Title: Desire to eat and intake of ‘insect’ containing food is increased by a written passage: the potential role of familiarity in the amelioration of novel food disgust

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Abstract

Over two studies we investigated the effect of various written interventions (passages) on the disgust response towards a food (falafels) which supposedly contained mealworm (insect) flour. Actually, participants (Study 1 N = 80, Study 2 N = 78) were given the same non-mealworm containing food in all conditions. Disgust was measured using: tactile sensitivity, food intake, liking and desire to eat. Results of Study 1 showed that a sustainability passage (sustainability advantages of entomophagy), but not a delicacy passage (oro-sensory qualities of insects), was effective in reducing disgust. In Study 2, contrary to prediction, a passage describing the sustainability and nutritional advantages entomophagy failed to reduce disgust - falafel intake, liking and desire to eat were decreased. However, a passage which described how mealworm flour is produced, did significantly reduce disgust. Taken together, these studies demonstrate that written passages can alter the disgust response, notably resulting in a maintenance of food intake. Interventions that increase the perception of familiarity of a novel food, but not logic-based arguments, may be a key driver of the amelioration of disgust. These results also support the suggestion that altering the ideational component of disgust can result in changes of distaste perception.

Keywords:
Entomophagy
Disgust
Novel food
Tactile Sensitivity
Food Neophobia
Familiarity

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1. Introduction

Due to population growth the demand for animal protein is expected to rise over the next 10 – 30 years (Pelletier & Tyedmers, 2010; van Huis & Oonincx, 2017). As the livestock sector is the third largest contributor to climate change (Steinfeld et al., 2006) a sustainable alternative animal protein needs to be incorporated into the Western diet. Entomophagy, the practice of eating insects, may be a solution due to the environmental sustainability of rearing insects (Alexander et al, 2017; Oonincx & de Boer, 2012; Smetana et al., 2016; van Huis, 2015, 2016; van Huis & Oonincx, 2017; van Huis et al., 2013) and their equal, if not superior, nutritional quality compared to some conventional protein sources (Belluco et al., 2013; DeFoliart, 1992; Kouřimská & Adámková, 2016; Nadeau, Nadeau, Franklin, & Dunkel, 2015; Sun-Waterhouse et al., 2016; van Huis et al., 2013).

Despite the benefits of entomophagy the practice remains widely unacceptable in the Western culture (Hartmann & Siegrist, 2016; van Huis et al., 2013). This lack of acceptance, and consumption, is attributed to the emotion of disgust that is associated with the ingestion of insects. Food is a common elicitor of disgust due to the potential for harm upon its oral incorporation into the body (Rozin, Ruby, & Cohen, 2019). Indeed, disgust is described as one of four types of food rejection by Rozin and Fallon (1987). The notion that disgust drives the rejection of entomophagy is supported by studies which assessed attitudes towards consuming insects and found that disgust emerges as the most common response, and the largest barrier, to entomophagy (Cicatiello, De Rosa, Franco, & Lacetera, 2016; Menozzi, Sogari, Veneziani, Simoni, & Mora, 2017; Ruby, Rozin, & Chan, 2015). Therefore, successful introduction of insect protein into the Western diet will require reducing disgust towards entomophagy.

Many studies have investigated the negative attitudes towards insect consumption to better understand how they can be overcome. Some have argued that increasing familiarity (Caparros Megido et al., 2016; Hartmann, Shi, Giusto, & Siegrist, 2015; Menozzi et al., 2017; Wilkinson et al., 2018) or the
sensory appeal of the insects (Deroy, Reade, & Spence, 2015; Hamerman, 2016; Myers & Pettigre, 2018; Sogari, Menozzi, & Mora, 2017, 2018) will increase their acceptance.

Others have investigated the use of educational interventions to increase the acceptance of entomophagy. Such interventions are based solely on increasing knowledge via the provision of information. These investigations have led to contradictory conclusions about the effectiveness of this type of intervention. Some studies have used consumer profiling to determine factors likely to increase the acceptance of entomophagy and conclude that educational arguments based on the nutritional (Hartmann et al., 2015) and sustainability advantages (Hoek et al., 2011; Verbeke, 2015) of entomophagy may not be effective. Others suggest educational interventions can also not overcome the emotion of disgust (Hartmann & Siegrist, 2016), as it is a deep-rooted and visceral response (Looy, Dunkel, & Wood, 2014) unlikely to be altered by rationalisation. Nonetheless, other studies have found that educational information can be used to increase positive attitudes towards entomophagy (Lensvelt & Steenbekkers, 2014) or increase intention to consume insects (Looy et al., 2014). More recently, Schouteten et al. (2016) found that participants who were given information about the environmental and nutritional advantages of entomophagy, before being asked to taste an insect containing burger, made significantly higher ratings of expected and actual liking and perceived nutritiousness, compared to another condition where they tasted the same burger but were not informed of the insect ingredients, nor given the positive information. This suggests that educational interventions on the topics of sustainability and nutrition can be effective at increasing acceptance of entomophagy.

Results of a study conducted by Verneau et al. (2016) support this suggestion. They investigated the impact of viewing a video outlining some environmental benefits of entomophagy on a) intention to consume insects and b) the behaviour of consuming a cricket containing snack bar. Snack bar consumption was reported in a binary manner, such that participants were scored as either consuming the bar, or not. Participants who viewed this video had increased intention to consume insects, and were more likely to
consume the snack bar, compared to a control condition in which participants viewed a different video, unrelated to entomophagy.

Very few studies which investigate methods to increase the acceptance of entomophagy measure intake of insect-containing food. The authors are aware of only one study which quantitatively measured the amount of insect-containing food consumed by participants (Ammann, Hartmann, & Siegrist, 2018). This was reported in a binary manner, such that participants were categorised as either willing to eat the food or not willing to eat the food. The importance of measuring actual intake lies in the potential disconnect between intention and behaviour. Schlup & Brunner (2018) found that when rating agreement with, and relevance of, arguments in support of entomophagy, participants rated environment-based arguments most highly. However, the importance of participants’ environmental ethics was not a significant predictor of their willingness to consume insects. The authors describe this disconnect between intention and behaviour as the Attitude-Behaviour Gap which posits that attitudes alone are often poor predictors of behaviour (Ajzen, 2001; Vermier & Verbeke, 2006). Similarly, Kraus (1995) argues that attitudes and behaviours are not synonymous and therefore behavioural measures cannot be substituted for the more easily measured attitude response. For these reasons, measuring the amount of food consumed is a useful, and largely novel, method to explore the effectiveness of interventions which aim to increase the acceptance of entomophagy.

1.1 The Present Studies

The present studies investigated disgust reduction as a means of increasing acceptance of entomophagy – something previous research has not explored directly. Over two studies we tested the hypothesis that disgust towards insect containing food would be reduced by three different intervention passages. Some participants were served food that they were told contained insects (mealworm flour). In reality, none of the food contained insects. This was to maintain visual and oro-sensory consistency between the conditions in order to understand the effect of intervention passages on disgust in isolation.
from potentially confounding differences in intrinsic sensory qualities of the food. Disgust responses towards the food were based on measures of: food intake, tactile sensitivity, liking (taste pleasantness) and desire to eat.

Food intake was used as a measure of the disgust response across both studies – as disgust feelings increase, intake should decrease as the food is rejected. This was to overcome the associated limitations of failing to measure actual behaviour. It could be argued that food intake is an implicit measure as it is less associated with explicit decision making than what is required for self-report measures. However, as an individual has control over the amount they consume, they could alter their behaviour depending on demand characteristics of the study. Participants not having either awareness that the measure is being taken and/or the capacity to alter their responding, is the requirement to be deemed an implicit measure in the present studies.

