

## Original Research



# Consumer acceptance of edible insect foods: an application of the extended theory of planned behavior

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## OPEN ACCESS

**Received:** Jun 16, 2019

**Revised:** Oct 21, 2019

**Accepted:** May 6, 2020

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### Funding

This research is based support of “Woosong University Academic Research Funding”.

### Conflict of Interest

The authors declare no potential conflicts of interests.

### Author Contributions

Conceptualization: Choi J, Bae Y; Data curation: Bae Y; Formal analysis: Choi J,

## ABSTRACT

**BACKGROUND/OBJECTIVES:** The purpose of this study was to measure consumer acceptance of edible insect foods (EIFs) while applying the extended theory of planned behavior (ETPB). Insects as food have attracted interest as potential possible sources of nutrition for the future. This study investigated consumers' perception toward insect food and future purchase behaviors.

**SUBJECTS/METHODS:** A survey was conducted among citizens of Korea. About two thirds of respondents had tried an EIF previously, and the mean value for food neophobia was 3.1 on a 5-point Likert scale. Respondents were divided into 2 groups of those experienced with EIFs and those not and by level of food neophobia. An independent t-test, multiple regression and descriptive analyses were conducted on the data.

**RESULTS:** The primary reason for not eating EIFs was that their insect form induced disgust. Comparisons of ETPB attributes by experience with EIFs showed significant differences between groups for food neophobia, subjective norm, attitude, and behavioral intention. In addition, significant differences were found for subjective norm, perceived behavioral control, attitude, and behavioral intention between 2 neophobia groups. Finally, the results of measuring the relationships between ETPB attributes and behavioral intention showed only subjective norm and attitude affected behavioral intention.

**CONCLUSIONS:** These results suggest that enhanced subjective norms producing a publicly accepted EIFs environment would help encourage the purchase of EIFs. The results of this study can help the development of EIF products for future food markets.

**Keywords:** Insect; food; consumer behavior

## INTRODUCTION

Insects have existed in different forms as food ingredients throughout human history, such as ingredients of a side dish, snack or a main dish [1]. They have been a part of essential diet in Africa, Latin America, and Asia and were not only used as a nutritive source, but as forms of medicines and delicacies [2]. However, Western societies were not familiar with eating insects, entomophagy and considered edible insects as occasional delicacies [1]. Approximately 2,100 edible insects were consumed [3].

Bae Y; Funding acquisition: Choi J, Bae Y;  
Investigation: Bae Y; Methodology: Choi J;  
Project administration: Choi J; Resources: Choi  
J, Bae Y; Software: Choi J, Bae Y; Supervision:  
Choi J; Validation: Choi J, Bae Y; Visualization:  
Choi J, Bae Y; Writing - original draft: Choi J,  
Bae Y; Writing - review & editing: Choi J.

However, the practice of eating insects as food is generally considered as unusual, although some cultures are more accepting of insects as food. For instance, the Chinese have a greater tolerance toward insect foods because they have a history consuming certain types of insects. Previous studies have shown that cultural differences have led to a variety of different attitudes towards consuming insects as food [4]. Regardless of these special contexts, insects as food have attracted interest as potential possible sources of nutrition for the future. It is known that food made from insects can be more efficient than meat products in terms of cost, nutrition, and other factors [5]. Edible insects can be a good source of protein because many are comprised of more than 50% protein [6]. For examples, mealworms, maggots, and rhinoceros beetle larva have more protein by weight than pork. Interestingly, however, nutritional value is not the most important consideration when it comes to the consumption of insects [7]. Despite nutritional values of edible insects for developing edible insects as food for the future, consumers do not pay much attention to edible insect foods (EIFs) products and in fact show food neophobia toward these foods. Hence, this study uses food neophobia and experience to explain consumer behavior in accordance with the extended theory of planned behavior (ETPB).

Neophobia is a term that is primarily related to food, and it is rooted in perceptions of immoral human behaviors or sources of disgust, such as insects, rotten food, or bad odors [7]. In regards specifically to the tendency to avoid new foods, this is referred to as food neophobia. Food neophobia is defined as “the extent to which consumers are reluctant to try novel foods,” which was revealed by findings regarding children’s reluctance to eat novel food [8]. Children aged 2 to 6 years, which is a developmental stage, limits ingestion of unfamiliar food items received as potentially dangerous. Therefore, these kinds of food might taste unpleasant [9]. Previous studies showed that food neophobia affects both quality and preference of food among children [9]. Many studies have examined the relationship between food neophobia, a key construct in the food choice behavior, and purchasing behaviors; however, the context is still not entirely understood [10-13]. Many studies have examined the relationships between food neophobia which has been a key construct in the food choice behaviors and purchasing behaviors; however, the full context is still not fully understood [10-13]. Previous studies have shown that food neophobia is a barrier for the consumption of non-traditional foods [14] and for insect food consumption in some countries [15]. Furthermore, food neophobia has also been studied for determining the dining choices of tourists [16] and organic food consumption [17]. Food neophobia can be demonstrated as the level of willingness to consume new foods, and differences in food neophobia can be shown by factors such as gender, age, level of education, and others [11]. Regarding age differences, it was found that older people showed higher neophobia than younger people [11,18]. For example, adults were more neophobic towards animal-origin food than children [19]. Gender differences also exist, wherein boys were more neophobic than girls [20]. Among adults, men were more neophobic than women [11,20]. In terms of the educational level, neophobia decreased with an increase in the education level [11,18]. Learning in the early stages of life about food and eating shapes one’s food preferences [21]. In early childhood, eating habits develop [22], such as oral abilities [23] and cognitive functions [24]. Transition to complementary feeding accompanied by discovery of food, development of a sense of smell, taste, flavor, texture, energy density, and microbial communities at different stages leads to the development of food neophobia [25]. In addition, tasting education that provides more food experiences may help reduce food neophobia [26]. Korsmeyer and Sutton [27] examined how humans utilize their senses to experience food. Sensory experiences are necessary to learn to accept a food; however, they are inadequate when unusual foods are involved [12].

