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Short Communication

Engaging in entomophagy: The role of food neophobia and disgust between insect and non-insect eaters

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ABSTRACT

Past tasting experience with edible insects could influence food neophobia (FN) and disgust, and consequently, it could increase the intention to engage with entomophagy by influencing our food neophobia and disgust. Thus, this study aims to measure the effect of food neophobia and insect disgust on the willingness to engage in entomophagy (WTE) and to explore the differences between consumers who had previous experience eating insects and those who did not. An online cross-sectional survey was distributed in five countries (Belgium, China, Italy, Mexico, and the USA) and the total sample (n = 3421) was divided into two consumer groups: insects eaters vs non-insect eaters. A Multigroup structural equation model was implemented to analyse the relationship between the FN and the sub-dimension Disgust of the Entomophagy Attitude Questionnaire-EAQ towards the WTE. The main results showed that FNS and Disgust negatively influence the WTE towards whole and processed insects. In particular, for the total sample, the effect of EAQ-Disgust is a more powerful predictor to explain the WTE for both wholes and processed insects than the FNS. However, interestingly, while the disgust dimension of the EAQ negatively influences the WTE with the same magnitude for both insect eaters and non-insect eaters, the FNS is related to the WTE with a stronger explanatory power for insect eaters than non-insect eaters. Thus, overcoming negative attitudes towards direct entomophagy, especially driven by disgust reactions through promoting tasting sessions is paramount to reducing disgust and legitimating insects as a food source.

1. Introduction

Entomophagy, the practice of eating insects, is traditionally practiced in many cultures, especially in tropical and sub-tropical countries in Latin America, Africa, and Asia (van Huis, Halloran, Van Itterbeeck, Klunder, & Vantomme, 2022). In these areas, insects are mostly consumed as a whole and the practice of eating insects depends mainly on the availability of wild and harvested edible insect species (van Huis et al., 2022). On the other hand, in the Global North, most consumers have never tried edible insects (Payne et al., 2019) and currently, most of the insects available on the market are farmed and then processed to powder (Mancini et al., 2022). In the past years, in these regions, there has been a growing interest in using insect powder as an ingredient to enrich the protein of common food products (e.g., snacks, bakery products, pasta, and others) (Mancini et al., 2022). However, consumer acceptance is still a major barrier to the growth of the insect sector both in non-traditional entomophagy countries as well as in traditional insect-eating countries, where consumption is declining over time due to a change in eating habits (van Huis et al., 2022).

To overcome consumer rejection of eating insects as food, in recent years there has been an increasing number of studies exploring consumer perceptions, attitudes, and acceptance of such novel food (Mancini, Moruzzo, Riccioli, & Paci, 2019; Sogari, Menozzi, Hartmann, & Mora, 2019). In particular, many studies (see Dagevos, 2021 for a recent review) have focused on the antecedents of people's willingness to engage with entomophagy, both as whole insects and processed (non-

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visible) insects. The main results showed that not only in Western cultures, but also in Asian countries like China (Liu, Li, & Gómez, 2020), insects can evoke strong negative psychological reactions like food neophobia and disgust. These factors are strong barriers to trying new and/or unfamiliar food products like insects (Hartmann, Shi, Giusto, & Siegrist, 2015; La Barbera, Verneau, Amato, & Grunert, 2018; Moruzzo, Mancini, Boncinelli, & Riccioli, 2021; Sogari, Menozzi, & Mora, 2019). In particular, food neophobia has been identified as a main significant and negative predictor in influencing individuals' willingness to eat and purchase whole insects and insect-based food (Dagevos, 2021; Sogari, Menozzi, Hartmann, et al., 2019). However, differences exist in the likelihood of acceptance based on whole and processed insects (powder) used as ingredients in other products (Sogari, Menozzi, & Mora, 2019). On the other hand, disgust sensitivity is a basic reaction that, in general, prevents the consumption of harmful substances (e.g., toxin and pathogens) mostly due to the knowledge of the nature or history of a potential food (Kröger, Dupont, Büsing, & Fiebelkorn, 2022). For example in Western countries, insects are often related to undesirable thoughts such as dirt, death, disease, and contamination (Mancini, Sogari, et al., 2019). Thus, it is not surprising that overall disgust sensitivity is also a predictor of insect acceptance (Hartmann & Siegrist, 2016). However, so far most of the studies have used a general disgust scale for food products rather than a more specific measure for insects as food. This could be a limit considering that, in the Global North, eating insects was sporadic in the past and is currently dismissed, making insects a non-food item (Payne et al., 2019). For this reason, we believe that using a more specific measure for the disgust of insects as food could provide a more accurate understanding of how this factor influences entomophagy acceptance.

