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Encouraging willingness to try insect foods with a utility-value intervention

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ABSTRACT

Despite the benefits of eating insects (entomophagy), Western society is often inclined to reject this practice based on initial reactions of disgust. It is suggested there is potential to overcome this attitude through increasing interest and gaining knowledge of the benefits. One way to accomplish this is through an adapted utility-value intervention, traditionally applied in education research, to increase interest and perceived value in a topic. Across two studies (each with a one-month follow-up) participants researched and wrote an essay designed to increase interest and value in entomophagy or a control essay. Participants then completed a rating task assessing their willingness to try insect and familiar foods, along with other key attributes (e.g., sustainability). The utility-value intervention increased willingness to try insect foods as well as other key attributes compared to a non-insect control essay (Study 1). Unexpectedly, we also found a potentially similar (but smaller) effect of researching an insect-based recipe (Study 2) on willingness to try. The effects found in both studies were consistent at follow-up. These findings indicate the usefulness of utility-value interventions in encouraging entomophagy but also suggest that exposure to information about insect food, although less effective than a utility-value intervention, may also be sufficient.

1. Introduction

Entomophagy – eating insects – has been practiced for centuries and in some cultures, it is already a key sustainable protein source (Gahukar, 2011). The need for more sustainable protein sources is becoming more pressing over time. As the population continues to grow and consumption of animal-derived proteins increases, sourcing sufficient high-quality protein is likely to become a global challenge by 2050 (Boland et al., 2013). Traditional animal-derived protein sources have much larger negative environmental impacts in comparison to insect-based protein sources (van Huis, 2013). Problems stemming from the production of traditional animal-derived proteins such as greenhouse gas emissions, water consumption, and scarcity of resources to feed livestock, are all growing concerns for which entomophagy is a viable alternative (Gahukar, 2011; van Huis, 2013). While the sustainability credentials of insect-based foods have been questioned, mainly due to a lack of data on the impact of wide-scale industrial production, which accounts for approximately only 2% of products at present (Skotnicka, Karwowska, Kłobukowski, Borkowska, & Pieszko, 2021), research suggests that insect-based foods are more sustainable than conventional livestock systems (e.g., Broiler chickens and beef cattle; van Huis & Oonincx, 2017), and certain meat substitutes such as lab-grown meat, dairy-based and gluten-based alternatives (Smetana, Mathys, Knoch, & Heinz, 2015). Not only is the consumption of insects a more sustainable alternative to traditional animal-derived proteins, insect-based foods also boast higher nutritional value and safer consumption in terms of animal transmitted diseases than traditional protein sources (Lombardi, Vecchio, Borrello, Caracciolo, & Cembalo, 2019).

One of the main issues with adopting entomophagy is that the practice is typically met with aversion in Western cultures (La Barbera, Verneau, Amato, & Grunert, 2018). Several factors are said to contribute to the negative attitudes towards insect foods, such as perceived taste, being unaware of the benefits, social influence, and perceived appropriateness of the food (e.g., Sogari, 2015; Tan, Fischer, van Trijp, & Stieger, 2016; Woolf, Zhu, Emory, Zhao, & Liu, 2019). Despite these barriers to adoption, research suggests that a single positive experience with entomophagy may encourage future consumption (Hartmann &

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Siegrist, 2016). Furthermore, this effect extends across from one type of insect food to another. For example, Hartmann and Siegrist (2016) found that a tasting experience using processed insects (tortilla chips made with cricket flour) increased willingness to try several different types of unprocessed insect foods. Therefore, one potential route to encouraging entomophagy is to motivate consumers to engage with that first positive experience.

In previous research, interest and curiosity have been suggested as key motivators of entomophagy (Stone, FitzGibbon, Millan, & Murayama, 2022). However, to date little research has explored the possibility of intervening on these epistemic factors to increase willingness to try eating insects. In the current study, we expand the toolkit of potential interventions to increase entomophagy by investigating the efficacy of an intervention typically employed in education research – a utility-value intervention that targets interest and curiosity. This type of intervention was used because it is designed to go beyond mere information provision by having participants discover and reflect on the value of a topic for themselves (Asher, Harackiewicz, Beymer, & Smith, 2023). We hypothesised that a utility-value intervention would be particularly effective in view of the negative attitudes and aversion of Western consumers towards insect food consumption.

1.1. *The critical role of interest in the adoption of entomophagy*

Interest and curiosity can be conceptualised as people's intrinsic motivation to gain and develop knowledge (Murayama, FitzGibbon, & Sakaki, 2019). There is considerable debate about the separability of these constructs (e.g., Aslan, Fastrich, Donnellan, Jones, & Murayama, 2021; Donnellan, Aslan, Fastrich, & Murayama, 2021; Pekrun, 2019; Silvia, 2008; Tang et al., 2022). However, given their conceptual proximity and also because the existing relevant consumer behaviour literature does not differentiate between them, for the purpose of this research we use these terms interchangeably.

Interest and curiosity have been identified as important motivators of consumer behaviour in general (e.g., Daume & Hüttl-Maack, 2020; Menon & Soman, 2002; Polman, Ruttan, & Peck, 2022; Ruan, Hsee, & Lu, 2018) and of insect food consumption specifically (e.g., House, 2016; Verbeke, 2015; Videbæk & Grunert, 2020). This is due to the powerful influence of curiosity/interest in initiating exploration of novel stimuli (Gottlieb, Oudeyer, Lopes, & Baranes, 2013), even when there are potentially negative expectations or consequences associated with the novel stimuli (e.g., FitzGibbon, Lau, & Murayama, 2020; Hsee & Ruan, 2016; Lau, Ozono, Kuratomi, Komiya, & Murayama, 2020). For example, Polman et al. (2022) found that curiosity can be used to encourage people to do more normatively desirable and less tempting behaviours, such as taking the stairs instead of the elevator. It is, therefore, possible that promoting curiosity and interest in insect foods may encourage willingness to try despite the preconceived negative expectations in Western societies.

In fact, several studies have suggested that having an interest in entomophagy, or in the benefits of entomophagy, has the potential to improve attitudes towards and willingness to try insect-based foods (e.g., House, 2016; Sogari, 2015; Verbeke, 2015; Videbæk & Grunert, 2020). For example, House (2016) conducted semi-structured interviews with consumers who had previously purchased insect food products. The findings suggested that a general interest in entomophagy was the initial motivating factor in the purchase, followed by an awareness of the environmental and health benefits. In line with this, Verbeke (2015) found that an interest in sustainable food choices predicted a 71% increase in the likelihood of engaging with entomophagy. Finally, Stone et al. (2022) found that curiosity was a significant predictor of willingness to try insect foods even after controlling for many other previously identified factors (e.g., taste, healthiness and sustainability). Overall, this research suggests that a general interest or curiosity towards entomophagy or the associated benefits are potentially useful tools in supressing the negative preconceptions and motivating individuals to try insect foods.

We believe interest or curiosity provides a powerful route to increase the initial intention to eat insect-based foods. In fact, theoretical accounts of curiosity[1] (e.g., Hidi & Renninger, 2006; Loewenstein, 1994; Murayama, 2022) indicate that due to certain characteristics of insect-based foods, it may be easier for us to intervene based on interest or curiosity. First, people often do not know much about such foods; therefore, it is relatively easy to stimulate their curiosity by making them aware of the knowledge gap. As indicated in the past literature, once this knowledge gap is made salient, people become motivated to seek information in order to close the gap (Loewenstein, 1994). However, it is possible that a knowledge gap alone may not be sufficient to motivate information seeking; it may be that positive expectations or a sense of relevance in the information is required to stimulate information seeking (e.g., Abir et al., 2022). Once motivated to seek information there is a positive rewarding feeling gained through engagement with a topic (Hidi & Renninger, 2006) and this can promote further information seeking and longer-term engagement with a topic (e.g., Hidi & Renninger, 2006; Murayama, 2022).

Second, it is typically the positive aspects of entomophagy that are unknown, such as its healthiness and sustainability implications. Therefore, new information, particularly related to a healthy diet and environmental gains from consuming insect-based foods, is likely to elicit positive feelings, an important component of interest-based engagement. For example, Lombardi et al. (2019) compared people's willingness to pay for food products containing insects (pasta, cookies, and a chocolate bar, all containing processed mealworms) against their counterparts containing familiar ingredients. After receiving information on the benefits (either health or sustainability), participants' willingness to pay for insect-based products increased, and they valued them equally or even higher than their conventional counterparts. Woolf et al. (2019) also found that being aware of the health and environmental benefits of insect foods is an important factor in influencing willingness to eat insects. Another recent study by Bao and Song (2022) demonstrated the promise of an interdisciplinary approach by applying psychological theory (Theory of Planned Behaviour; Ajzen, 1991) to the issue of low acceptance of insect foods using information boosts in the form of infographics. Finally, knowing the positive aspects of entomophagy may involve "prediction errors" in the value of new knowledge. This argument grounded in recent theoretical approaches to motivation which indicate that when new knowledge is surprising, the actual value of the information is greater than the expected value (i.e., there is a positive prediction error; see Marvin & Shohamy, 2016).

[1] Some may argue that our theoretical account is somewhat similar to a knowledge deficit-based model of eating behaviour (Hilgartner, 1990; Irwin & Wynne, 1996), which has been criticised in the literature related to food consumption (Hansen, Holm, Frewer, Robinson, & Sandøe, 2003). The knowledge deficit theory proposes that experts and lay people conceptualise food-related risk differently and when the public does not comply with expert opinion this is due to a lack of understanding regarding the information (i.e., a knowledge deficit). Criticism of this theory relies on the idea that consumers' attitudes and values are complex and a lack of knowledge alone, is not an adequate explanation (Hansen et al., 2003). However, there are several differences between the knowledge deficit theory and the theoretical accounts of interest we propose for motivating the consumption of insect foods. While the curiosity/interest-based theories shed light on the knowledge deficit, they also put an emphasis on the importance of emotional and motivational as well as personal value components in information seeking (Hidi & Renninger, 2006; Murayama et al., 2019). We also suggest the conceptual basis of this study is not at odds with the criticisms of the knowledge deficit account. Specifically, we do not argue that a knowledge gap alone is sufficient to motivate information seeking; as noted below, our proposed intervention stands on the assumption that positive expectations or a sense of relevance in the information is required to stimulate information seeking (e.g., Abir et al., 2022).

1.2. Utility-value interventions

Having identified interest as a well-placed target for intervention, the next challenge is to stimulate interest in entomophagy. One potential route to increasing interest in a topic is through a utility-value intervention. Utility-value interventions involve an interactive activity designed to increase personal relevance and connection to a topic (value) and have been shown to be effective across a range of educational contexts (Hulleman, Godes, Hendricks, & Harackiewicz, 2010). Interventions of this kind are linked to Hidi and Renninger's (2006) model of interest development, which suggests that developing or sustaining interest in a topic is dependent upon the levels of value, positive affect, and knowledge gain experienced while engaging in an activity (Hulleman et al., 2010). In other words, the intervention stimulates the knowledge gap to trigger interest in the first place, but also aims to consolidate it by promoting the value, positive affect, and perceived knowledge gain. Utility-value interventions within educational settings have been shown to enhance student motivation, interest, and performance across a range of disciplines (Gaspard et al., 2015; Hulleman et al., 2010; Rosenzweig, Wigfield, & Hulleman, 2020). They share a broad aim of increasing the perceived relevance of the content to be learned and this, in turn, increases interest in the topic and is said to lead to better performance (Hulleman, Kosovich, Barron, & Daniel, 2017; Shin et al., 2019).

An example of a typical utility-value intervention can be seen in Gaspard et al. (2015), who used a psychoeducational presentation along with two relevance-inducing tasks (evaluating quotations about the usefulness of mathematics for personal relevance or an essay self-generating the personal relevance of mathematics to their lives) to increase students' value beliefs for mathematics. Both intervention conditions showed increased utility value at up to five months post-intervention compared to the wait-control condition, with the effect being slightly larger for the quotations condition. This style of utility-value intervention has consistently shown positive long-term effects, such as increased value and interest in the subject matter and improved exam performance (e.g., Brisson et al., 2017; Rosenzweig et al., 2020).