Eating behavior differs according to the context. The same dishes are not appreciated in the same way [28]. Food presentation and plating that is remembered by sight can also influence one's food experience [26]. According to social learning theory, individual experiences affect beliefs and expectations [29]. As per the health belief model, past health-related behavioral experience impacts the development of beliefs towards perceived susceptibility and perceived efficacy [30]. The more the direct experience with fast food consumption, the more the individual's ability to understand the consequences, such as health risks of their behavior [31]. Consumers' food-related experiences evolves with diverse stages. Dynamic states include complex interactions with food characteristics, like taste, scent, flavor, texture, color, and other visual factors [32]. Uncertainty regarding these factors might cause food neophobia [11,33].

Previous studies have found that a higher level of knowledge and experience of EIFs increased the probability of eating them [4]. It was demonstrated that cognitive structures of food choice can vary in relatively close cultural areas [4]. In their study [4], they looked at differences in the willingness to buy insect foods between those living in Northern Europe and those in Central Europe, and the results showed that product related experiences were positively affected by subjective and objective knowledge influencing general attitudes that eventually made an impact on the willingness to buy. However, in comparisons between Hungarians and Belgians, certain groups would not try a new food even if they acknowledged the food was healthier than other choices [34].

Theory of reasoned action (TRA) proposed that consumers use information and recognize their role as a social influence [35]. The later theory of TRA, which is the theory of planned behavior (TPB), demonstrates that personal behaviors are difficult to control by rational judgement. TPB is an extended theory of TRA which was added the element of perceived control. TPB explained that attitude, subjective norms and PBC explained one's behavioral intentions. PBC is "the perceived ease or difficulty of performing the behavior;" subjective norm is "the perceived social pressure to perform or not to perform the behavior;" behavioral intention is "the degree to which a person has a favorable or unfavorable evaluation or appraisal of the behavior in question [36]." Therefore, the TPB indicates that a person's willingness and motivation to behave a certain way should be based on the person's actions [37]. Willingness and motivation are described by attitude, subjective norm, and perceived behavioral control [36]. This model with added variables is what comprises the previously mentioned ETPB.

Generally, in TPB, attitude measures favoritism, such as how positivity or negativity one feels towards the subject. Consumer attitudes for products are influenced by perceived benefits that can also be divided into utilitarian or hedonic benefits [38]. Further, attitude is the association of memory with the evaluation of an object [39]. Attitude needs to be segmented in a more detailed manner, such as one's personality easily categorized as introverted and extroverted. Attitude that leans towards other's opinions and social environment is an extroverted attitude, while one that follows one's beliefs is an introverted attitude. With consumer characteristics, such as age, values, personality, lifestyles, experiences affect attitudes, purchase intentions, and willingness to pay for products [40]. A subjective norm is the perception of a standard course of action as socially acceptable throughout a social group. Shin and Hancer [41] found that subjective norms influenced behaviors. However, subjective norms had no impact on behavioral intentions [42]. Perceived behavioral control indicates that one's perceived self-efficacy represents one's belief in being able to act. Perceived behavioral control was the most critical variable for predicting high school students' fast food consumption [43], choosing fruits and vegetables for South Asians [44], and predicting the intention to avoid food with additives

[45]. Numerous studies have found that attitude, subjective norm, and perceived behavioral control affect consumer behavioral intention. This study examines if individuals' experience and neophobia of EIFs show any differences in their attributes of TPB. In addition, this study investigates which attributes affect the behavioral intention to purchase EIFs.

## SUBJECTS AND METHODS

### Survey methods

This study explored consumer perceptions towards EIFs using a survey method. Participants were informed that they could stop at any stage during the survey as the questions about edible insects might induce disgust. In addition, participants were asked to disclose if they had any allergies. The survey consisted of 3 parts. The first part of the survey consisted of questions about consumer behaviors regarding edible insects on a 5-point Likert scale. Questions regarding food neophobia were adopted from a previous study [4], such as, "I like to try novel food (1: strongly disagree–5: strongly agree)," and attitudes toward edible insects were adopted from the study, such as, "I am interested in EIFs (1: strongly disagree–5: strongly agree)" [4,46]. Questions on subjective norms, such as, "I will try EIFs if my friends eat (1: strongly disagree–5: strongly agree)," and perceived behavioral control, such as, "I do not eat EIFs since others feel disgust while eating EIFs (1: strongly disagree–5: strongly agree)," were adopted from the study [47]. Purchasing intention questions, such as, "I will use EIFs for my daily food preparations (1: strongly disagree–5: strongly agree)," were adopted from the study [13]. All measurement items are listed in **Table 1**.

The second part of the survey asked for the details of previous experience eating edible insects. For example, the eating experience for specific edible insects that are acceptable to be consumed in Korea, such as silkworm pupa, rice grasshopper, Chinese silkworm, 2-spotted cricket, mealworm, maggot, and rhino beetle. The last part asked the participants demographic questions. Before the survey, the study questionnaire was approved by the Woosong University Institutional Review Board (1041549-181-16-SB-62).

