Eating novel foods: An application of the Theory of Planned Behaviour to predict the consumption of an insect-based product

Eating Novel Foods: An Application of the Theory of Planned Behaviour to Predict the Consumption of an Insect-Based Product

Davide Menozzi [a] *, Giovanni Sogari [a], Mario Veneziani [b], Erica Simoni [a], Cristina Mora [a]

[a] Department of Food and Drug, University of Parma, Parco Area delle Scienze 59/A, 43124 Parma, Italy, emails: davide.menozzi@unipr.it, giovanni.sogari@unipr.it, cristina.mora@unipr.it.

[b] Department of Economics and Management, University of Parma, Via J. F. Kennedy 6, 43125 Parma, Italy, email: mario.veneziani@unipr.it.

* Corresponding author: email: davide.menozzi@unipr.it; Tel.: +39-0521-032519; Fax: +39-0521-032498.

Abstract

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

around, the incompatibility with local food culture and the lack of products in the supermarket. Interventions may consider targeting behavioural control, developing food products close to the Western dietary pattern, such as bakery products containing insect flour, and signalling the positive effects on health and the environment.

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

1. Introduction

The acceptance or rejection to eat unfamiliar food items, especially of animal origin, has always been influenced by many factors, including sensory properties, cultural and societal environment, personal traits and individual beliefs, health concerns and availability on the market (Martins & Pliner, 2006; Sogari, 2015; Hartmann & Siegrist, 2016). Hence, some animals and animal-based products are considered traditional delicatessen food in some countries while they are perceived as taboos in others (DeFoliart, 1999; Meyer-Rochow, 2009; Sogari & Vantomme, 2014). The practice of eating insects (i.e., entomophagy) is part of the traditional diet of at least two billion people in the world, mostly settled in tropical and subtropical countries, which concerns about 1,900 edible insect species (van 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 of insects, this practice has never become popular in Europe, except in a few countries (Bodenheimer, 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 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 conversion, greenhouse gas emissions, water and soil use and edible mass compared to most domestic 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 disgusting, a food source of contamination, low in prestige and prevalent in poor countries (Martins & Pliner, 2006; MacClancy, Henry, & Macbeth, 2007; Sogari & Vantomme, 2014; Hartmann, Shi, Giusto, & Siegrist, 2015; Deroy, Reade, & Spence, 2015). Rather than a delicious and nutritious gastronomic option, currently the narrative of eating insect-based food is framed as a necessary response to overpopulation and the environmental pressure caused by meat production (Schösler, De Boer, & Boersema, 2012), painting the cuisine in a negative light (Shelomi, 2016). However, in the last years, entomophagy has been gaining ever-increasing interest in Italy and other European

63 countries, catching the attention of the media, research institutes, the food industry and restaurants as
64 well as that of policy makers (Belluco et al., 2013; Bednáøová, Borkovcova, Mlček, Rop, & Zeman,
65 2013; Sogari, 2015; Shelomi, 2016), suggesting that a possible niche market might be served in the
66 near future (Gmuer, Guth, Hartmann, & Siegrist, 2016; Schouteten et al., 2016). The likelihood of
67 accepting insects as food seems to increase with consumer awareness of the environmental impact of
68 food production (Cicatiello, De Rosa, Franco, & Lacetera, 2016), with the younger age (Schösler et
69 al., 2012; Caparros Megido et al., 2016) and with being male (Verbeke, 2015; Caparros Megido et
70 al., 2016; Tan, van den Berg, & Stieger, 2016). On the other hand, one of the strongest barriers to
71 consumer acceptance is the lack of attractiveness of insects from a culinary point of view (Deroy et
72 al., 2015) and the low sensory quality of insect-based products (Schouteten et al., 2016). As far as the
73 geographical distribution of these niche markets is concerned, it appears that the United States are
74 increasingly served by many food start-ups which have developed familiar products (snacks, energy
75 bars, chips) using insect flour (mainly cricket) as an ingredient (Vantomme, 2015; Sogari, 2015). As
76 suggested by De-Magistris, Pascucci, and Mitsopoulos (2015), the potential market of meat-substitute
77 products and other insect-based ingredients might become in the future a profitable business in
78 Western countries, provided that insects are prepared and presented in attractive ways and satisfy the
79 sensory expectations of Western consumers (Deroy et al., 2015; Tan et al., 2016).
80 Because the causes of dismissing insects as suitable food are largely and still unknown, there is an
81 urgent need for more social research investigating entomophagy in Western societies further (Looy,
82 Dunkel, & Wood, 2014; Cicatiello et al., 2016). Therefore, this study aims to predict the behaviour
83 towards, and understand the main determinants of, the consumption of edible insects. The
84 implications of this study might contribute to understand whether Western consumers are ready to
85 adopt insects as an ingredient in other food products. In our study, we focused our attention on a
86 cookie featuring an insect-based ingredient (10% cricket flour) which might be considered a substitute
87 for the traditional cookie enriched in proteins.
88

