UNIVERSITÀ DEGLI STUDI DI NAPOLI FEDERICO II

DIPARTIMENTO DI AGRARIA

PhD Thesis

INSECTS AS FOOD: A CROSS-CULTURAL COMPARISON OF CONSUMERS' INTENTION AND BEHAVIOUR

Candidate: MARIO AMATO

Supervisor: PROF. FABIO VERNEAU

PhD Course
Scienze Agrarie ed Agroalimentari
29° Ciclo

"A PhD thesis is either perfect or submitted"

Anonymous

1 Introduction

Food is essential for our survival, but its production is undermining the environment in which that survival is achieved. Clean air and water, health of the land, the presence of a wide range of species and adaptation to climate, together constitute our life support system. However, as numerous scholars pointed out, food supply chain is seriously threatening these normal operations: it is a major cause of greenhouse gas emissions as well as excessive water extraction, pollution, deforestation and biodiversity loss that, over time, has led to important and negative consequences for human well-being (Hoekstra, 2008; Weber and Matthews, 2008; Garnett, 2011; Kummu et al, 2012; Hoekstra and Wiedmann, 2014).

Most important, the food system does not seem to fulfil its primary function: to effectively feed people on the planet. The right to nutrition, enshrined in Article 25 of the Universal Declaration of Human Rights proclaimed by the General Assembly of the United Nations (UN 1948), is satisfied whether two conditions are guaranteed at the same time: the permanent and unlimited access to food (*food security*) and the availability of adequate food quality (*food safety*). Therefore, food production in sufficient quantities and of adequate quality, under nutritional and health aspects, for the whole population is a key mission for researchers. But not an easy one, since FAO efforts to reduce the structural causes of hunger in the world have not achieved the expected results for a variety of reasons, including

poverty, political instability, illiteracy, inadequate storage of food and difficulties in food distribution. In 2000, FAO set the goal of eradicating world hunger by 2015 but the current situation makes it clear that this ambitious aim has not been reached yet. In fact, the contemporary paradox sees on the one hand a billion undernourished people whilst, on the other, an equally large number of individuals are developing metabolic diseases.

According to the UN report "World Population Prospects: The 2015 Revision" (DESA, 2015), the growth rate of the world population has already reached its peak and is bringing the current 7.3 billion citizens of the world (it was 1.6 in the early 1900s) to increase to nearly 8.5 billion by 2030, 9.7 billion in 2050 and 11.2 billion in 2100. A growing number of people means a growing demand for food. This, combined with climate change and environmental issues, compounds the nutritional imbalance problems making food production increasingly difficult and unpredictable in upcoming years. Consequences of this growth will be borne by Third World and Developing Countries where higher fertility, a younger age of first birth and a different conception of society are leading to a significant growth, unlike industrialized countries where the number is going to remain almost stable, excluding the contribution of the immigration.

Simultaneously with the population growth, the demand for food will rise and will change its composition: processes such as urbanization and globalization are influencing markedly changes in the diet of a large part of the population. The result is an increase in demand for high biological value protein (FAO/WUR,

2014), such as meat, the production of which is a challenge for the future, especially considering the current production techniques either have a considerable environmental impact, but also a low efficiency level. Meat consumption is linearly related to the average income per inhabitant: the examination of the trend of the individual average consumption since 1980 make reasonable to expect an increase in demand for the next 20 years in emerging countries, with annual quantities for individual that will rise to 37 kg of meat and 66 kg of milk - dairy products already by 2030, differently from developed countries where individual consumption of these products will remain essentially unchanged (Delgado, 2003). European Parliament recently pointed out that the shortage of protein sources has become one of the major issues in Europe, given the fact that about 80% of Europe's demand for protein crops is imported from other countries, raising the issue of genetically modified products (Van Huis, 2013). In essence, on one side humanity is facing the urgent need to deal with the environmental consequences of the current food production systems; on the other, it becomes more and more important to develop systems which ensure access to sufficient food to meet a world growing population nutritional needs.