Utility-value interventions have also been adapted to lab-based experiment contexts, still within the field of education but outside of a classroom setting (Hulleman et al., 2010). For example, Hulleman et al. (2010) showed that a utility-value intervention increased perceptions of the value of a mathematical technique and this, in turn, predicted increased interest and performance. Participants in the intervention condition were asked to write a short essay on the relevance of the mathematical technique to their own lives or the lives of others. Those in the control condition wrote an essay describing pictures hanging on the wall in the testing room. The intervention condition not only showed increased interest in the task but also increased willingness to engage with the task again in the future in comparison to the control condition. Value interventions have also been adapted to suit a variety of different subjects and student groups with positive practical implications (e.g., Hulleman et al., 2010; Shin et al., 2019).

Despite their great promise for increasing interest across a broad range of topics (e.g., Gaspard et al., 2015; Rosenzweig et al., 2020), utility-value interventions have received little attention outside of the field of education. To the best of our knowledge, to date no studies have adapted a utility-value intervention task for use outside of the field of education and, while interest has been examined in the context of entomophagy, previous work has not explicitly sought to manipulate interest or curiosity to increase willingness to try. Given that curiosity and interest likely play a crucial role in motivating the consumption of insect foods (e.g., Sogari, 2015; Stone et al., 2022; Videbæk & Grunert, 2020), we believe that it is possible to increase interest in entomophagy and willingness to try insect foods by adapting a utility-value intervention based on the potential relevance of insect foods. By having participants discover and reflect on the value of insect foods for themselves, a utility-value intervention will both provide the participants with positive information about insect foods and increase their interest in the topic and in trying insects for themselves. Previous research suggests that curiosity and/or interest may have a direct effect on exploratory eating behaviour in relation to insect foods (e.g., House, 2016), even after controlling for other previously identified factors that influence consumption curiosity was in the top three strongest predictors of willingness to try (Stone et al., 2022). An awareness of the benefits is also suggested to increase willingness to try insect foods (e.g., Lombardi et al., 2019; Woolf et al., 2019). Therefore, a value intervention may be an effective way to combine both of these potential influences into one task. We suggest that, by engaging in a value intervention task in which participants learn about the benefits of insect foods, they will gain an awareness of the benefits and potentially also an interest in entomophagy. The adopted intervention approach has the ability to make salient the knowledge gap relating to entomophagy by providing a sense of relevance to the information and also to engender positive feelings through topic engagement or reward prediction errors, thus has the potential to increase interest. Increased interest, in turn, could result in increased willingness to try and ultimately help overcome the barriers Western societies typically experience with regard to insect foods.

1.3. The present studies

In two pre-registered studies, we aimed to examine whether a utility-value intervention based on learning about the benefits of eating insect-based foods can increase people's willingness to try those foods and, if so, whether this change is maintained over a prolonged time period. In the first study, participants were randomly allocated to a utility-value intervention (hereafter referred to as the value intervention condition for brevity) or a control condition. In both conditions, participants were asked to research and write a short essay. Participants in the value intervention condition were asked to write about the potential relevance of eating insects to their lives or the lives of others, whereas participants in the control condition were asked to write about what constitutes a healthy and sustainable diet. The key differences between the two conditions were the topic and the self-generation of value. While both topics were based around eating behaviours and dietary choices, the value intervention was specific to incorporating insect foods into one's diet. Further to this, the value intervention condition focused on self-generating value through the wording of the essay question. Participants then completed an image rating task (Stone et al., 2022), rating a series of insect food dishes and visually matched familiar foods on willingness to try, and five further attributes (including curiosity, sustainability, and healthiness). A substantial database of insect food images and visually matched familiar foods were used to ensure that any results were not specific to a particular type of edible insect. Our main research question was whether we would see increased willingness to try insect foods (as assessed by the image rating task) in the value intervention condition compared to the control condition. To determine the longevity of any observed effects, participants were then invited back one month later to complete the same image rating task using different images from the same database.

The purpose of Study 2 was to uncover whether any effects of a value intervention task were unique to the generation of value on the topic or whether an exposure to insects as a food source could be an alternative explanation. To examine this, instead of the control condition used in Study 1, an alternative insect recipe condition was introduced. Study 2 followed a very similar structure to that of Study 1, however, the recipe condition asked participants to research and write an essay on how to cook a meal using edible insects. The main research question was the same as in Study 1 – whether willingness to try insect foods would be higher after the value intervention condition than after the recipe control condition. Participants were once again invited back one month later to complete the same image rating task with different images. The research question was again to examine whether the effects of the value intervention condition would still be present one month later.

2. Study 1

The preregistered research question (hypothesis) was whether participating in a value intervention task designed to self-generate value and increase interest in insect foods would increase willingness to try. The main dependent variable was willingness to try as assessed by an experimental image rating task (Stone et al., 2022). Various aspects of insect foods were also assessed (curiosity, attitude, tastiness, healthiness, and sustainability) using the same experimental task and pre-post self-reported questions (value, interest, mood, and task engagement). The impact of the value intervention on these measures was also examined. At the follow-up, we tested another preregistered hypothesis: whether the effects of the value intervention on willingness to try insect foods would still be present one month later. In addition to the main hypothesis, again, we examined whether the intervention has an impact on other aspects of insect foods (curiosity, attitude, tastiness, healthiness, and sustainability) as well as on pre-post self-reported questions on value, interest, entomophagy re-engagement, and general attitudes towards entomophagy.

2.1. Method

2.1.1. Transparency and openness

2.1.1.1. Data, analytic methods (code) and research materials. Anonymised data are publicly available through the Open Science Framework. The analytic code and all research materials used in the study can also be found on the OSF (https://osf.io/4reys/?view_only=16d0605344d84f879128935566387f96).

2.1.1.2. Pre-registration. The study design, hypotheses and plan for the primary analyses (image rating task, pre-post measures and questionnaire measures) were pre-registered (https://osf.io/djrz6/?view_only=cb346a531a754a4380232bdb24531142 and https://osf.io/5z7rq/?view_only=8a4da138e5b746b2845189b3181e0cb6).

2.1.2. Participants

A total of 300 participants were recruited for the study. However, 20 participants were excluded prior to data analysis due to technical issues or incomplete data. Ultimately, 280 participants were included in the analysis (67.5% females, Mean Age = 34.01 SD = 12.27). The sample size was determined using data from a pilot study, following a new method for calculating sample sizes for nested data in mixed-effects modelling by Murayama, Usami, and Sakaki (2020) and using their accompanying app (https://koumurayama.shinyapps.io/summary_statistics_based_power/). We determined that a sample size of 249 participants was required to achieve 80% power, using the t value (0.95) and sample size (n = 30) from the pilot data. Recruitment was conducted using Prolific (https://www.prolific.co). Prolific was chosen as it has been shown to provide the highest quality data across several online participant recruitment platforms (Peer, Rothschild, Gordon, Evernden, & Damer, 2021). However, we also added several extra measures to ensure quality data were obtained. A reCAPTCHA was added to the start of the study to attempt to exclude bots. Additionally, all slider responses had to be moved off the mid-point before a response could be made and a minimum time, and minimum word limit was set for the essay task to discourage low-effort or fraudulent responses. Participants were financially rewarded £5 for 60 min of their time. All participants were British citizens as reported on Prolific; however, four participants reported different nationalities in the demographic questionnaire in the study (Bulgarian, Italian, Bangladeshi and Nigerian). All participants resided in the UK. The majority of participants were native English speakers (97.5%), of those who were not native speakers their Mean learning age was 9.71 years (SD = 9.20).

All 280 participants were invited to take part in a follow-up study: invitations were sent through the Prolific system one month after their original participation. The follow-up study was not part of the initial study pre-registration, but the design and hypotheses were registered prior to follow-up data being collected (with the exception of three participants who had already completed the task due to the one-month deadline) and prior to any analysis being conducted. The study link was active for 5 days, 223 participants (retention rate = 80%) completed the follow-up study (65% females, Mean Age = 35.17 SD = 12.70). Of these 223 participants, 108 were originally assigned to the value intervention condition and 115 to the control condition. As in the main study, most participants were native English speakers (97.8%). For those who were not, their mean learning age was 10.40 years (SD = 10.97). Participants were rewarded £3 for 30 min of their time for the follow-up study. Ethical approval was granted by the University of ReadingSchool of Psychology and Clinical Language Science's School Ethical Review Committee.

2.1.3. Intervention

Participants were randomly assigned to either the value intervention condition (n = 141) or the control condition (n = 139). Both conditions were given a short background to their assigned topic and informed that they would be required to conduct a web search and write a short essay on the given topic. The essay task was adapted from Hulleman et al. (2010). Participants in the value intervention condition were instructed as follows:

> "Edible insects have gained a large amount of media attention recently. The reason for this is due to the need to find an alternative protein source that is more environmentally sustainable than current meat production practices. It is widely agreed that insects have the potential to fulfil this need, however many people are still unaware of this. During this experiment you will be asked to search for information on edible insects that is readily available on the internet. Specifically, we ask that you conduct a web search to find information on the benefits of eating insects."
>
> "Please conduct a web search and type a short essay (1–3 paragraphs) describing the potential relevance of eating insects, to your own life and the lives of others, please focus on how this information could be useful to you or others and give examples."

Participants in the control condition were instructed as follows:

> "Within the UK media attention has long focused on the need for a healthy and environmentally sustainable diet. However, with many confusing and unhealthy options readily available the need for information on healthier and more sustainable choices continues. During this experiment you will be asked to search for information on a healthy and sustainable diet that is readily available on the internet. Specifically, we ask that you conduct a web search to find information on the factors of a healthy and sustainable diet."
>
> "Please conduct a web search and type a short essay (1–3 paragraphs) on the factors that are important for a healthy and environmentally sustainable diet."

2.1.4. Measures

2.1.4.1. Image rating task (including "willingness to try"). Participants were asked to rate a series of images on a range of attributes. The images were presented as though on a specials board in a restaurant with the image, title and a short description. Fourteen pairs of images, each including matched dishes with and without insects (see below for more details), were randomly selected for each participant, the order of these was then randomised when presented to participants to reduce any potential item-specific effects (Murayama, Sakaki, Yan, & Smith, 2014). Thus, all participants rated matched images for both 'insect' and 'non-insect' food types. Participants were required to rate the images on the following six scales: (1) Willingness to try (the main dependent variable in our study hypothesis), "How likely would you be to try this food?"; (2) Curiosity, "How curious are you about this food?"; (3) Attitude, "How do you feel about this food?"; (4) Tastiness, "How tasty do you think this food would be?"; (5) Healthiness, "How healthy do you think this food is?"; (6) Sustainability, "How sustainable do you think large scale production of this food would be?". Ratings were given on a visual analogue scale (0–100) with anchors at either end. Willingness to try was always presented first to avoid priming effects of other questions, whereas the order of the other rating scales was randomised across participants. This meant that each participant had a fixed order of questions, but the order of the questions changed for each participant.

The same image rating task was used in the follow-up study; however, participants were shown images they had not previously rated in Study 1. To select images for the rating task, a database of dishes containing several different types of edible insects was collated from the internet. These images depict insects in genuine culinary uses, including forming the central part of a dish (e.g., deep-fried tarantula and grasshopper kebabs) and being used as a garnish (e.g., chocolates topped with gold-covered crickets and bee larvae sprinkled on top of a soup). Forty-two images were selected to ensure a variety of edible insects within the dishes, including types of insects that are readily available for purchase for culinary use in the UK, where this study was conducted. To find suitable matched non-insect food images, these images were then run through Google's reverse image search and the closest resemblance containing familiar ingredients was selected. This resulted in 42 pairs of images (insect foods vs. non-insect foods) matched for visual similarity. The inclusion of the matched insect and non-insect food pictures allows us to examine whether the intervention has specific effects on insect foods (as opposed to non-insect foods). An example of a visually matched pair of images is provided in Fig. 1.

