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1 Eating Novel Foods: An Application of the Theory of Planned Behaviour to Predict the

2 Consumption of an Insect-Based Product

3

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11	
12	Abstract

Insects are a potential ingredient of food preparations, providing nutrients (e.g. proteins) with a low 13 environmental impact. Despite the benefits, consumers in Western countries generally reject the 14 practice of eating insects. This work aims to measure the intention to and the behaviour of eating 15 novel food products containing insect flour in the next month. The novel food product of choice 16 was a chocolate chip cookie with an ingredient from edible insects (10% of cricket flour), which 17 might be considered as an enriched-in-proteins substitute of traditional cookies. We investigated 18 231 Italian young adults using the Theory of Planned Behaviour (TPB), assuming that behaviour, 19 given sufficient control, is guided by intention. We used the observation of the actual tasting of the 20 novel food product as a measure of prospective behaviour. The TPB model accounted for 78% of 21 22 the variance in intention and 19% of the variance in behaviour. Attitude and Perceived Behavioural Control (PBC) are statistically significant predictors of intention, while intentions and PBC are of 23 behaviour. Beliefs that eating an insect-based food product has positive effects on health and the 24 environment significantly affect attitudes and intention. The main barriers preventing the intention 25 of eating food products containing insect flour are the sense of disgust arising from seeing insects 26

27	around, t	he incom	patibility	with l	local	food	culture	and th	e lack	of pro	oducts	in the	supermark	et.
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28 Interventions may consider targeting behavioural control, developing food products close to the

29 Western dietary pattern, such as bakery products containing insect flour, and signalling the positive

30 effects on health and the environment.

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Keywords: Insect Flour; Novel Food; Theory of Planned Behavior; Young Adults; Intention;
Entomophagy.

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- 36

37 **1. Introduction**

The acceptance or rejection to eat unfamiliar food items, especially of animal origin, has always been 38 influenced by many factors, including sensory properties, cultural and societal environment, personal 39 traits and individual beliefs, health concerns and availability on the market (Martins & Pliner, 2006; 40 Sogari, 2015; Hartmann & Siegrist, 2016). Hence, some animals and animal-based products are 41 considered traditional delicatessen food in some countries while they are perceived as taboos in others 42 (DeFoliart, 1999; Meyer-Rochow, 2009; Sogari & Vantomme, 2014). The practice of eating insects 43 (i.e., entomophagy) is part of the traditional diet of at least two billion people in the world, mostly 44 settled in tropical and subtropical countries, which concerns about 1,900 edible insect species (van 45 46 Huis et al., 2013). While many countries in Central America (i.e., Mexico), Asia (i.e., Japan, Thailand, and China) and Africa are characterised by a historically long-term familiarity with the consumption 47 of insects, this practice has never become popular in Europe, except in a few countries (Bodenheimer, 48 49 1951; Caparros Megido et al., 2014; Mlcek, Rop, Borkovcova, & Bednarova, 2014). In 2013, the Food and Agriculture Organization of the United Nations (FAO) highlighted the challenges of using 50 51 edible insects for human and animal consumption to achieve a more sustainable food system (van Huis et al., 2013). Insects are rich in nutrients (proteins and fibres) and more efficient in terms of feed 52 conversion, greenhouse gas emissions, water and soil use and edible mass compared to most domestic 53 54 breeding animal species (van Huis et al., 2013). Despite all these environmental and health benefits, the population of Western countries, including Italy, rejects entomophagy and considers insects 55 disgusting, a food source of contamination, low in prestige and prevalent in poor countries (Martins 56 & Pliner, 2006; MacClancy, Henry, & Macbeth, 2007; Sogari & Vantomme, 2014; Hartmann, Shi, 57 Giusto, & Siegrist, 2015; Deroy, Reade, & Spence, 2015). Rather than a delicious and nutritious 58 gastronomic option, currently the narrative of eating insect-based food is framed as a necessary 59 response to overpopulation and the environmental pressure caused by meat production (Schösler, De 60 Boer, & Boersema, 2012), painting the cuisine in a negative light (Shelomi, 2016). However, in the 61 last years, entomophagy has been gaining ever-increasing interest in Italy and other European 62