A more implicit measure is tactile (touch) sensitivity as this would appear to be a largely unconscious physiological response accompanying disgust. Previously, tactile sensitivity has been found to increase in response to disgust inducing stimuli (Cannell, 2014; Hunt et al., 2017). This was included in both of the current studies as it is particularly beneficial to use implicit methods when measuring emotion, to potentially rule out demand characteristics as an explanation of an intervention’s effects – something previous research has not prioritised.

In addition to these measures of disgust, explicit self-report measures of liking and desire to eat the food were included. Liking is a measure of distaste (rejection motivated by sensory factors) which is one of two components (the other is ideation) that together form disgust (Rozin & Fallon, 1987) – liking is therefore a possible indicator of a disgust response.

2. Study 1
Study one investigated the effectiveness of two written passages to reduce disgust towards falafels which some participants were told contained mealworm (a type of insect) flour. One was a sensory intervention designed to portray insects as a delicacy and the other was an educational intervention that outlined the sustainability benefits of consuming insects.

The inclusion of a sensory-based intervention was due to findings that the taste and oro-sensory aspects of conventional meats are highly valued by their consumers (Verbeke, 2015; Verbeke, Pérez-Cueto, Barcellos, Krystallis, & Grunert, 2010). This suggests that those who eat meat for its taste are unlikely to consume insects unless they are of equal, or higher, sensory appeal. It has also been theorised that priming the sensory qualities of insects should reduce consumers’ distaste towards them (Deroy et al., 2015). Consistent with this belief, it has been found that those who have more positive taste expectations of insect-containing food are more willing to try these foods (Hartmann et al., 2015). Therefore, highlighting the sensory aspects of insect protein may increase consumers’ likelihood to consume it. Indeed, companies who sell insect-containing foods have been advised to describe their foods as a ‘delicacy or novelty’ (Taylor, 2014). However, empirical evidence on the effectiveness of this approach is lacking.

An educational intervention which outlined sustainability advantages of entomophagy was investigated due to the contradictory findings in the literature about the usefulness of arguments made on this basis. Some studies suggest that knowledge about the sustainability benefits of insects may increase their consumption (Ruby et al., 2015; Sogari, 2015). However, this claim, in addition to claims of the contrary, are mostly speculative as no direct measures of consumption were taken.

Participants were given two types of falafel – one was tasted at baseline and one eaten in an ad libitum portion post-passage. Participants in three conditions (Irrelevant-information, Sustainability and Delicacy) were informed that the post-passage falafel contained mealworm flour, and those in a fourth condition (Control) were informed that the post-passage falafel contained a different herb mix to the baseline sample. The use of two flavours of falafel was therefore necessary in order for the inclusion of
mealworm flour in the second, but not first, sample to be plausible (neither flavours of falafel actually contained mealworm flour). Participants were also given plain flatbreads to consume. This was appropriate as they are a typical accompaniment to falafel but would not be claimed to contain insects. Because of this, they would serve as a within group control for the effect of the information about the falafel. Including flatbread also allows an assessment of potential contamination effects. Measures of disgust (tactile sensitivity) and food acceptance (liking and desire to eat), were taken at baseline and post-passage, and food intake was measured post-passage.

2.1 Hypotheses

Hypothesis one: Post-passage tactile sensitivity will be higher, and liking, desire to eat and food intake lower, in the Irrelevant-information condition than in the Control condition (indicating disgust towards the falafel purported to contain mealworm flour).

Hypothesis two: Post-passage tactile sensitivity will be higher, and liking, desire to eat and food intake lower, in the Irrelevant-information condition than in the Sustainability and Delicacy conditions (indicating that disgust towards falafel purported to contain mealworm flour is reduced by sustainability and delicacy information).

2.2 Method

2.2.1 Participants

80 volunteer students and staff members from the University of Bristol (n = 57, 71% female and n = 23, 29% male. Age: M = 21.6, SD = 4.2 years. BMI: M = 22.7, SD = 3.3 kg/m²) participated in this study in exchange for a free lunch and a chocolate bar. This sample size (n = 20 per group) was based on the assumption that disgust would have a similarly large effect on desire to eat and liking of a tasted food to the effects of consuming a small meal on these measures, observed in previous studies of food reward (Rogers & Hardman, 2015). To prevent a bias in selection towards those interested in trying insect containing food, the advert merely stated that the study was investigating willingness to try ‘world foods’.
Exclusion criteria for this study included being vegan or vegetarian, being on a diet to lose weight, having any allergies or intolerances, not having a good understanding of English and not being willing to expose the underside of their forearm for the purpose of measuring tactile sensitivity. The study was granted ethical approval by the University of Bristol Faculty of Science Research Ethics Committee (approval code: 43241). All participants gave informed consent before the study began.

2.2.2 Design
This was a single-blind, between-subjects study, comparing the effects of four written passages (independent variable), namely Control, Irrelevant-information, Sustainability and Delicacy. Participants were assigned randomly to one of these four conditions. The dependent variables were tactile sensitivity, liking, desire to eat and food intake. All measures, other than food intake, were taken both at baseline and post-passage in order for baseline scores to be included as covariates in the analysis model and thus control for individual differences. As two types of falafel were used in each study session, the order in which each type of falafel was served was counterbalanced. The passage groups differed based on the information they were given about the contents of the second portion of falafel and on the information passage they were asked to read.

2.2.3 Condition Passages
The information passages comprised 233-237 words included in a study booklet, which also contained the liking and desire to eat measures. The passage was read after the first tactile sensitivity measure. Those in the sustainability condition were given a passage promoting the sustainability of entomophagy. Those in the delicacy condition were given a passage emphasising the positive sensory qualities of insects as food both in general, and as a result of cooking. Their taste was also compared to other conventionally consumed meats. The two control conditions (Irrelevant-information and Control) read a similarly constructed passage about electric motors. The contents of the passages are provided in the supplementary material.
2.2.4 Measures and Materials

2.2.4.1 Tactile Sensitivity – Semmes-Weinstein monofilaments. Tactile sensitivity measures were taken using Semmes-Weinstein monofilaments which range in force from 0.008 g to 6.0 g. They are thin pieces of nylon fibre that are typically used in clinical settings. The standard procedure for applying monofilaments, as outlined by Hunt et al. (2017), was followed. They were applied to the underside of the participants non-dominant forearm when rested against a table and all jewellery removed. Care was taken to ensure that the monofilament was placed in the same location for both the baseline and post-passage measures and that this was an area of the arm not obstructed by hair. The filaments were pressed onto the arm until they created a ‘C’ shape. The process began with the lowest weighted filament (0.008 g) and ended when the participant reported sensing the filament. A large cardboard screen with a hole for the arm was placed between the experimenter and the participant to ensure participants did not see the filaments being pressed onto their arm. Soft material was placed on the table to ensure participants could not hear the filaments being put down and thus be prompted to expect sensation.

2.2.4.2 Liking and Desire to eat – 100mm line scales. For measures of self-report food liking and desire to eat, participants were given one falafel and one flatbread taster on two occasions (at baseline and post-passage) during the test session. On one occasion, they would receive one whole ‘Cauldron’ falafel and one quarter of a ‘Sainsbury’s Plain Folded Flatbread’, and on the other, they would be given one ‘Sainsbury’s’ falafel and, again, one quarter of a ‘Sainsbury’s Plain Folded Flatbread’. These foods were served separately in glass taster pots. Measures were obtained through vertical marks made by participants on 100mm horizontal lines anchored ‘Not at all’ and ‘Extremely’, assessing liking and desire to eat based on a single bite of food, based on those used by Rogers & Hardman (2015).