1.1 Edible Insects?

A diet that which envisages the gradual introduction of insect-based substances (entomophagy) has recently attracted increasing attention as a viable alternative to meet the major challenges of nutrition that the world is facing (Van Huis et al,

2013; Verbeke, 2015). Western countries' interest towards insects as a potential source of nutrition has grown a lot in the last years. In particular, the high content of high quality protein and the sustainability of the production process compared to traditional sources contribute to increase the scientific debate (Tan et al., 2015, Testa et al., 2016). In this context, insects may represent a sustainable and favourable option for several reasons. First and foremost, for their efficient metabolism plus the ability to transform the organic waste they feed on (e.g. remains of food, compost and animal manure) into high quality proteins, which can be used for animal feed (FAO/WUR, 2014). Moreover, the FAO has recently detailed in a report multiple reasons (from cultural, economic, ecological, technological, nutritional and legislative perspective) in order to emphasize the potential that such ingredients have in offering a feasible solution to the problems of food security (Van Huis, 2013; FAO/WUR, 2014).

However, a diet based on insects (or their components) involves undoubtedly a radical departure from existing food traditions for westerners. Albeit recent research has demonstrated how consuming insects (as a whole or powder) exert significant benefits contribution in terms of protein content (Rumpold and Schlüter, 2013; van Huis, 2013; Halloran et al., 2015, Testa et al., 2016), the social acceptance is still very low in Western societies (DeFoliart, 1999; de Boer et al., 2013; van Huis, 2013; Hartmann et al., 2015). Even though the use of insect and derivate in food is not entirely new in the West (products such as jams and juices contain traces, for an average per capita consumption estimated at 250 grams /

year, according to Sogari and Vantomme, 2014), there is still a lack of awareness. Several studies have been conducted in the literature in order to analyse consumers' behaviour vis-à-vis insect-based food consumption and numerous factors, that may affect the degree of opening or acceptability of these radical innovations, have been identified (Tan et al., 2015; Verbeke, 2015). In the next section, a brief scheme of present literature will be presented in order to systematize the results, in particular concerning (i) barriers to insect-based foods in western societies and (ii) potential drivers that might lead to a change in eating-habits. Understand whether and to what extent consumers are willing to accept insects (or their components) in their diets is crucial to estimate whether and how reorganize the food chain towards the introduction of insects based ingredients in Western diets.

1.2 A brief panoramic upon insects' properties

Edible insects have been promoted by the FAO for several environmental benefits, for health and for the sustainability of their production processes. Insects appear to be important for all terrestrial ecosystems, due to their rapid rate of reproduction and the many benefits of which are responsible (e.g. food industry for both men and animals, medical applications and their use as recyclers of organic matter). In fact, insects are used in the production of dyes, silk, wax, as well as food by extensive nutritional benefits such as honey, propolis and royal jelly.

Being cold-blooded animals, insects have a high nutritional conversion efficiency

compared to animals normally reared: the efficiency rates of meat (the amount of feed necessary to produce an increase of 1kg in weight per animal) vary widely depending on animal type and farming practices. On average, insects can convert 2 kg of food in 1 kg of mass, where cattle require 8 kg of food to produce an increase of 1 kg of body weight (Halloran and Vantomme, 2013). In addition, the final mass of the insects is completely usable, guaranteeing yields close to 100%. According to Schabel, 2010, caterpillars convert plant biomass into animal ten times more than the cattle, using less land and with less ecological footprint. What is more, the crickets, to get the same protein yield of farm animals, require 1/12 and 1/4 compared to the food needed to breed cattle and sheep, respectively, and about half of the food used for pigs and chickens (Deroy et al., 2015). Furthermore, insects' greenhouse gases production is potentially lower compared to conventional livestock (Oonincx & de Boer, 2012; Testa et al., 2016). Insects may be fed from organic waste such as remains of human food, animal sewage compounds and can turn them into high-quality protein that might be used as animal feed. Moreover, the breeding of insects requires less land and less water compared to conventional livestock (Costa-Neto, 2014; Soares & Forkes, 2014).

Albeit it is difficult to generalize on the organoleptic and nutritional properties insect (Sogari and Vantomme, 2014), insects have indeed other benefits: for example, many insects provide a significant caloric intake. Lipids are the main culprits and are well represented in these animals, especially in the larval forms

(Belluco et al., 2013; Testa et al., 2016). In practice, almost all types of insects have a higher values compared to most common foods, except for the pork that has a higher lipid content (Ramos-Elorduy, 2006). Moreover, putting under the light he nutritional components it is possible to see that edible insects have a high content of essential amino acids, polyunsaturated fatty acids, fibre and micronutrients. Differently from common beliefs, insects are safer than other protein sources in terms of the spread of potential zoonotic diseases. From the point of view of allergy, problems are comparable to those arising from the consumption of shrimps (Broekman et al., 2015).

