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Willingness to pay for insect-based food: The role of information and carrier

Alessia Lombardi*, Riccardo Vecchio, Massimiliano Borrello, Francesco Caracciolo, Luigi Cembalo

Department of Agricultural Sciences, AgEcon and Policy Group, University of Naples Federico II (ITA), Via Università 96, 80055 Portici (Naples), Italy

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ABSTRACT

There is increasing interest toward insects as an alternative protein source in Western countries even though, so far, most Western consumers react with disgust and rejection. The literature on consumer behavior has mainly investigated the willingness to consume insects with regard to human diet, revealing that providing information about the positive effects of edible insects and using familiar foods while ensuring that insects are not visible will increase the willingness to eat insects. What is still unclear are consumers preferences for specific insect-based products having different features in a non-hypothetical market. The current study analyzed 200 Italian consumers' preferences for three insect-based products (carriers) such as pasta, cookies and chocolate bars through a non-hypothetical willingness to pay (WTP) elicitation mechanism, the Multiple Price List (MPL), in a mixed within/between experimental design. The influence of the different types of information on consumer choice and the main forces driving consumer preferences for insect-based food were tested. The findings reveal that different carriers generate different results in terms of WTP for conventional and insect-based versions of the products. Further, without being provided information, consumers deem insect-based products either equivalent (the same WTP for the two versions of pasta) or weakly inferior (lower WTP in the case of cookies and chocolate), while when information on the benefits of insect consumption is provided, consumers' WTP increase for all the insect-based products analyzed. Finally, among the psychographic scales, Food Neophobia and Beliefs and Attitudes toward insects negatively affect the WTP for insect-based products.

1. Introduction

The practice of eating insects, entomophagy, is widespread in approximately 80 countries across the world (Van Huis et al., 2013; Baker, Shin, & Kim, 2016). In South and East Asia, as well as in many African, South and Central American countries and Oceania, approximately 2,100 species of insects constitute the daily diet of approximately 3,000 ethnic groups (Deroy, Reade, & Spence, 2015; Jongema, 2015). Insects provide a valuable source of high-quality proteins, minerals, vitamins and carbohydrates (DeFoliart, 1992; Belluco et al., 2013; Payne et al., 2016), and due to their high nutritional value, in countries where malnutrition is diffuse, insects may represent a potential solution to deficiencies in minerals such as zinc and iron (Christensen et al, 2006; McLean et al., 2009; Van Huis et al., 2013; Gibson, 2015). Additionally, the Earth's population is expected to exceed over 9 billion by 2050; this phenomenon will result in a growth in the demand for meat with the consequences of unsustainable environmental impacts and resources wastefulness (Borrello, Caracciolo, Lombardi, Pascucci, & Cembalo, 2017; Tan, van den Berg, & Stieger, 2016; Anankware, Fening, Osekre, & Obeng-Ofori, 2015; Van Huis, Dicke & van Loon, 2015). Insects provide food at low environmental cost and contribute positively to livelihoods, compared to conventional livestock system of production (Oonincx et al., 2010; Smetana et al., 2015; Halloran, Roos, Eilenberg, Cerutti, & Bruun, 2016). The latter is relevant since the pressure on resources such as land, water and energy related to the production and consumption of meat (Carlsson-Kanyama & González, 2009; Buttriss, 2011; Vinnari & Tapio, 2012; Tucker, 2013) is predicted to double by 2050 to satisfy world demand (FAO, 2006).

For these reasons, public attention has been directed toward insects as an alternative protein source, even in Western countries (Belluco et al., 2013; Pascucci & De-Magistris, 2013; Looy, Dunkel, & Wood, 2014). Entomophagy campaigns have spread rapidly both in business and in the scientific arena (Oonincx & de Boer, 2012; Veldkamp et al., 2012). New ventures will be guided, from January 1st 2018, by the Novel Food EU Reg. 2015/2283. According to this regulation, insect producing companies must receive an a priori authorisation from the European Commission to be entitled to sell their products across the EU. However, only a few EU countries equipped themselves with internal

* Corresponding author.
E-mail address: alessia.lombardi@unina.it (A. Lombardi).

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legislations regulating the trade of insect based food. One of the implications is that only a few companies had already started to produce insects for human consumption (Fellows, 2014; Sexton, 2014; Shelomi, 2015), often through prototype plants, making difficult to perform long term and effective cost analysis. With a very scattered diffusion of retailers selling insect products, moreover, it is not possible a description of this embryonal market. In any case, examples of start-ups selling insect-based products have already bloomed in France, the Netherlands, Belgium, the UK, Germany and Italy (Schösler, De Boer, & Boersema, 2012; Fellows, 2014; Sexton, 2014; Van Huis et al., 2013; Schouteten et al., 2016).

Despite the emphasis on the theme of insects as food, most Western consumers, so far, react with disgust and rejection (Yen, 2009; Gere, Székely, Kovács, Kókai, & Sipos, 2017). The main drivers of consumers' rejection are the presence of food taboos in terms of sociocultural and psychological barriers (Meyer-Rochow, 2009; Hartmann, Shi, Giusto, & Siegrist, 2015; Tan et al., 2015). Current literature highlights that food neophobia, defined as a reluctance to eat unfamiliar foods (Pliner & Hobden, 1992; Ritchey et al., 2003; Laureati, Proserpio, Jucker, & Savoldelli, 2016), is one of the most relevant factors that determines consumers' unwillingness to accept insects as food (Raudenbush & Frank, 1999; Tuorila et al., 2001; Verbeke, 2015; Fenko, Backhaus, & van Hoof, 2015; Hartmann, Shi, Giusto, & Siegrist, 2015). The main scope of previous studies was to investigate consumers' willingness to consume insects in their diet (Schösler et al., 2012; Vanhonacker et al., 2013; Caparros Megido et al., 2014; Verbeke, 2015). The results were often controversial but share the conclusion that using familiar food/preparation and ensuring that insects are not visible increases the willingness to eat insects (Tuorila et al., 2001; Wansink, 2002; Hartmann et al., 2015; Caparros Megido et al., 2014; Tan et al., 2015). In addition to the importance of familiarity and the visual absence of insects in the food in Western cultures, another important aspect found to help people overcome their reluctance to eat insects is the role of information. Indeed, information has already been demonstrated to influence willingness to try a novel food (Woodward, 1945; Cardello, Maller, Masor, Dubose, & Edelman, 1985; Tuorila et al., 1998). In the specific case of insects, information about the positive effects of edible insects, from sustainability and environmental perspectives, positively influences consumers' willingness to consume insect-based products (Lensvelt & Steenbekkers, 2014; Verbeke, 2015; Laureati et al., 2016), but little is known about the effects of different types of information on insect-based food consumption (Pelchat & Pliner, 1995).