2.1.4.2. Pre-post measures. To assess participants' feelings and motivation outside of the context of the image rating task, participants were asked to complete a series of questions prior to and following the intervention task. The questions were based on similar measures used in utility-value intervention research (e.g., Hulleman et al., 2010). Participants were asked questions before the intervention to assess the perceived value of the information they were going to research, based on reading the short background to the given topic (e.g., "I think I could use the information I learn in the future"). After the intervention perceived value of the information was once again measured, with the questions slightly re-worded, for comprehension purposes, to make sense after the intervention had taken place (e.g., "I think I will use the information I have learned today in the future"). The same style of pre-post questions was used for interest in the information (e.g., pre: "I think this information will be interesting"; post: "I found the information to be interesting"). For perceived value and interest the questions were rated on a 5-point Likert scale (0–4) ranging from strongly disagree to strongly agree. Participants also rated mood ("How are you feeling right now?") and task engagement ("How engaged do you feel right now?") before and after the task. These questions were rated on a 5-point Likert scale (0–4) with mood ranging from very bad to very good and engagement from very bored to very engaged. See Appendix A for a full list of the pre-post items.

The same post interest and perceived value questions were used for the follow-up; however, these were slightly re-worded to make sense one month later. For example, "I enjoyed learning this information" was re-worded to "I enjoyed learning the information from the essay task" (see Appendix A). To ensure that participants understood the questions related to the essay task from Study 1, the following prompt was shown at the top of the page: "The questions on this page are related to the information you learned while completing the essay task in the first study".

2.1.4.3. Other measures. Previous tasting experience with insect foods was measured with the question "Have you previously tried foods containing insects?"; Yes/No. The purpose of including this measure was to ensure that the two conditions did not differ in their prior experience with insect foods, as it is suggested that a positive tasting experience can substantially increase willingness to try insect foods again in the future (Hartmann & Siegrist, 2016).

The interest and disgust sub-scales of the Entomophagy Attitudes Questionnaire (EAQ) were included in the follow-up to measure participants' general attitude towards insect-based foods (La Barbera, Verneau, Videbæk, Amato, & Grunert, 2020). The scale consists of three sub-scales, of which the third one was excluded as it relates to human consumption of animal protein from insects' animal feed. The disgust sub-scale consists of five items (Cronbach's $\alpha = 0.91$) measuring an individual's level of disgust towards eating insects (e.g., "I would be disgusted to eat any dish with insects"). The interest sub-scale consists of three items (Cronbach's $\alpha = 0.84$) capturing the level of interest in eating insects (e.g., "I'd be curious to taste a dish with insects, if cooked well").

The 'entomophagy re-engagement' questions were created for the follow-up to examine how often the participants in each condition had

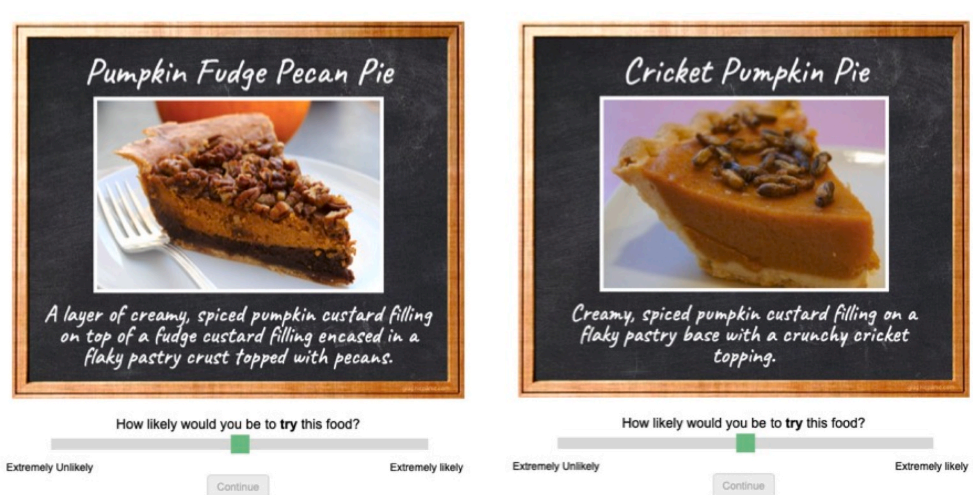

Fig. 1. Example stimuli used in all studies (visually matched image pair, titles and descriptions).

thought about eating insects and the potential value of eating insects since completing Study 1 (e.g., "In the past month I have thought about the idea of eating insects."). The questions were rated on a scale of 0 (Never) to 4 (A great deal). The full list of entomophagy re-engagement questions is presented in Appendix B.

2.1.5. Procedure

Participants were invited to take part in the 'Food Information Study'. In each condition, they were shown task-specific instructions as described earlier. Participants were then asked to complete the pre-task questions (value, interest, mood, and task engagement) and then proceeded to the essay writing task. They were instructed that they would be given a maximum of 20 min to complete the task and a countdown timer appeared on the screen to make them aware of the remaining time. The task required participants to use the search bar within the experiment page which would then bring up search results that when clicked would open the web page in a new browser tab. A minimum word and time limit was imposed to ensure participants had to engage with the task for at least 5 min and write a minimum of 150 words. Following this, participants were required to complete the post-task questions (value, interest, mood, and task engagement) and were then given instructions for the image rating task. Participants rated their willingness to try insect foods (the main dependent variable), as well as their curiosity, attitude, tastiness, healthiness and sustainability. After the main task, participants completed questionnaire items to assess individual differences in eating behaviour: the Food Neophobia scale (Pliner & Hobden, 1992); the VARSEEK scale (Van Trijp & Steenkamp, 1992); the food involvement scale (Bell & Marshall, 2003); and the openness to experience sub-scale of the HEXACO 60 (Ashton & Lee, 2009). Finally, participants were asked if they had any previous experience with insect foods.

For the follow-up study, participants were asked to take part in further tasks related to the 'Food Information Study'. This involved completing a second image rating task using the same procedure as in Study 1. Following this, participants took part in a recall task, during which they were asked to type as much information as they could recall about the content of the essay which they were asked to write one month previously (the recall question was not included in the pre-registration of the follow-up study in error). Participants were then asked to complete the post measures on perceived value and interest again. After this, participants were asked to complete the entomophagy re-engagement questions, followed by the interest and disgust subscales of the EAQ.

2.1.6. Data analysis

Data analysis was performed in R 4.0.4 (R Core Team, 2021) using the *lme4* package (Bates, Maechler, Bolker, & Walker, 2015) for linear mixed-effects modelling and the *caret* (Kuhn, 2020) and *glmnet* (Friedman, Hastie, & Tibshirani, 2010) packages for the machine learning models. Linear mixed-effects models were estimated to predict each of the six attributes from condition at the between-participant level and food type at the within-person level. Before analysis, all six attributes were re-scaled from 0 - 100 to 0–10 to aid model fitting. Pre-post measures were analysed using ANCOVA to examine between-group differences after controlling for participants' baseline scores. For the follow-up data, the entomophagy re-engagement questions and EAQ sub-scales were analysed using *t*-tests to examine differences between conditions.

2.1.6.1. Model specification of linear mixed-effects modelling. Condition (value intervention vs. control, effect coded as 1 and -1 respectively), food type (insect vs. non-insect, effect coded as 1 and -1 respectively) and their interaction were included as fixed effects in each model. We included random participant slopes as well as intercepts. To resolve convergence or singularity issues, where necessary models were simplified by setting random effect covariances to zero. The same strategy was used for all 6 attributes measured. For all mixed-effects models, we focused on the interaction effects as this enabled us to investigate the effect of the intervention specific to insect food images. The full model tables including the intercepts and random effects are reported in tabular form in supplementary materials to give a complete picture of the model estimates. To follow up significant interaction effects, 'simple effects' of condition for insect and non-insect foods were determined using models in which food type was dummy coded: to explore the effect of condition on insect foods, insect foods were coded as 0 and non-insect foods were coded as 1, meaning that the 'simple effect' of condition describes the effect for insect foods only; to explore the effect of condition on non-insect foods, the dummy coding was reversed. Effect sizes were calculated for the effect of condition on ratings of insect and non-insect food respectively using a summary statistics approach – mean ratings were calculated for each participant for each food type and the Cohen's d statistic was calculated based on group differences between conditions.

2.1.6.2. Machine learning analysis of essay content. Additional exploratory analysis of essay content was conducted to explore whether features of participants' essays predicted their willingness to try insect food. Each participant's essay was spellchecked and tokenised using the *hunspell* (Ooms, 2020) and *quanteda* (Benoit et al., 2018) packages, this also removed stop words and counted the frequency each word stem was used for each participant. During the spellchecking process the essays were checked by the researchers to ensure the essays were written on the correct topic. These data along with condition were added as predictors to a lasso regression model with willingness to try ratings for insect foods as the dependent variable. The data was split into training (70%) and testing (30%) datasets. The optimal tuning parameter (λ) was selected using 10-fold cross-validation using the training data set. Once the optimal λ was selected, this value was used to run the lasso model across the entire training data set. The lasso model applied feature selection to the training data and coefficients were extracted using the optimal tuning parameter. The final model and optimal λ were used to make predictions on the test data. To examine the predictive power of the model, RMSE and R^2 were calculated for both the training and test data.

2.1.6.3. Memory data. Exploratory analysis of the memory data was also conducted for the follow-up data. Memory data was coded by the researchers; memory responses were coded as 'remembered' if participants were able to remember any of the content or topic of their essay and 'not remembered' if they were unable to remember, remembered the topic incorrectly or only described the image rating task. This data was then analysed using a chi-squared test to look for a possible association between condition and memory performance.

2.2. Results

2.2.1. Intervention effects on image rating task

Mean ratings by condition and food type as well as effect sizes for the effect of condition and the test statistics for the interaction between condition and food type are presented in Table 1 and Fig. 2. A mixed-effects model was conducted predicting willingness to try from condition, food type and their interaction. Condition was a significant predictor of willingness to try, suggesting those in the value intervention condition gave higher willingness to try ratings compared to the control condition across both food types, $\beta = 0.26$, $p = .006$. Importantly, the main effect was qualified by a significant interaction between condition and food type, $\beta = 0.27$, $p < .001$. Simple effects analyses revealed that participants in the value intervention condition rated willingness to try significantly higher for insect food images compared to the control condition, $\beta = 0.53$, $p < .001$, $d = 0.48$. In contrast, there was no significant difference in ratings of willingness to try non-insect foods between participants in the value intervention and control conditions, $\beta =$

Table 1
Study 1 mean ratings by condition and food type, effect size for the difference between the intervention and control condition by food type, and test statistics for the interaction between condition and food type from the mixed-effects model.