Edible insects have other advantages from a production perspective: in fact, they can be easily grown with minimal use of land, allowing the production in the poorest parts of the world, thus representing a major source of entrepreneurship for disadvantaged areas. Insects transformation in food and the extraction of protein, in addition, did not reveal as complex processes. Furthermore, insects provide important ecosystem services, playing an important role in pollination, biological control and decomposition of organic material and processing of manure into fertilizer (Van Huis et al., 2013). Therefore, insects represent an economically sustainable solution, capable of meeting the growing demand for nutrients alongside conventional meat sources (Finke, 2002; Kinyuru et al., 2009).

1.3 Main barriers

Despite several scientific studies (i.e., Costa-Neto, 2003; van Huis, 2013; Tan et al.,

2015) proved the potential benefits (as shown above) of consuming insects, the growth potential of insects as everyday foods for humans in all parts of the world is still not clear (Srivastava et al., 2009) and a number of obstacles to their widespread use as human food in the West remains (House, 2016).

The development and globalization of the insect-based foods would face stiff barriers due to the current very low consumer demand compared with the normal (non-insect) foods, whose development of is highly consumer-driven, probably because of the eradicated fear of failure to comply with hygiene standards ensuring the safety of food produced or the absence of laws or regulations which ensure the proper functioning of the entire food chain (Rumpold and Schlüter, 2013). Moreover, in Western countries, human's insect consumption is not only infrequent, but is also considered culturally inappropriate. What it follows is that this argument is rarely included in the policy agenda of international organizations (van Huis, 2013). Furthermore, insects' ecological benefits (Lundy & Parella, 2015) and "healthiness" (Payne et al., 2016) of food insects related to conventional sources of animal-based protein are debated, asking for further research in terms of nutritional content (Shockley & Dossey, 2013; Payne et al., 2016; Testa et al., 2016), safety and allergenicity (Belluco et al., 2013; Broekman et al. 2015; Testa et al., 2016), in the context of a prohibitive EU legislation (Pascucci & De Magistris, 2013; Finke et al., 2015).

1.3.1 Legal barriers

The lack of precise and insect-inclusive legislation, standards, labelling and other regulatory instruments remains a major barrier to globalized entomophagy, even though some good progress has been achieved in this field. Extensive reviews and discussions on edible insects have been conducted by Food Authorities all over the world. In the 2010 proposal "Development of a Regional Standard for Edible Crickets and Their Products" (prepared by Lao PDR in the 17th session of FAO/WHO CCASIA), a "standard" setting was requested for house crickets or other edible insect products for human consumption and food trade purposes (Laos, 2010). In late December 2013, ten insect species were authorized by the Belgian Food Safety Authority (FAVV, 2014). In October 2014, the Dutch Office for Risk Assessment & Research proposed, according to the General Food Law (Regulation 178/2002), and admitted three insect species, *Tenebrio molitor*, *Alphitobius diaperinus* and *Locusta migratoria,* which are currently produced and sold in the Netherlands. Even though the new Novel Food Regulation (Regulation (EU) No 2015/2283), has finally clearly included whole insects under the scope of its application, the EU still needs to resolve a number of outstanding legal questions in order to promote innovation and growth while guaranteeing food and feed safety, such as a regulation on the living and killing conditions of insects (Lahteenmaki-Uutela & Grmelová, 2016)

Regulatory frameworks including legislation, standards and associated regulatory bodies must be set up to guide, monitor, assure and govern the production,

conservation, trade and use of edible insects as human food or animal feed. The absence of laws and regulations governing the production, use and marketing of edible-insects is by far the strongest barrier to the growth of such a sector (Halloran and Munke, 2014). In fact, legislation has an impact on the ability of companies to innovate, how they develop new technologies, organize trade and marketing of the final product (Porter and van der Linde, 1995). Implications are significant also for supply chain relationships (Boons and Lüdeke-Freund, 2013). It is clear that a change in the organization of innovative supply chains can exert influence even in terms of acceptance of radical food innovations. The role of the supply chain governance in explaining the success (or failure) of innovation may be especially relevant for the agro-food sector (Hobbs and Young, 2001; Nijhoff-Savvaki et al., 2012)

While it is crucial to acknowledge that supply-side changes in food distribution cannot alone account for a novel food's popularity, food consumption and production are mutually constitutive (Murcott, 2001). Therefore, as it has been historically highlighted, the demand for new foodstuff is substantially affected by increase in supply (Ellis et al., 2015; Mintz, 1986), so a particular food must be widely available if it is to become an accepted and integrated part of people's diet (House, 2016).

