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Food neophobia and disgust, but not hunger, predict willingness to eat insect protein

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ABSTRACT

Due to the environmental benefits of entomophagy, a growing field of research is now investigating the factors that predict people's willingness to eat insects. In the current studies, we examined how willingness to eat insects may vary as a function of individual differences in disgust sensitivity, food neophobia, and hunger. We conducted two studies, one using a self-report measure and one using a behavioral measure of willingness to eat insects. In both studies, higher food neophobia predicted reduced willingness to eat insects. Disgust predicted lower self-reported, but not behavioral, willingness to eat insects. By contrast, hunger did not predict willingness to eat insects in either study. Our findings suggest that reducing food neophobia toward insects may be important for acceptance of entomophagy and may inform future marketing strategies that aim to encourage people to view insect protein as a viable source of nutrition.

1. Introduction

Insects are a healthy and sustainable food source (Van Huis et al., 2013). Insect protein is a low-cholesterol source of protein (Hartmann & Siegrist, 2017), and many insects provide a rich source of nutrients, such as fats, calcium, and zinc (Van Huis et al., 2013). Insect farming produces less greenhouse gas and less ammonia than traditional livestock farming. Insect farming also requires less land and less feed to produce protein amounts equivalent to traditional livestock (Oonincx & de Boer, 2012; Van Huis et al., 2013). These qualities make insect farming a viable and more sustainable alternative to conventional livestock. Entomophagy, or eating insects, may also reduce animal suffering compared to consumption of traditional livestock (see House, 2018).

Despite these health, ecological, and ethical benefits, and despite the existence of approximately 2000 known species of edible insects (Evans et al., 2015; Ramos-Elorduy, 2009), entomophagy is often considered disgusting in the Western world (Van Huis et al., 2013). Due to the environmental benefits of entomophagy, a growing field of research is investigating the various factors that predict willingness to eat insects or insect protein (e.g., Barbera et al., 2018).

1.1. Food Neophobia

Novel foods pose unknown risks. Food neophobia – a disinclination to eat unfamiliar foods – is hypothesized to protect an organism from consuming harmful substances, such as pathogens, parasites, and toxins (Al-Shawaf et al., 2015a; Pliner & Hobden, 1992). But not all unfamiliar foods are alike: animal products typically pose greater infection risks than non-animal products (Fessler, 2002). Consistent with the hypothesized function of food neophobia, people show more food neophobia to animal than non-animal products (Fessler, 2002; Pliner & Pelchat, 1991).

The specific types of foods that trigger food neophobia may be culture-dependent, because children raised in different cultures observe different eating behaviors among their peers and elders (Hartmann et al., 2015; Piha et al., 2018; Van Huis et al., 2013; see also Al-Shawaf et al., 2019). As a result, insects may trigger food neophobia in cultures where they are an unfamiliar food type, as in the Western world.

There are also individual differences in people's food neophobia (Pliner & Hobden, 1992), which may predict psychological and behavioral outcomes regarding entomophagy. Specifically, individual differences in trait food neophobia may negatively predict willingness to eat insects (see Barbera et al., 2018; Jensen & Lieberoth, 2019; Lombardi

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et al., 2019).

1.2. Disgust

The pathogen avoidance theory of disgust suggests that disgust functions to help an organism avoid pathogens and parasites in its environment, thereby decreasing the likelihood of infection (Al-Shawaf & Lewis, 2013; Al-Shawaf et al., 2016; Cepon-Robins, in press; Curtis et al., 2004; Tybur et al., 2018). Consistent with this theory, stimuli associated with infection risk elicit disgust (Curtis et al., 2004). Many insects pose a risk of disease transmission or are associated with a lack of cleanliness, which may explain disgust responses to certain insects (Lorenz-Reaves et al., 2014). Furthermore, people in Western countries may be largely unfamiliar with edible insects, because insects are not part of the typical Western diet. In these countries, even innocuous insects may be misperceived as infection risks, resulting in an over-inclusive disgust response to insects (Looy et al., 2014; Lorenz-Reaves et al., 2014; Van Huis et al., 2013).