	Insect			Non-insect				
	Value intervention	Control	Effect size	Value intervention	Control	Effect size	Interaction effect	
	Mean (*SD*)		*d* (95% CI)	Mean (*SD*)		*d* (95% CI)	β *(SE)*	*p*
Willingness to try	3.00 (2.49)	1.93 (1.90)	0.48 (0.24–0.72)	7.03 (1.73)	7.05 (1.65)	−0.01 (-0.24 – 0.22)	0.27 (0.07)	**<.001**
Curious	4.53 (2.74)	3.31 (2.40)	0.47 (0.24–0.71)	5.11 (1.98)	5.23 (1.98)	−0.06 (-0.29 – 0.18)	0.33 (0.1)	**.001**
Attitude	3.21 (2.21)	2.16 (1.69)	0.53 (0.29–0.77)	6.79 (1.45)	6.71 (1.47)	0.06 (-0.18 – 0.29)	0.24 (0.07)	**<.001**
Tasty	3.67 (2.23)	2.67 (1.80)	0.49 (0.25–0.73)	7.33 (1.37)	7.39 (1.37)	−0.04 (-0.28 – 0.19)	0.26 (0.06)	**<.001**
Healthy	5.85 (1.51)	4.95 (1.88)	0.53 (0.29–0.77)	5.02 (1.20)	4.96 (1.07)	0.05 (-0.18 – 0.29)	0.21 (0.05)	**<.001**
Sustainable	6.44 (1.67)	5.33 (2.18)	0.57 (0.33–0.81)	5.28 (1.52)	5.31 (1.36)	−0.02 (-0.26 – 0.21)	0.29 (0.07)	**<.001**

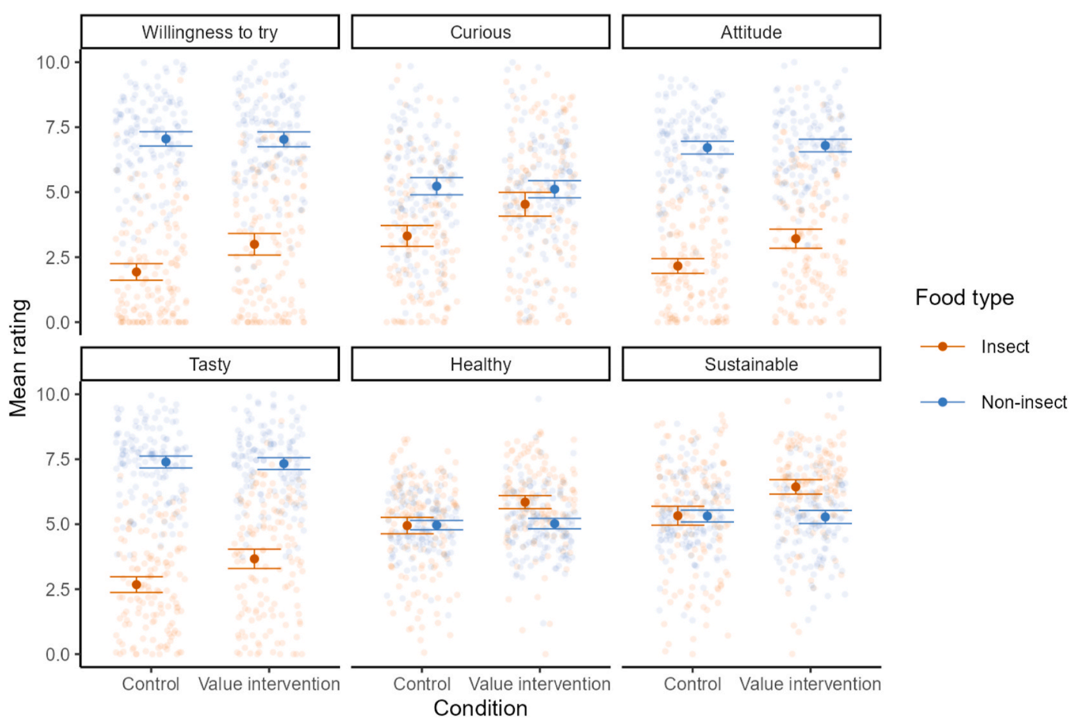

Fig. 2. Mean ratings of willingness to try and five additional attributes by condition (Control and Value intervention) and food type (Insect and Non-insect) from Study 1
Note. Lighter points represent individual participants, darker points represent group-level means and error bars represent 95% confidence intervals around the group-level mean.

-0.01, $p = .931$, $d = -0.01$. The same model structure was used for each of the other five attributes. For the remaining five attributes condition was also a significant predictor, suggesting that those in the value intervention condition gave higher ratings for all attributes compared to the control condition across both food types, $\beta s = 0.23–0.28$, $ps < .007$ (See Table 1 for descriptive statistics). As with willingness to try, the main effects were qualified by significant interactions between condition and food type, $\beta s = 0.21–0.33$, $ps < .002$. Again, simple effects analyses revealed that participants in the value intervention condition rated insect food images significantly higher on all attributes compared to the control condition, $\beta s = 0.45–0.61$, $ps < .001$, $ds = 0.47–0.57$. These effects of the intervention were specific to insect foods, with no significant effects of condition for non-insect foods $\beta s = -0.06 – 0.09$, $ps > .620$, $ds = -0.06 – 0.06$. The mixed-effects models are presented in Table S1, simple effects models and tables of effect sizes are presented in the supplementary materials (Tables S2, S3, and S4).

Mean ratings for the follow-up as well as effect sizes for the effect of condition and the test statistics for the interaction between condition and food type are presented in Table 2 and in the supplementary materials Fig. S1. The mixed-effects model for the follow-up showed that the effect of condition on willingness to try was still present one month later, $\beta = 0.26$, $p = .007$. The interaction effect was also sustained at follow-up, $\beta = 0.23$, $p = .003$ and simple effects analyses revealed that the effect of condition was specific to insect foods, $\beta = 0.49$, $p < .001$, $d = 0.47$, with no effect of condition for non-insect foods, $\beta = 0.03$, $p = .772$, $d = 0.04$. One month after the intervention had taken place those in the value intervention condition still rated insect foods significantly higher than those in the control condition. Many of the effects seen during the original intervention were also sustained one month later for the other five attributes. A significant effect of condition was seen for

Table 2
Study 1 follow up mean ratings by condition and food type, effect size for the difference between the intervention and control condition by food type, and test statistics for the interaction between condition and food type from the mixed-effects model.

	Insect			Non-insect				
	Value intervention	Control	Effect size	Value intervention	Control	Effect size	Interaction effect	
	Mean (*SD*)		*d* (95% CI)	Mean (*SD*)		*d* (95% CI)	β *(SE)*	*p*
Willingness to try	2.58 (2.33)	1.61 (1.80)	0.47 (0.20–0.73)	7.24 (1.57)	7.18 (1.55)	0.04 (-0.22 – 0.3)	0.23 (0.08)	**.003**
Curious	3.81 (2.66)	2.96 (2.43)	0.33 (0.07–0.6)	5.15 (2.05)	5.34 (1.89)	−0.10 (-0.36 – 0.16)	0.26 (0.11)	**.022**
Attitude	2.69 (2.14)	1.93 (1.74)	0.39 (0.12–0.65)	6.92 (1.41)	6.94 (1.38)	−0.02 (-0.28 – 0.25)	0.19 (0.08)	**.011**
Tasty	3.14 (2.22)	2.34 (1.88)	0.39 (0.13–0.66)	7.41 (1.36)	7.39 (1.24)	0.02 (-0.24 – 0.28)	0.20 (0.07)	**.008**
Healthy	5.32 (1.54)	4.84 (1.85)	0.28 (0.02–0.55)	5.23 (1.30)	4.93 (1.06)	0.25 (-0.01 – 0.52)	0.05 (0.06)	.476
Sustainable	6.01 (1.90)	5.40 (2.30)	0.29 (0.02–0.55)	5.65 (1.50)	5.81 (1.44)	−0.1 (-0.37 – 0.16)	0.19 (0.08)	**.020**

attitude, tastiness and healthiness (βs = 0.18–0.21, *ps* < .030). Suggesting that for these attributes, those in the value intervention condition provided higher ratings than those in the control condition across insect and non-insect food. The effects of condition on ratings of curiosity and sustainability were not maintained at the one-month follow-up (*ps* > .100). The only attribute not to show a significant interaction at follow-up was healthiness (*p* = .476), all other attributes showed sustained interactions between condition and food type, β s = 0.19–0.26, *ps* < .030. At one-month post-intervention, the pattern of interactions is consistent with Study 1, where those in the value intervention condition rated insect food images higher compared to those in the control condition. Simple effects analyses revealed that participants in the value intervention condition rated willingness to try significantly higher for insect food images compared to the control condition, βs = 0.24–0.43, *ps* < .035, *ds* = 0.29–0.39, but not for non-insect food images, βs = −0.10 – 0.15, *ps* > .433, *ds* = −0.11 – 0.25. Model results are presented in Table S4, simple effects models are presented in the supplementary materials (Tables S5 and S6).

2.2.2. *Previous experience*

Due to technical issues 20 participants were unable to record responses to the previous experience question, the question was asked at the end of the study and some participants did not reach this page but as they had completed the main task and questionnaire measures their data was not excluded. Of the 260 participants who did respond, 27% reported having previously eaten insects (value intervention = 26%, control = 27%). The number of participants who had reported trying insect foods did not differ significantly between groups, as confirmed by a *t*-test, $t(258) = 0.21$, $p = .831$, $d = 0.03$.

To determine whether our findings were robust for naïve participants who had not previously tried insect foods, exploratory linear mixed-effects models were additionally estimated including only participants who reported never having tried insect foods previously to understand if a previous exposure to insect foods might impact the intervention. The same strategy as the main analysis was followed. The results are reported in the supplementary materials.[2] [3]

2.2.3. *Pre-post measures*

ANCOVA's were conducted on each of the pre-post measures to assess whether there were differences between conditions post intervention, after controlling for participants pre-scores. There was a significant difference between conditions in participants' post interest scores, $F(1, 277) = 5.82$, $p = .017$, $\eta_p = 0.02$. The value intervention condition showed higher interest scores post-intervention ($M = 3.15$, $SD = 0.78$) compared to the control condition ($M = 3.08$, $SD = 0.71$). Post-intervention value scores did not show a significant difference between the conditions after controlling for pre-intervention scores, $F(1, 277) = 0.01$, $p = .919$, $\eta_p = 0.00$. There was no statistically significant difference between conditions in mood, $F(1, 277) = 0.19$, $p = .661$, $\eta_p = 0.00$. There was also no statistically significant difference between conditions in post-intervention task engagement, $F(1, 277) = 0.57$, $p = .449$, $\eta_p = 0.00$. See Table 3 for pre-post descriptive statistics.

The post measures taken at follow-up were also analysed using ANCOVA's to assess whether there were any differences between conditions one month after the intervention whilst still controlling for the pre-scores taken during Study 1. Consistent with Study 1, there was a significant difference between conditions in post interest scores, $F(1, 220) = 7.20$, $p = .008$, $\eta_p = 0.03$. There was no statistically significant

[2] The mixed effects models for willingness to try and the five other attributes were conducted for only participants who reported having not tried insect foods previously (value $n = 97$; control $n = 94$). After excluding those with previous experience of insect foods the main effect of condition was no longer significant for willingness to try, curiosity and perceived tastiness. However, there were significant interaction effects for willingness to try and all five attributes suggesting that those in the value intervention condition rated insect foods significantly higher on all measured attributes compared to the control condition. See Table S7 in the supplementary material for model results.

[3] Consistent with the main analyses the same model was estimated for the follow-up using only participants who reported never having tried insect foods before (value $n = 73$; control $n = 76$). The significant interaction effect found for willingness to try and sustainability was consistent across both samples, as was the non-significant interaction for healthiness. However, for the remaining attributes (curiosity, attitude and perceived tastiness) the interactions were not sustained at follow-up. Suggesting that for those attributes the intervention may more effective in those with previous experience. See Table S8 in the supplementary material for model results.

Table 3
Mean pre-post and questionnaire measures for the value intervention and control conditions for Study 1 (S1) and one month follow-up (S1 follow-up).

Measure		Value Intervention		Control	
		S1	S1 follow-up	S1	S1 follow-up
		Mean (*SD*)			
Value					
	pre	2.55 (0.77)	–	2.93 (0.60)	–
	post	2.61 (0.89)	2.35 (0.93)	2.81 (0.89)	2.27 (0.85)
Interest					
	pre	2.85 (0.79)	–	3.04 (0.61)	–
	post	3.15 (0.78)	2.91 (0.81)	3.08 (0.71)	2.70 (0.76)
Mood					
	pre	2.75 (0.66)	–	2.77 (0.63)	–
	post	2.85 (0.72)	–	2.83 (0.69)	–
Task engagement					
	pre	3.04 (0.63)	–	3.06 (0.65)	–
	post	3.21 (0.65)	–	3.17 (0.70)	–
EAQ-interest		–	2.03 (1.24)	–	1.54 (1.30)
EAQ-disgust		–	2.02 (1.10)	–	2.47 (1.14)
Entomophagy re-engagement		–	1.01 (0.88)	–	0.51 (0.69)

difference in post value between the value intervention and control conditions, $F(1, 220) = 3.72$, $p = .055$, $\eta_p = 0.02$.

2.2.4. Other measures

The entomophagy re-engagement questions (5 items, $\alpha = 0.88$) showed that participants in the value intervention condition ($M = 1.01$, $SD = 0.88$) thought about insects as a food source and the related benefits over the previous month more than those in the control condition ($M = 0.51$, $SD = 0.69$), $t(221) = 4.69$, $p < .001$, $d = 0.63$.