1.3.2 Socio cultural barriers

The challenge of convincing an insect phobic culture to recognize the value of

insects in sustainable ecosystems and sustainable food supply chains is not just about raising, processing and transporting edible insects but also about creating consumer demand and increasing acceptance of such “mini-livestock” (Bharucha & Pretty, 2010; van Huis, 2013). It is difficult to overcome consumer aversions towards insects (aversions seeded and propagated by contemporary media, proverbs and even scientific publications on insect pests and unsanitary characteristics or disease transfer) (Meyer-Rochow et al, 2000). Insects have been commonly considered harmful by a large proportion of consumers who often react with disgust at the prospect of considering these creatures as food, creatures that, culturally speaking, have never been considered so (DeFoliart, 1992; Yen, 2009); rather, insects are carriers of disease and are harmful for plants (Tan et al., 2015), as well as being able to "contaminate" the food making it not acceptable (Rozin et al., 1985). This latter aspect is undoubtedly mainly a cultural barrier: in fact, while insects like caterpillars and grasshoppers feed mainly on fresh vegetables, crustaceans (commonly considered to be of precious value) very often feed on decaying organisms (Sogari and Vantomme, 2014). A greater familiarity with insects as food can be certainly and easily found in Eastern cultures and in some developing countries, where different species of insects are considered traditional specialties (Ramos-Elorduy, 1997; Hanboonsong, 2010). According to Schösler et al., 2012, consumers’ preferences and acceptability of insects as a food source may vary a lot, whether insects are or are not visible or recognizable. Little research, in fact, have been conducted so far in order to

understand which are the factors specifically related to insects (shape, type, colour, visibility, novelties) that can be a source of disgust reactions in Western societes.

Although the psychological and the cultural dimensions of the problem have already found some interest in literature (Looy et al., 2014; Tan et al., 2015), research conducted so far on the subject were fairly focused on the negative perception that Western consumers have towards insects as a source of proteins (DeFoliart, 1992; Yen, 2009, Hartmann et al., 2015; Ruby et al., 2015), and willingness to adopt them as a meat substitute (Hartmann et al., 2015; Schösler et al., 2012, Vanonhacker et al., 2013; Verbeke, 2015).

Taking into account that a prolonged exposure to the same food appears to have different effects on the willingness to accept it or appreciate it as such (de Wijk et al., 2012), the appreciation of food may increase, remain stable or decrease with the only exposure to it (Pliner, 1982; Porcherot and Issanchou, 1998; Kremer et al., 2013). Even though many psychological and biological factors regulate the preferences and food "aversions", the appreciation of food is mainly acquired through experience (Tan et al., 2015). In the case of insects, however, there is no evidence of innate aversion to them (Bodenheimer, 1951). Individuals learn through experience which foods are appropriate for their diet and how they should be eaten. Both cultural exposure and individual experience play a key role: each of us learns from an early age to accept the foods that are available according to their own culture (Tan et al., 2015), since exists a motivational

difference between trying and regularly eating a food, especially for unfamiliar foods including insect-based foods (Martins & Pliner, 2006; Tan et al., 2015). Unfamiliar foods (for example, an unfamiliar animal or insect-based product) tend to gain low initial acceptance or even complete rejection due to perceptions of disgust, distastefulness, riskiness or unsafeness (Fallon & Rozin, 1983). Moreover, social environment plays a key role in food preference (Larson & Story, 2009). Consumers learn the characteristics of various food sources from their very early years of childhood through food ingestion. Subsequently, perceived characteristics of a food from childhood remain deeply entrenched in their minds. This explains the unease of many adults, who disliked or rejected the association of insects with foods, to accept entomophagy.

Another aspect with significant weight on the low predisposition to experience "insects in the diet" in western countries is given by the lack of information on how they are produced and prepared and, moreover, on the level of security and availability (Tan et al., 2015).