There are large individual differences in people's disgust thresholds (Al-Shawaf & Lewis, 2017; Tybur et al., 2009), which can predict important psychological and behavioral outcomes. Evidence suggests that these individual differences in disgust predict variation on manifold other dimensions, ranging from mating strategy (Al-Shawaf et al., 2015b) to political orientation (Inbar et al., 2012). Individual differences in disgust may also predict willingness to eat insects. That is, because some insects pose potential disease risks (Lorenz-Reaves et al., 2014), individuals with higher disgust sensitivity may be less willing to eat insects than those with lower disgust sensitivity (see Barbera et al., 2018; Jensen & Lieberoth, 2019).

1.3. Hunger

Recent work suggests that hunger may be a "coordinating mechanism" (Al-Shawaf et al., 2016) that orchestrates different aspects of cognition, perception, and physiology in service of finding and consuming food. This perspective suggests that increased levels of hunger should predict greater willingness to eat unfamiliar foods (e.g., insects)—even those that may pose a pathogen risk. In extreme conditions, one might expect someone on the brink of starvation to eat foods that they would otherwise classify as disgusting or spoiled (Al-Shawaf, 2016; Tybur et al., 2018). Although many have hypothesized that hunger might increase willingness to eat novel or disgusting foods whether hunger actually has these effects is still unclear (see Hoefling et al., 2009; Perone et al., 2021 and Pliner et al., 1995).

1.4. The current studies

The current studies were designed to test whether food neophobia, disgust, and hunger predict people's willingness to eat insects. In Study 1, we examined whether these variables predicted people's self-reported willingness to eat foods containing insects. In Study 2, we tested whether the relationships observed in these self-report measures translated to real-life behavior: we tested whether these variables predicted people's actual behavioral decisions to eat roasted crickets.

2. Study 1

2.1. Method

Participants were 241 students (184 women; 52 men; 3 non-binary; 1 transgender) between 18 and 57 years old (M = 22.00, SD = 6.05). Participants were recruited from a university in [the Rocky Mountain region] of the United States and were compensated with research credit for participating in a study regarding "hunger & cognition." Participants completed an online survey in which they provided informed consent, demographic information, and responded to the scales and questions detailed below.[1] This study received ethics approval from the Institutional Review Board of [the University of Colorado, Colorado Springs]. Additionally, we laid out the predictions to be tested and the analytic plan to be employed prior to data collection.

2.1.1. Measures

To assess disgust, we used the seven items from the 21-item Three Domain Disgust Scale (Tybur et al., 2009) that pertain to pathogen threats. Because disgust toward insects falls most squarely in the pathogen domain of disgust, that is the only scale that we included in this study. Participants rated how disgusting (0 = *Not at all disgusting*; 6 = *Extremely disgusting*) they found hypothetical scenarios such as "seeing a cockroach run across the floor." We averaged responses to the seven items to form a composite of pathogen disgust (α = .82).

To assess participants' reluctance to eat new foods, we used the 10-item Food Neophobia Scale (Pliner & Hobden, 1992). Participants rated their agreement (1 = *Strongly Disagree*; 7 = *Strongly Agree*) with items such as "I don't trust new foods." We averaged the items to create a composite of food neophobia (α = .92).

To assess participants' hunger levels, we used the Satiety Labeled Intensity Magnitude scale (Cardello et al., 2005). Participants rated their hunger on a sliding scale (−100 = *Greatest imaginable hunger*; 100 = *Greatest imaginable fullness*).

Finally, participants self-reported their willingness to eat insects and insect protein. Participants answered whether they would be willing (1 = *No*; 2 = *Maybe*; 3 = *Yes*) to eat the insect foods. Participants answered this question separately for roasted crickets, fried worms, and insect protein bars. We averaged responses to the three separate foods to form a variable assessing overall willingness to eat insects (α = .80).

2.2. Results

We ran a stepwise multiple regression in which we predicted participants' overall willingness to eat insects from their levels of food neophobia, pathogen disgust, and hunger. The final model, which explained 19 % (f^2 = 0.23) of the variance in willingness to eat insects, F (2, 238) = 26.93, p < .001, included food neophobia (β = −.34, p < .001) and pathogen disgust (β = −.22, p < .001) as independent predictors of (reduced) willingness to eat insects (see Table 1). We re-ran the analyses following the removal of a single outlier and the results were unchanged.