**Table 1.** Measurement items for the study

Constructs	Measurement items	Mean ± SD
Food neophobia	I generally try new food items	3.040 ± 1.038
	I like to try novel food	3.060 ± 1.080
	I like food from different countries	3.220 ± 1.023
Subjective norms	If my parents eat EIF, I will eat EIFs with them	2.290 ± 1.130
	If my friends eat EIF, I will eat EIF with them	2.280 ± 1.144
	If a doctor recommends EIF for health issues, then I will try EIF	3.190 ± 1.198
	I will try EIFs if these products were eaten by celebrities on TV	2.080 ± 1.144
Perceived behavioral control	I do not purchase EIF since these products are hard to find at grocery markets	2.590 ± 1.354
	I do not eat EIF since others feel disgust with eating EIF	2.710 ± 1.210
	I do not eat EIF since other no not eat EIF	2.510 ± 1.153
	I do not eat EIF because I feel EIF are expensive	2.080 ± 1.035
Attitude	EIFs are beneficial to good health	3.180 ± 0.944
	EIFs are moral food	2.810 ± 0.855
	I am interested in EIF	2.720 ± 1.098
	I am generally satisfied with EIF	2.360 ± 0.873
Behavioral intention	I will use EIF for my daily food preparations	2.040 ± 0.912
	I will purchase EIF at grocery stores if available	2.150 ± 1.030
	I will recommend EIF to others if available at grocery stores	2.150 ± 1.045

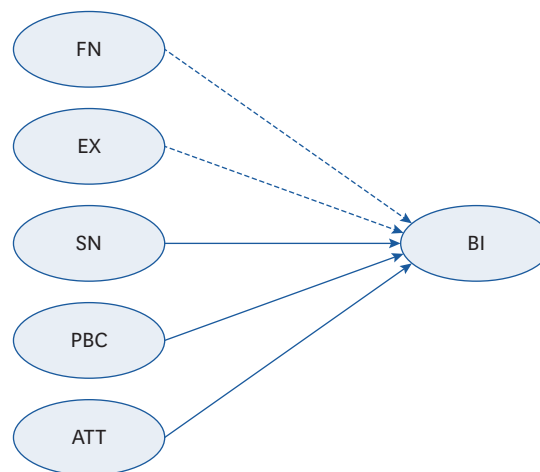
All measurement items were asked on 5-point Likert Scale (1: strongly disagree–5: strongly agree). EIF, edible insect food.

### Study subjects

In Seoul, a restaurant offering food made of edible insects has recently opened, and edible insects have been added to shelves in supermarkets. However, people in places other than Seoul have not had the same opportunities to try EIFs. This study used convenience sample to collect data in 2 areas which are Gyongsang-do and Chugcheong-do areas. Gyongsang area, where Busan, the second most populated city in Korea, is located, and Chungcheong area, the fastest growing area in Korea and where governmental administrative offices are located. Hence, this study chose these 2 areas to draw the sample of this study as the opinions of possible buyers are important for new product development. Therefore, the survey was conducted with people who reside in these 2 areas.

### Data analysis

Using the G\*Power statistical power program to calculate the required sample size based on the hypotheses of this study and the numbers of questions used, it was found that a minimum of 300 participants was required. Hence, this study aimed at obtaining 400 participants for a better data analysis. The survey was conducted from October 16 to November 16, 2018. A total of 392 questionnaires were used for further analyses after a screening of the 400 questionnaires that were distributed and the removal of 8 questionnaires. The data was analyzed using IBM's Statistics Program for the Social Sciences (SPSS; ver. 23.0; IBM Corp., Armonk, NY, USA). This study used multiple regression analysis, which is well-known for linking the gap between correlation and analysis of variance [48]. With such a long history, multiple regression is a sophisticated and flexible tool for various kinds of data analyses [49]. First, each attribute was tested for reliability using a Cronbach's alpha and for validity by analyzing the correlations of each attribute. Second, each attribute for the EIFs was compared by whether participants had previous experience with EIFs. Third, each attribute for the EIFs was compared by level of food neophobia. Fourth, a multiple regression analysis was run to measure the relationships between the attributes for the EIFs and behavioral intention. Lastly, descriptive analyses were run to analyze the demographic information of the participants. **Fig. 1** shows proposed study model with the results.



**Fig. 1.** Proposed study model.

FN, food neophobia; EX, experience; SN, subjective norm; PBC, perceived behavioral control; ATT, attitude; BI, behavioral intention.

## RESULTS

### Characteristics of subjects

Participants in this study were analyzed based on their gender, age, marital status, occupation, monthly income, monthly expenses for dining out, and health condition (**Table 2**). The number of female participants was 218 (55.9%), and male participants was 172 (44.1%). Most of the participants were aged between 20 and 29 (37.7%) years, followed by those 30–39 (23.6%), 40–49 (19.5%), and over 50 (19.2%). Married participants was 209 (53.5%), single participants was 179 (45.8%), and others (0.8%). For occupation, 119 (30.4%) of the respondents were office workers, followed by 69 students (17.6%), 54 house wives (13.8%), and then others. Most of the respondents earned a monthly income of 2,000–2,999 thousand

**Table 2.** Demographic characteristics of the respondents

Characteristics	Frequency	Percentage (%)	Valid percentage (%)	Missing
Gender				2
Women	218	55.6	55.9	
Men	172	43.9	44.1	
Age (yrs)				2
20–29	147	37.5	37.7	
30–39	92	23.6	23.6	
40–49	76	19.5	19.5	
50–59	60	15.4	15.4	
60 and over	15	3.8	3.8	
Marital status				1
Single	179	45.7	45.8	
Married	209	53.3	53.8	
Others	3	8.0	0.8	
Occupation				1
Student	69	17.6	17.6	
Office worker	119	30.0	30.4	
House wives	54	4.0	13.8	
Company owners	3	8.0	0.8	
Governmental officer	10	2.6	2.6	
Technical experts	48	12.2	12.3	
Sales/service	34	8.7	8.7	
Professionals	20	5.1	5.1	
Others	34	8.7	8.7	
Average monthly income (thousand won) <sup>1)</sup>				19
Less than 1,200	80	20.4	21.4	
1,200–1,999	87	22.2	23.3	
2,000–2,999	111	28.3	29.8	
3,000–3,999	49	12.5	13.1	
4,000–4,999	27	6.9	7.2	
5,000 or above	19	4.8	5.1	
Average expenses for eating out (thousand won) <sup>1)</sup>				1
Less than 20	83	21.2	21.2	
20–39	178	45.5	45.5	
40–59	68	17.4	17.4	
60–79	27	6.9	6.9	
80–99	24	6.1	6.1	
100 or above	11	2.8	2.8	
Health condition				1
Very bad	4	1.0	1.0	
Bad	33	8.4	8.4	
So-so	204	52.0	52.2	
Good	112	28.6	28.6	
Very good	38	9.7	9.7	