89 **2. Theoretical framework**

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

111 This theory has been applied in the past to explain and predict broad categories of food-related
112 behaviours, such as healthy eating, dietary behaviour or green food consumption (McEachan,
113 Conner, Taylor, & Lawton, 2011; Zhu, Li, Geng, & Qi, 2013; McDermott et al., 2015), or more
114 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.

141 Therefore, this paper aims to confirm the TPB model predictors of novel food consumption, in the
142 case of an insect-based food product. This approach adds knowledge to the current literature,
143 providing further evidence of the role of psychosocial determinants (attitude, subjective norms,
144 PBC) in explaining healthy- vs. risky food behavioural choices, such as eating novel food. The
145 relevant beliefs were also analysed to help defining targeted interventions.
146

147 **3. Material and Methods**

148 *3.1 Data collection and sample*

149 We conducted a preliminary public engagement exercise with 109 participants to elicit salient
150 beliefs related to attitudes, subjective norms and PBC. It was organised as a single 2-hours event at
151 the University of Parma (Italy) with students of different subjects, who were first asked to answer a
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
154 received specific information by two experts, the participants were invited to attend a "bug
155 banquet". Finally, a final post-tasting questionnaire was administered. Using content analysis, that
156 examines textual information to identify its key messages, we have isolated salient behavioural,
157 normative and control beliefs, which have been instrumental in designing the TPB questionnaire. A
158 comprehensive report on the findings of this preliminary stage of the research is available in Sogari,
159 Menozzi, and Mora (2017).
160 The main survey collecting the information for the TPB study reached a larger sample of students at
161 the University of Parma, who answered an online questionnaire. Excluding incomplete answers, the
162 final sample consisted of 231 students, 62% of whom were female (Table 1). Mean age was 23.6 ±
163 3.8 years. 72% of the students was from Northern Italy, 8% from Central Italy, 19% from Southern
164 Italy and only one student was from abroad. The subjects studied were social (29%), food (56%)
165 and environmental sciences (15%). Out of the valid responses to the online survey, a 110
166 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
168 and tasting the novel food.
169
170 **Table 1.** Sample socio-demographic characteristics (n = 231).

Socio-demographic characteristics and levels	
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

171
172
173 *3.2 Measures*
174 The behaviour of interest was defined as "Eating products containing insect flour in the next
175 month". We assessed the direct measure of *attitude toward the behaviour* with four semantic
176 differentials, using a 7-point unipolar scale: "Eating products containing insect flour in the next
177 month is: pleasant/unpleasant, irrelevant/relevant, not tasty/tasty, and useless/useful". We used three
178 items to assess *behavioural belief* strength (b) towards eating products containing insect flour in the
179 next month: "Positive effects on health", "Positive effects on the environment" and "Similar taste as
180 known products". Each item was anchored on a bipolar differential 7-point scale ranging from
181 "strongly disagree" to "strongly agree". For each belief strength variable, we included an equivalent