countries, catching the attention of the media, research institutes, the food industry and restaurants as 63 64 well as that of policy makers (Belluco et al., 2013; Bednáøová, Borkovcova, Mlček, Rop, & Zeman, 2013; Sogari, 2015; Shelomi, 2016), suggesting that a possible niche market might be served in the 65 near future (Gmuer, Guth, Hartmann, & Siegrist, 2016; Schouteten et al., 2016). The likelihood of 66 accepting insects as food seems to increase with consumer awareness of the environmental impact of 67 food production (Cicatiello, De Rosa, Franco, & Lacetera, 2016), with the younger age (Schösler et 68 al., 2012; Caparros Megido et al., 2016) and with being male (Verbeke, 2015; Caparros Megido et 69 al., 2016; Tan, van den Berg, & Stieger, 2016). On the other hand, one of the strongest barriers to 70 consumer acceptance is the lack of attractiveness of insects from a culinary point of view (Deroy et 71 72 al., 2015) and the low sensory quality of insect-based products (Schouteten et al., 2016). As far as the geographical distribution of these niche markets is concerned, it appears that the United States are 73 increasingly served by many food start-ups which have developed familiar products (snacks, energy 74 75 bars, chips) using insect flour (mainly cricket) as an ingredient (Vantomme, 2015; Sogari, 2015). As suggested by De-Magistris, Pascucci, and Mitsopoulos (2015), the potential market of meat-substitute 76 77 products and other insect-based ingredients might become in the future a profitable business in Western countries, provided that insects are prepared and presented in attractive ways and satisfy the 78 sensory expectations of Western consumers (Deroy et al., 2015; Tan et al., 2016). 79

80 Because the causes of dismissing insects as suitable food are largely and still unknown, there is an urgent need for more social research investigating entomophagy in Western societies further (Loov, 81 Dunkel, & Wood, 2014; Cicatiello et al., 2016). Therefore, this study aims to predict the behaviour 82 towards, and understand the main determinants of, the consumption of edible insects. The 83 84 implications of this study might contribute to understand whether Western consumers are ready to adopt insects as an ingredient in other food products. In our study, we focused our attention on a 85 cookie featuring an insect-based ingredient (10% cricket flour) which might be considered a substitute 86 for the traditional cookie enriched in proteins. 87

89 **2. Theoretical framework**

The analysis was conducted employing the Theory of Planned Behaviour (TPB) (Ajzen, 1991), 90 which suggests that behaviour is guided by intention that, in turn, is driven by attitudes toward the 91 92 behaviour (i.e., the favourable or unfavourable evaluation of the behaviour), subjective norms, including perceived social pressure, and perceived behavioural control (PBC), which accounts for 93 the perceived ability to perform the behaviour of interest. According to the TPB, human behaviour 94 95 is guided by considerations regarding its likely consequences (behavioural beliefs), by perceived opinions of the social environment (normative beliefs), and by individual perceptions of barriers 96 and facilitators existing when attempting to perform the behaviour (control beliefs) (Fishbein & 97 98 Ajzen, 2010). Intention, which captures the motivational factors that influence behaviour, together with PBC, should account for considerable variance in the actual behaviour. The TPB has been 99 widely applied to predict intentions and behaviour in many fields. The review of previous meta-100 101 analyses of the TPB capability of predicting a broad range of behaviours suggests that the theory produces mean multiple correlations with intentions ranging from 0.50 to 0.60, and is capable of 102 103 accounting for about 0.30 to 0.40 of the variance in behaviour (Fishbein & Ajzen, 2010). More 104 precisely, a meta-analysis on 30 prospective dietary behaviour tests has shown that 21.2% of the variance in dietary behaviour was successfully explained. The TPB proved to be one of the most 105 106 solid theories to ground evidence-based interventions on, including health-related behaviours (Hardeman et al., 2002; McDermott et al., 2015). Interventions based on the evidence from TPB 107 studies should be directed at modifying salient beliefs in order to produce corresponding changes in 108 attitudes, subjective norms, and PBC, which, in turn, may further influence intentions in the desired 109 direction. 110

This theory has been applied in the past to explain and predict broad categories of food-related
behaviours, such as healthy eating, dietary behaviour or green food consumption (McEachan,
Conner, Taylor, & Lawton, 2011; Zhu, Li, Geng, & Qi, 2013; McDermott et al., 2015), or more
specific behaviours related with healthy- vs. risky food choices, including eating fruit and

115	vegetables (Guillaumie, Godin, & Vézina-Im, 2010; De Bruijn, 2010; Menozzi & Mora, 2012;
116	Allom & Mullan, 2012; Menozzi, Sogari, & Mora, 2015), genetically modified food (Prati,
117	Pietrantoni, & Zani, 2012), innovative products such as functional food (Patch, Tapsell, &
118	Williams, 2005). In the present study, we attempt to first test the ability of the TPB model to
119	measure beliefs that underlie attitude, subjective norms, and PBC and how they influence the
120	intentions to eat novel food, such as a cookie with an ingredient from edible insects. Second,
121	exploiting the measurement of the prospective behaviour, i.e., the actual attendance at an
122	appointment where the novel food product was offered for tasting, we have tested the power of the
123	TPB model to predict the actual behaviour. Third, since carrying out a behaviour may affect
124	individual beliefs (Fishbein & Ajzen, 2010), we have tested the effects of the tasting experience on
125	attitudes and future intentions. As also suggested by other studies (Hartmann et al., 2015; Hartmann
126	& Siegrist, 2016), exposure to a familiar food, such as a chocolate cookie, made with an unfamiliar
127	ingredient, may enhance the familiarity with the novel ingredient increasing the likelihood of
128	repeating the behaviour in the future. In accordance with previous results, given the premises above,
129	we have formulated the following hypotheses.
130	H1: A favourable attitude would significantly predict the intention to eat food products
131	containing insect flour.
132	H2: Subjective norms would significantly predict the intention to eat food products containing
133	insect flour.
134	H3: PBC would significantly predict the intention to eat food products containing insect flour.
135	H4: Intention would significantly predict prospective behaviour, i.e., actually eating food
136	products containing insect flour in the next month.
137	H5: PBC would significantly predict prospective behaviour, i.e., actually eating food products
138	containing insect flour in the next month.
139	H6: Attitudes towards the behaviour and the intention to eat products containing insect flour

140 change after the behaviour is performed.

