L., & Wadley, A. L. (2012). Modeling of food intake is moderated by salient psychological group membership. *Appetite, 58* (2), 754–757. https://doi.org/10.1016/j.appet.2011.12.002

Faul, F., Erdfelder, E., Buchner, A., & Lang, A.-G. (2009). Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. *Behavior Research Methods, 41*, 1149–1160.

Fay, S. H., Ferriday, D., Hinton, E. C., Shakeshaft, N. G., Rogers, P. J., & Brunstrom, J. M. (2011). What determines real-world meal size? Evidence for pre-meal planning. *Appetite, 56*(2), 284–289. https://doi.org/10.1016/j.appet.2011.01.006

Goldman, S. J., Herman, C. P., & Polivy, J. (1991). Is the effect of a social model on eating attenuated by hunger? *Appetite, 17*(2), 129–140. https://doi.org/10.1016/0195-6663(91)90068-4

Hayes, A. F. (2018). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach* (2nd ed.). Guilford Press.

Herman, C. P., Koenig-Nobert, S., Peterson, J. B., & Polivy, J. (2005). Matching effects on eating: Do individual differences make a difference? *Appetite, 45*(2), 108–109. https://doi.org/10.1016/j.appet.2005.03.013

Herman, C. P., & Polivy, J. (1980). Restrained eating. In A. J. Stunkard (Ed.), *Obesity* (pp. 209–225). Saunders.

Herman, C. P., Polivy, J., Pliner, P., & Vartanian, L. R. (2019). *Social influences on eating.* Springer.

Herman, C. P., Roth, D. A., & Polivy, J. (2003). Effects of the presence of others on food intake: A normative interpretation. *Psychological Bulletin, 129*(6), 873–886. https://doi.org/10.1037/0033-2909.129.6.873

Hermans, R. C. J., Larsen, J. K., Herman, C. P., & Engels, R. C. M. E. (2009). Effects of social modeling on young women's nutrient-dense food intake. *Appetite, 53*(1), 135–138. https://doi.org/10.1016/j.appet.2009.05.004

Hermans, R. C. J., Larsen, J. K., Herman, C. P., & Engels, R. C. M. E. (2012). How much should I eat? Situational norms affect young women's food intake during meal time. *British Journal of Nutrition, 107*(4), 588–594. https://doi:10.1017/S0007114511003278.

Hermans, R. C. J., Salvy, S. J., Larsen, J. K., & Engels, R. C. M. E. (2012). Examining the effects of remote-video confederates on young women's food intake. *Eating Behaviors, 13*(3), 246–251. https://doi.org/10.1016/j.eatbeh.2012.03.008

Hoaglin, D. C., & Iglewicz, B. (1987). Fine-tuning some resistant rules for outlier labeling. *Journal of the American Statistical Association, 82*, 1147–1149. https://doi.org/10.1080/01621459.1987.10478551

Latané, B., & Darley, J. M. (1970). *The unresponsive bystander.* Appleton-Century-Crofts.

Leone, T., Pliner, P., & Herman, C. P. (2007). Influence of clear versus ambiguous normative information on food intake. *Appetite, 49*(1), 58–65. https://doi.org/10.1016/j.appet.2006.11.005

Lewis, H. B., Forwood, S. E., Ahern, A. L., Verlaers, K., Robinson, E., Higgs, S., & Jebb, S. A. (2015). Personal and social norms for food portion sizes in lean and obese adults. *International Journal of Obesity, 39*(8), 1319–1324. https://doi.org/10.1038/ijo.2015.47

McFerran, B., Dahl, D. W., Fitzsimons, G. J., & Morales, A. C. (2010). I'll have what she's having: Effects of social influence and body type on the food choices of others. *Journal of Consumer Research, 36*(6), 915–929. https://doi.org/10.1086/644611

Morris, W. N., Miller, R. S., & Spangenberg, S. (1977). The effects of dissenter position and task difficulty on conformity and response conflict. *Journal of Personality, 45*(2), 251–266. https://doi.org/10.1111/j.1467-6494.1977.tb00150.x

Nemeth, C., Wachter, J., & Endicott, J. (1977). Increasing the size of the minority: Some gains and some losses. *European Journal of Social Psychology, 7*(1), 15–27. https://doi.org/10.1002/ejsp.2420070103

Nisbett, R. E., & Storms, M. D. (1974). Cognitive and social determinants of food intake. In H. London, & R. E. Nisbett (Eds.), *Thought and feeling: Cognitive alteration of feeling states* (pp. 190–208). Aldine.

Rosenthal, B., & McSweeney, F. K. (1979). Modeling influences on eating behavior. *Addictive Behaviors, 4*(3), 205–214. https://doi.org/10.1016/0306-4603(79)90029-7

Roth, D. A., Herman, C. P., Polivy, J., & Pliner, P. (2001). Self-presentational conflict in social eating situations: A normative perspective. *Appetite, 36*(2), 165–171. https://doi.org/10.1006/appe.2000.0388

Ruddock, H. K., Long, E. V., Brunstrom, J. M., Vartanian, L. R., & Higgs, S. (2021). People serve themselves larger portions before a social meal. *Scientific Reports, 11*, 11072. https://doi.org/10.1038/s41598-021-90559-y

Salvy, S.-J., Vartanian, L. R., Coelho, J. S., Jarrin, D., & Pliner, P. P. (2008). The role of familiarity on modeling of eating and food consumption in children. *Appetite, 50*(2), 514–518. https://doi.org/10.1016/j.appet.2007.10.009

Schultz, P. W., Nolan, J. M., Cialdini, R. B., Goldstein, N. J., & Griskevicius, V. (2018). The constructive, destructive, and reconstructive power of social norms: Reprise. *Perspectives on Psychological Science, 13*(2), 249–254. https://doi.org/10.1177/1745691617693325

Timmerman, G. M., & Gregg, E. K. (2003). Dieting, perceived deprivation, and preoccupation with food. *Western Journal of Nursing Research, 25*(4), 405–418. https://doi.org/10.1177/0193945903025004006

Vartanian, L. R., Sokol, N., Herman, C. P., & Polivy, J. (2013). Social models provide a norm of appropriate food intake for young women. *PLoS One, 8*(11), Article e79268. https://doi.org/10.1371/journal.pone.0079268

Vartanian, L. R., Spanos, S., Herman, C. P., & Polivy, J. (2015). Modeling of food intake: A meta-analytic review. *Social Influence, 10*(3), 119–136. https://doi.org/10.1080/15534510.2015.1008037

Vartanian, L. R., Spanos, S., Herman, C. P., & Polivy, J. (2017). Conflicting internal and external eating cues: Impact on food intake and attributions. *Health Psychology, 36*(4), 365–369. https://doi.org/10.1037/hea0000447

Wilkinson, L. L., Hinton, E. C., Fay, S. H., Ferriday, D., Rogers, P. J., & Brunstrom, J. M. (2012). Computer-based assessments of expected satiety predict behavioural measures of portion-size selection and food intake. *Appetite, 59*(3), 933–938. https://doi.org/10.1016/j.appet.2012.09.007