The interest and disgust sub-scales of the EAQ measured at the one-month follow-up, also showed differences between the two conditions. In accordance with the pre-post measures, those in the value intervention condition ($M = 2.03$, $SD = 1.24$) showed higher levels of interest in insect foods compared to the control condition ($M = 1.54$, $SD = 1.30$), $t(221) = 2.85$, $p = .005$, $d = 0.38$. The value intervention condition ($M = 2.02$, $SD = 1.10$) also showed significantly lower levels of disgust toward insect foods compared to the control condition ($M = 2.47$, $SD = 1.14$), $t(221) = -2.99$, $p = .003$, $d = -0.40$. See Table 3 for descriptive statistics on all follow-up post measures and questionnaires.

2.2.5. Essay content

Machine learning was applied to the essay data with the tokenised word stems and condition added to a lasso model as predictors for willingness to try ratings for insect foods. Willingness to try (How likely would you be to try this food?) was rescaled to a scale of 0 (Extremely Unlikely) to 10 (Extremely Likely). The feature selection applied by the lasso regression suggested that 14 word stems and condition were predictors of the willingness to try ratings (see Table 4). However, the combination of the rather idiosyncratic selected features and the measures of predictive power (R^2 and RMSE) suggest that essay content was not particularly informative in terms of predicting willingness to try insect foods for test ($R^2 = 0.02$; RMSE = 2.33) as well as training ($R^2 = 0.05$; RMSE = 2.23) datasets.

Table 4
Selected features and coefficients from machine learning model including RMSE and R^2 for Study 1 essay data.

Predictors	Coefficients	
Intercept	2.19	
thailand	0.48	
protein	0.02	
shortag	0.23	
given	0.08	
soon	0.22	
beef	0.16	
just	0.07	
yield	0.97	
go	0.03	
give	0.05	
scientist	0.85	
100g	0.12	
avocado	0.59	
minute	0.51	
condition	0.08	
	RMSE	R^2
Train	2.23	0.05
Test	2.33	0.02

2.2.6. Memory

Our results suggested that those in the value intervention condition remembered the topic or content of their essays (72%) more than those in the control condition (58%), χ^2 (1, $N = 223$) = 4.18, $p = .041$.

2.3. Discussion

The results from Study 1 addressed the main research question: participants in the value intervention condition rated insect foods more favourably on willingness to try compared to the control condition and the effect was specifically stronger for insect foods. The effect was persistent in a one-month follow-up. In addition, this same effect was found for the other 5 attributes (curiosity, attitude, perceived tastiness, healthiness and sustainability) in the main data, and most of these effects were persistent in the follow-up (except for healthiness). We also found the effects of the intervention on self-reported interest, entomophagy re-engagement and both sub-scales of the EAQ, with the value intervention condition reporting higher levels of interest, entomophagy re-engagement and lower levels of disgust. Contrary to our expectation, there was no significant difference between conditions in self-reported value after the intervention. However, this result is difficult to accurately interpret, as we only asked participants about their interest and value of the information participants learned in the task. In other words, participants in the control condition did not rate the value of the information related to insect foods. This issue will be addressed in Study 2.

3. Study 2

Overall, Study 1 suggests that the value intervention was successful at increasing interest in entomophagy and willingness to try, along with other measures which point toward a positive role of the intervention. However, as the control condition topic was not related to insect foods, it is not yet known whether any positive exposure to insect foods may be sufficient for an effective intervention, or whether participants' considering the value of insect foods plays a crucial role. It is important to investigate whether positive information exposure alone is enough to encourage willingness to try in comparison to an intervention. If a singular exposure to the contextualised use of insect foods is enough to change attitudes towards such foods, this strategy may be easier to implement on a larger scale than interventions to encourage behaviour change. To address the issue, the control condition was changed to a recipe task, which exposed participants to the use of insects as food in recipes but did not ask them to self-generate value in the topic. We also assessed other exploratory variables, including some new measures for the current study (explained in the method section), to further examine potential psychological and behavioural variables that a value intervention has an impact on.

Similar to Study 1, the preregistered research question (hypothesis) was whether participating in a value intervention task would increase interest in insect foods in comparison to the recipe control condition and whether the effect would be sustained in a one-month follow-up. The main dependent variable was again willingness to try as assessed by the same task used in Study 1.

3.1. Method

3.1.1. Transparency and openness

3.1.1.1. Data, analytic methods (code) and research materials. Anonymised data, analytic code and research materials are publicly available through the Open Science Framework (https://osf.io/4reys/?view_only=16d0605344d84f879128935566387f96).

3.1.1.2. Pre-registration. As in Study 1, the study design, hypotheses and plan for the primary analyses (image rating task, pre-post measures and questionnaire measures) were pre-registered (https://osf.io/dcfrm/?view_only=509f0af273d64216acb1d200128bab93) and https://osf.io/59pwv/?view_only=d191a3242caa467db703e2b328c7e413).

3.1.2. Participants

A sample of 422 participants were recruited, the sample size was predetermined based on data from Study 1. We determined an approximate sample size of 422 to achieve 90% power with a 50% reduction in effect size of the smallest interaction effect from Study 1 (i.e., the curiosity interaction effect). Here the effect size is based on a correlation metric (we used a squared correlation to compute the 50% reduction), which is defined and explained by Murayama et al. (2020). Of those 422 participants, 37 were excluded prior to analysis due to technical issues or incomplete data on the main task or questionnaire measures. The remaining 385 participants completed the study (68.3% females, Mean Age = 33.39 *SD* = 13.45). Participant recruitment was conducted through Prolific and participants were rewarded £4.17 for 50 min of their time. All participants were UK residents and reported British nationality on Prolific (used to screen potential participants), however, 12 participants reported other nationalities in the demographic questionnaire provided in the study (French, Bangladeshi, Irish, Italian, Polish, Norwegian, Pakistani, Chinese, Bulgarian, German, Nigerian). As in Study 1, the majority of participants were native English speakers (95.1%). The mean learning age for non-native speakers was 8.35 years (*SD* = 7.54), two participants reported that English was not their first language but did not report their learning age.

The 385 participants who completed Study 2 were invited to take part in the follow-up study one month after their original participation. The link was sent through the Prolific system and lasted 5 days, a financial reward of £3 for 30 min participation was offered. Two hundred and eighty-one participants completed the follow-up study (retention rate = 73%, 68.7% females, Mean Age = 34.96 *SD* = 14.21). Of these, 146 were originally assigned to the value intervention condition and 135 to the recipe condition. The majority were, again, native English speakers (94.7%), for non-native speakers their mean learning age reported was 9.46 years (*SD* = 8.30). Two participants reported English was not their first language but did not report their learning age.

3.1.3. Intervention

The structure of the intervention was the same as that of Study 1, both conditions were given a short background to their topic and were required to complete an information search and short essay task. Participants were randomly assigned to the value intervention condition (*n* = 197) or the recipe condition (*n* = 188). The instructions for participants in the value intervention condition were identical to Study 1, participants in the recipe condition were instructed as follows:

> "Edible insects have gained a large amount of media attention recently. The reason for this is due to the need to find an alternative protein source that is more environmentally sustainable than current meat production practices. It is widely agreed that insects have the potential to fulfil this need, however many people are still unaware of this. During this experiment you will be asked to search for information on edible insects that is readily available on the internet. Specifically, we ask that you conduct a web search to look for a recipe made using edible insects."

> "Please conduct a web search and type a short essay (1–3 paragraphs) on how to cook a meal using edible insects, including ingredients and instructions."

3.1.4. Measures

3.1.4.1. Image rating task (including "willingness to try"). The image rating task was identical to that of Study 1 in terms of the image database, ratings and scales used. Participants were asked to rate fourteen pairs of randomly selected images on the same 6 attributes, with willingness to try presented first followed by the other 5 attributes which were randomised across participants.

The same image rating task was used in the follow-up with participants being shown images they had not previously rated in Study 2.

3.1.4.2. Pre-post measures. The pre and post measures were expanded from Study 1 to include 4 questions for perceived value and 4 questions for interest. The perceived value and interest questions were changed to capture value (e.g., "I think edible insects could be beneficial to me in daily life.") and interest (e.g., "For me edible insects are an interesting topic.") in edible insects rather than just in the information as in Study 1. Rated on a 5-point Likert scale (0–4), the 4 interest and 4 value questions were asked before and after the intervention. The full list of pre and post measures for Study 2 can be seen in Appendix C. Mood ("How are you feeling right now?") and task engagement ("How engaged do you feel right now?") remained the same and the questions were asked before and after the intervention as in Study 1.

The post questions were asked again in the one-month follow-up for both perceived value and interest.

3.1.4.3. Other measures. Previous tasting experience with insect foods was once again measured with the question "Have you previously tried foods containing insects?"; Yes/No.

The interest and disgust sub-scales from the EAQ were used to measure general attitudes towards entomophagy. The interest sub-scale (e.g., "I'd be curious to taste a dish with insects, if cooked well"), comprised of three items, aims to measure general levels of interest in entomophagy. The disgust sub-scale consists of five items (e.g., "I would be disgusted to eat any dish with insects") and aims to measure the level of disgust towards edible insects.

Both the interest and disgust sub-scales of the EAQ were asked again in the one-month follow-up.

The 'entomophagy re-engagement' questions used in the Study 1 follow-up were used again in this follow-up to examine whether participants had thought about edible insects and their potential value since completing Study 2 (e.g., In the past month I have thought about the idea of eating insects). The questions were rated on the same 0 (Never) to 4 (A Great Deal) scale. See Appendix B for the full list of questions.

3.1.4.4. Discount code and purchase intentions. To assess behavioural intention to eat insect foods, participants were also given the opportunity to click a link to receive a 15% discount code for the edible insect website Crunchy Critters (https://www.crunchycritters.com). If they did not click the link, they simply moved on with the experiment.

For the follow-up study, participants were asked if they had purchased any insect foods since completing Study 2. If they responded 'yes', they were asked if they had used the voucher offered in the previous study. If they responded 'no', they were asked if they would consider purchasing insect foods in the future ("Would you consider purchasing insect food products in the future?").

3.1.5. Procedure

Participants were invited to take part in the "Food Information Study". Identical to the procedure of Study 1, participants completed the pre-task questions then proceeded to complete the information search and essay task on their assigned topic. The essay task followed the same rules as Study 1 in terms of minimum and maximum time limits as well as the minimum word count. The information search part of the task also worked in the same way as that of Study 1. Immediately after the essay task, participants completed the post-task questions. Participants were then asked to complete the image rating task. Participants rated willingness to try along with the other 5 attributes (curiosity, attitude, tastiness, healthiness and sustainability) for each image. Participants then went on to complete the interest and disgust sub-scale of the EAQ. After this, participants were presented with the opportunity to claim the 15% discount code, followed by a question asking if they had any previous experience with insect foods.

The follow-up was similar to that in Study 1. Participants were invited back to take part in further tasks related to the 'Food Information Study'. A second image rating task was completed following the same procedure as in the Study 1 follow-up, but each participant rated a different set of 14 image pairs in the follow-up. Participants then completed a recall task, in which they were asked to write down everything they were able to remember regarding the content of their essay from Study 2. Participants then completed the post questions, followed by the entomophagy re-engagement questions and then the interest and disgust sub-scales of the EAQ. Participants were also asked if they had purchased insect foods in the past month. Finally, participants were given a second chance to redeem the discount code they were offered in Study 2.

3.1.6. Data analysis

Data analysis followed the same structure as in Study 1, including model specification (value intervention vs. recipe, effect coded as 1 and -1 respectively), machine learning, scaling and pre-post analysis. The option to claim the discount code for the edible insects website and questions on purchasing insect foods were analysed using chi-squared tests to examine any differences between the conditions.

3.2. Results

3.2.1. Intervention effects on image rating task

Mean ratings by condition and food type as well as effect sizes for the effect of condition and the test statistics for the interaction between condition and food type are presented in Table 5 and Fig. 3. A mixed-effects model was again conducted on willingness to try. Condition was not a significant predictor of willingness to try, suggesting ratings did not significantly differ across conditions for both food types, $\beta = 0.03$, $p = .778$. There was also no significant interaction, $\beta = 0.04$, $p = .539$. This would suggest that for willingness to try, ratings given by those in the value intervention condition were not significantly different from those in the recipe condition for either food type.