The rejection that some people express towards new or unfamiliar foods is defined neo-phobia (Barrena and Sanchez, 2013): an illness or a tendency to avoid new foods (Pliner and Hobden, 1992) or unfamiliar compared to the individual's culture (Tuorila et al., 1994; Barrena and Sánchez , 2013). Among the factors that have an impact on the decision to eat unfamiliar food (eg, insects) in addition to the disgust can be added aversion and danger (Rozin and Fallon, 1980). As suggested by Martins and Pliner (2006), the danger refers to the

reactions towards food based on anticipated consequences of eating them. Disgust also involves accepting or rejecting a food for the real or imagined sensory characteristics (e.g. taste, smell, texture or appearance). Understanding the nature or origin of the substance may also have a role in the acceptance or rejection of a food (Martins and Pliner 2006). Sometimes the refusal is based on considerations of inappropriateness of the product in question: there are elements typically not classified as food in a given culture, such as fabrics, paper or ornamental plants. Disgust instead is sometimes manifested by the very nature of the food, its origin, its history (Martins and Pliner, 2006). Unusual products (Pliner & Hobden, 1992), products created using new technologies (Cox & Evans, 2008), food neophobia and food technology neophobia could all impact the degree of readiness of consumers to adopt insects (Caparros Megido et al., 2014). Adding familiarity to an insect-based food would lift the acceptance e.g. incorporating insects into popular or conventional consumer foods (Hoek et al., 2011). However, the way in which insects are included in a food, as well as how the insect-based food is presented and advertised, will also influence consumer response. Visual appearance and certain texture or mouth feel of insects may trigger a disgust-based food rejection response (e.g. seeing an entire insect or body part, or something slimy on the tongue) (Rozin & Fallon, 1987), especially for those with minimal experience with insects as food (Shan et al., 2015).

1.4 Purpose of this study

Taking into account what has already been analyzed, this work relies on three different papers who share the main objective of exploring consumer behavior towards edible insects, using both direct and indirect methods (computer questionnaires and more daring techniques such as IAT), while linking two European countries that share little in terms of eating habits, Denmark and Italy.

- In "**The effect of communication and implicit associations on consuming insects: an experiment in Denmark and Italy."** it was examined the influence of the type and message of communication upon the behavior and intention to perform the behavior of eating insects, while exploring the role of implicit associations.

- In the second work instead, "**Understanding Westerners' disgust for the eating of insects: the role of food neophobia and implicit associations."** it was investigated the impact of food neo-phobia and disgust on the intention to eat insect-based food, and how disgust is related to implicit attitude towards insects.

- In the third study, lastly, **"Assessing the role of Food Related Lifestyle in predicting intention towards edible insects: a case study"** a tentative of market segmentation was performed via lifestyles in order to predict consumers' behaviour towards edible insects. Furthermore, the role of perceived behavioural control was analysed.

2 The Effect Of Communication And Implicit Associations On Consuming Insects: An Experiment In Denmark And Italy.

Fabio Verneau; Francesco La Barbera, Suzanne Kolle[b], Mario Amato[c], Teresa Del Giudice[c], Klaus Grunert[b]

[a]Department of Political Sciences, University of Naples Federico II, Italy

[b]MAPP Centre, Aarhus University, Denmark

[c]Department of Agriculture, University of Naples Federico II, Italy

2.1 Abstract

It has been widely noted that the introduction of insects in Westerns' diet might be a promising path towards a more sustainable food consumption. However, Westerns' are almost disgusted and sceptical about the eating of insects. In the current paper we report the results of an experiment conducted in two European countries—Denmark and Italy—different for food culture and familiarity with the topic of eating insects. We investigated the possibility to foster people's willingness to eat insect-based food through communication, also comparing messages based on individual vs. societal benefits of the eating of insects. Communication proved to be effective on intention and behaviour, and the societal message appeared to be more robust over time. The communication effect is significant across nation, gender, and previous knowledge about the topic. In addition, we investigated the impact of non-conscious negative associations with insects on the choice to eat vs. not eat insect-based food. Implicit attitudes proved to be a powerful factor in relation to behaviour, yet they did not impede the effectiveness of communication.