<sup>1)</sup>One thousand won is about 0.94 US dollar.

won, while there were 67 with an income of 1,200–1,999 thousand won (23.3%) and 80 with an income below 1,200 thousand won (31.4%). Average expenses for dining out each month showed that the most of the respondents spent 20–39 thousand won (45.5%), followed by less than 20 thousand won (21.1%), 40–59 thousand won (17.4%), 60–79 thousand won (6.9%), 80–99 thousand won (6.1%) and more than 100 thousand won (2.8%).

### Respondents' experience and perceptions of edible insects

**Table 3** shows the respondents' experience with EIFs. About two thirds of the respondents (63.5%) had experience with eating edible insects. Of the edible insects that had been eaten, all 249 of the respondents with EIF experience had eaten silkworm pupa before, followed by 103 (26.3%) who had eaten rice grasshopper. The majority of the respondents (78.6%) had seen edible insects previously, and this number was higher than those who had eaten EIFs. The main reason for not eating the edible insects was that the insect shape caused disgust (51.7%), and 43.3% answered that they did not have a specific reason to eat the edible insects.

### Differences in the attributes between those experienced with EIFs and those not

Cronbach's alphas were used to test the reliability of each of the attributes. The results for each attribute in the study model showed both high reliability and validity (**Table 4**). Independent t-tests were run on each attribute from the ETPB to see if there were any significant differences between those who had experience with EIFs and those who had none. The results showed neophobia ( $t = 5.304, P < 0.001$ ), subjective norm ( $t = 9.586, P < 0.001$ ), attitude ( $t = 6.086, P < 0.001$ ), and behavioral intention ( $t = 6.894, P < 0.001$ ) were significantly different based on experience with EIFs (**Table 5**). Respondents with EIFs experience had a greater tendency to try new food ( $M = 3.281, SD = 0.861$ ) as compared with those who had no EIF experience ( $M = 2.801, SD = 0.861$ ). In terms of subjective norm, respondents with EIF experience scored higher for

**Table 3.** Experience with and perceptions of EIFs

Questions	Responses	Frequency	Percentage (%)	Valid percentage (%)	Missing
Have you seen an EIF before?	Yes	308	78.6	-	-
	No	84	21.4	-	-
Have you eaten an EIF before?	Yes	249	63.5	-	-
	No	143	36.5	-	-
Which edible insect have you eaten previously? (multiple responses)	Silkworm pupa	249	63.5	-	-
	Rice grasshopper	103	26.3	-	-
	Chinese silkworm	5	1.3	-	-
	2-spotted cricket	14	3.6	-	-
	Mealworm	14	3.6	-	-
	Maggot	3	0.8	-	-
	Rhino beetle	5	1.3	-	-
Preference of an EIF (multiple responses)	Silkworm pupa	299	76.3	76.3	-
	Rice grasshopper	137	34.9	34.9	-
	Chinese silkworm	18	4.6	4.6	-
	2-spotted cricket	27	6.9	6.9	-
	Mealworm	37	9.4	9.4	-
	Maggot	12	3.1	3.1	-
	Rhino beetle	1	5.1	5.1	-
Preferred an EIF	With insect shape	366	93.4	95.3	8
	Without insect shape	18	4.6	4.7	-
Reason for not try an EIF	Taste	8	2.0	3.1	-
	Shape	135	34.4	51.7	-
	Nutritional value	1	0.3	0.4	-
	No need to eat	113	28.8	43.3	-
	Others	4	1.0	1.5	-

EIF, edible insect food.

**Table 4.** Correlations among variables and Cronbach's alpha

Variables	FN	SN	PBC	ATT	BI
FN	1.000				
SN	0.439**	1.000			
PBC	0.112*	0.254**	1.000		
ATT	0.347**	0.612**	0.125**	1.000	
BI	0.320**	0.697**	0.211**	0.622**	1.000
Cronbach's alpha	0.808	0.912	0.693	0.811	0.913

FN, food neophobia; SN, subjective norm; PBC, perceived behavioral control; ATT, attitude; BI, behavioral intention.

\* $P < 0.05$ ; \*\* $P < 0.01$ .

**Table 5.** Results of the independent t-tests between who had experience of EIF and not

Variables	Experienced (n = 249)	No experience (n = 143)	t-value
FN	3.281 ± 0.861	2.801 ± 0.861	5.304***
SN	2.775 ± 0.988	1.910 ± 0.775	9.586***
PBC	2.468 ± 0.829	2.484 ± 0.917	-0.166
ATT	2.939 ± 0.721	2.470 ± 0.733	6.086***
BI	2.329 ± 0.952	1.738 ± 0.726	6.894***

All measurement items were asked on 5-point Likert Scale (1: strongly disagree-5: strongly agree). Data are mean ± SD.

EIF, edible insect food; FN, food neophobia; SN, subjective norm; PBC, perceived behavioral control; ATT, attitude; BI, behavioral intention.

\*\*\* $P < 0.001$ .

subjective norm ( $M = 2.775$ ,  $SD = 0.988$ ) than the no experience group ( $M = 1.910$ ,  $SD = 0.775$ ). The same pattern was shown for attitude and behavioral intention. Only perceived behavioral control showed no significant differences between the 2 groups ( $t = -0.166$ ,  $P > 0.05$ ).