182 outcome evaluation statement (e), measuring the subjective evaluation of the single attribute. Each
183 statement was measured on a bipolar 7-point scale (from "not at all important" to "extremely
184 important"). A composite measure of each behavioural belief was computed multiplying belief
185 strength and outcome evaluation (Fishbein & Ajzen, 2010).
186 Fishbein and Ajzen (2010) make a clear distinction between perceived injunctive norms, reflecting
187 what important others think we should do, and perceived descriptive norms, that reflect what we
188 believe other have done or are doing. Fishbein and Ajzen (2010) recommend including a measure of
189 social norms that incorporates both injunctive and descriptive norms in empirical analysis.
190 However, given the novelty of the food product and the unpractised behaviour in the country, we
191 decided to measure subjective norms considering only injunctive norms. Therefore, we used two
192 items on a 7-point unipolar scale as direct measures of *subjective norms*: "Most people who are
193 important to me think that I should/I should not eat products containing insect flour in the next
194 month", and "Most people whose opinion I value would approve of my eating products containing
195 insect flour in the next month (unlikely/likely)". Groups or individuals whose opinion might
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
198 assess *normative belief* strength (n), such as "My family think that I should eat products containing
199 insect flour in the next month (extremely unlikely/extremely likely)", scored on a bipolar 7-point
200 scale. For each normative belief, we included a question enquiring about the motivation to comply
201 (m), such as "Generally speaking, how important is the opinion of your family?" scored on a
202 unipolar 7-point scale (from "not at all important" to "extremely important"). We multiplied belief
203 strengths and motivation to comply with every single referent to obtain a composite indirect
204 measure of normative beliefs.
205 We directly measured *perceived behavioural control (PBC)* with two items, on a 7-point scale:
206 "The decision to eat products containing insect flour in the next month is under my complete
207 control" and "Eating products containing insect flour in the next month is completely up to me"

208 (strongly disagree/strongly agree). *Control beliefs* about factors that would enable or impede
209 performing the behaviour were assessed considering that the product is "Not available in the
210 supermarket", "Incompatible with the local food culture", and that the respondent is "Disgusted
211 when seeing insects around". We measured belief strength with three items (c), such as "The
212 products containing insect flour are not available in the supermarkets". Each item was anchored on
213 a unipolar 7-point scale ranging from "strongly disagree" to "strongly agree". To assess the power
214 of each factor (p) in discouraging the consumption of these products, we included three items on a
215 bipolar 7-point scale, such as "Not having these products available in the supermarket would make
216 it easier/more difficult for me eating products containing insect flour in the next month". We
217 obtained a composite indirect measure of control beliefs multiplying each control factor's belief
218 strengths and perceived power.
219 We used three items to assess behavioural *intention*: "I intend to eat products containing insect flour
220 in the next month", "For sure I will eat products containing insect flour in the next month", and "I
221 will try to eat products containing insect flour in the next month". Each item was measured on a 7-
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
224 the questionnaire to achieve a greater reliability of the results. We carefully evaluated using
225 unipolar and bipolar scales across the questionnaire items, based on recommendations in Fishbein
226 and Ajzen (2010). Therefore, after preliminary calculations we decided to score control belief
227 strength on an unipolar scale, and to include the motivation to comply, although it was often found
228 to contribute little to the prediction of subjective norms. Moreover, positive and negative endpoints
229 were counterbalanced to avoid possible systematic response set.
230 At the end of the questionnaire, we asked respondents to state their willingness to participate in the
231 tasting of a product containing cricket flour; those who agreed had to indicate their preferred date,
232 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.

3.3 Data analysis

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

4. Results

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

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

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".