In summary, both high food neophobia and disgust levels, which are highly correlated (La Barbera et al., 2018), could prevent the consumption of edible insects, especially due to a lack of familiarity with the product itself. In fact, insect food rejection is influenced by several factors, including a tasting experience (Ghosh, Jung, & Meyer-Rochow, 2018). Previous studies have shown differences between those individuals who tried edible insects at least once and those who did not (Hartmann & Siegrist, 2016; Mancini, Sogari, et al., 2019; Sogari, Menozzi, & Mora, 2019). This can be explained by the fact that taste is considered one of the most important drivers of food preferences (Ghosh et al., 2018), and a positive tasting experience enhances familiarity with the novel insect ingredient (Hartmann & Siegrist, 2016). During the past years, several scales have been developed to test consumers' attitudes to new foods such as the *Motivation to Eat New Foods scale* of (Nezlek, Forestell, & Cypryanska, 2021) or to edible insects like *Insect Phobia Scale* of (Moruzzo et al., 2021). In addition, regarding the measures of disgust towards insects, several scales have been used in the past years; some cover general food aspects (e.g., the food disgust scale) while others are specific to insects (e.g., Entomophagy Attitude Questionnaire-EAQ)(Kröger et al., 2022).

To explore better the role of previous consumption and rejections traits, our study aims at comparing a validated scale for disgust for edible insects – i.e., a subscale of the EAQ (La Barbera, Verneau, Videbæk, Amato, & Grunert, 2020) - and the well-known Food Neophobia Scale (Pliner & Hobden, 1992) to predict the willingness to engage to (whole and processed) entomophagy between two consumers groups: insects eaters vs non-insect eaters.

Past studies using the EAQ scales used either convenience samples (La Barbera, Verneau, Amato, Grunert, & Schnettler, 2021; La Barbera et al., 2020; Verneau, Zhou, Amato, Grunert, & La Barbera, 2021), or were mainly conducted by surveying individuals who had never intentionally eaten insect-based food before (Sogari, Menozzi, Hartmann, et al., 2019). Therefore, our study aimed to test a large respondent sample from five countries with a quota sampling method using gender, age, and region stratification in each country, and sampling also population with an average entomophagy experience. Therefore, we tested and distinguished the significance and power of the effect of food neophobia and insect disgust on the intention to engage in entomophagy practice and explored the differences between participants who had previous experience of (intentionally) eating insects and participants who did not.

Given this background information, we presume that insect eaters vs non-insect eaters differ in their willingness to engage in entomophagy practice, and this is affected by food neophobia and disgust factors. We hypothesize that individuals who have already tried insects would be more willing to consume and purchase insects as food again than those who have never tried them. Moreover, we suppose that specific disgust towards insects eating would be a more important predictor than neophobia in explaining the willingness to engage in entomophagy practices. Finally, we also expect differences in the intention to eat insects between whole and processed insects (powder) in foods.

Finally, we propose both research and industry implications for designing better research on consumer behaviour toward eating insects as food and for increasing the willingness to try such products.

2. Materials and methods

2.1. Data collection

An online cross-sectional survey was developed using the software Qualtrics TM and distributed in five countries (Belgium, China, Italy, Mexico, and the USA). The questionnaire was originally written in English (US) and then translated into Dutch and French (Belgium), Chinese (China), Italian (Italy), and Spanish (Mexico) by either a professional translator service specialized in consumer surveys (survey in French) or by native speakers familiar with the topic and consumer science jargon. The country-specific quota sampling procedure was set according to gender, age, income, and geographic area based on the representative national census data.