### Differences in the attributes between those with high and low neophobia group

Independent t-tests were run to examine the differences for each attribute based on level of neophobia. The mean value for neophobia was 3.10; therefore, if the participant's score was higher than 3.10, the participant was considered as having high neophobia group, otherwise the score was considered as low neophobia group. The divided groups were coded as "1" for high neophobia group and "2" for low neophobia group. The results showed that all of the attributes of the study model were significantly different between the participants with high and low neophobia group (Table 6). Subjective norm was higher for low neophobia group ( $M = 2.855$ ,  $SD = 1.044$ ,  $t = -7.695$ ,  $P < 0.001$ ) than for high neophobia group ( $M = 2.123$ ,  $SD = 0.837$ ). Perceived behavioral control was greatly different between those with high neophobia group ( $M = 2.393$ ,  $SD = 0.911$ ) and those with low neophobia group ( $M = 2.569$ ,  $SD = 0.789$ ,  $t = -2.019$ ,  $P < 0.05$ ). In addition, attitude and behavioral intention demonstrated a similar trend.

### Test of the ETPB

A multiple regression analysis was used. The 5 attributes of food neophobia, subjective norm, perceived behavioral control, experience, and attitude were run against behavioral intention (Table 7). The results showed that subjective norm ( $B = 0.450$ ,  $SE = 0.045$ ,  $t = 10.032$ ,  $P < 0.000$ ) and attitude ( $B = 0.388$ ,  $SE = 0.054$ ,  $t = 7.251$ ,  $P < 0.001$ ) significantly influenced behavioral intention. However, experience ( $B = 0.041$ ,  $SE = 0.074$ ,  $t = 0.547$ ,  $P > 0.05$ ), food

**Table 6.** Results of the independent t-tests between low and high FN

Variables	High FN (n = 212)	Low FN (n = 180)	t-value
SN	2.123 ± 0.837	2.855 ± 1.044	-7.695***
PBC	2.393 ± 0.911	2.569 ± 0.789	-2.019*
ATT	2.573 ± 0.748	2.989 ± 0.712	-5.557***
BI	1.908 ± 0.830	2.355 ± 0.964	-4.927***

All measurement items were asked on 5-point Likert Scale (1: strongly disagree-5: strongly agree). Data are mean ± SD.

FN, food neophobia; SN, subjective norm; PBC, perceived behavioral control; ATT, attitude; BI, behavioral intention.

\* $P < 0.05$ ; \*\*\* $P < 0.001$ .



**Table 7.** Regression analysis for effectiveness of experience, subjective norm, and perceived behavioral control towards behavioral intention

Models	B	SE	Beta	t-value
Constant	-0.207	0.145	-	-1.425
Experience <sup>1)</sup>	0.041	0.074	0.021	0.547
FN <sup>2)</sup>	-0.057	0.069	-0.031	-0.831
SN	0.450	0.045	0.490	10.032***
PBC	0.056	0.039	0.053	1.456
ATT	0.388	0.054	0.318	7.251***

R<sup>2</sup> = 0.549, Adjusted R<sup>2</sup> = 0.543, F = 92.131.

FN, food neophobia; SN, subjective norm; PBC, perceived behavioral control; ATT, attitude; EIF, edible insect food.

<sup>1)</sup>Experience with EIFs was coded as '1', while no experience with EIFs was coded as '0'; <sup>2)</sup>High neophobia was coded as '1', while low neophobia was coded as '0'.  
\*\*\**p* < 0.001.

neophobia (B = -0.057, t = -0.831, *P* > 0.05), and perceived behavioral control (B = 0.056, SE = 0.039, t = 1.456, *P* > 0.05) did not affect behavioral intention. Moreover, multiple regression analyses were used to predict behavioral intention of 2 sets of 2 groups separated by experience (Appendix 1) and by levels of neophobia (high and low) (Appendix 2). Results showed the same patterns in both of 2 groups.

## DISCUSSION

The results of this study have provided insights into consumer perceptions of EIFs. About two thirds of the respondents had eaten EIFs, more specifically silkworm pupa, previously. Since silkworm pupa is considered as a common street snack, Koreans are familiar with it. In addition, it is considered as possible choice for eating if necessary. However, if it was not necessary to eat EIFs, about 63% of participants would choose not to eat them. The reasons were mostly the appearance of the insect (51.7%) and the lack of a need to eat them (43.3%). Taste and nutritional value were not much more important than other reasons. These results show the opposite of the suggestions from the previous study that claimed that sensory traits such as taste were insufficient for insect food acceptance [12]. Emphasizing the taste and nutritional value of EIFs may lead consumers to try them. Furthermore, EIFs without an insect shape were preferred by respondents as an insect appearance was the main reason for not trying an EIF. Therefore, an insect appearance should not be maintained in EIFs. For example, cookies made of insect powder might be more appealing to consumers than cookies with a noticeable insect figure.

Analyses of the t-test results showed that experience plays important role in the consumption of EIFs. Significant differences based on experience with EIFs showed for food neophobia, subjective norm, attitude, and behavioral intention. In other words, those participants who had lower levels of neophobia had more experience with EIFs. Since neophobia is based on a person's emotional cognition towards food, effort is needed to demonstrate that insects are not something new to try. As silkworm pupa is a part of Korean food culture, people are less hesitant about consuming it than other edible insects. This suggests that story telling about an EIF might help reduce the negativity towards the EIF by persuading listeners that consuming it a part of human nature and not a strange practice. In addition, people who follow subjective norms had more experience with EIFs than no experience. People may be swayed by others who influence them. In this case, the necessary reasons for the EIFs given in a social environment and persuaded by influencers are needed. If an individual's reference group eats an EIF, there may be a greater possibility that the person will also try the EIF. Perceived behavioral control did not differ whether experienced or not. In other words, experience may not be the basis for a person's perceived behavioral control. Attitude

and behavioral intention were much higher in experienced group, which means that sensory traits influence attitude as they impact on the learning process. However, in this study, the sensory traits were something more than taste. The less there is of an insect appearance in a food, the more charming the shape, color, or smell of the food. Respondents preferred EIFs without insect shapes. When shapes of the insects appeared in a food, consumers hesitated or even were reluctant to try the food. Therefore, packaging and presentation might also help to make a more positive impact on attitude and behavioral intention to purchase EIFs.