Despite the recent increasing public interest and numerous scientific studies on the topic, there are still some issues that remain to be uncovered.

How do consumers behave in a non-hypothetical market when they have to express their preferences for specific insect-based products with different features? Do different information affect consumers' choice? If yes, which types of information? What are the determinants of consumers Willingness to Pay (WTP) for insects based product? These are the four main research questions we addressed with the current study. To the best of our knowledge, the present research, analyzes for the first time consumers' preferences for three different insect-based carriers through a non hypothetical WTP elicitation mechanism in a mixed within/between experimental design.

A non-hypothetical, incentive-compatible experiment was conducted on three food products with the relevant features stated before: commonly available in the market, familiar to consumers, similarity with a conventional counterpart and nonvisible insects. We selected a non-hypothetical method to measure WTP to control possible deviations from true values and the strategic behaviour of participants. Indeed, due to the specific characteristics of the products investigated (completely new and not easily available on the market), outcomes of stated preference elicitation techniques might have been strongly biased by people tendency to overstate their actual WTP in hypothetical situations (e.g. List & Gallett, 2001). More specifically, the selected products were pasta, cookies and chocolate bars with nonvisible mealworms, chosen due to their high familiarity in the study region, high purchasing frequency and representing diverse consumption contexts (main meals and snack).

Experiment participants expressed individual WTP not only for the insect-based products but also for the closest conventional counterpart. The hypothesis behind the selection of these three products is that different products could generate different consumers' WTP according to carrier general features and the perceived appropriateness of the specific carrier used with insects.

General features of carriers and, more specifically, the general perception of the carrier used in the experiment could influence consumers' acceptance and willingness to buy (Van Kleef et al., 2005; Ares & Gámbaro, 2007; Siegrist, Stampfli, & Kastenholz, 2008). In our case, general features such as the carriers' hedonic value and the mode of consumption could influence the respondents' WTP.

The perceived food appropriateness, on the other hand, is based on whether the product is harmonious with the context of consumption (Cardello, Schutz, Snow, & Lesher, 2000; Tan et al., 2016; Schutz & Martens, 2001). According to Tan and colleagues (2016, 2017), in the case of insects, food appropriateness is defined as the perceived suitability of insects in foods for human consumption. A particular combination of ingredients in a carrier with insects as the ingredient could be judged inadequate in a product and, because of this, disliked (Stallberg-White & Pliner, 1999; Cardello et al., 2000; Schutz & Martens, 2001; Tan et al., 2016). Therefore, our hypothesis was that if consumers judge a product combination (insect in a specific carrier) as inappropriate, this could impact their willingness to buy and, consequently, their willingness to pay will decrease.

As for the importance of providing information, building on the previous argument concerning the benefits of introducing insects in human diets, the benefits of insects were summarized into two umbrella categories: *benefits for the individual* and *benefits for the community*. We elaborated those two categories of benefits starting from the categorization proposed by the FAO report (Van Huis, 2013) in which benefits for individual (healthiness) and benefits for community (environment) are stated.

Finally, to explain the individuals' WTP, several variables were collected by means of validated scales consistent with the experimental design: the Food Neophobia Scale (Pliner & Hobden, 1992), attitudes toward healthfulness of foods (Roininen, Lähteenmäki, & Tuorila, 1999), specific beliefs and attitudes about insects (Ruby, Rozin, & Chan, 2015) and the New Environmental Paradigm scale (Dunlap, Van Liere, Mertig, & Jones, 2000).

The present study provides four main contributions to consumer preferences research. First, previous studies focused mainly on willingness to eat, as well as product liking, rather than on the non-hypothetical WTP of consumers for edible insects (Alemu, Olsen, Vedel, Pambo, & Owino, 2015; de-Magistris, Pascucci, & Mitsopoulos, 2015). Second, we assess the role of carriers in influencing consumers' acceptance and WTP. Third, we contribute to consumer research on novel foods by investigating the relative importance of different types of information on individual preferences. Fourth, we measure the role of selected psychographic forces driving consumer preferences for insect-based food.