Therefore, this paper aims to confirm the TPB model predictors of novel food consumption, in the case of an insect-based food product. This approach adds knowledge to the current literature, providing further evidence of the role of psychosocial determinants (attitude, subjective norms, PBC) in explaining healthy- vs. risky food behavioural choices, such as eating novel food. The relevant beliefs were also analysed to help defining targeted interventions.

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147 **3. Material and Methods**

148 *3.1 Data collection and sample*

We conducted a preliminary public engagement exercise with 109 participants to elicit salient 149 150 beliefs related to attitudes, subjective norms and PBC. It was organised as a single 2-hours event at the University of Parma (Italy) with students of different subjects, who were first asked to answer a 151 152 short semi-structured questionnaire about their expectations and knowledge on different aspects of 153 entomophagy (e.g., environmental, nutritional, sensory, and social issues). Then, after having received specific information by two experts, the participants were invited to attend a "bug 154 banquet". Finally, a final post-tasting questionnaire was administered. Using content analysis, that 155 156 examines textual information to identify its key messages, we have isolated salient behavioural, normative and control beliefs, which have been instrumental in designing the TPB questionnaire. A 157 comprehensive report on the findings of this preliminary stage of the research is available in Sogari, 158 Menozzi, and Mora (2017). 159

The main survey collecting the information for the TPB study reached a larger sample of students at the University of Parma, who answered an online questionnaire. Excluding incomplete answers, the final sample consisted of 231 students, 62% of whom were female (Table 1). Mean age was $23.6 \pm$ 3.8 years. 72% of the students was from Northern Italy, 8% from Central Italy, 19% from Southern Italy and only one student was from abroad. The subjects studied were social (29%), food (56%) and environmental sciences (15%). Out of the valid responses to the online survey, a 110 individuals intended to taste a chocolate chip cookie containing an amount (10%) of cricket flour 167 (spp. *Acheta domesticus*). 53 students actually performed the behaviour, attending the appointment

and tasting the novel food.

- 169
- **Table 1.** Sample socio-demographic characteristics (n = 231).

Socio-demographic characteristic levels	es and
Gender	%
Male	38.1
Female	61.9
Age	mean (sd)
Age of respondents	23.6 (3.8)
Place of origin	%
Northern Italy	72.3
Central Italy	8.2
Southern Italy	19.0
Other countries	.5
Topic of study	%
Environmental sciences	15.2
Food sciences	55.8
Social sciences	29.0

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172

173 *3.2 Measures*

The behaviour of interest was defined as "Eating products containing insect flour in the next 174 month". We assessed the direct measure of attitude toward the behaviour with four semantic 175 differentials, using a 7-point unipolar scale: "Eating products containing insect flour in the next 176 177 month is: pleasant/unpleasant, irrelevant/relevant, not tasty/tasty, and useless/useful". We used three items to assess *behavioural belief* strength (b) towards eating products containing insect flour in the 178 next month: "Positive effects on health", "Positive effects on the environment" and "Similar taste as 179 180 known products". Each item was anchored on a bipolar differential 7-point scale ranging from "strongly disagree" to "strongly agree". For each belief strength variable, we included an equivalent 181

outcome evaluation statement (e), measuring the subjective evaluation of the single attribute. Each
statement was measured on a bipolar 7-point scale (from "not at all important" to "extremely
important"). A composite measure of each behavioural belief was computed multiplying belief
strength and outcome evaluation (Fishbein & Ajzen, 2010).

Fishbein and Ajzen (2010) make a clear distinction between perceived injunctive norms, reflecting 186 what important others think we should do, and perceived descriptive norms, that reflect what we 187 believe other have done or are doing. Fishbein and Ajzen (2010) recommend including a measure of 188 social norms that incorporates both injunctive and descriptive norms in empirical analysis. 189 However, given the novelty of the food product and the unpractised behaviour in the country, we 190 191 decided to measure subjective norms considering only injunctive norms. Therefore, we used two items on a 7-point unipolar scale as direct measures of subjective norms: "Most people who are 192 important to me think that I should/I should not eat products containing insect flour in the next 193 194 month", and "Most people whose opinion I value would approve of my eating products containing insect flour in the next month (unlikely/likely)". Groups or individuals whose opinion might 195 196 influence respondent intention and behaviour were also explored. In particular, we have considered 197 three normative referents: the family, friends, and doctors/nutritionists. We used three statements to assess normative belief strength (n), such as "My family think that I should eat products containing 198 insect flour in the next month (extremely unlikely/extremely likely)", scored on a bipolar 7-point 199 scale. For each normative belief, we included a question enquiring about the motivation to comply 200 (m), such as "Generally speaking, how important is the opinion of your family?" scored on a 201 unipolar 7-point scale (from "not at all important" to "extremely important"). We multiplied belief 202 strengths and motivation to comply with every single referent to obtain a composite indirect 203 measure of normative beliefs. 204