Mixed-effects models were conducted on the remaining attributes, as in Study 1. Condition was not a significant predictor for any of the attributes, $\beta = 0.02$–0.10, $ps > .080$. There were also no significant interactions between condition and food type, $\beta = 0.03$–0.13, $ps > .060$, suggesting there was no statistically significant difference in ratings of any attribute between the value intervention and recipe condition for either type of food. See Table S9 for model results.

Mean ratings for the follow-up are presented in Table 6 and in the supplementary materials Fig. S2. The same pattern as in Study 2 emerged in the one-month follow-up, condition was not a significant predictor of willingness to try, $\beta = 0.02$, $p = .875$. There was also no significant interaction between condition and image type, $\beta = 0.03$, $p = .675$.

Condition was not a significant predictor of any of the other 5 attributes, $\beta = -0.06$ – 0.04, $ps > .400$. Nor were there any significant interactions between condition and food type, $\beta = 0.03$–0.05, $ps > .400$. Similar to Study 2, our results suggest there were no differences between conditions on the ratings given for any of the attributes for either food type. Mixed-effects models are presented in Table S10.

3.2.2. Previous experience

Twenty-one participants did not provide responses to the previous experience question due to technical issues. Of the 364 responses collected, 15% of participants reported having previously eaten insects (value intervention = 16%, recipe = 14%). As in Study 1, the number of participants who had reported trying insect foods did not significantly differ between groups ($t(362) = -0.44$, $p = .662$, $d = -0.05$).

Once again, to determine whether our findings were robust for naïve participants who had not previously tried insect foods, exploratory linear mixed-effects models were estimated using only participants who reported never having tried insect foods previously. The results are reported in the supplementary materials.[4] [5]

3.2.3. Pre-post measures

As in Study 1, ANCOVAs were conducted on each of the pre-post measures to assess post-intervention differences between conditions after controlling for baseline scores. Unlike the image rating task, value intervention condition showed higher post interest and value scores compared to the recipe condition. Participants in the value intervention condition ($M = 2.67$, $SD = 0.89$) showed higher post-interest scores compared to the recipe condition ($M = 2.39$, $SD = 0.97$). This was significantly different between conditions, $F(1, 381) = 36.60$, $p < .001$, $\eta_p = 0.09$. One participant was removed from the pre-post interest analysis due to a technical issue resulting in a missing score. A similar pattern was seen for post value; the value intervention condition ($M = 2.77$, $SD = 0.83$) also showed higher post-value scores compared to the recipe condition ($M = 2.34$, $SD = 0.95$). This was once again significantly different between conditions, $F(1, 382) = 56.01$, $p < .001$, $\eta_p = 0.13$. Participants in the value intervention condition also appeared to find the task more engaging ($M = 3.29$, $SD = 0.63$) in comparison to the recipe condition ($M = 3.17$, $SD = 0.64$), $F(1, 382) = 9.42$, $p = .002$, $\eta_p = 0.02$. This same pattern was also reflected in the mood measure, with the value intervention condition having higher mood scores post-intervention ($M = 2.75$, $SD = 0.72$) compared to the recipe condition ($M = 2.60$, $SD = 0.81$), $F(1, 382) = 6.83$, $p = .009$, $\eta_p = 0.02$.

[4] The main analyses were conducted with those who had not tried insect foods previously (value $n = 153$; recipe $n = 156$). The results show a very similar pattern to that of the full sample with the exception of a significant interaction between condition and image type for curiosity. For those who had not tried insect foods before, those in the value intervention condition showed higher levels of curiosity towards insect food images compared to those in the control condition. This may suggest that for those without previous experience, the value intervention induces higher levels of curiosity towards insect foods compared to the recipe condition. See Table S11 in the supplementary material for model results.

[5] Again for the follow-up, the analyses were repeated for those who reported not having tried insect foods previously (value $n = 112$; recipe $n = 114$). The pattern of results was, again very similar to that of the full sample. Condition was not a significant predictor of any of the attributes measured and there were no significant interactions. See Table S12 in the supplementary material for model results.

Table 5
Study 2 mean ratings by condition and food type, effect size for the difference between the intervention and control condition by food type, and test statistics for the interaction between condition and food type from the mixed-effects model.

	Insect			Non-insect				
	Value intervention	Recipe	Effect size	Value intervention	Recipe	Effect size	Interaction effect	
	Mean (*SD*)		*d* (95% CI)	Mean (*SD*)		*d* (95% CI)	β *(SE)*	*p*
Willingness to try	2.92 (2.54)	2.79 (2.46)	0.05 (-0.15 – 0.25)	6.99 (1.60)	7.01 (1.78)	−0.02 (-0.22 – 0.18)	0.04 (0.06)	.539
Curious	4.06 (2.57)	3.76 (2.62)	0.12 (-0.08 – 0.32)	5.04 (1.95)	5.24 (2.10)	−0.1 (-0.3 – 0.1)	0.13 (0.08)	.112
Attitude	3.12 (2.16)	2.99 (2.16)	0.06 (-0.14 – 0.26)	6.69 (1.35)	6.70 (1.51)	−0.01 (-0.21 – 0.19)	0.03 (0.06)	.569
Tasty	3.61 (2.19)	3.36 (2.19)	0.11 (-0.09 – 0.31)	7.18 (1.34)	7.18 (1.48)	0 .00 (-0.2 – 0.2)	0.06 (0.06)	.276
Healthy	5.44 (1.68)	5.09 (1.67)	0.21 (0.01–0.41)	5.07 (1.24)	5.00 (1.18)	0.05 (-0.15 – 0.25)	0.07 (0.05)	.128
Sustainable	6.05 (1.64)	5.81 (1.81)	0.14 (-0.06 – 0.34)	5.20 (1.43)	5.36 (1.40)	−0.11 (-0.31 – 0.09)	0.10 (0.05)	.064

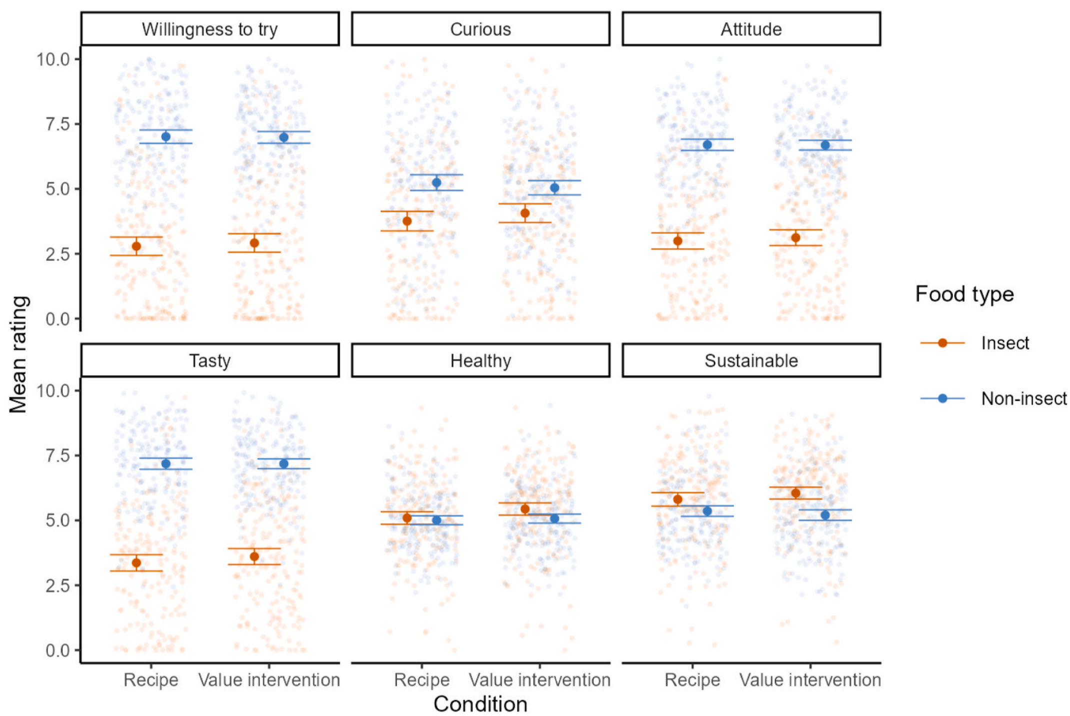

Fig. 3. Mean ratings of willingness to try and five additional attributes by condition (Control and Value intervention) and food type (Insect and Non-insect) from Study 2.
Note. Lighter points represent individual participants, darker points represent group-level means and error bars represent 95% confidence intervals around the group-level mean.

To assess differences between conditions on post measures at one-month follow-up, ANCOVAs were again conducted controlling for the pre-scores taken in the main data collection. The significant differences in self-reported interest measures were sustained at follow-up, $F(1, 277) = 16.42$, $p = < .001$, $\eta_p = 0.06$. As were the significant differences in the value measure, $F(1, 277) = 17.11$, $p = < .001$, $\eta_p = 0.06$. Participants in the value intervention condition reported higher post-interest ($M = 2.43$, $SD = 0.95$) and value ($M = 2.52$, $SD = 0.84$) at follow-up compared to the recipe condition ($M = 2.09$, $SD = 1.09$ for interest; $M = 2.23$, $SD = 0.96$ for value).

3.2.4. Other measures

Participants also completed the interest and disgust subscales of the EAQ; in the main study, independent samples *t*-tests showed that there were no significant differences between conditions on the interest sub-scale, $t(383) = 0.75$, $p = .454$, $d = 0.08$. The same was found for the disgust sub-scale, $t(383) = -0.45$, $p = .652$, $d = -0.05$. Similarly, in the one-month follow-up, participants showed no significant differences between conditions on the interest sub-scale, $t(279) = 0.16$, $p = .874$, $d = 0.02$. The disgust sub-scale of the EAQ also showed no significant differences between conditions, $t(279) = -0.64$, $p = .526$, $d = -0.08$.

The entomophagy re-engagement questions showed no significant differences between conditions at the one-month follow-up, $t(279) = 1.83$, $p = .069$, $d = 0.22$, suggesting that participants in both the value intervention condition ($M = 0.91$, $SD = 0.92$) and the recipe condition ($M = 0.71$, $SD = 0.85$) thought about insects as a food source and the related benefits similar amounts within that previous month. Descriptive statistics for pre-post measures and questionnaire measures are presented in Table 7.

Table 6
Study 2 follow up mean ratings by condition and food type, effect size for the difference between the intervention and control condition by food type, and test statistics for the interaction between condition and food type from the mixed-effects model.

	Insect			Non-insect				
	Value intervention	Recipe	Effect size	Value intervention	Recipe	Effect size	Interaction effect	
	Mean (*SD*)		*d* (95% CI)	Mean (*SD*)		*d* (95% CI)	β *(SE)*	*p*
Willingness to try	2.51 (2.33)	2.42 (2.34)	0.04 (-0.2 – 0.27)	7.06 (1.60)	7.08 (1.65)	−0.02 (-0.25 – 0.22)	0.03 (0.07)	.675
Curious	3.38 (2.44)	3.28 (2.65)	0.04 (-0.2 – 0.27)	5.22 (1.88)	5.31 (2.11)	−0.04 (-0.28 – 0.19)	0.04 (0.09)	.630
Attitude	2.77 (2.05)	2.58 (2.09)	0.09 (-0.14 – 0.33)	6.73 (1.34)	6.76 (1.38)	−0.02 (-0.25 – 0.22)	0.05 (0.07)	.425
Tasty	3.29 (2.12)	3.14 (2.25)	0.07 (-0.17 – 0.3)	7.25 (1.33)	7.22 (1.31)	0.02 (-0.21 – 0.25)	0.03 (0.06)	.627
Healthy	5.08 (1.65)	4.95 (1.70)	0.07 (-0.16 – 0.31)	5.14 (1.13)	5.14 (1.16)	0.00 (-0.23 – 0.24)	0.03 (0.05)	.565
Sustainable	5.60 (1.81)	5.61 (1.87)	−0.01 (-0.24 – 0.22)	5.47 (1.37)	5.70 (1.45)	−0.16 (-0.39 – 0.08)	0.05 (0.06)	.422

Table 7
Mean pre-post and questionnaire measures for the value intervention and recipe conditions for Study 2 (S2) and one month follow-up (S2 follow-up).