2.2.4.3 Food intake. Food intake was measured after participants had eaten ad libitum from pre-weighed portions of falafels and flatbread. This was recorded using calibrated food scales. Participants were presented with either eight ‘Cauldron’ or ten ‘Sainsbury’s’ falafels (200 g measured to the nearest 0.1 g). These were whichever type had not been given as a taster for the baseline measure of liking and desire.
to eat. The falafels participants were given for the ad libitum meal were therefore the same as the second falafel they had tasted for post-passage measures of liking and desire to eat. They were also given two whole ‘Sainsbury’s Plain Folded Flatbreads’ (72 g measured to the nearest 0.1 g). The falafels were served in a white bowl and the flatbreads were served on a separate white plate.

2.2.5 Procedure

Participants were instructed not to consume any food or calorie-containing beverages for three hours prior to their test session. Participants were tested individually over one 40-minute test session.

First, participants provided an initial hunger and fullness ratings on 100mm scales anchored ‘Not at all’ and ‘Extremely’. Then, a baseline tactile sensitivity measure was taken. After this, participants were invited to taste their first sample of flatbread and falafel and rate their liking and desire to eat. After this, participants were presented their second sample of flatbread and falafel. They were then verbally told (by an impartial experimenter) the food either contained a different herb mix (Control condition), or 50% chickpea and 50% dried mealworm flour (Irrelevant-information, Sustainability and Delicacy conditions). They were then given their corresponding passages to read. They were told to pay close attention to the main ideas of the passage, as they would be asked to recall these later. After they had read the passage, the second tactile sensitivity measure was taken. Participants were then invited to taste the second falafel and flatbread using the same method of tasting and rating as for the first falafel.

Following this, participants were served the ad libitum portion of flatbread and the ad libitum portion of the same falafels as the second taster and were instructed to eat as much or as little of these foods as they would like to. The experimenters left the room for 12 minutes to allow participants to eat comfortably. After 12 minutes, the food was taken away and the amounts remaining weighed. The participant’s height and weight were measured before they were debriefed and thanked for their contribution to the study.
2.2.6 Data analysis

The analysis plan, and study hypotheses, were specified prior to data collection. The tactile sensitivity, taste pleasantness, desire to eat (post-passage minus baseline scores) and food intake data was screened for outliers by converting the data to z-scores. Values with z-scores lying outside of a pre-defined criteria of $z > 3.29$ or $z < -3.29$ (i.e., scores falling outside 99.9% of a normal distribution, approximately $\pm 3$ SD) were excluded (this exclusion criteria has been used in Rogers & Shahrokni, 2018 and Ferriday et al., 2015).

ANCOVA models were used to compare the post-passage measures of each dependent variable (falafel intake, flatbread intake, falafel taste pleasantness, flatbread taste pleasantness, falafel desire to eat, flatbread desire to eat and tactile sensitivity) between the four conditions. Further details of these analyses are described in the footnotes of Table 1.

2.3 Results

On arrival for testing participants mean ± SD hunger and fullness ratings were 64 ± 18 mm and 28 ± 23 mm, respectively. The scores for hunger and also for fullness were similar across the four groups (shown in supplementary materials Table 3).

2.3.1 Effects of information

There were significant effects of condition on post-passage tactile sensitivity, liking for (taste pleasantness) and desire to eat falafel (Table 1). There was no effect of condition on falafel intake (Table 1). The planned comparisons revealed two results consistent with greater disgust towards falafel in the Irrelevant-information condition compared with the Control condition; specifically, higher tactile sensitivity (lower force detected) and lower desire to eat falafel in the Irrelevant-information condition. The planned comparisons also suggest a greater disgust response towards falafel in the Irrelevant-information condition compared to the Sustainability condition, where liking for and desire to eat were lower, and tactile sensitivity somewhat higher, in the Irrelevant-information condition. By contrast, liking and desire to eat were equally low, and tactile sensitivity equally high, in the Irrelevant-information and Delicacy conditions.
There was a significant effect of condition on post-passage liking for flatbread, with lower liking in the Sustainability condition and somewhat lower liking in the Control condition than in the Irrelevant-information condition (Table 2). There was not a significant effect of condition on desire to eat flatbread or intake of flatbread.
Table 1.
Effects of information about the contents of a food (falafel) on tactile sensitivity and evaluation and intake of that food.

<table>
<thead>
<tr>
<th>Information condition</th>
<th>Control ('herb mix')</th>
<th>Irrelevant-information condition (n = 20)</th>
<th>Sustainability information condition</th>
<th>Delicacy information condition</th>
<th>Omnibus ANCOVA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tactile sensitivity, g</td>
<td>0.162 ± 0.028*</td>
<td>0.105 ± 0.028</td>
<td>0.162 ± 0.028</td>
<td>0.162 ± 0.028</td>
<td></td>
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<tr>
<td>p = .006, η² = .189</td>
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<tr>
<td>Taste pleasantness, mm</td>
<td>46 ± 3</td>
<td>52 ± 3</td>
<td>43 ± 3*</td>
<td>53 ± 3*</td>
<td>F(1,75) = 2.93</td>
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<td>Desire to eat, mm</td>
<td>65 ± 3</td>
<td>98 ± 3</td>
<td>54 ± 3*</td>
<td>63 ± 3*</td>
<td>F(1,74) = 4.44</td>
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<td>β = .588; η² = .182</td>
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<tr>
<td>Flatbread intake, g</td>
<td>38 ± 5</td>
<td>63 ± 5</td>
<td>45 ± 5</td>
<td>70 ± 5*</td>
<td>F(1,74) = 0.98</td>
</tr>
<tr>
<td>β = .359; η² = .083</td>
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</table>

Table 2.
Effects of information about the contents of a food (falafel) on tactile sensitivity and evaluation and intake of another food (flatbread) served concurrently.

<table>
<thead>
<tr>
<th>Information condition</th>
<th>Control ('chickpeas')</th>
<th>Irrelevant-information condition (n = 20)</th>
<th>Sustainability information condition</th>
<th>Delicacy information condition</th>
<th>Omnibus ANCOVA</th>
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</table>

1 Data are estimated marginal means ± SE. The covariate in the analyses was the respective measure taken at baseline (i.e., before exposure to the information about the food).
2 The value corresponding to the outlying value in the dataset for desire to eat falafel was excluded (Delicacy condition).
3 Two outlying values (3%) were excluded from the tactile sensitivity dataset (one each excluded from the Sustainability and Delicacy conditions) and one outlying value (1%) was excluded from the desire to eat dataset (Control condition), based on the criteria of z > 3.29 or z < -3.29 (described in the data analysis methods section).
4 Significantly different from Irrelevant-information condition. There were two hypotheses concerning (1) the Control condition versus the Irrelevant-information condition, and (2) the Sustainability and Delicacy information conditions versus the Irrelevant-information conditions.

For the first hypothesis the critical p value = .05, and for the second hypothesis the critical p value = .025 (Bonferroni correction).

Note. Higher tactile sensitivity is demonstrated by a lower score (lower force detected).
2.4 Discussion

Consistent with this study’s hypotheses, information passage was shown to have a significant effect on participants’ tactile sensitivity, and liking for and desire to eat, falafel. Contrary to prediction, condition did not have a significant effect on food intake; however, due to the sample size, and given there are substantial individual differences in food intake even under highly controlled conditions (e.g. Gadah, Brunstrom, & Rogers, 2016), the study was likely underpowered to detect differences in food intake.