We directly measured *perceived behavioural control (PBC)* with two items, on a 7-point scale: "The decision to eat products containing insect flour in the next month is under my complete control" and "Eating products containing insect flour in the next month is completely up to me"

(strongly disagree/strongly agree). Control beliefs about factors that would enable or impede 208 performing the behaviour were assessed considering that the product is "Not available in the 209 supermarket", "Incompatible with the local food culture", and that the respondent is "Disgusted 210 when seeing insects around". We measured belief strength with three items (c), such as "The 211 products containing insect flour are not available in the supermarkets". Each item was anchored on 212 a unipolar 7-point scale ranging from "strongly disagree" to "strongly agree". To assess the power 213 of each factor (p) in discouraging the consumption of these products, we included three items on a 214 bipolar 7-point scale, such as "Not having these products available in the supermarket would make 215 it easier/more difficult for me eating products containing insect flour in the next month". We 216 217 obtained a composite indirect measure of control beliefs multiplying each control factor's belief strengths and perceived power. 218

We used three items to assess behavioural intention: "I intend to eat products containing insect flour 219 220 in the next month", "For sure I will eat products containing insect flour in the next month", and "I will try to eat products containing insect flour in the next month". Each item was measured on a 7-221 222 point scale ranging from "strongly disagree" to "strongly agree". The above three items indicate the 223 individual proactivity to perform the behaviour. We used two or more items for every construct in the questionnaire to achieve a greater reliability of the results. We carefully evaluated using 224 225 unipolar and bipolar scales across the questionnaire items, based on recommendations in Fishbein and Aizen (2010). Therefore, after preliminary calculations we decided to score control belief 226 strength on an unipolar scale, and to include the motivation to comply, although it was often found 227 228 to contribute little to the prediction of subjective norms. Moreover, positive and negative endpoints were counterbalanced to avoid possible systematic response set. 229

At the end of the questionnaire, we asked respondents to state their willingness to participate in the

tasting of a product containing cricket flour; those who agreed had to indicate their preferred date,

out of the several dates we allowed for organising the tasting experience in the following month.

233 The *behaviour* was measured observing the actual presence at the appointment and tasting of the

novel food. Therefore, we used a dichotomous criterion to assess whether the behaviour was
performed (0 = "did not taste the novel food product" and 1 = "did taste the novel food product").
Upon completing the tasting experience, participants received a shorter version of the TPB
questionnaire to measure their attitude toward the behaviour and the intention to eat products
containing insect flour in the future. We employed the same items described in this section to obtain
comparable direct measures of attitude and intention.

240

241 *3.3 Data analysis*

The data were initially analysed to confirm correlations between attitude, subjective norm and PBC 242 with, respectively, their behavioural, normative and control beliefs, as well as between the 243 predictors and both intention and the behaviour (Fishbein & Ajzen, 2010). In TPB studies, the effect 244 of background variables, such as socio-demographic or personal characteristics, can be assessed 245 analysing their correlation with intention and/or behaviour. Therefore, a point-biserial correlation 246 was run to determine the relationship between background variables and intention/behaviour. Then, 247 we used the Structural Equation Modelling (SEM) approach to test the proposed model and the 248 research hypotheses (Byrne, 2010). We assessed model fit with the Chi-Square (χ^2), the 249 Comparative Fix Index (CFI), the Tucker-Lewis Index (TLI), and the Root Mean Square Error of 250 Approximation (RMSEA), while the Coefficient of Determination (R^2) measured the explained 251 variance of the endogenous variables (intention and behaviour). We estimated the model using the 252 Bayesian estimation routine in IBM[®] SPSS[®] AMOS 23.0, recommended for analysing categorical 253 data (Byrne, 2010). 254

255

256 **4. Results**

257 *4.1 Descriptive analysis*

Results show a moderately positive attitude toward the behaviour (mean score 4.36), a moderately
negative social pressure (3.85), and a generally positive perceived control (5.37) over eating

260	products containing insect flour in the next month (Table 2). Overall, respondents reported weak
261	intentions to eat products containing insect flour (3.48). The internal consistency of the scales
262	(Cronbach's alpha), ranging from 0.70 (subjective norm) to 0.90 (intention), suggests that they are
263	homogenous (Table 2). Furthermore, 23% of the sample did perform the behaviour; indeed, 53
264	respondents (out of 231) accepted to participate in the tasting experience and actually tasted a
265	product containing insect flour in the following month.