The selected countries were chosen in relation to their long-standing entomophagy culture (China and Mexico) *versus* countries where edible insects are novel (food) and the production sector is still in its emerging stage (Italy, Belgium, and US), even if in these latest countries several economic investments have been already done. This selection, based also on our experience in entomophagy and knowledge about country's cultures, represent a heterogeneous dataset with strong/unique food habits of such countries. The sample belongs to the consumers' panel recruited by the specialized market research company Lightspeed Research and the data collection took place between February and April 2022.

The experiment was approved by the Ethics Committee of the University of Pisa (Committee on Bioethics of the 125 University of Pisa - Review No. 26/2021) and was conducted according to the ethical principles expressed in the Declaration of Helsinki. Informed consent was obtained from respondents before the collection of the survey data.

2.2. Sample

After cleaning for incomplete and fast respondents (i.e., whose total survey duration was<40 % of the median of the total survey duration), the final sample was 3421 respondents. They are almost equally distributed by gender (49 % female, 48 % male, 3 % other) and over 43 % have a higher education at College/University (Bachelor's or equivalent level). The greatest part of respondents falls within the age range of 35 and 55 years (38 %). In addition, 59 % of the total population was represented by workers. A summary of the sample description is included below (Table 1).

Looking at the two groups (insect eaters and non-insect eaters), we noticed significant differences in some categories: people over 55 years old belong mostly to the non-insect eaters (79 %); women non-insect eaters are almost 70 %; the percentage of non-insect eaters is higher than 74 % in people who have a lower level of education, while for those with a higher level of education (bachelor's degree or higher), the

Table 1
Descriptive statistics of the sample (n = 3421).

Characteristics	Total Sample Frequency	Sample (%)	Non-insect eaters Frequency	Sample (%)	Insect eaters Frequency	Sample (%)	Statistic Pearson chi2	Pr
Age								
18–24	484	14.15 %	286	59.09 %	198	40.91 %	181.36	0.000
25–34	715	20.90 %	351	49.09 %	364	50.91 %		
35–55	1290	37.71 %	801	62.09 %	489	37.91 %		
over 55	932	27.24 %	740	79.40 %	192	20.60 %		
Gender								
Male	1626	47.53 %	943	58.00 %	683	42.00 %	50.50	0.000
Female	1678	49.05 %	1170	69.73 %	508	30.27 %		
Other	117	3.42 %	65	55.56 %	52	44.44 %		
Education								
Primary	50	1.46 %	37	74.00 %	13	26.00 %	150.77	0.000
Middle school	254	7.42 %	198	77.95 %	56	22.05 %		
Secondary education	1004	29.35 %	764	76.10 %	240	23.90 %		
Bachelor's or equivalent level	1487	43.47 %	805	54.14 %	682	45.86 %		
Master or doctoral degree	342	10.00 %	219	64.04 %	123	35.96 %		
Other	284	8.30 %	155	54.58 %	129	45.42 %		
Occupation								
Worker	2006	58.64 %	1158	57.73 %	848	42.27 %	157.16	0.000
Housewife/husband	205	5.99 %	150	73.17 %	55	26.83 %		
Unemployed	192	5.61 %	148	77.08 %	44	22.92 %		
Retired	491	14.35 %	409	83.30 %	82	16.70 %		
Student	191	5.58 %	116	60.73 %	75	39.27 %		
Other	336	9.82 %	197	58.63 %	139	41.37 %		
Country								
Italy	523	15.29 %	485	92.73 %	38	7.27 %	633.48	0.000
Mexico	765	22.36 %	270	35.29 %	495	64.71 %		
Belgium	487	14.24 %	370	75.98 %	117	24.02 %		
US	797	23.30 %	627	78.67 %	170	21.33 %		
China	849	24.82 %	426	50.18 %	423	49.82 %		
Previous experience								
No	2178	63.67 %						
Yes	1243	36.33 %						

Note: Pearson's chi-squared test between non-insect eaters and insect eaters. Statistically significant $p < 0.001$.

percentage is lower than 64 %. In Italy, more than 90 % have never tasted them, whereas in Belgium and the US this value is lower than 70 %. In Mexico, more than half of the people have tasted them at least once.