Similar trends were found in comparisons of the attributes of the study model between levels of high and low neophobia. The group who had high levels of neophobia showed a much lower value for subjective norm, perceived behavioral control, attitude, and behavioral intention than the group with low neophobia. Furthermore, the high neophobia group showed lower perceived behavioral control, which was not found in the group comparisons of those with experience and without experience. Those in the high neophobia group consider their ability to take the action to try eating EIFs low. This result suggests that those in the high food neophobia group may not have sufficient opportunities to attempt experiencing EIFs. Food neophobia results from negative expectations of taste [13,33] and uncertainty of the origin of the food [12]. Therefore, reducing negative expectations by providing more information or opportunities by inducing associations with acquainted food might lead to its acceptance [11]. In addition, increasing the availability of an EIF for purchase or making it affordable might be helpful. Offering information on recipes might help ease people's uncertainty towards a food that they have not tried before or they have a hesitation to consume.

While the results provided insights into the differences in behavioral intention toward EIFs based on experience and high and low levels of food neophobia, the results of the multiple regression analysis suggested other recommendations. Subjective norm and attitude greatly influenced behavioral intention, while experience, food neophobia, and perceived behavioral control did not. In case of EIFs, the other ETPB attributes did not impact on consumer behavioral intention but subjective norm and attitude did. Unlike the results of a previous study [50], subjective norm had a great impact on behavioral intention. If others accept edible insects as regular food ingredients, then those who were hesitant to try EIFs will follow their recommendations. Food neophobia and previous experience did not affect behavioral intention. Food neophobia has been found as a barrier to consuming EIFs in some countries [15]; however, this study did not have the same outcome. It can be speculated that, as was mentioned in a previous study mentioned, the contexts between food neophobia and behaviors are still limited [10]. The development of a context that could help explain the relationship between food neophobia and behavior should be studied. Experience itself did not affect behavioral intention; however, a past study showed that previous experience can make a strong impact on EIF consumption behaviors [4]. Therefore, not only offering acceptable sensory traits but also making good conditions for consuming EIFs is crucial. For example, an EIF sampling event with target consumers and their reference groups will help build positivity towards eating EIFs. The presentation of an EIF makes a positive impact on having a pleasant experience [26] as respondents of this study did not prefer recognizing insect figures in food.

This study utilized the ETPB in order to measure consumer behavioral intention to purchase EIFs. This study contributes new ideas and import results for the development of EIF products and markets. The results of this study suggest that the development of edible insects as food may be more difficult than has been considered. Previous studies have shown that all TPB attributes were strong indicators for predicting food consumption behavioral intentions; however, EIFs are in

a different category than the other foods that were considered. Consumers might not recognize EIFs as a part of their regular diet or not even consider them as food. Hence, it is necessary to create public recognition of the importance of EIFs and make them no different than any other animal product. When it comes to EIFs, subjective norm and attitude play crucial roles in consumer behavioral intention. Public acceptance of EIFs should be widely promoted, and EIFs should be shown being utilized by consumers' reference groups or influencers.

The limitations of this study should be considered for future research. This study was conducted in 2 major cities in Korea, which shows geographic and demographic limitations. In addition, a future study might need to include a sensory test with different conditions, such as by utilizing reference groups. As in much of the research using the ETPB, this study used behavioral intention as a proxy for actual behavior rather than actual behavior itself, which might lead to respondents making different decisions. Future studies might need to measure actual consumption behaviors involving EIFs. In addition, a sensory test with the perception of EIFs would help expand the development of the future of EIF products. Results of comparisons between experienced and no experience with EIF groups showed significant differences on behavioral intention. However, when it comes to test a multiple regression model with ETBP variables, experience had no impact on behavioral intention. It suggests that ETBP model might not be the best fit to test effectiveness of experience with edible insect on food purchase intention. Hence, adaptations of other theories should be followed in future. Applying other statistical methods would be beneficial for further analyses.

## REFERENCES

1. Verkerk MC, Tramper J, van Trijp JC, Martens DE. Insect cells for human food. *Biotechnol Adv* 2007;25:198-202.  
[PUBMED](#) | [CROSSREF](#)
2. Harris M. *Good to Eat: Riddles of Food and Culture*. New York: Waveland Press; 1998.
3. LaMotte S. The food that can feed and maybe save, the planet: bugs [Internet]. Atlanta: CNN; 2019 [cited 2020 April 22]. Available from: <https://edition.cnn.com/2019/10/25/health/insects-feed-save-planet-wellness/index.html>.
4. Piha S, Pohjanheimo T, Lähteenmäki-Uutela A, Křečková Z, Otterbring T. The effects of consumer knowledge on the willingness to buy insect food: an exploratory cross-regional study in Northern and Central Europe. *Food Qual Prefer* 2018;70:1-10.  
[CROSSREF](#)
5. Tabassum-Abbasi , Abbasi T, Abbasi SA. Reducing the global environmental impact of livestock production: the mini livestock option. *J Clean Prod* 2016;112:1754-66.  
[CROSSREF](#)
6. Bukkens S. The nutritional value of edible insects. *Ecol Food Nutr* 1997;36:287-319.  
[CROSSREF](#)
7. Schwartz GE, Weinberger DA, Singer JA. Cardiovascular differentiation of happiness, sadness, anger, and fear following imagery and exercise. *Psychosom Med* 1981;43:343-64.  
[PUBMED](#) | [CROSSREF](#)
8. Pliner P, Hobden K. Development of a scale to measure the trait of food neophobia in humans. *Appetite* 1992;19:105-20.  
[PUBMED](#) | [CROSSREF](#)
9. Pliner P, Pelchat M, Grabski M. Reduction of neophobia in humans by exposure to novel foods. *Appetite* 1993;20:111-23.  
[PUBMED](#) | [CROSSREF](#)
10. Jaeger SR, Rasmussen MA, Prescott J. Relationships between food neophobia and food intake and preferences: findings from a sample of New Zealand adults. *Appetite* 2017;116:410-22.  
[PUBMED](#) | [CROSSREF](#)