266

Table 2: Constructs Cronbach's alpha, mean scores and standard deviations (in parentheses).

	Alpha	Mean score (sd)
Attitude	0.76	4.36 (1.34)
Subjective norms	0.70	3.85 (1.34)
PBC	0.74	5.37 (1.68)
Intention	0.90	3.48 (1.85)
Behaviour ^a		0.23 (0.42)

^a Values 0 = "did not taste the novel food product", and 1 = "did taste the novel food product".

269

270 We have computed the correlation between socio-demographic variables and intention, as well as the behaviour, and the difference in the mean scores between groups (Table 3). A statistically 271 significant positive correlation between intention and gender was detected (r = 0.18, p<0.01), 272 indicating that male respondents had higher intention to eat products containing insect flour in the 273 next month, compared to females. Students enrolled in food and environmental sciences-related 274 subjects were more willing to eat products containing insect flour than students of social sciences (r 275 = -0.24, p < 0.001). This variable is also significantly correlated with the actual behaviour (r = -0.15, 276 p < 0.05), indicating that students enrolled in social sciences-related subjects were less likely to taste 277 the insect-based food product. The differences in the mean scores of the behaviour across the three 278 study groups, being statistically significant, confirm this finding. Place of origin is also negatively 279 280 correlated with intention, since students from the Southern regions of Italy demonstrated a lower

intention to eat products containing insect flour than those from the Central and Northern regions (r 281 = -0.16, p<0.05). Other socio-demographic characteristics, such as the Body Mass Index (BMI) and 282 age, were neither correlated with intentions nor with behaviour in a statistically significant manner 283 (data not shown). 284

285

Table 3. Biserial correlation (r) between intention, behaviour and socio-demographic characteristics 286 287 (gender, topic of study and place of origin), mean scores and standard deviation (in parentheses).

Gender	r	Females (n = 143)	Males (n = 88)	-	p ^a
Intention	0.18**	3.22 (1.87)	3.91 (1.73)	-	**
Behaviour	0.10	0.20 (0.40)	0.28 (0.45)	-	ns
Studies	r	Environment (n = 34)	Food (n = 129)	Social (n=67)	p ^a
Intention	-0.24***	3.75 (1.77)	3.88 (1.84)	2.61 (1.60)	***
Behaviour	-0.15*	0.29 (0.46)	0.27 (0.45)	0.12 (0.33)	*
Place of origin	r	North (n = 167)	Centre (n = 19)	South (n=44)	p ^a
Intention	-0.16*	3.58 (1.83)	4.53 (1.74)	2.64 (1.65)	***
Behaviour	-0.01	0.23 (0.42)	0.32 (0.48)	0.20 (0.41)	ns

^a one-way ANOVA with Intention as dependent variable; Cramer V test with Behaviour. * p<0.05. ** p<0.01. *** p<0.001. ns = not significant. 288

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291
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4.2 Predicting intention and the behaviour 292

The TPB model fits the data very well (χ^2 (46) = 86.097, CFI = 0.97, TLI = 0.95, RMSEA (CI 90%) 293

= 0.062 (0.041; 0.081)). Attitude and subjective norms are statistically significantly correlated with 294

intentions (respectively, r = 0.70 and 0.32, p < 0.001); however, only attitude and PBC are 295

significant predictors of intention (beta = 0.86, p<0.001, and 0.13, p<0.05), confirming H1 and H3. 296

In contrast with H2, the effect of subjective norm on intention is not statistically significant. The 297

behaviour is statistically significantly correlated with intention and PBC (r = 0.39, p < 0.001, and 298

299 0.21, p <0.01); intention is the main predictor of the behaviour (beta = 0.35, p<0.001), followed by

²⁸⁹

²⁹⁰

PBC (beta = 0.17, p<0.05). Therefore, results confirm H4 and H5. Based on the R², the TPB model explains 77.8% and 18.7% of the variance in intention and behaviour, respectively.

302

Table 4. Structural Equations Model: R^2 , correlations (r), and standardized regression coefficients

304 (b).

	\mathbf{R}^2	r	b
Behaviour predictors:	0.19		
Intention		0.39***	0.35***
PBC		0.21**	0.17^{*}
Intention predictors:	0.78		
Attitude		0.70^{***}	0.86***
Subjective Norm		0.32***	0.01
PBC		0.12	0.13*

 $305 \quad \overline{p < 0.05. * p < 0.01. * p < 0.001.}$

307 *4.3 Underlying beliefs*

The TPB postulates that personal beliefs about the likely outcomes of the behaviour (behavioural 308 309 beliefs), the normative expectations of others (normative beliefs), and the presence of factors that may facilitate or impede performing the behaviour (control beliefs) influence attitude, subjective 310 norms and PBC, respectively, and these effects mediate for their impact on intentions and behaviour 311 (Fishbein & Ajzen, 2010). Table 5 shows the mean scores of these beliefs. The positive effect on 312 the environment is, on average, the most important outcome of eating products containing insect 313 flour identified by participants in this study. Health promotion and environmental protection are 314 both important values for respondents, while eating novel products with a familiar taste seems less 315 important. Respondents believe that friends and doctors/nutritionists do not think they should eat 316 products containing insect flour. The opinion of the family members is not relevant in this case. 317 Unfamiliarity with the concept and the practice of entomophagy in the respondents' social and 318 cultural context may have partially influenced this weak perceived social pressure. Although 319