Measure		Value Intervention		Recipe	
		S2	S2 follow-up	S2	S2 follow-up
		Mean *(SD)*			
Value					
	pre	2.12 (0.93)	–	2.12 (0.95)	–
	post	2.77 (0.83)	2.52 (0.84)	2.34 (0.95)	2.23 (0.96)
Interest					
	pre	2.09 (0.97)	–	2.16 (1.03)	–
	post	2.67 (0.89)	2.43 (0.95)	2.39 (0.97)	2.09 (1.09)
Mood					
	pre	2.54 (0.73)	–	2.52 (0.73)	–
	post	2.75 (0.72)	–	2.60 (0.81)	–
Task engagement					
	pre	3.03 (0.68)	–	3.09 (0.55)	–
	post	3.29 (0.63)	–	3.17 (0.64)	–
EAQ-interest		2.25 (1.25)	2.07 (1.27)	2.16 (1.27)	2.04 (1.27)
EAQ-disgust		1.99 (1.08)	2.10 (1.12)	2.04 (1.13)	2.19 (1.14)
Entomophagy re-engagement		–	0.91 (0.92)	–	0.71 (0.85)

3.2.5. *Essay content*

Machine learning was applied to the essay data in the same way as Study 1. The feature selection applied by the lasso suggested ten-word stems as predictors of willingness to try insect foods (see Table 8). As in Study 1, the combination of the idiosyncratic features selected and measures of predictive power suggested the essay content was not particularly predictive of willingness to try insect foods for both test ($R^2 = -0.01$; RMSE = 2.62) and training ($R^2 = 0.06$; RMSE = 2.41) data sets.

3.2.6. *Memory*

Memory responses of essay content at the one-month follow-up were coded identically to the Study 1 follow-up. The results suggested that there was no significant difference between the value intervention condition (80% remembered) and the recipe condition (73% remembered) in memory of the content or topic of the essays, χ^2 (1, $N = 281$) = 1.46, $p = .226$.

Table 8
Selected features and coefficients from machine learning model including RMSE and R^2 for Study 2 essay data.

Predictors	Coefficients	
Intercept	2.74	
insid	0.28	
actual	0.47	
lose	0.05	
level	0.08	
vitamin	0.00	
obtain	0.00	
franc	−0.19	
save	1.05	
broccoli	0.36	
sculpt	0.00	
	RMSE	R^2
Train	2.41	0.06
Test	2.62	−0.01

3.2.7. *Discount code and purchase intentions*

In the value intervention condition, 77 participants revealed the discount when given the option compared to 60 in the recipe condition, this difference was not significant χ^2 (1, $N = 385$) = 1.86, $p = .173$. When given the opportunity to reveal the discount code at the follow-up, 42 participants from the value intervention condition and 33 from the control condition revealed the code. Of these participants, 29 from the value intervention condition and 21 in the recipe condition revealed the code in both Study 2 and the follow-up. There were no significant differences in the number of times the code was revealed between conditions χ^2 (1, $N = 281$) = 0.47, $p = .494$.

Three participants (value intervention $n = 1$, recipe $n = 2$) reported having purchased insect food products between the main study and the follow-up. Those who had not made a purchase ($n = 278$) were asked if they would consider purchasing insect foods in the future, 68 participants from the value intervention condition and 50 from the recipe condition replied they would consider purchasing in the future. There were no significant differences on future purchase intentions between conditions, χ^2 (1, $N = 278$) = 2.09, $p = .148$.

3.2.8. *Supplementary comparison analysis*

To further understand the potential effects of the recipe condition, a supplementary comparison analysis was conducted using the control condition from Study 1 and the recipe and value intervention conditions from Study 2. This design allows us to examine the reason behind the generally non-significant differences between the value intervention condition and the recipe condition. If the value intervention condition and the recipe condition in Study 2 are statistically different from the control condition in Study 1, this indicates that both conditions in Study 2 enhanced willingness to try insect food, indicating that both interventions are effective.

To compare the three conditions two contrast coded variables were created using the control condition from Study 1 as the reference category – value intervention condition in Study 2 vs. control condition in Study 1 (value contrast) and recipe condition in Study 2 vs. control condition in Study 1 (recipe contrast). For willingness to try, there was a significant interaction between value contrast and image type in favour of the value intervention condition, $\beta = 0.20$, $p = .005$. Simple effects analyses revealed that for insect food images participants in the value intervention condition in Study 2 gave higher willingness to try ratings compared to the control condition in Study 1, $\beta = 0.37$, $p = .009$, $d = 0.41$, but not for the non-insect condition, $\beta = -0.03$, $p = .763$, $d = -0.04$. The same pattern was found for the other five attributes of interest, $\beta = 0.11$–0.24, $ps < .050$. The pattern indicates that the value intervention condition in Study 2 acted exactly like the same condition in Study 1 – the value intervention was effective in facilitating willingness to try insect food.

On the other hand, the recipe contrast showed no significant interaction effect with the image type, $\beta = -0.03$ – 0.12, $ps < .090$. This suggests that the recipe condition in Study 2 was not statistically different from the control condition in Study 1. One plausible interpretation of this pattern of the results is that, while the recipe condition is not statistically different from the control condition or the value intervention condition, the recipe condition sits somewhere between them. In other words, the recipe condition may have a somewhat weaker intervention effect in encouraging insect food eating than value intervention condition, although the difference was not statistically significant. See Table S13 for the full model results, Tables S14 and S15 for the simple effects analyses for insect and non-insect foods respectively, and Table S16 for a table of effect sizes. However, it should be noted that this is a post-hoc analysis which was conducted on data collected at different times for Study 1 and Study 2, respectively.

3.3. Discussion

Our results from Study 2 showed that for willingness to try (the main dependent variable) there was no significant interaction between condition and food type, suggesting that participants in the value intervention condition were not significantly more willing to eat insect foods than those in the recipe condition. The same pattern was found for the other five attributes. Considering the significant effect of the value intervention condition found in Study 1, this could suggest that it is not the value intervention itself that increases willingness to try but rather the exposure to insects as a food source. The results of the EAQ subscales suggest the same pattern as there were no significant differences between conditions in the levels of interest and disgust reported. Critically, the pre-post measures did show significant differences between the value intervention and recipe conditions suggesting participants found the task more interesting and perceived more value in the task in the value intervention condition (for both the main study and one-month follow-up). These results support the idea that the value intervention was effective at increasing interest and perceived value, but in terms of increasing willingness to try exposure to insect foods may be sufficient. The supplementary comparison analysis adds further support for the usefulness of the value intervention, suggesting that this was the most effective at encouraging willingness to try and the other measured attributes. The recipe condition was not significantly different from the value intervention condition, but recipe condition was also not significantly different from the control condition, suggesting that this may be positioned in between the other two conditions in terms of effectiveness.

4. General discussion

We have shown that a value intervention in which participants researched and wrote a short essay about the value of insect-based foods for a healthy and sustainable diet has the potential to increase the willingness to try insect foods, as well as increasing curiosity, attitude, perceived tastiness, healthiness, and sustainability ratings of insect foods. Our results also suggest that the intervention has an extended effect, surviving at a one-month follow-up. The main results were robust to excluding participants who have had previous experience with insect-based foods. These results are consistent with the value intervention studies within the field of education, which have shown it is possible to increase interest and performance through increasing the perceived value of a topic (e.g., Brisson et al., 2017; Gaspard et al., 2015; Rosenzweig et al., 2020).

However, we also found that there were no significant differences between the value intervention condition and recipe condition in terms of willingness to try and general attitudes towards entomophagy, despite that value intervention indeed increased self-reported interest and value for insect foods. Given, the effectiveness of the value intervention seen in Study 1 (and willingness to try in value intervention condition showed similar values between Study 1 and Study 2), these results suggest that it may not be the increase in perceived value driving this attitudinal change but rather exposure to insects as a food. In fact, by placing insect ingredients in the context of a recipe this may increase the familiarity of the food, thus changing the perceptions regarding how appropriate insects are as an ingredient (i.e., perceived food appropriateness). Previous findings have suggested that both familiarity and food appropriateness are important predictors of willingness to try insect foods (e.g., Jensen & Lieberoth, 2019; Tan et al., 2016). Importantly, Stone et al. (2022) found that curiosity towards insect foods can interact with other previously identified factors so that when curiosity is high the relationship between the other factor and willingness to try is strengthened (a curiosity-boosting effect). Therefore, in the recipe condition, it could be that increased familiarity or food appropriateness and interest affect one another and, in turn, increase willingness to try. Future studies should examine the possible mechanisms of how the recipe condition increased willingness to try, in particular, whether this is due to a change in perceived food appropriateness and familiarity.

4.1. Other benefits and predictors

Our results showed that the value intervention influenced perceptions about insect foods in various ways, in addition to a willingness to try them. The results are consistent with the existing entomophagy literature, in that factors relevant to the adoption of entomophagy were bolstered by the intervention. For example, healthiness and sustainability ratings increased for insect foods in comparison to the control condition; this is in line with Lombardi et al. (2019) who found that when given information on these benefits participants were willing to pay more for insect-based products. This suggests that using a value intervention task to enable individuals to learn about those benefits also has a positive effect on the perceptions of insect-based foods. The same effects were found for tastiness and attitude; perceived tastiness has been shown to be a consistent predictor of willingness to try insect foods (Tan et al., 2016). Improving attitudes towards insect foods and overcoming disgust is again, a main component in adoption of entomophagy (La Barbera et al., 2018). The improved attitude and reduction of disgust is supported by the EAQ results, particularly the disgust sub-scale — Study 1 follow-up showed lower disgust in the value intervention condition compared to the control condition.

While reduced disgust may be a somewhat surprising finding, as disgust has been reported to be a strong and pervasive barrier (e.g., La Barbera et al., 2018), other research suggests that disgust may actually be driven by perceived social norms and the perception that insects are not an appropriate food source (Jensen & Lieberoth, 2019). Therefore, by placing insect-based foods in a context that changes the perceived social norms or appropriateness, individuals may be more willing to try. It is possible that by researching the benefits of insect-based foods during the value-intervention condition, participants were exposed to others with positive attitudes towards insect-based foods, thus shifting the perceived social norm. Interestingly, a recent study used a social norm intervention, where participants read a brief passage describing other university students eating and enjoying cricket snacks (Gumussoy & Rogers, 2023). The study found a decrease in disgust and greater intake of cricket snacks compared to a control condition. It is also possible that the recipe condition achieves a similar goal using the mechanism of perceived food appropriateness. Placing insect foods in the context of cooking may make the ingredients seem more acceptable to consumers.

A similar effect can be seen for curiosity, participants in the value intervention (Studies 1 and 2) and recipe (Study 2) conditions appeared to rate insect food images higher on curiosity than those in the control condition (Study 1). Entomophagy research once again supports this finding, with curiosity being a key factor in encouraging entomophagy (House, 2016; Stone et al., 2022; Verbeke, 2015). Consumer behaviour research suggests that increased curiosity about a product can lead to increased information seeking and more favourable product evaluations (Daume & Hüttl-Maack, 2020; Menon & Soman, 2002; Ruan et al., 2018). Our results support these notions with higher curiosity and interest ratings shown across several different measures for the value intervention condition when contrasted with the other conditions (including the pre-post items, interest-subscale of the EAQ and the entomophagy re-engagement questions). The increased curiosity and interest in entomophagy is consistent with both the value intervention's ability to increase interest in a topic (e.g., Gaspard et al., 2015; Hulleman et al., 2017) and with interest research more broadly in the sense that it is important for knowledge acquisition, information seeking, and felt rewarding experiences (Litman, 2008; Murayama et al., 2019; Rotgans & Schmidt, 2018).