It is unsurprising that there was not an effect of condition on ratings of desire to eat, and intake of, flatbread as there was no manipulation relating to the flatbread. The results for liking of flatbread differed from the corresponding results for falafel, particularly in respect of the Sustainability versus Irrelevant-information comparison. Whilst for this comparison liking for falafel was greater in the Sustainability condition, liking for flatbread was greater in the Irrelevant-information condition. This result was not predicted, but it may indicate a contrast effect whereby the decrease in liking for the target food (falafel) caused the non-target, neutral food (flatbread) to be evaluated correspondingly higher. These results are in-keeping with a lack of a contamination effect whereby the presence of a disliked or disgusting food reduces the value of another in close proximity. As the falafel and flatbread were served on separate plates for evaluation (and consumption) proximity was likely minimised, and therefore so was perceived contamination, which is reflective of the results.

A novel and important finding from this study was that there were effects of the interventions on the measure of tactile sensitivity, preliminarily indicating that this method is useful for investigating food disgust. Tactile sensitivity was higher, or somewhat higher, in the Irrelevant-information compared with the Control and Sustainability conditions. As higher tactile sensitivity indicates increased disgust, this study supports the suggestion that Western consumers are disgusted by insect-containing food. The passages also had comparable effects on measures of self-reported desire to eat and liking, demonstrating concordance between implicit and explicit measures.
The lack of increase in tactile sensitivity in the Sustainability condition, but increase in the Delicacy condition, suggests that priming the sustainability of entomophagy may reduce the disgust felt towards eating insects. As disgust is one of the main emotional factors stimulating avoidance of insect-containing food (Yen, 2009), this is a notable finding. The results in the Delicacy condition suggest that priming the sensory qualities of insects did very little to reduce participants’ disgust towards eating them. This contradicts the proposed use of sensory strategies to increase acceptance (e.g. Deroy et al., 2015; Hartmann et al., 2015). These results are, however, consistent with results reported by Sogari (2015). Sogari’s research indicated that the taste and sensory appeal of insects were the least important factors in bringing about the incorporation of insects into the diet. Contrastingly, environmental benefits were the second most important factor in provoking the consumption of insects, following the effects of curiosity.

The suggestion that disgust towards entomophagy is reduced after reading a sustainability-based passage but not a delicacy-based passage, would be strengthened if the disgust reactions in each condition had been reflected in the behavioral measure of food intake. As this was not the case in the present study (likely due to a lack of statistical power), conclusions concerning the relative effectiveness of each intervention remain somewhat tentative at this point - further investigations are required. Therefore, the key conclusions of this study are, 1) asking participants to consume falafels believed to contain mealworm flour leads to altered tactile sensitivity and evaluations of the food indicative of a disgust reaction, and 2) a passage of text can reduce the disgust response.

3. Study 2

Study 2 was designed to extend the findings from Study 1 and to obtain baseline measures of food intake – this was in order to control for individual differences in appetite which would increase power to detect effects on food intake. This study investigated the effectiveness of an educational intervention passage based on the sustainability and nutritional advantages of entomophagy. Sustainability advantages
were included because of their success in Study 1. Nutritional advantages were included due to recent findings that the environmental and nutritional advantages of entomophagy may be key drivers of increasing acceptance (Apostolidis & McLeay, 2016; Menozzi et al., 2017; Ruby et al., 2015). Along with these topics, the educational intervention passage also described how mealworms produced for human consumption are reared in hygienic conditions. This was to reduce the widespread association of insects with vectors of disease (Lensvelt & Steenbekkers, 2014; Lorenz, Libarkin, & Ording, 2014; Ruby et al., 2015) in order to help ensure that the food is not deemed unacceptable due to posing a ‘danger’, as danger is a confounding form of food rejection (Rozin & Fallon, 1987).

There were three conditions in this study: Mealworm + education, Mealworm and Control. A fourth, ‘Threat’, condition was also included as a control for general negative arousal. A manipulation check, however, showed that the method used to induce threat was not believed and consequently it was excluded from the analysis and will not be reported further. Some participants (Mealworm + education and Mealworm conditions) were told the falafels they would be invited to consume contained mealworm flour – participants in the Control condition were not told this. Participants in the Mealworm + education condition were given the educational intervention passage to read. Passages of text were given to those in the Control and Mealworm conditions which were matched for length and topic – they both described the process of producing their respective ingredients. They were also both designed to be affectively neutral, similar to the irrelevant-information passage provided in Study 1, but on a topic related to food.

Study 2 differed from Study 1, firstly, in respect of a two-session design in order to obtain baseline intake measures of falafel and pitta bread (similar to the flatbread given in Study 1). Secondly, in addition to the measures of tactile sensitivity, food intake, desire to eat and liking included in the previous study, the present study included an exploratory implicit measure: latency to eat, as well as a retrospective explicit self-report measure of disgust.
3.1 Hypothesis

Post-passage tactile sensitivity and self-reported disgust will be higher, latency to eat longer, and falafel liking, desire to eat and intake lower in the Mealworm condition than in the 1) Control condition and 2) Mealworm + education condition.

3.2 Method

3.2.1 Participants

78 members of the public participated (n = 55, 70% female and n = 23, 30% male. Age: ranged from 18 – 24 years, 47.4% to 65+ years, 1.3%. BMI: M = 23.6, SD = 3.8 kg/m²) in this laboratory study in exchange for monetary reimbursement. This sample size (n = 26 per group) was determined by power analysis using an effect size (d = 1.0) calculated from the desire to eat data in Study 1. Participants were recruited via an advert on the University webpage and through the research group mailing list. Participants were all non-vegan or vegetarian, did not have any food allergies or intolerances and were not on a diet to lose weight. The study was granted ethical approval by the University of Bristol Faculty of Science Research Ethics Committee (approval code: 22031861441). All participants gave informed consent before the experiment began.

3.2.2 Design

This was a two-session, single-blind, between-subjects study comparing the effects of three written passages (independent variable), namely, Control, Mealworm and Mealworm + education. Participants were randomly assigned to one of these three conditions in blocks of 12 at the start of each week – four participants in each condition were tested each week. The dependent variables were tactile sensitivity, liking, desire to eat, food intake, latency to eat, and self-report disgust. All measures, other than self-report disgust, were taken both at baseline and post-passage in order for baseline scores to be included as covariates in the analysis model and thus control for individual differences. As two types of falafel were used in this study, one in each session, the order in which each type of falafel was served was counterbalanced.
3.2.3 Condition passages
All passages in this study were 320 words in length. They were given to participants after the baseline tactile sensitivity measure. The Control passage informed participants the falafels they would consume were chickpea falafels and went on to describe how spices are produced (designed to be affectively neutral). The Mealworm and Mealworm + education passages informed participants that the falafels they would consume contained 50% chickpeas and 50% dried mealworm flour – this was not true. The Mealworm condition passage went on to describe how mealworm flour is produced (designed to be affectively neutral), whereas the Mealworm + education passage went on to describe the environmental and nutritional advantages of consuming mealworms and the hygienic conditions in which they are reared (educational intervention).

3.2.4 Measures and materials

3.2.4.1 Primary Measures.

3.2.4.1.1 Tactile Sensitivity – Semmes-Weinstein Monofilaments. Tactile sensitivity measures were taken twice: at baseline and post-passage within session two. The same procedure as in Study 1 was used.