³⁰⁶

- measures of injunctive norms are obtained at the individual level, the norm often concerns a
 behavioral rule that applies (or does not apply) to all members of a population. Nevertheless,
 participants are motivated to comply with family and doctors/nutritionists' opinions. The product
 being unavailable in the supermarket and being incompatible with the local food culture are the
 main factors that could impede the behaviour.
- 325

Table 5. Behavioural, normative and control beliefs constructs, mean scores^a and standard deviation

327 (in parentheses).

Behavioural beliefs	Belief strength (b)	Outcome evaluation (e)
Positive effects on health	-0.06 (1.57)	2.41 (0.97)
Positive effects on environment	0.92 (1.62)	1.73 (1.23)
Similar taste as known products	-0.06 (1.87)	0.08 (1.74)
Normative beliefs	Belief strength (n)	Motivation to comply (m)
Family	0.01 (1.95)	4.72 (1.59)
Friends	-0.34 (1.81)	3.90 (1.56)
Doctors and nutritionists	-0.41 (1.36)	4.73 (1.61)
Control beliefs	Belief strength (c)	Power (p)
Not available at the supermarket	5.68 (1.94)	1.19 (1.95)
Incompatible with the local food culture	4.88 (2.00)	0.52 (1.93)
Disgusted when see insects around	4.10 (2.28)	0.44 (1.99)

^a Mean scores are calculated on bipolar 7-point scales, ranging from -3 to +3, and on unipolar 7-point
 scales, ranging from 1 to 7. Behavioural beliefs (b = bipolar; e = bipolar), Normative beliefs (n = bipolar; m
 = unipolar), Control beliefs (c = unipolar; p = bipolar).

331

Exploring the correlation between the salient beliefs and their relative direct measures, as well as

intentions, provides important insights on how to target interventions (Table 6). In principle,

interventions should target the beliefs statistically significant for the component that is the most

sizeable predictor of intention. In the present study, we found that several behavioural beliefs are

statistically significant, including believing that eating a product containing insect flour has positive

- effects on health promotion and on the protection of the environment. Experiencing a product with a
- taste similar to known products seems irrelevant in affecting individuals' attitude and intention.

Several correlation coefficients between normative beliefs and the direct measure of subjective 339 norm and intention are statistically significant. In particular, considerations about the opinions of 340 parents and friends, and to a lesser extent of doctors and nutritionists, are positively correlated with 341 both the subjective norm and the intention. None of the control factors correlates with PBC, while 342 the three factors are all negatively correlated with intention. This means that the main barriers 343 preventing the intention of eating a product containing insect flour are the sense of disgust arising 344 from seeing insects around, the incompatibility with the local food culture and the lack of products 345 in the supermarket. 346

347

Table 6. Correlations (r) between beliefs and their relative direct measure (attitude, subjective norm
and PBC), and intention.

Beliefs	Construct	Correl the co	lation with nstruct	Correlation with intention	
		r	р	r	р
Positive effects on health	Attitude	0.53	***	0.49	***
Positive effects on environment	Attitude	0.46	***	0.40	***
Similar taste as known products	Attitude	-0.04	ns	0.07	ns
Parents	Subjective Norm	0.55	***	0.43	***
Friends	Subjective Norm	0.50	***	0.38	***
Doctors and nutritionists	Subjective Norm	0.34	***	0.37	***
Not available at the supermarket	PBC	0.07	ns	-0.22	**
Incompatible with the local food culture	PBC	0.04	ns	-0.54	***
Disgusted when see insects around	PBC	-0.10	ns	-0.58	***

350 * p < 0.05. ** p < 0.01. *** p < 0.001. ns = not significant.

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352 *4.4 Attitudes and intentions after tasting*

After the tasting experience, we measured the attitude of the participants (n = 53) toward the behaviour and the intention to eat products containing insect flour in the future. Comparing the preand post-tasting scores, we found an increase in the intention to eat products containing insect flour

in the future (+0.49, p<0.001), and a more favourable attitude toward the behaviour (+0.36, p<0.05)

(Table 7). This confirms H6, since performing the behaviour has significantly improved
participants' attitudes and intention to eat products containing insect flour in the future. As noticed
by Fishbein and Ajzen (2010), carrying out a behaviour can result in unanticipated positive
consequences that are likely to change the individual's beliefs, affecting future intentions and
actions. This is confirmed by qualitative information collected during the experiment, when most
participants preferred the taste of the chocolate chip cookie containing 10% of cricket flour (data
not shown).