All differences in the socio-demographic characteristics between the two sub-groups are statistically significant ($p < 0.001$) as reported in Table 1.

2.3. Survey design and measures

The questionnaire was first pilot tested with a small sample (10 % of the total sample) and refined before application; adjustments for understanding and better flow were made based on the feedback received. The questionnaire was based on a review of existing methods that have been used to assess consumer acceptance of edible insects and was organized into five sections: (1) screening questions (e.g., excluding vegans and individuals younger than 18 years old); (2) previous insect consumption; (3) two attitudinal scales; (4) the willingness to eat and purchase both whole insects and insect-based foods; and (5) socio-demographic characteristics.

First, since the willingness to consume edible insects can be strongly influenced by a consumer's previous insect consumption, a question about past exposure was measured with four alternatives, from "I have never tried edible insects" to "I have tried edible insects on many occasions". As done in previous studies (Hartmann et al., 2015; Hartmann & Siegrist, 2016; Verneau et al., 2021), in the subsequent analysis, a dichotomous variable was created to distinguish two sample subgroups, i.e., those participants who never intentionally ate insects (n = 2178) and who ate them at least once in their life, regardless of the intensity of the exposure (n = 1243).

The survey measurements included two psychometric scales adopted from well-established studies due to reliability and validity concerns: the Food Neophobia Scale-FNS (Pliner & Hobden, 1992) and the Entomophagy Attitude Questionnaire-EAQ (La Barbera et al., 2020). All items were measured using a 7-point Likert scale ("Completely disagree" to "Completely agree"). The FNS consists of ten statements (five positively worded and five negatively worded) and represents the tendency to avoid unfamiliar food or novel food. The higher the FNS score, the greater the participant's food neophobia. In the past years, it has been applied in many studies on consumer responses to edible insects as food (La Barbera et al., 2018; Mancini, Sogari, et al., 2019; Sogari, Menozzi, & Mora, 2019). On the other hand, the EAQ is a rather new scale specifically developed to measure the attitude to incorporate insects as food for humans and feed for animals. Moreover, the EAQ scale has shown to be a robust and reliable instrument to measure attitudes toward entomophagy, both in Western and non-Western countries (Verneau et al., 2021), fitting well with our sample. We specifically included the 'disgust subscale' of the Entomophagy Attitude Questionnaire made by five items, which measures individuals' negative attitude toward direct entomophagy, driven by disgust and negative expectations about eating insects in different settings (La Barbera et al., 2020). These five items are: "1-I would be disgusted to eat any dish with insects", "2-Thinking about the flavour that a bug might have sickened me", "3-If I ate a dish and then came to know that there were insects among the ingredients, I would be disgusted", "4-I would avoid eating a dish with insects among the ingredients, even if it was cooked by a famous chef" and "5-I would be bothered by finding dishes cooked with insects on a restaurant menu". The reason for including only the disgust scale is that this

predictor is one of the main motivations for the rejection of novel foods of animal origin (Hartmann et al., 2015; La Barbera et al., 2018).

In addition, based on previous literature (e.g., Hartmann et al., 2015; La Barbera et al., 2018; Laureati et al., 2016; Sogari et al., 2019), we administered four items to measure the willingness to engage with entomophagy (WTE) both with (1) whole insects and (2) insect-based food (e.g., pasta, bread, burger, protein shakes), i.e., food containing insects in powder form. Answers were collected on scales ranging from 1 (Very unlikely) to 7 (Very likely).

All questionnaire items are available in the electronic supplementary materials.

2.4. Data analysis

Statistical analyses were conducted using Stata V17.0 (StataCorp LLC, College Station, TX, USA). Using Cronbach's Alpha coefficient, we tested the internal reliability of WTE to whole insects and insect-based food: the Cronbach's Alpha was around 0.93 in both cases. We repeated this test also for FNS and EAQ-Disgust scales: the Cronbach's Alpha was around 0.85 and 0.95 respectively. All values revealed a good internal consistency.

The Multigroup structural equation model was analysed using the comparative fit index (CFI), Tucker-Lewis index (TLI), and root mean square error of approximation (RMSEA). See section 3 for more details. The accepted significance level was set at $p < 0.001$.