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 significant positive correlation between intention and gender was detected ($r = 0.18$, $p<0.01$), indicating that male respondents had higher intention to eat products containing insect flour in the next month, compared to females. Students enrolled in food and environmental sciences-related subjects were more willing to eat products containing insect flour than students of social sciences ($r = -0.24$, $p <0.001$). This variable is also significantly correlated with the actual behaviour ($r = -0.15$, $p<0.05$), indicating that students enrolled in social sciences-related subjects were less likely to taste the insect-based food product. The differences in the mean scores of the behaviour across the three study groups, being statistically significant, confirm this finding. Place of origin is also negatively 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 = -0.16, p<0.05). Other socio-demographic characteristics, such as the Body Mass Index (BMI) and age, were neither correlated with intentions nor with behaviour in a statistically significant manner (data not shown).

Table 3. Biserial correlation (r) between intention, behaviour and socio-demographic characteristics (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.

4.2 Predicting intention and the behaviour

The TPB model fits the data very well (χ^2 (46) = 86.097, CFI = 0.97, TLI = 0.95, RMSEA (CI 90%) = 0.062 (0.041; 0.081)). Attitude and subjective norms are statistically significantly correlated with intentions (respectively, r = 0.70 and 0.32, p <0.001); however, only attitude and PBC are significant predictors of intention (beta = 0.86, p<0.001, and 0.13, p<0.05), confirming H1 and H3. In contrast with H2, the effect of subjective norm on intention is not statistically significant. The behaviour is statistically significantly correlated with intention and PBC (r = 0.39, p <0.001, and 0.21, p <0.01); intention is the main predictor of the behaviour (beta = 0.35, p<0.001), followed by

PBC (beta = 0.17, $p<0.05$). Therefore, results confirm H4 and H5. Based on the R^2, the TPB model explains 77.8% and 18.7% of the variance in intention and behaviour, respectively.

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

	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^{*}

* $p<0.05$. ** $p<0.01$. *** $p<0.001$.

4.3 Underlying beliefs

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

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.

Table 5. Behavioural, normative and control beliefs constructs, mean scores[a] and standard deviation (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).

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 norm and intention are statistically significant. In particular, considerations about the opinions of parents and friends, and to a lesser extent of doctors and nutritionists, are positively correlated with both the subjective norm and the intention. None of the control factors correlates with PBC, while the three factors are all negatively correlated with intention. This means that the main barriers preventing the intention of eating a product containing insect flour are the sense of disgust arising from seeing insects around, the incompatibility with the local food culture and the lack of products in the supermarket.

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

Beliefs	**Construct**	**Correlation with the construct**		**Correlation with intention**	
		r	**p**	**r**	**p**
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	***

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

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 pre- and 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).

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**	**p**
Attitude	5.14 (1.05)	5.50 (1.08)	*
Intention	4.80 (1.31)	5.29 (1.30)	***

* $p<0.05$. ** $p<0.01$. *** $p<0.001$.

5. Discussion

This research examined whether the TPB could be employed to understand young adults' behaviour when faced with the prospect of eating products containing insect flour. Findings suggest that attitude and, to a lesser extent, PBC play a significant role in affecting the intention of performing the behaviour, while the subjective norm is not a significant factor in forming the behavioural intention. This result is common in several studies, and the subjective norm is generally a weak predictor of intentions (Armitage & Conner, 2001), although its predictive ability varies across behaviours (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 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 is mostly influenced by the incompatibility with the local food culture and the lack of these products