3. Study 2

3.1. Method

In Study 2, we employed a behavioral measure of willingness to eat insect protein. Participants were 103 students (72 women; 30 men; 1 transgender) between 18 and 47 years old (M = 22.94, SD = 6.35). Participants were recruited from a university in [the Rocky Mountain

Table 1
The results for each variable included in the final regression model.

Multiple regression predicting willingness to eat insects						
Column1	*B*	*SE B*	*β*	*p*	95 % CI for *B*	
					Lower	Upper
Food neophobia	−0.18	0.03	−.34	<.001	−0.24	−0.12
Pathogen disgust	−0.12	0.03	−.22	<.001	−0.19	−0.06

[1] Data for both studies discussed here are available upon request from the corresponding author.

region] of the United States and were compensated with research credit for participating in a study regarding "cognition and perception." In the lab, participants provided informed consent, answered demographic questions, and responded to the same scales measuring food neophobia, disgust, and hunger used in Study 1. After participants completed the scales, they were informed that "roasted crickets are safe to eat, and some people do actually eat them as a food source." Participants were also screened for potential allergies before being presented with a roasted cricket. Researchers recorded whether participants ate the cricket as a dichotomous behavioral measure of willingness to eat insects. This study received ethics approval from the Institutional Review Board of [the University of Colorado, Colorado Springs]. The predictions tested and the analytic plan employed were determined prior to data collection.

3.2. Results

We ran a binomial logistic regression (method: backward elimination; likelihood-ratio) in which we regressed the participants' decision to (not) eat the cricket on trait food neophobia, pathogen disgust, and hunger.[2] Only one variable emerged as a significant predictor: food neophobia (see Table 2). The final model explained 18 % (Nagelkerke R^2) of the variance in whether people ate the cricket, $\chi^2(2) = 13.74$, $p = .001$. It also correctly classified 78 % of cases; in other words, individual differences in food neophobia correctly predicted 78 % of participants' decisions to eat or not eat the roasted cricket.

4. General discussion

We found that disgust negatively predicted self-reported willingness, but not behavioral willingness, to eat insects. In Study 1 and Study 2, we found that food neophobia predicted reduced willingness to eat insects using both self-report and behavioral measures.

This project contributes to the limited literature on how food neophobia, disgust, and hunger predict willingness to eat insects. This is one of the first studies (see also Perone et al., 2021) to examine hunger as a predictor of behavioral willingness to eat insects. Our findings suggest that, consistent with some existing research (e.g., Barbera et al., 2018; Hartmann & Siegrist, 2016), food neophobia and disgust are inversely related to a person's willingness to eat insects.

The current studies' findings are also consistent with evolutionary approaches to food neophobia and disgust. These approaches suggest that food neophobia and disgust may function to protect an organism by avoiding – including not consuming – potentially dangerous substances (Barbera et al., 2018; Curtis et al., 2004; Jensen & Lieberoth, 2019; Pliner & Pelchat, 1991). Although the consumption of roasted crickets does not pose a veritable threat, food neophobia and disgust may be activated by this viable food source as a consequence of their over-inclusive design (Park et al., 2003)—they may be triggered by innocuous stimuli when those stimuli exhibit overlapping cues with stimuli that truly pose an infection risk (e.g., insects that serve as disease vectors). Understanding the influence of food neophobia and disgust on willingness to eat insects, and how to lessen or avoid such feelings when they are not grounded in an objective pathogen, parasite, or toxin threat, may inform future efforts to encourage the consumption of insect protein as a nutritious, sustainable food source.

We did not find any relationship between hunger and willingness to eat insects. One possible interpretation of this finding is that hunger simply does not play a role in people's willingness to eat these alternative protein sources (i.e., the null hypothesis is true; see also Perone et al., 2021). Alternatively, the null finding for hunger may be a result of our studies' limitations, discussed next.

4.1. Limitations

First, neither study was experimental. Rather than having a portion of the participants fast for a certain number of hours, we asked participants to rate their current hunger levels. This means that we cannot draw causal conclusions from this dataset.