Similar to previous studies (Hartmann et al., 2015), only a subset of the items was found to form a one-dimensional scale in cross-national research. Thus, five of the original items ("2-I don't trust new foods", "3-If I don't know what a food is, I won't try it", "5-Ethnic food looks too weird to eat", "7-I am afraid to eat things I have never had before" and "8-I am very particular about the foods I eat") were excluded to have acceptable item-total correlations (greater than0.30), similar to the study by Mancini, Sogari, et al., (2019). The five maintained items of the FNS were: "1-I am constantly sampling new and different foods", "4-I like foods from different cultures", "6-At dinner parties, I will try new foods", "9-I eat almost anything" and "10-I like to try new ethnic restaurants".

3. Results

3.1. Descriptive results

In the first phase, we explored the intercorrelations between the four latent variables: the willingness to engage in whole insects' entomophagy, the willingness to engage in processed insects' entomophagy, the EAQ-Disgust, and the FN scales. The average score of each latent variable was calculated. Table 2 provides means, standard deviations of the variables, and correlations among them. It is possible to note how the intention to eat insects, both whole and processed, is significantly correlated with the two examined scales ($p < 0.001$). By observing the means, participants prefer processed insects rather than whole insects.

After this, we analysed the scores of the WTE (whole and processed), EAQ, and FNS from the two subgroups of participants (insect eaters and non-insect eaters). Significant differences between both subgroups emerged (Table 3). The WTE for those who have tried whole or processed insects is almost double (around 4.7) compared to non-insect eaters (2.4 and 2.9). It is also observed that, on average, non-insect eaters have higher scores in EAQ-Disgust and FN than those who have tried insects.

Table 2
Pearson's correlation coefficients.

	EAQ-Disgust	FNS	WTE Whole	WTE Processed
EAQ-Disgust	4.40 (1.92)			
FNS	0.3385*	3.39 (1.38)		
WTE Whole	−0.5685*	−0.4616*	3.23 (1.92)	
WTE Processed	−0.5993*	−0.4788*	0.8380*	3.58 (1.93)

Note: WTE: Willingness to engage in entomophagy.
Diagonal cells report the means (standard deviation in parentheses).
*Indicates significant difference ($p < 0.001$).

3.2. Multigroup structural equation model results

The next step of our analysis was focused on a Multigroup Structural Equation Model (M−SEM) to assess the predictive validity of the EAQ-Disgust sub-dimension and FNS on the willingness to engage in entomophagy for both whole and processed insects (Fig. 1).

According to a previous work (Frey, 2022), the fit indexes revealed a significant score: the root mean squared error of approximation RMSEA value is 0.072 (smaller than the cut-off 0.08), the comparative fit index (CFI) and the Tucker-Lewis index (TLI) values are greater than the cut-off for an excellent model 0.95, there are 0.97 and 0.96 respectively. Considering the size of the residual, the standardized root mean square residual (SRMR) is 0.042 (smaller than the cut-off set at 0.1).

In the final phase, we introduced the associations between insect eaters' and non-insect eaters' groups to our model. As in the previous model, the statistically significant fit indexes are as follows: the RMSEA value is 0.077, and the CFI and TLI are equal to 0.95. On the other hand, the SRMR is 0.12, higher than the cut-off. The results of the models (pooled sample and two sub-sample groups) are shown in Table 4.

In each group, all the effects of sub-dimensions EAQ-Disgust and FNS on the WTE for both whole and processed insects were significant, with minimal differences. Results showed negative relationships among the four dimensions. Higher group differences were noted in the effects between FNS and WTE for both whole and processed insects; FNS – WTW for whole and processed insects were −0.22 and −0.26 for non-insect eaters, while for the eaters' group, both values were nearly doubled (-0.45).