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

Attitude, subjective norm and PBC together accounted for 77.8% of the variance in intention, while 18.7% of the variance in the behaviour is predicted by intention and PBC. Lower predictive power 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 19.3% of the variance in behaviour (McEachan et al., 2011). Likewise, McEachan et al. (2011) 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 behaviours, while intentions were the most important predictors of adolescents'. Several factors 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 behaviour, or sometimes it can be difficult to carry out the intended action (Fishbein & Ajzen, 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 participate in a tasting experience. Most of them reported they did not accept the invitation because they were short on time, although they were offered several options (days and hours) to facilitate participation. Therefore, it seems that our experiment suffered from a change in intentions, as well as from difficulties in carrying out the intentions. The length of time intervening between the 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 between the point in time at which they are measured and the one at which the behaviour occurs, and this should be less likely the longer the time interval (Ajzen, 1991). In general, intention is a better predictor of the measured behaviour the shorter the timeframe, although this evidence was

not significant for dietary behaviours (McEachan et al., 2011). Second, failing to carry out an 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 survey, they would have tasted the product, those who actually participate in the tasting experience have shown a higher perceived control than those who did not participate ($p<0.001$). The motivation to taste the product of those who did not participate was not sufficient to overcome the perceived impediments (e.g., being "short on time"). Third, self-reported measures of the behaviour are usually better predicted than objective or observed ones (Armitage & Conner, 2001; McEachan et al., 2011), like it is the case in this study. This may be explained by the stronger measurement 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 the prospective observed measure cannot (Armitage & Conner, 2001).

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 the one tested in this study. At the same time, we acknowledge that the fairly low correlation 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 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 presence of women in the sample, other studies have found a stronger readiness to try unusual foods like insects among males than females (see, e.g., Verbeke, 2015; Caparros Megido et al., 2016; Tan et al., 2016; Sogari et al., 2017). Participants curriculum of studies is also a significant factor, showing that students enrolled in food- and environmental-sciences related curricula exhibited higher intention and a more likely behaviour than students of social sciences. These students seem more involved in virtuous dietary behaviours and are more interested in the health and environmental impact of their food choices. Similarly, Verbeke (2015) demonstrated that the most

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

The TPB suggests that interventions shaping behavioural, normative, or control beliefs may succeed in producing the desired changes in attitudes, subjective norms, and perceptions of control. In turn, changes may further influence intentions and the behaviour in the desired direction, provided people are capable of carrying out their formed intentions. This happens only in presence of a significant causal link running from intentions and the behaviour, and if the intervention is targeted to the component most capable of predicting intentions. Therefore, interventions aimed at promoting, *inter alia*, the health and environmental benefits of this food practice might fortify individual attitude, 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 consumers. Other interventions may also consider targeting the behavioural control by developing 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 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 instance, bakery products (Shelomi, 2016). Moreover, more effective interventions should be focused on a sub-population of "early adopters", including male young adults, who ultimately determine if a novel food will succeed in the market (Verbeke, 2015; House, 2016).

Finally, the participants attitude and intention significantly improved after tasting the insect-based product, suggesting that an overall positive experience may help growing accustomed to novel food products. In accordance with previous results (Hartmann et al., 2015; Hartmann & Siegrist, 2016), exposure to a familiar food, such as a chocolate cookie, made with an unfamiliar ingredient, such as insect flour, enhances the familiarity with the novel ingredient, increasing the likelihood of repeating the behaviour in the future. Moreover, the factors affecting repeated consumption may become more practical and contextual, like the routine consumption of more conventional foods

459 (House, 2016). This is consistent with the TPB, since carrying out a behaviour can result in
460 unexpected feedback, which is likely to change individual behavioural, normative and control
461 beliefs, shaping future intentions and actions, too (Fishbein & Ajzen, 2010).
462 We need to address some limitations of this study. First, the sample is composed of very well
463 educated consumers, usually more aware of the environmental and health consequences of their
464 dietary behaviours (Verbeke, 2015). Therefore, generalising the results to the Italian population of
465 young adults is difficult. Second, we used a product containing insect flour, which, by definition,
466 conceals the presence of the "insect". We are aware that the looking at a whole edible insect may
467 dampen intention and shape behaviour strongly (Tan et al., 2015; Caparros Megido et al., 2016;
468 Gmuer et al., 2016). Therefore, the results cannot be generalized to all insect-based food products
469 either, but should be considered specific to this product category which, however, is considered at
470 least initially more promising in Western markets. Third, we acknowledge that this research would
471 have been more effective had we designed an intervention and measured its ability to change young
472 adults' behaviour. Hence, further research efforts should use longitudinal data to investigate how
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
475 TPB model to predict the intention to eat of products containing insect flour and the actual
476 behaviour.
477