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Table 7. Scores of the attitude toward, and the intention to, eat product containing insect flour in the future, pre- and post-tasting experience (n = 53).

	Pre-tasting	Post-tasting	р		
Attitude	5.14 (1.05)	5.50 (1.08)	*		
Intention	4.80 (1.31)	5.29 (1.30)	***		
^r p<0.05. ^{**} p<0.01. ^{***} p<0.001.					

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369 **5. Discussion**

This research examined whether the TPB could be employed to understand young adults' behaviour 370 when faced with the prospect of eating products containing insect flour. Findings suggest that attitude 371 and, to a lesser extent, PBC play a significant role in affecting the intention of performing the 372 behaviour, while the subjective norm is not a significant factor in forming the behavioural intention. 373 This result is common in several studies, and the subjective norm is generally a weak predictor of 374 intentions (Armitage & Conner, 2001), although its predictive ability varies across behaviours 375 376 (McEachan et al., 2011). The extant literature also suggested that the role of social norms might be more predictive of the behavioural intentions of adolescents, while attitudes are the most important 377 378 predictor of the dietary intentions of adults (McEachan et al., 2011). The perceived control over the ability of eating a product containing insect flour is a weak determinant of intentions; this construct 379 is mostly influenced by the incompatibility with the local food culture and the lack of these products 380

381 on the Italian market (Sogari et al., 2017). New ways of introducing insect flour in Western dietary 382 patterns can foster the compatibility with consumer food culture and increase the PBC. Moreover, we 383 can presume that assorting supermarket shelves with this novel food will raise perceived control and 384 intentions.

Attitude, subjective norm and PBC together accounted for 77.8% of the variance in intention, while 385 18.7% of the variance in the behaviour is predicted by intention and PBC. Lower predictive power 386 387 is common in studies addressing prospective, rather that concurrent, behaviour. For instance, a meta-analysis on prospective behaviours found that behavioural intention and PBC accounted for 388 19.3% of the variance in behaviour (McEachan et al., 2011). Likewise, McEachan et al. (2011) 389 390 found that adolescents' dietary behaviours may be predicted very poorly (9.6% of the variance), compared with adults' (26.7%). PBC was the most important predictor of adults' dietary 391 392 behaviours, while intentions were the most important predictors of adolescents'. Several factors 393 may have determined the low predictive capability of the TPB model of the behaviour of interest in the present study. First, intention can change before having the opportunity to perform the 394 395 behaviour, or sometimes it can be difficult to carry out the intended action (Fishbein & Ajzen, 396 2010). In our case, respondents that assured, in the on-line survey, they would have tasted a product containing insect flour in the near future declined the invitation, when solicited to actually 397 participate in a tasting experience. Most of them reported they did not accept the invitation because 398 they were short on time, although they were offered several options (days and hours) to facilitate 399 participation. Therefore, it seems that our experiment suffered from a change in intentions, as well 400 as from difficulties in carrying out the intentions. The length of time intervening between the 401 402 measurement of TPB variables and the ensuing behaviour can be a limiting condition of the prospective study. TPB variables are expected to predict behaviour as long as they remain stable 403 between the point in time at which they are measured and the one at which the behaviour occurs, 404 and this should be less likely the longer the time interval (Ajzen, 1991). In general, intention is a 405 better predictor of the measured behaviour the shorter the timeframe, although this evidence was 406

not significant for dietary behaviours (McEachan et al., 2011). Second, failing to carry out an 407 408 intended action may depend on many factors related to the perceived and actual control over performing the behaviour (Fishbein & Ajzen, 2010). Out of the people who assured, in the on-line 409 survey, they would have tasted the product, those who actually participate in the tasting experience 410 have shown a higher perceived control than those who did not participate (p < 0.001). The 411 motivation to taste the product of those who did not participate was not sufficient to overcome the 412 perceived impediments (e.g., being "short on time"). Third, self-reported measures of the behaviour 413 are usually better predicted than objective or observed ones (Armitage & Conner, 2001; McEachan 414 et al., 2011), like it is the case in this study. This may be explained by the stronger measurement 415 416 correspondence, where self-reported measures of behaviour are used; in other words, the subjective self-reported measure of behaviour usually correspond to the prior measure of intention, whereas 417 the prospective observed measure cannot (Armitage & Conner, 2001). 418

419 Intention is the most important predictor of the behaviour; Ajzen and Manstead (2007) noted that a measure of intention should be a good predictor of relatively novel or unpractised behaviours, like 420 421 the one tested in this study. At the same time, we acknowledge that the fairly low correlation 422 between PBC and the behaviour may suggest that perceptions of control were not sufficiently accurate to serve as a good proxy for the actual control (Fishbein & Ajzen, 2010). Moreover, results 423 424 highlighted a gender effect, whereby males expressed a stronger intention to eat insect-based food products than females. Although we should consider this result with some caution, given the larger 425 presence of women in the sample, other studies have found a stronger readiness to try unusual foods 426 like insects among males than females (see, e.g., Verbeke, 2015; Caparros Megido et al., 2016; Tan 427 et al., 2016; Sogari et al., 2017). Participants curriculum of studies is also a significant factor, 428 showing that students enrolled in food- and environmental-sciences related curricula exhibited 429 higher intention and a more likely behaviour than students of social sciences. These students seem 430 more involved in virtuous dietary behaviours and are more interested in the health and 431 environmental impact of their food choices. Similarly, Verbeke (2015) demonstrated that the most 432

likely early adopters of insects as a novel and more sustainable protein source in Western societiesare young males interested in the environmental impact of their food choices.