4. Discussion

The present work extends the current stream of articles on consumer attitudes toward eating insects in several ways. First, the study compared the FNS, an instrument not meant to measure different levels of disgust for a specific food, and the EAQ-Disgust scale, which was developed to measure disgust towards entomophagy. Past studies measured the relationship between food neophobia and disgust (Hartmann et al., 2015; Hartmann & Siegrist, 2016), showing that these traits are positively correlated – i.e., the higher the tendency to reject new foods (neophobic people), the greater the disgust towards insects as food will be. Our results show that these two traits are both negatively correlated with the willingness to eat and purchase (WTE) whole and processed insects. As a result, for the total sample, neophilic people have a higher willingness to accept insects as food than neophobic individuals (Laureati et al., 2016). In contrast with the findings of Ruby, Rozin, &

Table 3
Average scores on the latent variables across insect eaters and non-insect eaters.

	Previous Experience	Mean	SE	SD	t	p
WTE Whole	no	2.43	0.03	1.59	−38.95	<0.001
	yes	4.65	0.05	1.62		
WTE Processed	no	2.87	0.04	1.75	−32.82	<0.001
	yes	4.84	0.04	1.56		
EAQ-Disgust	no	4.96	0.04	1.82	23.96	<0.001
	yes	3.44	0.05	1.71		
FNS	no	3.72	0.03	1.38	19.60	<0.001
	yes	2.81	0.03	1.18		

Note: WTE is the Willingness to engage in entomophagy (sample size is 2178 for non-insect eaters and 1243 for insect eaters group).

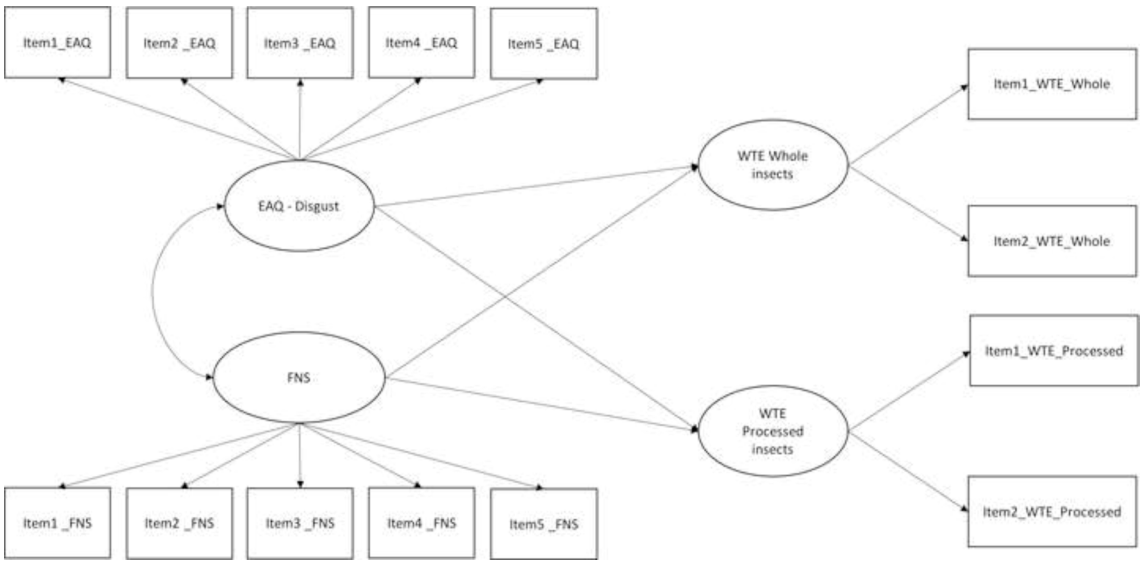

Fig. 1. Structural equation model where WTE is the Willingness to engage in entomophagy.

Table 4
Summarized results of M−SEM considering total sample, non-insect eaters' and insect eaters' groups.