478 **6. Conclusions**

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

485 this novel food. Gender, being enrolled in food- and environmental-sciences related curricula, and
486 the region of origin are the background factors influencing intention and the behaviour. Beliefs that
487 eating a product containing insect flour has positive effects on health and the environment are
488 significantly correlated with attitudes and intention, while the main perceived barriers are the sense
489 of disgust arising from seeing insects around, the incompatibility with the local food culture and the
490 lack of products in the supermarket. Given the limited number of TPB studies of the consumption
491 of insect-based food product, this paper provides a framework for defining targeted interventions
492 fostering the consumption of novel and more sustainable protein sources in Western societies.
493

494 **Acknowledgments:**
495 We gratefully acknowledge the assistance of Dr Franco Antoniazzi, who prepared the products in a
496 pilot plant according to industrial procedures, of Annachiara Toncelli, who assisted in organising
497 and conducting the preliminary seminar, and of the students who kindly participated in the study.
498 The authors would like to thank two anonymous reviewers for their helpful comments on earlier
499 versions of this paper.
500

501 **Funding:**
502 This research did not receive any specific grant from funding agencies in the public, commercial, or
503 not-for-profit sectors.
504

505 **References**

506 Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision*
507 *Processes, 50(2)*, 179–211.
508 Ajzen, I., & Manstead, A.S.R. (2007). Changing health-related behaviours: An approach based on
509 the theory of planned behaviour. In M. Hewstone, H.A.W. Schut, J.B.F. de Wit, K. van den Bos, &

M.S. Stroebe (Eds.), *The Scope of Social Psychology. Theory and applications* (pp. 43-63). East Sussex: Psychology Press.

Allom, V., & Mullan, B. (2012). Self-regulation versus habit: The influence of self-schema on fruit and vegetable consumption. *Psychology & Health, 27(2)*, 7–24.

Armitage, J.C., & Conner, M. (2001). Efficacy of the Theory of Planned Behaviour: A meta-analytic review. *British Journal of Social Psychology, 40*, 471–499.

Bednáøová, M., Borkovcova, M., Mlček, J., Rop, O., & Zeman, L. (2013). Edible insects – species suitable for entomophagy under condition of Czech Republic. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis, 61*, 587-593.

Belluco, S., Losasso, C., Maggioletti, M., Alonzi, C. C., Paoletti, M. G., & Ricci, A. (2013). Edible insects in a food safety and nutritional perspective: A critical review. *Comprehensive Reviews in Food Science and Food Safety, 12(3)*, 296–313.

Bodenheimers, F. S. (1951). *Insets as Human Food* (1st ed.). The Huage: Springer-Science+Business Media.

Byrne, B.M. (2010). *Structural Equation Modeling with AMOS: Basic Concepts, Applications and Programming*. New York, USA: Routledge-Taylor & Francis Group.

Caparros Megido, R., Gierts, C., Blecker, C., Brostaux, Y., Haubruge, É., Alabi, T., et al. (2016). Consumer acceptance of insect-based alternative meat products in Western countries. *Food Quality and Preference, 52*, 237–243.

Caparros Megido, R., Sablon, L., Geuens, M., Brostaux, Y., Alabi, T., Blecker, C. et al. (2014). Edible insects acceptance by Belgian consumers: Promising attitude for entomophagy development. *Journal of Sensory Studies, 29(1)*, 14–20.

Cicatiello, C., De Rosa, B., Franco, S., & Lacetera, N. (2016). Consumer approach to insects as food: barriers and potential for consumption in Italy. *British Food Journal, 118(9)*.