The TPB suggests that interventions shaping behavioural, normative, or control beliefs may succeed 435 in producing the desired changes in attitudes, subjective norms, and perceptions of control. In turn, 436 changes may further influence intentions and the behaviour in the desired direction, provided people 437 are capable of carrying out their formed intentions. This happens only in presence of a significant 438 causal link running from intentions and the behaviour, and if the intervention is targeted to the 439 component most capable of predicting intentions. Therefore, interventions aimed at promoting, inter 440 alia, the health and environmental benefits of this food practice might fortify individual attitude, 441 442 intention and make the behaviour more likely to occur. Effective interventions may take the form of advertising campaigns from companies and of challenges to the established perceptions of sceptical 443 consumers. Other interventions may also consider targeting the behavioural control by developing 444 445 food products close to the Western food culture, such as bakery products containing insect flour. Indeed, because most insects simply do not fit with the typical image of food that Westerners may 446 447 have, the best way to introduce them in the local gastronomic culture is to process them beyond recognition (Sogari et al., 2017), such as chopped into sauces or ground into flour and used in, for 448 instance, bakery products (Shelomi, 2016). Moreover, more effective interventions should be 449 focused on a sub-population of "early adopters", including male young adults, who ultimately 450 determine if a novel food will succeed in the market (Verbeke, 2015; House, 2016). 451 Finally, the participants attitude and intention significantly improved after tasting the insect-based 452 product, suggesting that an overall positive experience may help growing accustomed to novel food 453 products. In accordance with previous results (Hartmann et al., 2015; Hartmann & Siegrist, 2016), 454 exposure to a familiar food, such as a chocolate cookie, made with an unfamiliar ingredient, such as 455 insect flour, enhances the familiarity with the novel ingredient, increasing the likelihood of 456 repeating the behaviour in the future. Moreover, the factors affecting repeated consumption may 457

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become more practical and contextual, like the routine consumption of more conventional foods

(House, 2016). This is consistent with the TPB, since carrying out a behaviour can result in
unexpected feedback, which is likely to change individual behavioural, normative and control
beliefs, shaping future intentions and actions, too (Fishbein & Ajzen, 2010).

We need to address some limitations of this study. First, the sample is composed of very well 462 educated consumers, usually more aware of the environmental and health consequences of their 463 dietary behaviours (Verbeke, 2015). Therefore, generalising the results to the Italian population of 464 young adults is difficult. Second, we used a product containing insect flour, which, by definition, 465 conceals the presence of the "insect". We are aware that the looking at a whole edible insect may 466 dampen intention and shape behaviour strongly (Tan et al., 2015; Caparros Megido et al., 2016; 467 468 Gmuer et al., 2016). Therefore, the results cannot be generalized to all insect-based food products either, but should be considered specific to this product category which, however, is considered at 469 least initially more promising in Western markets. Third, we acknowledge that this research would 470 471 have been more effective had we designed an intervention and measured its ability to change young adults' behaviour. Hence, further research efforts should use longitudinal data to investigate how 472 473 theory-based interventions would be effective in delivering the intended change in the behaviour. 474 Nevertheless, this study is, to the best of our knowledge, one of the first experiments applying the TPB model to predict the intention to eat of products containing insect flour and the actual 475 behaviour. 476

477

478 **6.** Conclusions

In summary, the present study has tested the TPB model for its ability to predict and explain the main determinants of eating novel food by young adults in Italy, focusing on a chocolate chip cookie containing 10% of cricket flour. The TPB model accounted for 77.8% of the variance in intention and 18.7% of the variance in the behaviour. Attitude and PBC are significant predictors of intention, while intention and PBC significantly affected the behaviour. This suggests that efforts to strengthen intentions, by targeting attitudes and PBC, may result in an increased consumption of

this novel food. Gender, being enrolled in food- and environmental-sciences related curricula, and 485 the region of origin are the background factors influencing intention and the behaviour. Beliefs that 486 eating a product containing insect flour has positive effects on health and the environment are 487 significantly correlated with attitudes and intention, while the main perceived barriers are the sense 488 of disgust arising from seeing insects around, the incompatibility with the local food culture and the 489 lack of products in the supermarket. Given the limited number of TPB studies of the consumption 490 of insect-based food product, this paper provides a framework for defining targeted interventions 491 492 fostering the consumption of novel and more sustainable protein sources in Western societies.

493

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