3.2.4.1.2 Food intake. Food intake was measured in both session one and session two after participants had eaten ad libitum from pre-weighed portions. Two different flavours (named ‘Original’ and ‘Moroccan spiced’) of falafel were served to participants over the study, and white flour pitta bread. Pitta bread was Sainsbury’s own brand of ‘Sainsbury’s White Pitta’. Falafels used were from the brands ‘Gosh!’ or ‘Cauldron’ (depending on availability). It was ensured that falafels of the same flavour, but from different brands, were matched for ingredient content. There was no evidence that the falafels differed between brands to a degree large enough to affect the results of the study. Participants were served 485 g of water, 200 g falafels (approximately six falafels) cut in half and 120 g pitta bread (approximately two pitta breads; measured to the nearest 0.1 g) cut into inch wide slices - this was to ensure participants were not encouraged to consume more simply in order to finish the piece of pitta bread or falafel. Both foods
were served on the same plate. The portion was re-weighed after participants had consumed as much as they wished, in order to calculate food intake. No participant refused to eat the falafels.

3.2.4.2 Secondary Measures.

3.2.4.2.1 Liking and Desire to eat – 100mm line scales. Self-report food liking and desire to eat were measured in both sessions based on the first taste of both falafel and pitta bread. These tastes were taken from the ad libitum portion. Participants were verbally instructed to take a single bite of each of the two foods and rate their liking and desire to eat on the scales in front of them. Measures were made in the same way as in Study 1.

3.2.4.2.2 Latency to eat – Stopwatch. Latency to eat was defined as the time taken between the experimenter verbally signalling that participants can begin eating, to them taking the first bite of falafel. Latency to eat measures were taken in both session one and two when participants first tasted the falafel. An online stopwatch was used for this measure (found at: www.estopwatch.net), chosen due to its high precision.

3.2.4.2.3 Self-Report Disgust – 100mm line scales. At the end of session two, participants were asked to retrospectively report their feelings of disgust when asked to eat: 1. falafel and 2. pitta bread. This was scored with a vertical mark on a 100mm horizontal line anchored ‘Not at all’ and ‘Extremely’.

3.2.5 Procedure

Participants attended the lab twice, on both occasions around lunch time. They were instructed to refrain from eating and from drinking calorific beverages for three hours prior to the test session.

3.2.5.1 Session One. The first session lasted around 30 minutes and always took place on a Monday. Participants first read the information sheet, asked any questions, then gave informed consent. After completing demographic information participants completed ratings of hunger, fullness and thirst. Participants were then served the ad libitum portion of falafels (type 1), pitta bread and water. Participants then rated their liking and desire to eat the foods after taking a single bite of each. Latency to eat was
measured based on time taken to take the first bite of falafel. It was measured via direct observation from the experimenter with a stopwatch. Following this, participants were informed they had 12 minutes in which to eat ‘as much or as little’ of the food and water as they wished. The experimenter left the room while the participants ate. At the end of the 12 minutes the experimenter returned and participants then rated their hunger, fullness and thirst for a second time and were then thanked and dismissed.

3.2.5.2 Session Two. The second session lasted around one hour and took place on Tuesday to Friday of the week following the first session. The session began with hunger, fullness and thirst ratings and then the baseline tactile sensitivity measure was taken. Participants were then instructed to read the written passage contained within their test booklet which corresponded to their experimental condition. The experimenter was blind to which passage the booklet contained. Participants were told they would be asked to recall concepts of the text later in the study to ensure they maintained focus. The post-passage tactile sensitivity measure followed. Participants then completed hunger, fullness and thirst scales again while the experimenter collected their food for that session. Falafels (type 2), pitta bread and water were served. Following the same procedure as session one participants rated their liking and desire to eat and latency to eat was measured. As in session one, participants were then left for 12 minutes during which time they consumed as much or as little of the foods as they wished from the ad libitum portion. When the experimenter returned the participant was instructed to complete the final hunger, fullness and thirst ratings and to then go on to complete the rest of the booklet. This contained a section where participants were asked to briefly write down something they had learned from the passage to comply with the memory recall cover story. The booklet also included three personality questionnaires (though the results relating to these measures are not included in this paper) and the two questions relating to subjective ratings of retrospective disgust. Finally, participants completed a demand awareness question where they were asked to write what they thought the study was about and to report the frequency of any previous instances of consuming insects. Participants’ height and weight were recorded before they were reimbursed for their time, thanked, and dismissed.
3.2.6 Data analysis

The analysis plan, and study hypotheses, were specified prior to data collection. The tactile sensitivity, food intake, food liking, food desire to eat and latency to eat data (post-passage minus baseline scores) were screened for outliers by converting these data to z-scores and using the same exclusion criteria as in Study 1 (z > 3.29 or z < -3.29; i.e. scores falling outside 99.9% of a normal distribution, approximately ± 3 SD).

ANCOVA models were used to compare the post-passage measures of each dependent variable (falafel intake, pitta intake, falafel taste pleasantness, pitta taste pleasantness, falafel desire to eat, pitta desire to eat, tactile sensitivity and latency to eat) between the three conditions. A one-way ANOVA was used to analyse the self-report disgust data. Further details of these analyses are outlined in the footnotes of Table 3.

3.3 Results

On arrival for the second session participants mean ± SD hunger and fullness ratings (100mm scale) were 65 ± 21 mm and 27 ± 18 mm respectively. The scores for hunger and also for fullness were similar across the three groups (shown in supplementary materials Table 4).

3.3.1 Effects of Information

There were significant effects of condition on post-passage liking for (taste pleasantness), desire to eat, intake of and self-report disgust towards falafel (Table 3). There was no effect of condition on post-passage tactile sensitivity or latency to eat (Table 3). The planned comparisons revealed three results consistent with greater disgust towards falafel in the Mealworm + education condition compared with the Mealworm condition; specifically, lower liking, desire to eat and intake in the Mealworm + education condition than in the Mealworm condition. By contrast, falafel liking, desire to eat and intake did not differ between the Mealworm and Control conditions. However, self-report disgust in the Mealworm condition was higher than in the Control condition and did not differ to the Mealworm + education condition.
There were no effects of condition on post-passage measures of liking for, desire to eat, intake of and self-report disgust towards pitta bread (Table 4).

Table 3.
Effects of information about the contents of the falafel on tactile sensitivity, latency to eat, self-reported disgust, evaluations and intake of falafel.

<table>
<thead>
<tr>
<th>Information condition</th>
<th>Omnibus ANCOVA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control ('chickpeas') (n = 26)</td>
<td></td>
</tr>
<tr>
<td>Tactile sensitivity, g&lt;sup&gt;1,2&lt;/sup&gt;</td>
<td>0.092 ± .016</td>
</tr>
<tr>
<td></td>
<td>p = .234, η&lt;sub&gt;p&lt;/sub&gt;&lt;sup&gt;2&lt;/sup&gt; = .031</td>
</tr>
<tr>
<td>Taste pleasantness, mm&lt;sup&gt;1,2&lt;/sup&gt;</td>
<td>73 ± 3</td>
</tr>
<tr>
<td></td>
<td>p = .164, η&lt;sub&gt;p&lt;/sub&gt;&lt;sup&gt;2&lt;/sup&gt; = .043</td>
</tr>
<tr>
<td>Desire to eat, mm&lt;sup&gt;1,2&lt;/sup&gt;</td>
<td>73 ± 4</td>
</tr>
<tr>
<td></td>
<td>p = .082, η&lt;sub&gt;p&lt;/sub&gt;&lt;sup&gt;2&lt;/sup&gt; = .064</td>
</tr>
<tr>
<td>Falafel intake, g&lt;sup&gt;1,2&lt;/sup&gt;</td>
<td>129 ± 9</td>
</tr>
<tr>
<td></td>
<td>p = .153, η&lt;sub&gt;p&lt;/sub&gt;&lt;sup&gt;2&lt;/sup&gt; = .044</td>
</tr>
<tr>
<td>Latency to eat, s&lt;sup&gt;1,2&lt;/sup&gt;</td>
<td>3.8 ± 0.5</td>
</tr>
<tr>
<td></td>
<td>p = .328, η&lt;sub&gt;p&lt;/sub&gt;&lt;sup&gt;2&lt;/sup&gt; = .020</td>
</tr>
<tr>
<td>Self-reported disgusted, mm (max 100)&lt;sup&gt;1,2&lt;/sup&gt;</td>
<td>3 ± 5*</td>
</tr>
<tr>
<td></td>
<td>p = &lt;.001, η&lt;sub&gt;p&lt;/sub&gt;&lt;sup&gt;2&lt;/sup&gt; = .339</td>
</tr>
</tbody>
</table>