De Bruijn, G.-J. (2010). Understanding college students' fruit consumption. Integrating habit strength in the theory of planned behaviour. *Appetite, 54*, 16-22.

536 DeFoliart, G. R. (1999). Insects as food: why the western attitude is important. *Annual Review of*
537 *Entomology, 44(80)*, 21–50.
538 De-Magistris, T., Pascucci, S., & Mitsopoulos, D. (2015). Paying to see a bug on my food: how
539 regulations and information can hamper radical innovations in the European Union. *British Food*
540 *Journal, 117(6)*, 1777–1792.
541 Deroy, O., Reade, B., & Spence, C. (2015). The insectivore's dilemma, and how to take the West
542 out of it. *Food Quality and Preference, 44,* 44–55.
543 Fishbein, M., & Ajzen, I. (2010). *Predicting and Changing Behavior: The Reasoned Action*
544 *Approach*. New York: Psychology Press, Taylor & Francis Group.
545 Gmuer, A., Guth, J.N., Hartmann, C., & Siegrist, M. (2016). Effects of the degree of processing of
546 insect ingredients in snacks on expected emotional experiences and willingness to eat. *Food Quality*
547 *and Preference, 54*, 117–127.
548 Guillaumie, L., Godin, G., & Vézina-Im, L.-A. (2010). Psychosocial determinants of fruit and
549 vegetable intake in adult population: a systematic review. *International Journal of Behavioral*
550 *Nutrition and Physical Activity, 7*, 1-12.
551 Halloran, A., Vantomme, P., Hanboonsong, Y., & Ekesi, S. (2015). Regulating edible insects: the
552 challenge of addressing food security, nature conservation, and the erosion of traditional food
553 culture. *Food Security, 7*, 739–746.
554 Hardeman, W., Johnston, M., Johnston, D. W., Bonetti, D., Wareham, N. J., & Kinmonth, A. L.
555 (2002). Application of the Theory of Planned Behaviour in behaviour change interventions: A
556 systematic review. *Psychology & Health, 17*, 123–158.
557 Hartmann, C., & Siegrist, M. (2016). Becoming an insectivore: Results of an experiment. *Food*
558 *Quality and Preference, 51*, 118–122.
559 Hartmann, C., Shi, J., Giusto, A., & Siegrist, M. (2015). The psychology of eating insects: A cross-
560 cultural comparison between Germany and China. *Food Quality and Preference, 44*, 148–156.

561 House, J. (2016). Consumer acceptance of insect-based foods in the Netherlands: Academic and
562 commercial implications. Appetite, 107, 47-58.
563 Looy, H., Dunkel, F. V., & Wood, J. R. (2014). How then shall we eat? Insect-eating attitudes and
564 sustainable foodways. *Agriculture and Human Values, 31(1)*, 1-11.
565 MacClancy, J. M., Henry, J., & Macbeth, H. (Eds.) (2007). *Consuming the Inedible: Neglected*
566 *Dimensions of Food Choice* (Vol. 6). New York: Berghahn Books.
567 Martins, Y., & Pliner, P. (2006). "Ugh! That's disgusting!": Identification of the characteristics of
568 foods underlying rejections based on disgust. *Appetite, 46(1)*, 75-85.
569 McDermott, M. S., Oliver, M., Svenson, A., Simnadis, T., Beck, E. J., Coltman, T. et al. (2015).
570 The theory of planned behaviour and discrete food choices: a systematic review and meta-analysis.
571 *International Journal of Behavioral Nutrition and Physical Activity, 12*, 162.
572 McEachan, R. R. C., Conner, M., Taylor, N., & Lawton, R. J. (2011). Prospective prediction of
573 health-related behaviors with the Theory of Planned Behavior: A meta-analysis. *Health Psychology*
574 *Review, 5*, 97–144.
575 Menozzi, D., & Mora, C. (2012). Fruit consumption determinants among young adults in Italy: A
576 case study. *LWT – Food Science Technology, 49(2)*, 298-304.
577 Menozzi, D., Sogari, G., & Mora, C. (2015). Explaining vegetable consumption among young
578 adults: An application of the Theory of Planned Behaviour. *Nutrients, 7*, 7633-7650.
579 Meyer-Rochow, V. B. (2009). Food taboos: their origins and purposes. *Journal of Ethnobiology*
580 *and Ethnomedicine, 5*, 18.
581 Mlcek, J., Rop, O., Borkovcova, M., & Bednarova, M. (2014). A Comprehensive Look at the
582 Possibilities of Edible Insects as Food in Europe – a Review. *Polish Journal of Food and Nutrition*
583 *Sciences, 64(3)*, 147–157.
584 Patch, C. S., Tapsell, L. C., & Williams, P. G. (2005). Attitudes and Intentions toward Purchasing
585 Novel Foods Enriched with Omega-3 Fatty Acids. *Journal of Nutrition Education and Behavior,*
586 *37*, 235-241.