	Coefficient	SE	z	P>|z|
Total sample				
WTE Whole Insects ← EAQ-Disgust	−0.496	0.014	−35.630	0.000
WTE Whole Insects ← FNS	−0.313	0.015	−20.300	0.000
WTE Processed Insects ← EAQ-Disgust	−0.524	0.013	−39.460	0.000
WTE Processed Insects ← FNS	−0.328	0.015	−22.110	0.000
Group: non-insect eaters				
WTE Whole Insects ← EAQ-Disgust	−0.492	0.018	−26.920	0.000
WTE Whole Insects ← FNS	−0.225	0.021	−10.730	0.000
WTE Processed Insects ← EAQ-Disgust	−0.532	0.017	−31.600	0.000
WTE Processed Insects ← FNS	−0.264	0.020	−13.530	0.000
Group: insect eaters				
WTE Whole Insects ← EAQ-Disgust	−0.420	0.023	−18.260	0.000
WTE Whole Insects ← FNS	−0.457	0.023	−19.910	0.000
WTE Processed Insects ← EAQ-Disgust	−0.439	0.023	−19.230	0.000
WTE Processed Insects ← FNS	−0.451	0.023	−19.620	0.000

WTE: Willingness to engage in entomophagy; EAQ-Disgust: Entomophagy Attitude Questionnaire; FNS: Food Neophobia Scale.

Chan (2015), which showed that food neophobia decreases the acceptance of whole insects more than insect powder, our results did not show such a difference.

Second, most extant research on the willingness to include edible insects as food has been conducted in Western countries (Giovanni Sogari, Menozzi, Hartmann, et al., 2019), whereas our work includes a large consumer sample of both countries with eating-insect tradition (i.e., China and Mexico) and non-traditional entomophagy countries (i.e., Italy, Belgium, and the US). As a result, we could compare insect eaters and non-insect eaters on their negative attitude related to entomophagy, i.e., disgust and neophobia.

In line with previous studies (Hartmann et al., 2015; Hartmann & Siegrist, 2016), individuals with prior eating insect experience have a much higher willingness to eat and purchase edible insects than non-insect eaters. We can assume that individuals who have previously consumed insects and had an overall positive experience develop positive sensory expectations (Mancini et al., 2022; Giovanni Sogari, Menozzi, Hartmann, et al., 2019). This leads to an increase in the intention of repeating the behaviour in the future. Interestingly, for those who have already tried insects, their level of willingness to engage in entomophagy is very similar between whole and processed insects. This could be explained by the fact that most of the insect eaters in our sample are from traditional entomophagy countries (i.e., China and Mexico) and they are accustomed to the whole and visible insect as food. Whereas, for non-insect eaters, a slightly higher difference exists between the WTE for whole and processed insects, in line with previous findings (Hartmann et al., 2015; La Barbera et al., 2021). This suggests that processed and non-visible insects are more accepted by those who never experienced entomophagy. Differences between traditional and non-traditional insect-eating countries were also shown in past studies. Past studies shown that willingness to eat the different foods varied significantly in Western and Asian countries. For example, (Hartmann et al., 2015) showed that Chinese consumers were more positive towards insect-based food in terms of taste and familiarity compared with the German ones. Another cross-country study (Castro & Chambers, 2019) showed that even countries like Mexico and China exhibit neophobia toward products with insect-based ingredients, however the willingness to try such products is higher than in Western countries. This could be explained because the attitudes towards insects are socio-culturally dependent. Therefore, next studies should focus more deeply on the elicitors of rejection across different countries and identify the most appropriate attempts to establish insects as a legitimate food source.

In line with the study by Verneau et al., (2021), also our results show that insect eaters are less disgusted (neutral disgust score of 3.44 on 7-points of the EAQ-Disgust scale) than non-insect eaters (score of 4.96 on 7-points of the EAQ-Disgust scale). This finding confirms that disgust is a major distinctive element between those who never have eaten edible insects and who intentionally tried them at least once. Also, the Food Neophobia score is lower for insect eaters (who can be considered neophilic individuals) than non-insect eaters.

If we look at the model for the total sample, both the FNS and EAQ-Disgust are negatively correlated to the WTE indicating that an increase in these two traits leads to a decrease in the WTE. However, the effect of the EAQ-Disgust is a more powerful predictor for the WTE of both whole and processed insects than the FNS, in line with previous studies (e.g., La Barbera et al. 2018). Interestingly, while the disgust dimension of the EAQ negatively influences the WTE with the same magnitude for both insect and non-insect eater groups, the FNS is related to the WTE with a stronger explanatory power for the insect eaters than the non-insect eaters. Therefore, one of the main differences between the two groups is the role of Food Neophobia, which is more predictive of the WTE for non-insect eaters. Whereas, in the insect eater group, the FNS and EAQ-

Disgust have similar weights in predicting the WTE for both whole and processed insects. Thus, the eating experience of insects eliminates the difference in the explanatory power between FNS and EAQ-Disgust towards the WTE.