2. Materials and methods

This section will successively detail the sampling and study design, the products used, the elicitation task and information provided, and the post-experiment data collection. For estimating the WTP for insect-based food under different information conditions and to avoid hypothetical bias, we applied an incentive-compatible elicitation mechanism called the Multiple Price List (MPL) (Andersen, Harrison, Lau, & Rutstrom, 2006). The MPL is incentive-compatible, as each participants' dominant strategy is to submit a bid that is equal to his or her

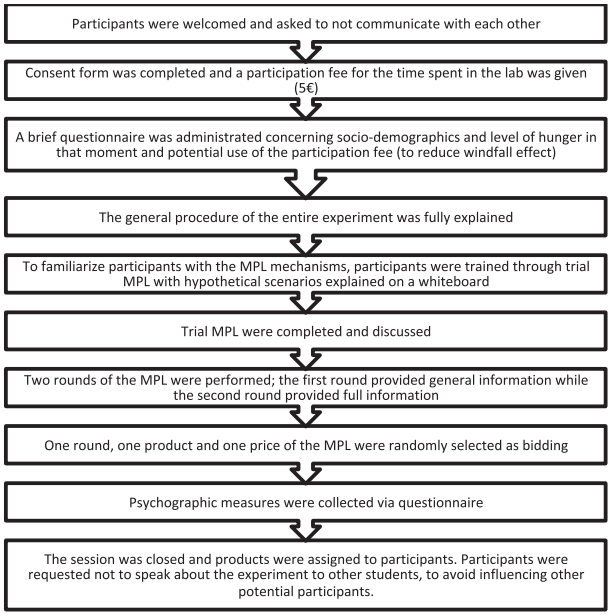

Fig. 1. Session stages.

valuation of the offered product (Alfnes & Rickertsen, 2011). MPL offers participants with an array of prices ordered on a table (from low to high), one per row, and asks the individual to choose whether she accepts the offer for each price level. Then one of the prices is randomly drawn as binding, and all participants who had indicated that they would buy the product at the drawn price do so[1]. MPL is particularly appreciated by food scholars as it is very easy to explain to participants and it is relatively easy for subjects to see that truthful revelation is in their best interest (Tomić & Alfnes, 2018; Lerro, Caracciolo, Vecchio, & Cembalo, 2018; Alphonce & Alfnes, 2016).

2.1. Participants and study design

A total of 200 students at the University of Naples Federico II were recruited to participate in a laboratory experiment. Since insects and crustaceans present similarities in terms of allergenic potential (Belluco et al., 2013; Van der Spiegel, Noordam, & Van der Fels-Klerx, 2013), participants not allergic to crustaceans were selected and were asked to sign an informed consent form. Women accounted for 40% of the sample; 63% of participants in the cohort are from 18 to 20 years of age (average age of total sample is 20.5). Of the participants, 22.5% of individuals stated a low subjective feeling of hunger (de-Magistris & Gracia, 2016), 44% a medium level and 36.5% a high level. Overall, 20 sessions were conducted over three consecutive days with 10 participants per session in the beginning of 2017. We provided participants with a cash endowment of 5€. However, as this might inflate WTP values, we asked individuals to write down how they will spend this money in the immediate future. This practice should reduce the so-called windfall effect, also known as house money effect (Harrison, 2007). Each session lasted about half an hour and involved ten consecutive stages (Fig. 1). No deceptive practice was applied in the study.

The experiment was based on a hybrid within-subject and between-subject design (Fig. 2). All participants took part in two consecutive

[1] As underlined by one reviewer MPL can also be used in a hypothetical manner (i.e. not involving real money and real transactions). Usually, in this case the scientific literature refers to payment cards. Whereas, the main disadvantages of the MPL are: it elicits valuations in an interval, individuals could express inconsistent valuations and it is susceptible to framing effects (Andersen, Harrison, Lau, & Rutstrom, 2006).

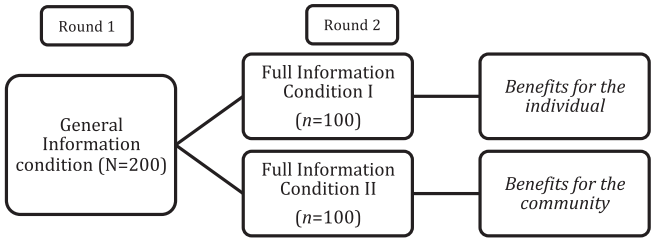

Fig. 2. Experimental procedure.

WTP elicitation rounds, differing in the amount and type of information provided. In the first round, participants were provided with general information about the products (general information condition): the distinction between conventional products and products with mealworms was presented, and the percentage of mealworms in the products was specified. In the second round, the sample was randomly divided into two groups of the same size, and different information concerning the introduction of insects into human diets was disclosed to each group (full information condition) The two groups can be considered statistically equivalent in terms of average age and gender composition according to the Hotelling's T-squared test ($F(2,197) = 2.13$; p-value 0.12).

2.2. Information treatments

In the second round, to capture the effect of information on the positive effects for individuals, the first group ($n = 100$) was provided with health information (*Full Information Condition I*), such as improvements in nutrient quality, diet quality and food safety (Table 1). The second group ($n = 100$) was instead provided with information regarding collective benefits (*Full Information Condition II*), such as food security, GHG reduction and water use reduction (Table 1).

The choice to provide two different types of information is not new in consumer studies aiming to understand food purchasing decisions, including insect-based products (House, 2016). To illustrate, in the process of understanding factors governing consumers' food choice, health and environmental concerns are primary taken into consideration (Hoek, Pearson, James, Lawrence, & Friel, 2017; Roininen et al., 1999; Steptoe, Pollard, & Wardle, 1995). Indeed, several studies have revealed that health concern is one of the most relevant factors driving today's food choices (see, among other, Grunert, 2017; Aschemann-Witzel, 2015). Similarly, an important driver of developed countries consumers' food selection, is individual interest towards the natural environment and sustainability at large (e.g. Van Loo, Hoefkens, & Verbeke, 2017; Verain et al., 2012; Vermeir & Verbeke, 2006). These two factors were also identified by Sogari (2015) and Verbeke (2015) as consumption drivers of insects as food for early adopters.

2.3. Products

Three categories of foods (i.e., pasta, cookies and chocolate bars) with insects and their conventional counterparts were evaluated in the experiment. The categories of products were selected according to their high familiarity and purchase frequency in the geographic area of the experiment and for being representative of different consumption contexts/type of meals. While pasta represents, together with bread, the main source of carbohydrate in Italy, largely consumed during lunch and dinner, cookies are among the most consumed product for everyday breakfast (Di Giuseppe et al., 2012). Finally, chocolate bar was indeed chosen being mainly eaten as occasional snack. Finally, to the best of our knowledge, no previous study has investigated these three products.