11. Tuorila H, Lahteenmaki L, Pohjalainen L, Lotti L. Food neophobia among the Finns and related responses to familiar and unfamiliar foods. *Food Qual Prefer* 2001;12:29-37.  
[CROSSREF](#)
12. Tan HS, Fischer AR, Van Trijp HC, Stieger M. Tasty but nasty? Exploring the role of sensory-liking and food appropriateness in the willingness to eat unusual novel foods like insects. *Food Qual Prefer* 2016;48:293-302.  
[CROSSREF](#)
13. Hartmann C, Siegrist M. Becoming an insectivore: results of an experiment. *Food Qual Prefer* 2016;51:118-22.  
[CROSSREF](#)
14. Choe JY, Cho MS. Food neophobia and willingness to try non-traditional food for Koreans. *Food Qual Prefer* 2011;22:671-7.  
[CROSSREF](#)
15. Verbeke W. Profiling consumers who are ready to adopt insects as a meat substitute in a Western society. *Food Qual Prefer* 2015;39:147-55.  
[CROSSREF](#)
16. Wu K, Raab C, Chang W, Krishen A. Understanding Chinese tourists' food consumption in the United States. *J Bus Res* 2016;69:4706-13.  
[CROSSREF](#)
17. Chen M. Consumer attitudes and purchase intentions in relation to organic foods in Taiwan: moderating effects of food-related personality traits. *Food Qual Prefer* 2007;18:1008-21.  
[CROSSREF](#)
18. Meiselman HL, King SC, Gillette M. The demographics of neophobia in a large commercial US sample. *Food Qual Prefer* 2010;21:893-7.  
[CROSSREF](#)
19. Pliner P, Pelchat ML. Neophobia in humans and the special status of foods of animal origin. *Appetite* 1991;16:205-18.  
[PUBMED](#) | [CROSSREF](#)
20. Hursti UKK, Sjöden P. Food and general neophobia and their relationship with self-reported food choice: familial resemblance in Swedish families with children of ages 7-17 years. *Appetite* 1997;29:89-103.  
[PUBMED](#) | [CROSSREF](#)
21. Nicklaus S. The role of food experiences during early childhood in food pleasure learning. *Appetite* 2016;104:3-9.  
[PUBMED](#) | [CROSSREF](#)
22. Schwartz C, Scholtens P, Lalanne A, Weenen H, Nicklaus S. Development of healthy eating habits early in life. Review of recent evidence and selected guidelines. *Appetite* 2011;157:796-807.  
[PUBMED](#) | [CROSSREF](#)
23. Nicklaus S, Demonteil L, Tournier C. Modifying the texture of foods for infants and young children. In: Chen J, Rosenthal A, editors. *Modifying Food Texture, Volume 2: Sensory Analysis, Consumer Requirements and Preferences*. London: Woodhead; 2015. p.187-222.
24. Bateson P, Barker D, Clutton-Brock T, Deb D, D'Udine B, Foley RA, et al. Developmental plasticity and human health. *Nature* 2004;430:419-21.  
[PUBMED](#) | [CROSSREF](#)
25. Dovey TM, Staples PA, Gibson EL, Halford JC. Food neophobia and 'picky/fussy' eating in children: a review. *Appetite* 2007;50:181-93.  
[PUBMED](#) | [CROSSREF](#)
26. Kallas Z, Vitale M, Gil JM. Health innovation in patty products. The role of food neophobia in consumers' non-hypothetical willingness to pay, purchase intention and hedonic evaluation. *Nutrients* 2019;11:E444.  
[PUBMED](#) | [CROSSREF](#)
27. Korsmeyer C, Sutton D. The sensory experience of food. *Food Cult Soc* 2011;14:461-75.  
[CROSSREF](#)
28. Dacremont C, Sester C. Context in food behavior and product experience – a review. *Curr Opin Food Sci* 2019;27:115-22.  
[CROSSREF](#)
29. Rotter JB. Some problems and misconceptions related to the construct of internal versus external control of reinforcement. *J Consult Clin Psychol* 1975;43:56-67.  
[CROSSREF](#)
30. Norman P, Brain K. An application of an extended health belief model to the prediction of breast self-examination among women with a family history of breast cancer. *Br J Health Psychol* 2005;10:1-16.  
[PUBMED](#) | [CROSSREF](#)