It is important to note that most of these effects were not observed in Study 2 when the value intervention was compared to the recipe condition. Again, these findings indicate that a utility-value intervention may not be the only way to develop these perceptions about insect foods. However, the additional comparison analysis indicates that the utility-value intervention may be the most effective way to improve these perceptions. Future studies should examine the exact mechanisms underlying the beneficial effects of a utility-value intervention. A utility-value intervention may be one of different possible ways to increase consumer acceptance of insect foods and may have additive effects with other types of interventions. It is important to consider that consumer attitudes toward entomophagy are complex and we acknowledge that many factors contribute to consumers' willingness to try insect foods. However, consumer research suggests that inducing curiosity toward a product favourably increases attitudes regarding the said product (e.g., Ruan et al., 2018). Related to this, a singular positive experience with insect foods is said to increase the willingness to try in the future (Hartmann & Siegrist, 2016). Therefore, it may be that interest generated through a utility-value intervention is a well-placed motivator for the initial positive experience with entomophagy, even though other factors may contribute to repeat consumption.

4.2. Memory and essay content

The analysis of the essay data suggested several word stems were predictors of willingness to try insect foods. However, many of these words appear to have little relevance to the essay topics. This may suggest that the content of the essays themselves are not as important as the act of participating in the task. It may be that the task allows individuals to familiarise themselves with the concept of entomophagy and this is what drives the effectiveness of the task. Similar conclusions about the lack of importance of the contents of self-generated materials have been found with expressive writing interventions for improving health outcomes. Smyth and Pennebaker (2010) suggested that the content may not be as important as previously thought when exploring the effectiveness of expressive writing, which aims to improve health outcomes by having participants write about negative experiences. Several studies found that similar health benefits may be obtained whether people write about negative experiences or positive ones; and indeed, some research even suggests it is not necessary to write about traumas at all (Burton & King, 2004; Pennebaker & Chung, 2007). This reinforces our explanation of the essay content not being as important as the engagement with the task itself.

When asking participants to recall the content/topic of the essay task our results suggested that people were better able to remember the content or essay topic when they were assigned to the value intervention or recipe condition. Participants in the control condition were unable to remember the topic or content as often. Gruber, Gelman, and Ranganath (2014) argue that individuals find it easier to learn about and remember information they are interested in. Research on memory repeatedly showed that people are better at memorizing valuable information (e.g., Middlebrooks, Murayama, & Castel, 2017). Our findings are consistent with such literature. The role of memory has not been examined in the context of value intervention studies, but it is an important topic of inquiry for future studies, as consolidated memory may serve as a mechanism for the potential long-term effects of the intervention (Gruber & Ranganath, 2019; Murayama et al., 2019).

4.3. Limitations and future research

We acknowledge certain limitations of our studies. Firstly, although we showed a significant increase in willingness to try insect foods in the value intervention condition compared to the control condition, willingness to try insect foods was still low in the value intervention condition (e.g., 3 out of 10 in Experiment 1), and below willingness to try non-insect foods across all conditions (stably around 7 out of 10 across experiments). This is perhaps unsurprising given the aversion experienced towards entomophagy in Western cultures – we do not expect people to become wholehearted adopters of entomophagy as a result of a single short-exposure intervention. However, the exposure and acquisition of new information, as well as the consideration of its value, may provide a sufficient nudge towards a first try of insect foods. Additionally, our studies mainly assessed the intention to try insect foods and not actual behaviour. We explored the potential of the interventions to affect behaviour by examining requests for the discount code, however, this is not a direct measure of purchase behaviour. Future studies could examine the impact of the utility value intervention on actual purchase and tasting behaviour, for example by giving the opportunity to taste real insect foods in the lab, or by monitoring purchase behaviour by issuing personalised vouchers to each participant and requesting purchase data from the vendor.

Secondly, our pre-post measures of interest and value in Study 1 may not be entirely comparable between conditions as they focused on the information learned in the task itself. As the value intervention and control conditions were assigned different essay topics, comparing the interest and value of the information learned may not be as informative as the comparison made in Study 2 where both conditions focused on the same topic (insect foods). It is also important to note that in Study 1 the use of a healthy and sustainable diet as the control condition provides two differences between the conditions: the topic and personal relevance. More research may be needed to disentangle these two components and further understand the observed differences between the two conditions. For example, a value intervention task focusing on an insect-based healthy and sustainable diet may provide further insight into the connectedness of personal relevance and development of interest in a topic.

Third, the images used in this study were deliberately chosen to include visible insect elements. The images included a wide variety of insects, including crickets, grasshoppers, mealworms, and buffalo worms, all currently available for purchase as culinary ingredients in the UK (where the study was conducted). It is thus a strength of our study that we included a wide variety of culinary uses of insects, increasing the generalisability of our findings. Previous research has demonstrated that experience with processed insect foods can lead to willingness to try unprocessed insect foods (Hartmann & Siegrist, 2016), suggesting some generalisability of attitudes across different types of insect foods. By testing this intervention with the more extreme case of visible insects, we provided a more stringent test of its efficacy than had we used the perhaps more readily accepted processed insect ingredients. Future research could test this assumption by comparing the efficacy of the value intervention across processed and unprocessed insect foods.

We also note that some of the insect food images used in this study are images of insects included in dishes that may not have contained traditional-animal derived proteins to begin with. We chose images such as these because they could be visually matched to familiar food images to ensure comparability across image type. However, we recognise that this could affect the ratings of sustainability across the insect and non-insect food images, since the insects are added to a dish instead of replacing less sustainable traditional protein elements. Nonetheless, ratings of sustainability were consistently higher for insect foods than for non-insect foods across the value intervention conditions in Studies 1 and 2 (see Figs. 2 and 3).

Fourth, the role of previous experience could also be explored further in future research. While the analysis, which excluded those who had previously tried insect foods, showed a very similar pattern of results to the full sample, there were still slight differences particularly for the follow-up measures. Future research could examine whether previous experience with insect foods impacts the effectiveness of the intervention and the acceptance of insect-based foods over time. This may also differ based on the type or level of previous experience and future research could examine the effectiveness of the intervention for individuals with different levels of previous experience and different forms of exposure to insects as a food source.

Fifth, it may be prudent for future research to examine the effects of both the value intervention and the recipe condition in comparison to the control condition in a single experiment. This will shed further light on the effectiveness of a value intervention in comparison to a contextualised insect foods' exposure and a control condition beyond our exploratory comparison across experiments. Future research could also investigate the underlying mechanisms of both the value intervention and the recipe conditions. It may be that both are effective motivators of insect food consumption; however, they may work in different ways. The results of the supplementary comparison analysis suggest that the recipe condition may be somewhat less effective than the value intervention but more effective than the control condition and this may be as they are underpinned by different mechanisms. These studies did not address this as the aim of this research was to understand if an interest-based intervention has the ability to encourage willingness to try. However, it may be useful for future research to address the mechanisms by which the intervention changes willingness to try. It is possible that there may be a measure specific to insect foods that may mediate to process between the intervention and increased willingness to try, future research should examine this possibility. In particular, a critical next step is to determine whether discovery of the information and the consideration of its value and relevance in the value intervention plays a role in its efficacy over and above the mere provision of information.

Finally, future research should assess whether these effects extend beyond insect foods to novel foods in general (e.g., lab-grown meat, 3D printed foods, or unknown foods). As global pressures on food production mount (Delabre et al., 2021), there will be an increasing need for people to accept novel food sources. Understanding interventions that are effective across different types of novel foods will be crucial for generating behaviour change. While the current study investigated only one type of novel food – insect-based food, we suggest that value interventions may be a promising approach to facilitating new and more sustainable ways of eating more generally.

4.4. Practical implications

Our findings suggest some potential practical uses of value intervention tasks for encouraging the adoption of entomophagy. Communicating the benefits of insect foods through advertising could help foster interest in insect foods. Our analysis of the text produced in the essay task suggested that engaging with the task and information may be more important than the essay task itself. This could suggest that communication of the benefits of entomophagy outside of an essay task, but still in an engaging format, may work as effectively. For example, using tools such as interactive advertisements could be used to promote engagement with information about entomophagy. Theory regarding interactive advertising suggests a role for engagement and recruiting attentional resources to process a topic; therefore, this type of advertisement could have the potential to promote the benefits effectively outside of a value intervention (e.g., Lombard & Snyder-Duch, 2001).

Future research should look at engagement with the benefits of entomophagy in the form of advertising materials to investigate whether it is possible to foster an interest in insect foods this way. The literature suggests that once this interest is sparked, it has the potential to grow and promote re-engagement (Hidi & Renninger, 2006). This may be key not only for encouraging the first try but also for longer-term adoption of entomophagy (House, 2016; Sogari, 2015). This could have positive long-term effects on the environment, as the consumption of traditional animal-derived proteins would decline causing reductions in water consumption and greenhouse gasses (Gahukar, 2011; van Huis, 2013). Additionally, given that utility-value interventions can promote interest and value in a topic (Gaspard et al., 2015), our results suggest that this task could be applied to many different areas with relative ease and success.

It should also be noted that research on encouraging entomophagy has thus far only achieved limited success with regard to real-world implementation and acceptance. Real-world acceptance of insect-based foods in Western societies is a complex issue and this study addresses only one factor (interest as a motivator). There are other factors to consider on top of an initial motivator such as product availability, appeal, and cost. Research suggests that there is a large selection of products available to consumers (e.g., de Carvalho, Madureira, & Pintado, 2020; Skotnicka et al., 2021). However, the ingredients used in these products are somewhat limited to certain types of insects and the most recognised products belong to a small selection of companies (de Carvalho et al., 2020). Similarly, it is suggested that insect food products cost more than the traditional meat equivalent, and this issue should be addressed in order to boost product appeal. It is possible that when industrial production (using sustainable breeding and processing practices) is increased and there is a wider product selection and more commercial interest, these factors may lead to a price decrease (de Carvalho et al., 2020).

Another potential reason for the lack of success so far is the failure of insect-based products to compete with other alternative proteins. A recent review of alternative proteins (insects, plant-based and cultivated meat) suggests that each type of alternative protein has a somewhat distinct set of advantages and barriers to consumption (Mancini & Antonioli, 2022). This could suggest that there is a market for each type of alternative protein and therefore competition with other alternatives may not pose a threat to the insect foods market. Specifically, Mancini and Antonioli (2022) suggest that the enduring negative prejudice towards insect foods may be rooted in a cultural perception of palatability and highly processed insect foods may be the road to acceptance. To ensure future success for edible insect products, research spanning several domains is necessary. Alongside initial motivators such as interest (as investigated within this study), investment in providing an acceptable range of inexpensive products should also be addressed.

Ethics statement

Ethical approval was granted by the University of Reading School of Psychology and Clinical Language Science's School Ethical Review Committee (2020-027-KM). Participants gave informed consent before taking part.

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Transparency and openness

Data, analysis code and materials are available through the Open Science Framework (https://osf.io/4reys/?view_only=16d0605344d84f879128935566387f96), as are the pre-registrations including study designs, hypotheses and main analysis plans for Study 1 (https://osf.io/djrz6/?view_only=cb346a531a754a4380232bdb24531142 and https://osf.io/5z7rq/?view_only=8a4da138e5b746b2845189b3181e0cb6) and Study 2 (https://osf.io/dcfrm/?view_only=509f0af273d64216acb1d200128bab93 and https://osf.io/59pwv/?view_only=d191a3242caa467db703e2b328c7e413).

CRediT authorship contribution statement

Hannah Stone: Conceptualization, Methodology, Software, Formal analysis, Investigation, Writing – original draft, Writing – review & editing, Project administration. **Lily FitzGibbon:** Conceptualization, Methodology, Software, Formal analysis, Writing – review & editing, Supervision, Project administration. **Elena Millan:** Conceptualization, Writing – review & editing, Supervision. **Kou Murayama:** Conceptualization, Methodology, Writing – review & editing, Supervision, Funding acquisition.

Declaration of competing interest

We have no conflicts of interest to disclose.

Data availability

Data is available via OSF (links in manuscript)

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.appet.2023.107002.

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