<sup>1</sup>Data are estimated marginal means ± SE. The covariate in the analyses was the respective baseline measure (i.e. before exposure to the information about the food), except for self-report disgust which was analysed without a covariate.

<sup>2</sup>Five participants (6%) data were removed from measures of falafel intake, taste pleasantness, and desire to eat. Two (one in Control and one in Mealworm) were given the wrong falafels for the second measure and three (two in Mealworm + education and one in Mealworm) informed the experimenter that consuming insects was common practice for them. The latter three participants’ data was also removed for the falafel self-report disgust, latency to eat and tactile sensitivity analyses. Two outlying values (3%; one in Control and one in Mealworm) were excluded from the tactile sensitivity dataset, one (1%; Mealworm + education) from the latency to eat dataset, one (1%; Mealworm condition) from the taste pleasantness dataset, and one (1%; Mealworm + education) from the falafel intake dataset based on the criteria of z > 3.29 or z < -3.29.

*Significantly different to the Mealworm condition. There were two hypotheses concerning (1) the Control condition versus the Mealworm condition, and (2) the Mealworm + education condition versus the Mealworm condition. There was a critical p-value of .05 for both comparisons.

Note. Higher tactile sensitivity is demonstrated by a lower score (lower force detected).
3.4 Discussion

3.4.1 Present findings

The results lead to the rejection of the hypothesis as the largest disgust response was exhibited in the Mealworm + education condition, rather than the Mealworm condition. Participants in the Mealworm + education condition had reduced post-passage measures of falafel intake, liking and desire to eat compared to those in the Mealworm condition. The finding from Study 1, that a sustainability intervention reduced disgust, is therefore not replicated by this study.

There were no differences between conditions for post-passage pitta bread intake, liking and desire to eat. These results for pitta bread were expected and show again that the differences for falafel were specific to the mealworm flour manipulation.

Table 4.
Effects of information about the contents of the falafel on intake, evaluation and self-reported disgust of another food (pitta bread) served concurrently.

<table>
<thead>
<tr>
<th>Information condition</th>
<th>Omnibus ANCOVA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control ('chickpeas') (n = 26)</td>
<td></td>
</tr>
<tr>
<td>Taste pleasantness, mm(^1)</td>
<td></td>
</tr>
<tr>
<td>47 ± 3</td>
<td>51 ± 3</td>
</tr>
<tr>
<td>(p = .426, \eta_p^2 = .013)</td>
<td>(p = .829, \eta_p^2 = .001)</td>
</tr>
<tr>
<td>Desire to eat, mm(^1)</td>
<td></td>
</tr>
<tr>
<td>45 ± 4</td>
<td>48 ± 4</td>
</tr>
<tr>
<td>(p = .571, \eta_p^2 = .007)</td>
<td>(p = .741, \eta_p^2 = .002)</td>
</tr>
<tr>
<td>Pitta bread intake, g(^1)</td>
<td></td>
</tr>
<tr>
<td>38 ± 4</td>
<td>42 ± 4</td>
</tr>
<tr>
<td>(p = .412, \eta_p^2 = .014)</td>
<td>(p = .776, \eta_p^2 = .002)</td>
</tr>
<tr>
<td>Self-report disgust, mm (max 100)(^1)</td>
<td></td>
</tr>
<tr>
<td>5 ± 3</td>
<td>8 ± 3</td>
</tr>
<tr>
<td>(p = .466, \eta_p^2 = .011)</td>
<td>(p = .259, \eta_p^2 = .025)</td>
</tr>
</tbody>
</table>

\(^1\)Data are estimated marginal means ± SE. The covariate in the analyses was the respective baseline measure (i.e. before exposure to the information about the food), except for self-report disgust as it was analysed without a covariate.

Data are estimated marginal means ± SE. The covariate in the analyses was the respective baseline measure (i.e. before exposure to the information about the food), except for self-report disgust as it was analysed without a covariate.
The most notable finding from this study was the difference in post-passage falafel intake between conditions. This finding is of particular importance because it is the first time, to our knowledge, that disgust towards insect containing food has shown large effects on food intake, rather than simply on self-report measures of acceptance and/or disgust. The tactile sensitivity results of Study 1 suggested that Western consumers are disgusted by insect-containing food. This assertion is supported by the results of food intake from this study – the reduction in intake signals a disgust response towards entomophagy.

Contrary to prediction there was not an effect of condition on post-passage measures of tactile sensitivity. The baseline measures of tactile sensitivity were higher than those in Study 1, meaning tactile sensitivity was initially high, and therefore there was a reduced likelihood of it increasing further (comparison shown in Table 5). This ceiling effect could have been caused by increased skin temperature among participants. England was experiencing a heatwave during the time of testing so many participants were visibly hot when attending the test session. Skin sensitivity is known to heighten when temperature is raised (B. G. Green, 1977; B. Green, Lederman, & Stevens, 1979) which suggests that temperature is critically important when investigating differences in tactile sensitivity (Kelley & Schmeichel, 2014).

<table>
<thead>
<tr>
<th>Study</th>
<th>Mean Tactile Sensitivity Scores (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baseline</td>
</tr>
<tr>
<td>1</td>
<td>0.16</td>
</tr>
<tr>
<td>2</td>
<td>0.091</td>
</tr>
</tbody>
</table>

Table 5. *Table showing the mean and standard deviation (SD) of tactile sensitivity scores, collated across all conditions, for studies 1 and 2.*

*Note.* Higher tactile sensitivity is demonstrated by a lower value (lower force detected).

There was not a significant effect of condition on the post-passage measure of latency to eat. As latency to eat was largely an exploratory measure and its pattern was, at least, in-keeping with the pattern
of results for falafel intake, liking and desire to eat, it may still be beneficial for future research to investigate this measure further, with a more controlled measurement technique.

Despite greater falafel intake, liking and desire to eat in the Mealworm condition compared to the Mealworm + education condition, self-report disgust did not differ between the two conditions and was higher in the Mealworm condition compared to Control. This might be understood as a demand characteristic - that is, participants in the Mealworm condition felt they should have felt disgusted by eating supposed mealworm containing falafels. This result demonstrates the importance of measuring actual behaviour (in this case food intake) as, here, self-reported attitude does not mirror the behavioural response. This finding supports other authors who stress this importance and describe the discrepancy as the Attitude-Behaviour Gap (Ajzen, 2001; Kraus, 1995; Schlup & Brunner, 2018; Vermier & Verbeke, 2006).