31. Russell CA, Buhrau D. The role of television viewing and direct experience in predicting adolescents' beliefs about the health risks of fast-food consumption. *Appetite* 2015;92:200-6.  
[PUBMED](#) | [CROSSREF](#)
32. Garber LL Jr, Hyatt EM, Starr RG Jr. Measuring consumer response to food products. *Food Qual Prefer* 2003;14:3-15.  
[CROSSREF](#)
33. Fallon AE, Rozin P. The psychological bases of food rejections by humans. *Ecol Food Nutr* 1983;13:15-26.  
[CROSSREF](#)
34. Gere A, Székely G, Kovács S, Kókai Z, Sipos L. Readiness to adopt insects in Hungary: a case study. *Food Qual Prefer* 2017;59:81-6.  
[CROSSREF](#)
35. Ajzen I, Fishbein M. *Understanding Attitudes and Predicting Social Behaviour*. Englewood Cliffs: Prentice-Hall; 1980.
36. Ajzen I. The theory of planned behavior. *Organ Behav Hum Decis Process* 1991;50:179-211.  
[CROSSREF](#)
37. Ajzen I, Madden TJ. Prediction of goal directed behavior: attitudes, intentions, and perceived behavioral control. *J Exp Soc Psychol* 1986;22:453-74.  
[CROSSREF](#)
38. Batra R, Ahtola OT. Measuring the hedonic and utilitarian sources of consumer attitudes. *Mark Lett* 1991;2:159-70.  
[CROSSREF](#)
39. Fazio RH, Chen JM, McDonel EC, Sherman SJ. Attitude accessibility, attitude-behavior consistency and the strength of the object-evaluation association. *J Exp Soc Psychol* 1982;18:339-57.  
[CROSSREF](#)
40. Brunsø K, Scholderer J, Grunert KG. Closing the gap between values and behavior - a means-end theory of lifestyle. *J Bus Res* 2004;57:665-70.  
[CROSSREF](#)
41. Shin YH, Hancer M. The role of attitude, subjective norm, perceived behavioral control, and moral norm in the intention to purchase local food products. *J Foodserv Bus Res* 2016;19:338-51.  
[CROSSREF](#)
42. Yazdanpanah M, Forouzani M. Application of the theory of planned behaviour to predict Iranian students' intention to purchase organic food. *J Clean Prod* 2015;107:342-52.  
[CROSSREF](#)
43. Mirkarimi K, Eri M, Ghanbari MR, Kabir MJ, Raeisi M, Ozouni-Davaji RB, Aryaie M, Charkazi A. Modifying attitude and intention toward regular physical activity using protection motivation theory: a randomized controlled trial. *East Mediterr Health J* 2017;23:543-50.  
[PUBMED](#) | [CROSSREF](#)
44. Qamar Z, McIntosh A, Hicks K. Improved perceived behavioral control in choosing fruits and vegetables as a result of the online nutrition program for South Asians. *J Acad Nutr Diet* 2017;117:A58.  
[CROSSREF](#)
45. Chen M. Modeling an extended theory of planned behavior model to predict intention to take precautions to avoid consuming food with additives. *Food Qual Prefer* 2017;58:24-33.  
[CROSSREF](#)
46. Arvola A, Vassallo M, Dean M, Lampila P, Saba A, Lähteenmäki L, Shepherd R. Predicting intentions to purchase organic food: the role of affective and moral attitudes in the theory of planned behaviour. *Appetite* 2008;50:443-54.  
[PUBMED](#) | [CROSSREF](#)
47. Menozzi G, Sogari C, Mora D. Explaining vegetable consumption among young adults: an application of the theory of planned behaviour. *Nutrients* 2015;7:7633-50.  
[PUBMED](#) | [CROSSREF](#)
48. McNeil K, Kelly F, McNeil J. *Testing Research Hypotheses Using Multiple Linear Regression*. Carbondale: South Illinois University Press; 1975.
49. Nusair K, Hua N. Comparative assessment of structural equation modeling and multiple regression research methodologies: E-commerce context. *Tour Manage* 2010;31:314-24.  
[CROSSREF](#)
50. Shaw D, Shiu E. Ethics in consumer choice: a multivariate modelling approach. *Eur J Mark* 2003;37:1485-98.  
[CROSSREF](#)

**Appendix 1.** Regression analysis for effectiveness of subjective norm, and perceived behavioral control towards behavioral intention by experience with EIF

Models	Without experience				With experience			
	B	SE	Beta	t-value	B	SE	Beta	t-value
Constant	0.032	0.226	-	0.142	-0.264	0.236	-	-1.117
FN	0.031	0.056	0.037	0.561	-0.039	0.055	-0.035	-0.712
SN	0.447	0.068	0.472	6.586***	0.428	0.061	0.442	7.010***
PBC	-0.004	0.050	-0.005	-0.071	0.099	0.056	0.086	1.784
ATT	0.311	0.070	0.315	4.460***	0.439	0.077	0.330	5.700***
$R^2 = 0.469$ , Adjusted $R^2 = 0.453$ , $F = 29.995$ ***				$R^2 = 0.513$ , Adjusted $R^2 = 0.505$ , $F = 62.760$ ***				

EIF, edible insect food; FN, food neophobia; SN, subjective norm; PBC, perceived behavioral control; ATT, attitude.

\*\*\* $P < 0.001$ .

**Appendix 2.** Regression analysis for effectiveness of experience with EIF, subjective norm, and perceived behavioral control towards behavioral intention by FN

Models	Low FN				High FN			
	B	SE	Beta	t-value	B	SE	Beta	t-value
Constant	-0.040	0.179	-	-0.220	-0.551	0.258	-	-2.132
Experience <sup>1)</sup>	0.059	0.090	0.035	0.652	0.011	0.128	0.005	0.083
SN	0.484	0.063	0.489	7.646***	0.407	0.066	0.440	6.205***
PBC	0.023	0.047	0.025	0.484	0.111	0.065	0.091	1.701
ATT	0.322	0.067	0.287	4.801***	0.485	0.087	0.358	5.561***
$R^2 = 0.499$ , Adjusted $R^2 = 0.489$ , $F = 49.838$ ***				$R^2 = 0.549$ , Adjusted $R^2 = 0.539$ , $F = 53.012$ ***				

EIF, edible insect food; FN, food neophobia; SN, subjective norm; PBC, perceived behavioral control; ATT, attitude.

<sup>1)</sup>Experience with EIFs was coded as '1', while no experience with EIFs was coded as '0'.

\*\*\* $P < 0.001$ .