Second, it is possible that hunger is subject to threshold effects, such that mild hunger has no effect on willingness to eat unusual or potentially pathogenic foods, but moderate or severe hunger does. In our sample, with college students who were not fasting, it is unlikely that many participants were experiencing severe hunger. Consequently, two key interrelated future directions are to experimentally manipulate hunger through, for example, participant fasting, and to have greater variance in hunger among participants. However, even restricting food intake as part of an experimental design may not be sufficient, given the food abundant culture in the United States. Future studies that choose not to experimentally manipulate hunger could recruit participants who are fasting for other reasons like intermittent fasting or fasting for religious reasons (e.g., Ramadan in the Muslim world).

Third, participants in our studies were not asked to report their existing familiarity with insect-based foods. Consequently, some participants may have been more familiar than others with these items. Familiarity with insects as food would likely reduce food neophobia toward insects (see Padulo et al., 2022). Moreover, participants with a greater familiarity with eating insects may have discriminated between the insect-based protein foods and whole insect foods, such as the fried mealworm, based on their experiences with the taste and texture of such foods. Future studies would do well to measure and control for participants' familiarity or prior experience with these foods uncommon in the typical Western diet. That said, we do not think it is likely that many of our participants had experience with foods like fried worms and roasted crickets.

Fourth, we did not include all possible predictors of willingness to eat insect protein, such as openness to experience, concerns for environmental sustainability, or concerns for animal welfare. Future studies would benefit from including such variables to obtain a more comprehensive understanding of the factors that contribute to a person's willingness to eat insect-based foods.

Fifth and finally, both of our studies employed a W.E.I.R.D. (Henrich et al., 2010) sample. Because of these limitations, we cannot confirm the generalizability of our findings, and we recommend that future studies seek to replicate our findings in other samples and cultures. We hope that this pair of studies serves as a first step toward that goal.

5. Conclusion

Due to the environmental benefits of entomophagy (e.g., lower greenhouse emissions produced by insect farming compared to livestock farming; Oonincx & de Boer, 2012; Van Huis et al., 2013), a growing field of research is now investigating the various factors that predict willingness to eat insects (e.g., Barbera et al., 2018; Hartmann & Siegrist, 2016). In the present studies, we investigated the role of food neophobia, disgust sensitivity, and hunger in people's willingness to eat insects. We found a consistent pattern across two studies: food neophobia predicted reduced willingness to eat insects. This pattern held for both self-report and behavioral measures of insect eating.

Our findings suggest that reducing food neophobia toward insects may be important for Western acceptance of entomophagy. One strategy may be to better familiarize Westerners with edible insects through exposure to insects as food. To maximize effectiveness in reducing food neophobia toward insects, it may also be important to increase Westerners' opportunities for positive tasting experiences with these foods (Birch et al., 1987; Loewen & Pliner, 1999). This may be achieved by incorporating insects or insect protein into popular food items (e.g.,

[2] Analyses revealed two standardized residuals with a value exceeding |2|. Neither case represented an extreme outlier. Therefore, both cases were included in the analyses.

Table 2
The results for each variable included in the final regression model.

Binomial logistic regression predicting willingness to eat insects								
	B	*SE*	Wald	*df*	*p*	Odds ratio	95 % CI for odds ratio	
							Lower	Upper
Food neophobia	−0.722	0.26	7.69	1	.006	0.486	0.294	0.809

pastas or snacks with flavor profiles that are already popular in the West).

If buttressed by future research, the current studies' findings could inform marketing strategies that encourage people to view insects as an appealing food source. Because of the ecological, ethical, and health benefits of eating insects compared to traditional meat sources (Oonincx & de Boer, 2012; Van Huis et al., 2013), understanding the various factors involved in people's willingness to eat insects may become increasingly important for the health of humans, the wellbeing of other sentient creatures, and the environment.

Ethics statement

Both studies included in this manuscript obtained ethics approval from the Institutional Review Board at the University of Colorado Colorado Springs (Study 1: 19-098; Study 2: 21-015). All participants provided informed consent before participating.

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Credit authorship contribution statement

LAS designed the hypotheses, LAS and KPW designed the studies, KPW collected and analyzed the data, KPW and LAS wrote the manuscript, all four authors revised and edited the manuscript.

Declaration of competing interest

None.

Data availability

Data for both studies discussed here are available by request from the corresponding author.

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