3.4.2 Mealworm Condition
The finding that participants in the Mealworm condition did not differ to those in the Control condition on measures of post-passage falafel liking, desire to eat, and crucially, intake, suggests the disgust response was reduced, which led to increased acceptance and consequently increased intake of a supposedly insect-containing food. The alternative argument, that the prospect of ingesting insect containing food simply fails to induce disgust, is not supported by these results. This is because a disgust response towards entomophagy was demonstrated in both studies – heightened tactile sensitivity in the Irrelevant-information condition in Study 1 and reduced falafel intake in the Mealworm + education condition in Study 2. This establishes that the prospect of consuming insects induces disgust; it therefore follows that disgust was reduced in the Mealworm condition, due to the contents of the passage provided.

The Mealworm passage was designed to be affectively neutral (i.e., not add to or reduce the disgust generated by the initial statement that the falafel contained mealworm flour) but may have primed both the cooking process and the familiarity of the ingredients in the falafel. It described how mealworm flour is produced which involves the mealworms being baked (cooking prime) and turned into flour (a familiar ingredient). Both cooking primes (Deroy, Reade, & Spence, 2015; Hamerman, 2016) and familiarity
interventions (Caparros Megido et al., 2016; Menozzi, Sogari, Veneziani, Simoni, & Mora, 2017) have previously been found to increase acceptance of entomophagy.

The cooking process is very important for animal ingredients such as insects, as it transforms them from being inedible into appealing food (Deroy et al., 2015; Hamerman, 2016). Cooking also allows the animal ingredient to appear less animal like which is important as insects are more likely to be accepted when their animal like properties are minimised (Hartmann et al., 2015).

Familiarity interventions may have their positive effect on the acceptance of entomophagy because food familiarity mitigates food neophobia. Uncertainty about a food product drives food neophobia and leads to rejection (Fallon & Rozin, 1983). Previous studies have found that food neophobia is an important barrier towards insect consumption (Caparros Megido et al., 2014; Hartmann et al., 2015; Tan, Van Den Berg, & Stieger, 2016; Verbeke, 2015; Wilkinson et al., 2018). The corollary of this is that food familiarity (the antithesis of food neophobia) may be a crucial contributor to the acceptance of entomophagy. This is evidenced in previous research; for example, Caparros Megido et al. (2016) found that when insects are incorporated into a familiar food, food neophobia is reduced. This resulted in increased positive ratings of the taste and appearance of the insect-containing food. Other studies have found that the consumption of insects in the processed form increases familiarity with the ingredient, which results in higher ratings of willingness to consume insects in the future (Hartmann & Siegrist, 2016; Menozzi et al., 2017).

It is even possible that the positive effect of cooking primes on the acceptance of entomophagy is mediated by familiarity. Wilkinson et al. (2018) found in a survey study that familiarity with the method used to prepare insect containing food, such as baking, increased ratings on dimensions such as food safety, taste and quality. They additionally found, similarly to the previously described studies, that incorporating insects into familiar products or cooked meals increased acceptance. While it is possible that cooking has inherent positive effects on the acceptance of novel foods, it may be the case that the positive effect of a cooking prime is due to the increased perception of familiarity that it evokes. It may therefore
be the case that the specific familiarity enhancement, more so than the cooking prime, was the driver of the relatively reduced disgust response in the Mealworm condition.

4. General Discussion

Taken together, these studies suggest 1) the prospect of entomophagy induces disgust among those in a ‘Western’ population; 2) the disgust response towards entomophagy reduces food acceptance to the extent that the intake is reduced; and 3) the disgust response can be altered, and reduced, by a written passage. These outcomes are evidenced by the implicit measure of tactile sensitivity (Study 1) and the behavioural measure of food intake (Study 2).

Tactile sensitivity was a novel method in these studies that seems to be a potentially useful measure of the disgust response towards food. First, it was effective in differentiating between experimental conditions in Study 1. Second, it is a non-invasive method that can be used to measure emotion in a way that is free from demand characteristics. However, due to the lack of replication of the effect of disgust on tactile sensitivity in Study 2, the technique of administering the measure should be refined to make it more reproducible. This could be achieved by incorporating an acclimatisation stage at the beginning of test sessions to ensure participants’ skin temperature is as consistent as possible.

Both Study 1 and 2 suggest, quite notably, that the disgust response can be affected by a written passage of text. In the Sustainability condition of Study 1 and the Mealworm condition in Study 2, disgust was altered by the written text and acceptance subsequently increased. This acceptance was extended to a maintenance of consumption in Study 2 – something that has not been investigated in previous research. Despite the relative success of these passages, further consideration is required to understand why passages with apparent similarities in topic had opposite effects on the disgust response across these studies. For example, the Sustainability intervention was more effective at reducing disgust than the
Mealworm + education intervention, despite their similarities. As well, there are unintentional overlaps between the Delicacy intervention and Mealworm passage that require reconciliation with the differences in disgust response between the two conditions.

4.1 Contrasting effectiveness of condition passages across the two studies

4.1.1 Delicacy and Mealworm passages

The Delicacy passage of Study 1 was designed to be a sensory intervention, and the Mealworm passage of Study 2 was designed to be affectively neutral. In the Delicacy intervention the taste of insects is compared to various conventional meats (which could enhance familiarity perception) and methods of cooking insects are outlined. If the discussion of cooking and the familiarity enhancement in the Mealworm passage led to the relative reduction in disgust, then why did the discussion of these topics not reduce disgust in the Delicacy condition? The answer may lie in the specificity of the passage to the food the participant was going to consume after reading the passage. When insect cooking is discussed in the Delicacy intervention some methods for cooking insects are outlined in a general way and the process is said to have positive effects on taste. However, when cooking is discussed in the Mealworm passage the method used to cook the mealworms, purportedly included in the falafels participants will be consuming, is methodically described. Regarding familiarity enhancement, the Delicacy intervention compared the taste of insects to well-known conventional meats, while the Mealworm passage reported the mealworms being ground into a ‘flour’ consistency – a highly transformative process. In both instances the messages in the Mealworm passage are specifically related to mealworms and the food in front of the participant, but this is not the case in the Delicacy intervention. Further, in the Delicacy intervention the messages are all related to the taste of insects which is not the case in the Mealworm passage. Perhaps emphasising taste/oro-sensory qualities is not sufficient to reduce disgust towards a novel food – a claim that remains in-line with Sogari’s (2015) conclusions. The specificity of the Mealworm passage may have resulted in the cooking and familiarity primes having greater impact than in the Delicacy condition.
4.1.2 Sustainability and Mealworm + education passages

The inconsistency in the usefulness of sustainability-based interventions between the two studies could, similarly, be attributed to slight differences in the topics included in the passages. In Study 2 there was the addition of an outline of the nutritional advantages of entomophagy, along with an explanation that the conditions in which mealworms are reared for human consumption are hygienic – this could have contributed to the discrepancy. It is possible that the discussion of hygiene could have alerted participants to the potential for a lack of hygiene that they otherwise would not have considered, thus undermining any reduction in disgust that had resulted from reading about the sustainability (and potentially nutritional) advantages of mealworm consumption.

That being said, the success of the educational intervention in Study 1 is inconsistent with much of the previous literature. Promoting a novel food on the basis of rational arguments has been deemed ineffective in previous studies (e.g. Edwards, 1990; Grob, 1995; Hartmann et al., 2015; Hartmann & Siegrist, 2016; Sheppard & Frazer, 2015; Verbeke et al., 2015), and the findings from Study 2 are in-line with this claim. It is especially difficult for a rational argument to affect behaviour when there is a disconnect between the perceived relevance of arguments and an individual’s decision to consume insects (Schlup & Brunner, 2018).