For each category, the pairs of products presented the same main qualitative characteristics (i.e., packaging, shape, weight), and all

Table 1
Information used in the second round (full information condition) (FAO, 2013).

Benefits for the individual	Nutrient quality: insects not only provide high-quality proteins and amino acids but also contain vitamin B12, omega-3, omega-6, minerals and 15% more iron than spinach. Diet quality: insects are a source of protein that, compared to other animal sources, do not negatively affect human health. For example, insects do not contain saturated fatty acids, which are the main determinants of high cholesterol. Food safety: insects are considered low risk in terms of the transmission of animal-transmitted diseases, such as avian flu and mad cow disease.
Benefits for the community	Nutrients for disadvantaged populations: insects are distributed worldwide, even in developing countries, and may be very important as a dietary supplement for undernourished children. GHG reduction: for example, the use of proteins derived from mealworms, rather than from pig farms, may reduce greenhouse gas emissions from 10 to 100 times. Water use reduction: insect farms for food and feed production require much less water than conventional livestock.

brands names were hidden (together with nutritional and manufacturing information).

More specifically, the products presented the following characteristics:

- 500 g pack of "fusilli" pasta;
- 250 g pack of lemon-flavored cookies;
- 100 g bar of dark chocolate.

Insects based products used in the research were bought through the French web site micronutris.com.

2.4. WTP elicitation procedure

Respondents were asked to state their WTP for all the six products under analysis. Participants' WTP was assessed by applying the incentive-compatible, experimental economics method, MPL, in a non-hypothetical setting. This mechanism has the great advantage of being transparent and very simple to understand for participants. Additionally, as participants bid against a random price, competition, affiliation or collusion should not occur (Lusk & Shogren, 2007). The core disadvantages are the interval response and the framing effect with a psychological bias toward the middle of the list (Andersen, 2006).

Before eliciting their WTP, participants were provided with a reference range of prices for each product category (Table 2). At the end of the experiment, participants had the chance to buy one of the six products; in each round, one product and one price were randomly selected for bidding.

As previously described, all participants took part in two consecutive rounds of MPL with a different amount and type of information provided: in the first round, participants were given general information about the products, and in the second round, full information on the products' benefits was disclosed.

After each round, participants were asked to express their WTP for the six products under evaluation. Therefore, each participant submitted 12 bids (6 products × 2 information scenarios). Price feedback was not provided between rounds, as it might introduce affiliation effects (Lusk & Shogren, 2007). To avoid demand reduction effects, it was clarified that at the end of the experiment, only one round and one product would be selected for bidding.

2.5. Psychographic measures

The post-auction questionnaire addressed participants' beliefs and attitudes toward insects, their concerns regarding individual and collective issues related to food, and their general attitudes toward food consumption.

More specifically, the following scales were used in the questionnaire: Food Neophobia Scale (FNS, 10 items; 7-point Likert scale from 1: strongly disagree to 7: strongly agree) (from Pliner & Hobden, 1992); Specific beliefs and attitudes about insects (BAI, 9 items; 7-point Likert scale from 1: strongly disagree to 7: strongly agree) (from Ruby, Rozin & Chan, 2015); General health interest related to food (GHI, 8 items; 7-point Likert scale from 1: strongly disagree to 7: strongly agree) (from Roininen et al., 1999); and New Ecological Paradigm (NEP, 15 items; 5 point Likert scale from 1: strongly disagree to 5: strongly agree) (from Dunlap et al., 2000). In the Appendix the full set of items for each scale, along with their descriptive statistics, are reported.

Table 2
Reference prices and price ranges in the MPL (€).

Product category	Reference prices	Price ranges
Pasta	0.40–0.90	0.20–1.40; 13 intervals of 10 cents
Cookies	1.20–2.00	0.60–3.00; 13 intervals of 20 cents
Chocolate bar	1.00–1.90	0.50–2.90; 13 intervals of 20 cents

The abovementioned scales have been chosen for capturing specific attitudinal aspects of consumers that could inhibit or motivate their WTPs during the experiment. More in detail, previous literature has identified disgust sensitivity and caution/aversion concerning the new or the unknown as important attitudinal barriers for consumption of insect-based products (House, 2016). Thus, following previous studies (Urala & Lähteenmäki, 2004; Verbeke & Poquiviqui López, 2005) FNS was selected to measure individual tendency of avoidance of novel foods, while BAI scale was selected to capture the role of consumers' specific aversion for insects. As concerns individual characteristics that may motivate consumption of insect-based products, attention to the environmental impact of food choice, as well as interest in the health characteristics, have been both documented to exert an important role (Schlup & Brunner, 2018; Sogari, 2015; Verbeke, 2015). Therefore, General health interest to food and New Ecological Paradigm have been chosen to capture these potential triggers.

All the internal consistencies of the above described constructs exceeded a reliable threshold value: Cronbach's α value was 0.84 for the Food Neophobia Scale (FNS), 0.80 for the General Health Interest (GHI) scale, 0.72 for beliefs and attitudes about insects' scale (BAI) and 0.71 for the New Ecological Paradigm scale (NEP).

2.6. Econometric analysis of WTP determinants

The role of selected psychographic forces driving consumers' preferences for insect-based food was investigated by means of a seemingly unrelated regression model (SUR). The SUR is a multivariate linear regression model that arises in a context where the estimation of a system of equations is necessary. In this case, the model consists of three linear regression equations—one for each carrier. More formally, the following system of equations was estimated for the *i*-th respondent:

$$\begin{cases} \Delta WTP_{pasta,i} = \boldsymbol{x}'\boldsymbol{\beta}_{pasta} + \boldsymbol{z}'\boldsymbol{\gamma}_{pasta} + e_{pasta,i} \\ \Delta WTP_{cookies,i} = \boldsymbol{x}'\boldsymbol{\beta}_{cookies} + \boldsymbol{z}'\boldsymbol{\gamma}_{cookies} + e_{cookies,i} \\ \Delta WTP_{chocolate,i} = \boldsymbol{x}'\boldsymbol{\beta}_{chocolate} + \boldsymbol{z}'\boldsymbol{\gamma}_{chocolate} + e_{chocolate,i} \end{cases}$$

The dependent variables ΔWTP represent the difference in the WTP

Table 3
WTP in general information condition (round 1) (€).