As a result, these outcomes contribute to the practical methodology implications of the study. Overall, the new specific and validated instrument of the EAQ-Disgust by La Barbera et al. (2020) performs better in predicting the WTE of individuals who previously have or have not tried insects compared to the common measure of food neophobia (Pliner & Hobden, 1992), which is often used in consumer entomophagy studies. On the other hand, our findings show that being food neophobic becomes more important in predicting the WTE when individuals have at least one experience eating insects. A possible interpretation of such results could be that for the insect eaters, the tasting of insects (even if they have tried them only once) makes individuals start to consider insects as food; whereas, before this eating experience, the idea of insects as food is not taken into consideration. As suggested by Ardoin & Prinyawiwatkul (2021), due to insects' novelty in Western food cultures, the role of neophobia in explaining aversion to eating insect could be misinterpreted. Therefore, the FNS becomes a better predictor for exploring insects as food phobia for individuals that have tried them at least once. As a matter of fact, the rejection of a novel food due to high food neophobia levels involves the consideration of the food in terms of its familiarity (La Barbera et al., 2018). Noteworthy, it could also be that individuals with lower disgust are more willing to try insects, and therefore more likely to have tried them in the past, regardless from the previous experience. Whereas for those that never tried entomophagy, the rejection could be mainly due to feelings of fear based on cultural conditioning rather than pure novelty of the product (Ardoin & Prinyawiwatkul, 2021).

A limitation of this study is related to the hypothetical nature of the survey itself. We measured the attitude and intention and not the behaviour. Therefore, we recommend that further studies will include a behavioural measure to assess the actual consumption and purchase of edible insect products. Moreover, we simplified the model by dividing the group into insect eaters vs non-insect eaters. Future research should explore how the level of past exposure (e.g., habitual vs occasional insect eaters) influences the attitude toward entomophagy. In addition, comparing the use of the insect disgust scale to other newly introduced scales, such as the Insect phobia scale and the MENF-scale, might provide a better understanding of the acceptance of insects as food. Finally, it would be important for private companies to understand better the role of individual socio-demographic traits (gender, age, region) within singular countries to properly address marketing strategies.

5. Conclusions

Our findings raise new approaches on how to appropriately study consumer behaviour toward entomophagy and reducing disgust sensitivity. The main result shows that the FNS becomes a better predictor (high correlation) in explaining the willingness to engage with entomophagy for those who have already tried eating insects compared to non-insect eaters. On the other hand, the EAQ-disgust scale has been shown to be a robust and reliable instrument to measure the attitude toward entomophagy both for insect eaters and non-insect eaters.

Moreover, the present experiment might suggest that a positive previous experience with insect products can reduce disgust and increase people's willingness to engage with both whole and processed insects. Thus, to overcome negative attitudes towards direct entomophagy, especially driven by disgust reactions, it is important to raise awareness of entomophagy and promote, for instance, tasting sessions, cooking shows, etc. Consequently, consumers will feel less sceptical and disgusted about consuming insects and will start considering insects as a legitimate food source. This will probably convince non-insect eaters to at least try insects and then, perhaps, accept them as food.

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CRediT authorship contribution statement

Giovanni Sogari: Conceptualization, Methodology, Investigation, Formal analysis, Writing – original draft, Writing – review & editing. **Francesco Riccioli:** Methodology, Data curation, Formal analysis, Writing – original draft, Writing – review & editing. **Roberta Moruzzo:** Conceptualization, Methodology, Writing – review & editing. **Davide Menozzi:** Methodology, Writing – review & editing. **Daylan Amelia Tzompa Sosa:** Investigation, Writing – review & editing. **Jie Li:** Methodology, Investigation. **Aijun Liu:** Methodology, Investigation. **Simone Mancini:** Conceptualization, Investigation, Methodology, Supervision, Funding acquisition, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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