In a similar vein, recent studies have claimed that information cannot be used to alter emotion, though self-reports of sensory judgements can be affected by the provision of information. One study investigated how participants evaluated the ‘appropriateness’ of cricket containing buns when given either negative, positive (including nutritional and environmental advantages) or neutral information. The effect of this information on participants’ sensory judgements and emotions was measured. Information affected sensory evaluations before actual tasting of the food, with the negative information leading to significantly lower perceptions of various sensory attributes than the positive or control information. However, information did not lead to differences in emotions across the groups (Pambo, Okello, Mbeche, Kinyuru, & Alemu, 2018). Similarly, Schouteten et al. (2016) found that despite the provision of information about the
benefits of entomophagy increasing overall liking of an insect-burger, the information did not affect emotional conceptualisations. These findings are in-keeping with the results of Study 2 in which educational information was unable to prevent an increase in emotion (disgust), although in Study 2 it also did not prevent a decrease in the sensory judgement of taste pleasantness (liking).

Based on the present results it is possible that the specificity of a passage is important and enhancing familiarity perception (and perhaps discussing the food being cooked) may be effective at reducing disgust towards entomophagy. Within the context of the present results, and the related literature, it seems that educational interventions based on rational arguments are not reliably effective at reducing the disgust response towards entomophagy. Across these studies the overall inconsistency in the type of written passage that reduced disgust suggests that small nuances in wording might have large effects on outcomes. Due to this high level of uncertainty, further controlled experiments are required to determine which aspects of interventions, if any, are reliably successful.

4.2 The potential role of Ideation in causing Distaste

This research raises a noteworthy theoretical point in relation to the theory of disgust put forward by Rozin & Fallon (1987). They define disgust as a combination of distaste and ideational factors and, further, suggest that negative ideation can cause distaste. An example of dried cockroaches which taste like sugar is used to illustrate this point – cockroaches which taste like sugar would not taste pleasant.

There is evidence that the food rejection across these studies, which was demonstrated by reduced desire to eat (Studies 1 and 2) and reduced food intake (Study 2), was caused by ideation and distaste. The argument is as follows; as falafel type was counterbalanced across conditions, rejection cannot be attributed to genuine differences in the oro-sensory qualities of the falafels. It is therefore highly likely that the food rejection originated solely from the only manipulation that was implemented: knowledge (ideation) that the falafels contained mealworm flour. Despite the lack of genuine differences in the sensory qualities of the foods, liking, a measure of distaste, was also affected significantly in both studies. This supports the theoretical suggestion that ideation causes distaste. In other words, the (false)
knowledge that the falafels contained mealworm flour caused them to taste unpleasant – that is, food
disgust is, at least in part, a ‘nasty taste’.

These results can also be viewed in relation to the Rogers & Hardman (2015) model of food reward. This model depicts food reward (measured by desire to eat) determined by liking (measured by taste pleasantness) and ‘wanting’ (measured by desire to eat minus taste pleasantness). In turn, food reward drives food intake. Across both of the present studies, measures of liking, desire to eat and intake tended to be similarly affected by the passages – they followed the same patterns of change. Therefore, the present data are consistent with a decrease in liking driving a decrease in food reward and consequently a decrease in intake. It is noteworthy, however, that the observed effects on desire to eat were somewhat larger than the effects on liking (especially in Study 1), meaning the effect on desire to eat cannot be explained by a decrease in liking alone. This indicates that the reduction in desire to eat comprised a decrease in both liking and wanting (desire to eat minus liking). This is preliminary evidence that ideation appears to cause disgust by affecting both liking and wanting. Further studies are required to test effects of ideation on liking versus wanting, as our previous research demonstrates the potential for participants to confuse pleasantness of taste (liking) with desire to eat (liking plus wanting) (Rogers & Hardman, 2015), leading to effects on wanting to be misclassified as effects on liking.

4.3 Future directions

Due to the unreliability of the tactile sensitivity measure used in these studies, other implicit and physiological measures of affect could be explored. Heart rate variability (HRV) could be one such measure. HRV is a measure of the variation in time intervals between heart beats - known as the R-R interval. HRV has been consistently found to increase in response to core disgust (De Jong, van Overveld, & Peters, 2011; Ottaviani, Mancini, Petrocchi, Medea, & Couyoumdjian, 2013; Rohrmann & Hopp, 2008) but decreases in response to other negative emotions (fear, anger, anxiety; Kreibig, 2010). This means HRV can measure the disgust response in isolation of confounding negative emotions, as well as measuring disgust implicitly.
HRV has not been used to measure insect-food disgust so this would be a novel, and potentially useful, application of it.

Future research may also benefit from further investigating the use of cooking primes, and emphasising the perception of familiarity, in order to reduce the disgust response towards entomophagy—and potentially other novel animal foods (e.g. cultured meat). It may be useful to isolate the effects of cooking and familiarity interventions in order to understand their individual contributions to potentially reducing disgust for use in real world applications.

Further research could be carried out to dissect the effects of different aspects (environment, nutrition and hygiene) of the educational intervention used in Study 2. This could be achieved in a study comparing each aspect with an Irrelevant-information condition, as used in Study 1. It may be that not all aspects have negative effects. It may also be interesting to investigate the usefulness of interventions when the food served actually contains insects, either visibly or not. It may be the case that even larger effects would be seen if insects were visible.

4.4 Limitations
Study 2 lacked a true control condition in which participants were told they would eat mealworms. The Mealworm condition was designed to achieve this but, instead, reduced disgust. It would have been preferable to include an Irrelevant-information condition in Study 2, in addition to the other conditions.

As the tactile sensitivity measures did not differ between conditions in Study 2, this study lacked evidence of an effect from a truly implicit measure of the disgust response. Therefore, the results, even for food intake, being due to demand characteristics cannot be entirely ruled out.

5. Conclusion
These studies show that disgust is the emotion that underlies the rejection of entomophagy among the ‘Western’ population. Most notably, it has been shown that a short passage of text can reduce the disgust response to the extent that acceptance, and intake, of supposed insect containing food is not reduced compared to Control. The present findings, in combination with the conclusions of previous studies relating to food neophobia, suggest familiarity plays a role in reducing food-disgust. However, further research would be required to better understand the nuance in wording, or topic, that causes seemingly large changes in emotion. The conclusions of these studies were reached using novel measures in this research area: actual food intake and tactile sensitivity (an implicit measure). The latter may be useful in future studies if administered under carefully controlled ambient conditions. Indeed, the development of implicit measures for the emotion of disgust should be prioritised in order to bridge the ‘attitude-behaviour gap’. Finally, this research can inform our understanding of the interplay between the two components of food-disgust - distaste and ideation - and supports the suggestion that ideation plays a role in causing distaste.

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Author contributions
CM, SB and PR conceived and designed Study 1, MG and PR designed Study 2. MG carried out data collection and data analysis (along with PR) for Study 2, wrote Study 2 and prepared the manuscript. CM and SB carried out data collection and CM wrote Study 1, which was adapted by MG when preparing the manuscript. PR conducted data analysis for Study 1, contributed to the preparation of the manuscript and gave detailed revisions throughout, as well as contributing key theoretical ideas. DH contributed advice and knowledge associated with disgust and tactile sensitivity as well as manuscript revisions. DH also trained CM, SB and MG to take tactile sensitivity measures.
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