Product	With Insects	Conventional	ΔWTP	ΔWTP(%)
Pasta	0.63 (0.37)	0.62 (0.23)	0.005 (0.34)	0.89%
Cookies	1.25 (0.72)	1.39 (0.45)	−0.131*** (0.70)	−9.4%
Chocolate bar	1.07 (0.70)	1.23 (0.41)	−0.161*** (0.66)	−13.0%

Note: In bracket standard deviations – Asterisks represent statistically significant at the levels: * $p \leq 0.1$; ** $p \leq 0.05$; *** $p \leq 0.01$. (Paired *t*-test).

in percentage terms between products with insects and their conventional counterparts; **x** is a vector of sociodemographic variables; **z** is a vector of selected psychographic measures; and the error terms, *e*, are assumed to be independent across individuals and correlated across equations. In each equation, the estimate of statistically significant coefficients **β** and γ identifies and measures the corresponding determinants of consumers preferences in terms of WTP. Statistical and graphical elaborations were performed with STATA v.15.

3. Results

As illustrated in the introduction, our study had four main goals: 1) to elicit consumers preferences toward insect-based food products using non hypothetical WTP of consumers for edible insects; 2) to assess the role of carriers in influencing consumers' WTP; 3) to investigate the importance of different types of information; and 4) to identify the main forces driving consumer preferences for insect-based food.

Regarding the first two aims, the results of Table 3 show the measured mean WTP for both conventional and insect-based products for the three analyzed carriers under the general information condition. Among participants who valued pasta equally for the two auctioned products (conventional and with insects), the WTP for cookies and chocolate bars was significantly higher for the conventional product than for the insect-based product. In percentage terms, the price difference obtained for the insect-based products ranged from less than +1% (pasta) to -13% (chocolate bar), highlighting a strong influence of carriers on consumers' WTP.

Fig. 3 shows the boxplots of the WTP differences between insect-based and conventional products, indicating that the **Δ**WTP for the chocolate bar is characterized by a more heterogeneous and diverse response from consumers. For instance, over 50% of respondents assigned a price discount (negative **Δ**WTP) for the chocolate bar with insects. This percentage decreases to 45% when pasta is the carrier.

The importance of different types of information (the third goal of the study) was measured in round 2 of the experiment, when participants were provided with full information concerning the benefits of eating insects (full information conditions – round 2). In this context, the consumers' WTP for products containing insects increased irrespective of the type of information provided (Table 4). In percentage terms, the positive effect that information had on WTP ranged from +5.9% (benefits for the community, cookies) to +16% (benefits for the individual, chocolate bar). In particular, when analyzing the two information conditions separately, the argument concerning the benefits for the individual has slightly higher impact on consumers' WTP for insect-based foods than that referring to the community benefits in all three considered products.

Due to the additional information on benefits, pasta containing insects gained a premium price of up to € 0.10; the cookies and the chocolate bar with insects, instead, recovered the difference with their conventional counterparts and gained a slight premium price (Fig. 4). Finally, the main forces driving consumers' preferences for insect-based food have been measured through the SUR estimation.

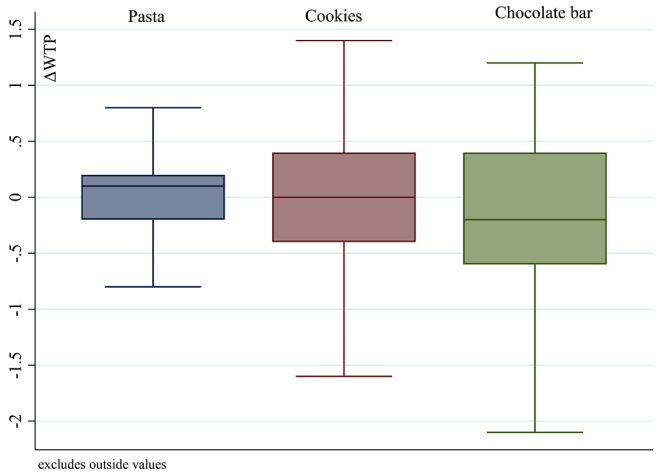

Fig. 3. Boxplot of **Δ**WTP (€) in general information condition (round 1).

Table 4
ΔWTP between the general information condition and the two full information conditions (€).

	Full information condition (ΔWTP)	
	Benefits for the community	Benefits for the individual
Pasta (with insects)	+0.055**	+0.086***
Cookies (with insects)	+0.074	+0.084***
Chocolate bar (with insects)	+0.081*	+0.171***

Asterisks represent statistically significant (according to the Paired *t*-test) at the levels: * $p \leq 0.1$; ** $p \leq 0.05$; *** $p \leq 0.01$.

The results are reported in Table 5. Post-estimation analysis was performed testing for independence, goodness of fit and correlation among the errors in the equations. Tests indicate the consistency of SUR model. While gender did not significantly affect participants' preferences, age was associated with price discount (or negative **Δ**WTP) for insect-based products[2]. This finding confirms common knowledge concerning higher availability of younger people willing to try new products (Schösler, De Boer, & Boersema, 2012; Vanhonacker et al., 2013; Verbeke, 2015). For the psychographic measures used in the study, the GHI and NEP scales conceptually related to the information provided under the full information condition did not significantly influence participants' WTP, except for the latter in the case of the chocolate bar. Finally, as hypothesized, negative beliefs and attitudes toward insects and high levels of neophobia negatively affect the WTP for insect-based products.