587 Prati, G., Pietrantoni, L., & Zani, B. (2012). The prediction of intention to consume genetically
588 modified food: Test of an integrated psychosocial model. *Food Quality and Preference, 25*, 163–
589 170.
590 Schösler, H., De Boer, J., & Boersema, J. J. (2012). Can we cut out the meat of the dish?
591 Constructing consumer-oriented pathways towards meat substitution. *Appetite, 58(1)*, 39-47.
592 Schouteten, J.J., De Steur, H., De Pelsmaeker, S., Lagast, S., Juvinal, J.G., De Bourdeaudhuij, et al.
593 (2016). Emotional and sensory profiling of insect-, plant- and meat-based burgers under blind,
594 expected and informed conditions. *Food Quality and Preference, 52*, 27–31.
595 Shelomi, M. (2016). The meat of affliction: Insects and the future of food as seen in Expo 2015.
596 *Trends in Food Science & Technology, 56*, 175-179.
597 Sogari, G. (2015). Entomophagy and Italian consumers: an exploratory analysis. *Progress in*
598 *Nutrition, 17(4)*, 311-316.
599 Sogari, G., & Vantomme, P. (2014). *A tavola con gli insetti*. Fidenza, Italy: Mattioli 1885.
600 Sogari, G., Menozzi, D., & Mora, C. (2017). Exploring young foodies' knowledge and attitude
601 regarding entomophagy: A qualitative study in Italy. *International Journal of Gastronomy and*
602 *Food Science, 7*, 16–19.
603 Tan, H. S. G., Fischer, A. R. H., Tinchan, P., Stieger, M., Steenbekkers, L. P., & van Trijp, H. C.
604 M. (2015). Insects as food: Exploring cultural exposure and individual experience as determinants
605 of acceptance. *Food Quality and Preference, 42*, 78–89.
606 Tan, H.S.G., van den Berg, E., & Stieger, M. (2016). The influence of product preparation,
607 familiarity and individual traits on the consumer acceptance of insects as food. *Food Quality and*
608 *Preference, 52*, 222–231.
609 van Huis, A., Van Itterbeeck, J., Klunder, H., Mertens, E., Halloran, A., Muir, G. et al. (2013).
610 Edible insects - Future prospects for food and feed security. FAO Forestry Paper 171.
611 Vantomme, P. (2015). Way forward to bring insects in the human food chain. *Journal of Insects as*
612 *Food and Feed, 1(2)*, 121–129.

613 Verbeke, W. (2015). Profiling consumers who are ready to adopt insects as a meat substitute in a
614 Western society. *Food Quality and Preference, 39*, 147–155.
615 Zhu, Q., Li, Y., Geng, Y., & Qi, Y. (2013). Green food consumption intention, behaviors and
616 influencing factors among Chinese consumers. *Food Quality and Preference, 28(1)*, 279–286.