4. Discussion and conclusion

In recent years, a growing number of studies have focused on consumers' acceptability of insects in human diets from different points of view, but none elicited willingness to pay related to insect consumption in a non hypothetical setting. The current study aims to fill this gap by investigating individuals' WTP for three different food carriers such as

[2] One reviewer pointed out that age, in the case of a sample of students, is scantly informative. We agree with him/her in principle. However, age was not a key-parameter in selecting our sample. For that reason, we believe that if the variable brings enough information to be statistically significant in the econometric model, it is mandatory to keep it. We want to make readers aware, however, that age must be taken with due caution in an experiment.

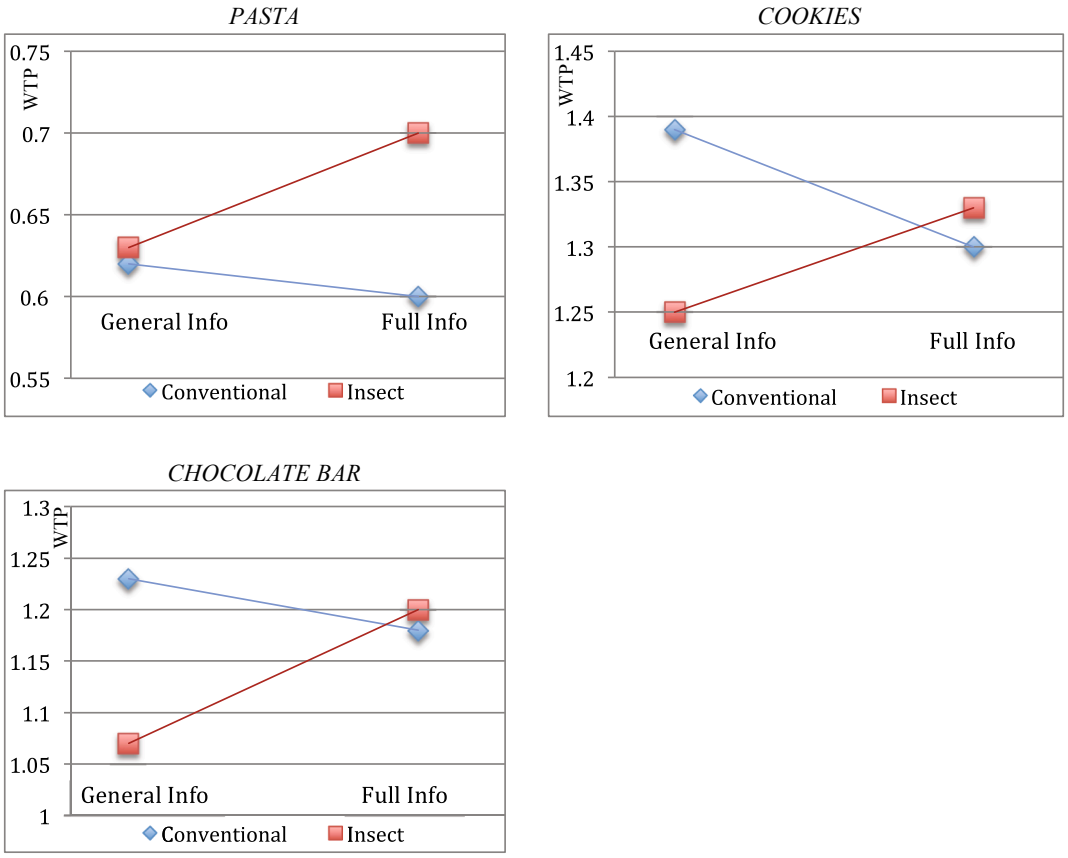

Fig. 4. Variation of WTP (€) from first (general information) to second round (full information).

Table 5
Seemingly Unrelated Regressions coefficients.

	Pasta	Cookies	Chocolate bar
FNS	−12.461***	−10.585***	−7.515***
GHI	0.671	0.992	2.751
NEP	−0.134	0.906	1.408***
BAI	−17.974***	−19.984***	−19.960***
Age	−3.142***	−2.158*	−2.390**
Gender	7.720	−2.936	0.589
Information BI	14.888**	12.339	17.305***
Information BC	19.218***	21.656***	13.371**
Constant	71.998*	21.849	23.898

Note: FNS = Food Neophobia Scale; GHI = General health interest related to food; NEP = New Ecological Paradigm; BAI = Beliefs and attitudes about insects; BI = benefits for the individual; BC = benefits for the community.
Asterisks represent statistically significant at the levels: * $p \leq 0.1$; ** $p \leq 0.05$; *** $p \leq 0.01$.

pasta, cookies and chocolate bars in a mixed within/between experimental design, with different types of information provided (benefits for the community versus benefits for the individual). First the respondents' preferences for insect-based products and the respective conventional counterpart were collected, applying a non hypothetical elicitation mechanism. The insect-based products chosen are available in the market, are familiar to consumers, are similar to the conventional counterpart, and do not contain visible insects. The findings reveal that when information concerning the benefits of eating insects was not disclosed, consumers deem insect-based products either equivalent (the same WTP for the two versions of pasta) or slightly inferior (lower WTP in the case of cookies and chocolate). For the latter products, participants would be willing to buy them only at a discounted price. The hypothesis behind the selection of the three products is that different products might generate different individuals' WTP, according to two main aspects: the carrier's general features, and the respondent's perceived appropriateness of the specific carrier. Sure enough, the carrier's general features and the consumers' perceived appropriateness of the specific carrier are two aspects individuals consider when they make their decision to consume a new product. For general carrier features, the results indicate a high hedonic value of cookies and chocolate. These two products are generally consumed for the pleasure of eating sweet and tasty foods. Consumers eat cookies and chocolate for enjoyable moments and may reject the thought of threatening the taste of their snacks with unconventional ingredients such as insects.

Consistent with this speculation, previous studies have demonstrated that people are unwilling to renounce the instant joy of a food experience for trying something that is unknown, especially when the food product under question is something they like a lot (van trijp & Fischer, 2010; Tan et al., 2016). Tan and colleagues (2016) show that in the specific case of insect-based food, the more consumers like a specific product, the greater is their dislike when the component "insect" is added in preparation. Such a scenario is drastically different in pasta. According to our findings, participants' WTP is the same whether pasta is conventional or insect-based. This result seems to be unique in the context of consumers' negative approach to insects as food: Tan and colleagues (2016) show that consumers generally see insect-based versions of food as inferior to its conventional counterpart. The carrier's general features may also explain the results observed with pasta. In

contrast to cookies and chocolate, pasta is a staple food with a low hedonic value, and its consumption is largely driven by nutritional value. We did not test for this, but it is reasonable to conclude that consumption of pasta made with insect flour would not modify the routine of eating it and, consequently, the individuals' WTP. Moreover, pasta is usually eaten by adding a dressing that largely affects taste. In the same vein, it has been demonstrated that the mode of preparation strongly influences the expectation of products, especially in the case of unfamiliar products such as insect-based products (Caparros Megido et al., 2014; Hartmann et al., 2015; Tan et al., 2015).

We now discuss the second aspect individuals consider when they decide to consume a new product, namely, the consumers' perceived appropriateness (Tan et al., 2017). Previous studies show that the perceived appropriateness of food is more relevant than other variables, such as sensory liking, in studies aiming to understand consumers' willingness to eat unusual food (Tan et al., 2016). Our results highlight that insect-based pasta is deemed more appropriate by consumers than insect-based cookies or chocolate bars. Put differently, pasta with insects is considered more suitable than the same combination with cookies and chocolate bars. In line with the findings of the current study, previous studies have demonstrated that insects in savory foods are considered more acceptable than insects in sweet foods; this may be attributed to the commonly accepted practice of classifying insects as protein substitutes that makes sweet preparation inappropriate (Shelomi, 2015; Tan et al., 2015). As expected, the introduction of insects in sweet preparations, such as in a dessert or in a chocolate cake or bar, is considered inappropriate by consumers (Cardello et al., 2000; Schutz & Martens, 2001).

Concerning the third contribution to consumer preferences research, we investigated the relative importance of different types of information on individual preferences. Given the relevance of information in influencing willingness to try a novel food (Hollinger & Roberts, 1929; Woodward, 1945; Cardello et al., 1985), the objective of the current study was to understand if and which types of information affect consumer choices. Full information provided in the second round of the experiment was classified as information concerning the benefits for the individual and that concerning the benefits for the community. Indeed, WTP elicitation significantly changed when full information on the benefits was disclosed. Providing information on the benefits of consuming insects, either for individuals or collectively, increased the consumers' WTP for all the insect-based products analyzed. This is not a new finding in the literature. The role of information in food choice is extensively discussed in the scientific debate demonstrating that food choice is determined not only by intrinsic characteristics of products themselves but also by extrinsic characteristics, such as information and recommendations (Stroebele & De Castro, 2004; Jaeger & Rose, 2008). Moreover, in the specific context of novel and unfamiliar food, which is the focus of the current study, previous studies have confirmed the impact of information on consumers' acceptance of unfamiliar and novel food (Tuorila et al., 1998; Cardello et al., 1985). In particular, a recent study conducted by Pambo and colleagues (2018), has examined the role of information (both positive and negative) specifically on consumers' perceptions and expectations of insect-based products. The results of this study support the idea that different sources of information have an (diversified) influence on the consumers' evaluation of insect-based food.

Finally, this study identified the main forces driving consumers' preferences for insect-based food by applying different psychographic scales. The results show that Food Neophobia preserves its role in predicting behavior toward unfamiliar food: the higher the value is, the more it negatively affects the WTP for insect-based products. This result is consistent with previous studies that identified neophobia as one of the most relevant factors determining consumers' readiness to accept novel food (Raudenbush & Frank, 1999; Tuorila et al., 2001; Caparros Megido et al., 2014; Verbeke, 2015; Fenko et al., 2015; Hartmann et al., 2015). General Health Index does not influence consumers' willingness to consume insects. This finding is in line with a recent research conducted by Schlup and Brunner (2018). Similarly, New Ecological Paradigm scores did not significantly influence participants' WTP, except in the case of chocolate bar. Furthermore, this outcome is not influenced by the information conditions; namely: individuals with diverse NEP index are not showing different WTP according to the type of benefits (for the community/for the individual).

This result is contrasting findings from Gere and colleagues (2017) and Verbeke (2015) which revealed that the environmental impact of food choice was also associated with a higher likelihood of adopting insects. An explanation for the contrast with the latter studies can be related to the fact that insects in those cases were considered specifically as a meat substitute. Finally, as expected, Beliefs and Attitudes toward insects highly affect the WTP negatively for insect-based products.

Current results should aid managers and marketers who want to launch their insect-based food products in several manners. First, further evidence is provided that some insect-based foods are more easily accepted by consumers (as pasta) and even more when matched with appropriate information. Therefore, specific foods could be marketed by first-mover practitioners to accustom individuals to the novel products and thoroughly invest on information campaigns that are truly relevant for final consumers. Furthermore, entrepreneurs should carefully identify their relevant target market, as groups of individuals with specific characteristics (e.g. less neophobic) are keener to consume insect-based foods. For policy makers interested in prompting consumption of insect-based foods, a core challenge remains enhancing consumer understanding of their benefits. However, conventional information and education campaigns on other public-relevant food issues (as healthful choices) have proven to modestly influence individuals' behavioural changes. Thus, alternative approaches based on behavioural economic principles that alter choice environments to increase selection could be tested (e.g. Sunstein, 2016).

Several limitations are evident in this study. First, we used a convenience sample of University students, which strongly restricts our ability to generalize results for the overall cohort of young consumers. Second, the products selected for the experiment, however familiar for participants, could not be representative of all food categories. Furthermore, we are aware that respondents in a laboratory environment are keener to concentrate fully on the specific task, leading to a heightened examination of products tested beyond what would occur in a normal market environment (Harrison & List, 2004). Other minor shortcomings stem from the specific design of the valuation mechanism applied: by expressing WTP for different product typologies, individuals may tend to excessively concentrate their bid on the item with the highest value to them at the expense of the other items being sold; the structure of MPL is prone to framing effects (Andersen et al., 2006); and carry-over and demand effects are inherent in within-subjects designs (Charness, Gneezy, & Kuhn, 2012).

Future research studies should aim to better investigate consumers' feelings, beliefs, attitudes, and motivations to choose insect-based food; applying, for instance, qualitative methodologies (as focus groups and projective techniques) and implicit measurements (i.e. subjects are unaware of the relationship between the dimension and the food investigated). Furthermore, scholars and practitioners could benefit of the continuously evolving methodological developments to include sensory features in the experimental design (e.g. Asioli et al., 2017; Grunert, 2005), allowing direct estimations of individual trade-offs between

intrinsic and extrinsic attributes of insect-based food. Finally, further insights could be provided by studies analyzing how consumers motives and preferences toward insect-based foods vary across different contexts (e.g. consumption moment, purchase occasion, usage situation).

Appendix A

See

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Table A.1
Food Neophobia Scale (FNS), summary statistics.

Variable	Mean	Std. Dev.	Min	Max
I am constantly sampling new and different foods	4.79	1.555	1	7
I don't trust new foods	2.82	1.503	1	7
If I don't know what is in a food, I won't try it	4.58	1.945	1	7
I like foods from different countries	4.69	1.711	1	7
Ethnic food looks too weird to eat	2.70	1.581	1	7
At dinner parties, I will try a new food	5.49	1.537	1	7
I am afraid to eat things I have never had before	2.56	1.593	1	7
I am very particular about the foods I will eat	3.68	1.676	1	7
I will eat almost anything	5.08	1.677	1	7
I like to try new ethnic restaurants	4.53	1.683	1	7

Source: our elaboration on the original FNS scale (Pliner & Hobden, 1992).

Table A.2
General Health index (GHI), summary statistics.

Variable	Mean	Std. Dev.	Min	Max
The healthiness of food has little impact on my food choices	2.71	1.309	1	7
I am very particular about the healthiness of food I eat	4.57	1.383	1	7
I eat what I like and I do not worry much about the healthiness of food	3.30	1.315	1	7
It is important for me that my diet is low in fat	3.46	1.410	1	7
I always follow a healthy and balanced diet	3.64	1.466	1	7
It is important for me that my daily diet contains a lot of vitamins and minerals	4.72	1.342	1	7
The healthiness of snacks makes no difference to me	3.26	1.614	1	7
I do not avoid foods, even if they may raise my cholesterol	3.67	1.474	1	7

Source: our elaboration on the original GHI scale (Roininen et al., 1999).

Table A.3
Beliefs and attitudes about insects (BAI), summary statistics.

Variable	Mean	Std. Dev.	Min	Max
Eating insects is disgusting	4.08	1.842	1	7
Eating insects will increase risk of infectious disease	2.52	1.504	1	7
Insects carry harmful microbes	3.09	1.642	1	7
Insects contain harmful toxins	2.83	1.368	1	7
Insects are highly nutritious	4.75	1.613	1	7
Eating insects is good for the environment	3.53	1.796	1	7
Killing insects is immoral	2.81	1.645	1	7
Insects are capable of feeling pain	4.53	1.756	1	7
It is not natural for humans to eat insects	2.97	1.842	1	7

Source: our elaboration on the original BAI scale (Ruby et al., 2015).

Table A.4
New Ecological Paradigm (NEP), summary statistics.

Variable	Mean	Std. Dev.	Min	Max
We are approaching the limit of the number of people the earth can support	3.58	0.909	1	5
Humans have the right to modify the natural environment to suit their needs	2.12	1.038	1	5
When humans interfere with nature it often produces disastrous consequences	4.29	0.870	1	5
Human ingenuity will insure that we do NOT make the earth unlivable	2.62	1.026	1	5
Humans are severely abusing the environment	4.53	0.701	1	5
The earth has plenty of natural resources if we just learn how to develop them	4.63	0.704	1	5
Plants and animals have as much right as humans to exist	4.37	0.798	1	5
The balance of nature is strong enough to cope with the impacts of modern industrial nations	2.41	1.099	1	5
Despite our special abilities humans are still subject to the laws of nature	4.27	0.843	1	5
The so-called “ecological crisis” facing humankind has been greatly exaggerated	2.76	1.063	1	5
The earth is like a spaceship with very limited room and resources	3.71	1.015	1	5
Humans were meant to rule over the rest of nature	2.38	1.096	1	5
The balance of nature is very delicate and easily upset	4.15	0.753	2	5
Humans will eventually learn enough about how nature works to be able to control it	2.77	0.937	1	5
If things continue on their present course, we will soon experience a major ecological catastrophe	4.10	0.839	1	5

Source: our elaboration on the original NEP scale (Dunlap et al., 2000).

Table A.5
Felling of hunger source, summary statistics.

Variable	Mean Std. Dev.		Min	Max
How hungry are you	3.24	0.947	1	5

Source: our elaboration on de-Magistris & Gracia (2016).

Appendix B. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.foodqual.2018.10.001.

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