KEY WORDS: *Consumer, Entomophagy, Insects, Communication, Implicit Association Test.*

2.2 Introduction

Ecological footprint is the load imposed on nature by a population or an individual, and it can be expressed as the portion of Earth's surface which is necessary to sustain the resource consumption and waste by that population or individual (Wackernagel and Rees, 1996). Food consumption—and meat consumption in particular—account for a large part of the ecological footprint of people with a carnivorous diet (FAO, 2005, 2006). In most countries, developed or not, livestock and fish are an important source of proteins. According to FAO (2006), 70% of all agricultural land and products are destined to livestock, and this measure in absolute terms has to double between 2000 and 2050 (from 229 million tonnes to 465 million tonnes) in order to satisfy the increasing world demand. Feeding the more and more demanding world population will determine an unsustainable pressure on land, oceans, water and energy. Therefore, the environmental issues, in particular those connected with cattle breeding, need prompt attention, and alternative protein sources could be promoted, such as algae (Fleurence, 1999), vegetables and mushrooms (Asgar et al., 2010) and mini-livestock (Paoletti, 2005). Among the different possible protein sources, recent research has been showing a growing interest in the introduction of edible insects into the Western diet, which could be a solution to environmental and nutrition world problems (Looy et al., 2014; Rumpold and Schlüter, 2013). According to the FAO (2006), the benefits of the introduction of insects in the human diet are twofold. On the one side, there are individual benefits stemming

from the excellent nutritional profile of many edible insects (Rumpold and Schlüter, 2013). For example, the oils extracted from several insects are richer in unsaturated fatty acids than meat, and frequently contain Omega 3, the nutritional importance of which is well recognized for human health, mainly for the healthy development of children and infants (DeFoliart et al., 2009). On the other side, there are relevant societal benefits, in terms of feed conversion efficiency, greenhouse gas emissions, freshwater consumption, food waste reduction, animal welfare, and prevention of zoonotic infection risk (van Huis et al., 2013). For example, species such as mealworm larvae, crickets and locusts compare favourably with beef cattle in their GreenHouse Gas (GHG) emissions (lower by a factor of 100). Insects are a more environmentally friendly source of animal protein also in terms of urine and manure production, energy depletion and land use (Oonincx et al., 2010 and Oonincx and de Boer, 2012) Despite all these individual and societal benefits, several studies show people's generally low willingness to introduce insect to the Western diet (Vanhonacker et al., 2013 and Verbeke, 2015), and there is still a lack of research about the psychological drivers and barriers which influence the willingness to eat insects. The discrepancy between the benefits of eating insects and the aversion of Westerners toward them suggests an important research question: Is it possible to positively affect the individual intention to eat insect-based food through communication of the individual and/or societal benefits connected to this new form of food consumption?

The idea of changing food preferences and aversions through communication has a prominent role in consumer behaviour research in relation to a large array of topics and disciplines (Aldridge et al., 2009; Larson and Story, 2009). However, few studies have addressed the issue of encouraging people in the Western countries to accept entomophagy, and while the educational experiences that have been carried out have increased the awareness of entomophagy, they did not significantly affect attitudes (Looy and Wood, 2006; Wood and Looy 2000). Therefore, our major aim was to investigate if it would be possible to positively affect people's willingness to eat insect-based food through communication (Del Giudice et al., 2015), also comparing different communication messages (individual vs. societal benefits of eating insect). To the best of our knowledge, the current study is the first to investigate this possibility with an experimental methodology. In addition, if an effect on intention occurs, we aim to test its stability over time, and to evaluate its transmission to actual behaviour. Also these two points have not been investigated before. Previous research has highlighted the significant effect of several factors, such as gender and familiarity with the topic. We studied the main effect of these two factors, and of different nationality of the participants in the experiment as well. Moreover, we also explored the moderating role of the same factors on the effectiveness of communication. It is also important to note that, although scholars have underlined the role of affective and non-conscious psychological processes as the basis of the aversion to insects as food, research has empirically studied the drivers and barriers only in terms of

deliberate/explicit processes (Strack and Deutsch, 2004), using self-report measures. Therefore, it will be crucial for a more comprehensive understanding to explore the implicit processes as well, and we do address this issue in the current study using a measure of implicit associations (Greenwald et al., 1998). In recent years, research in social psychology has focused on automatic or implicit processes, which are assumed to affect behaviour by operating outside of conscious awareness (Banaji, 2001; Bargh and Ferguson, 2000; Blair, 2001). Strack and Deutsch (2004) distinguish the *impulsive system* and the *reflective system*: In the latter, the link between cognitive beliefs and behaviour is mediated by reasoning, behavioural decision and intention; in the former, implicit associations between categories and concepts (such as "insect" or "elderly", and "bad" or "good") take place, which are directly linked to behaviour. Recourse to implicit measures, in addition to traditional ones, has been shown to improve the prediction of behaviour (Greenwald et al., 2009; Vantomme et al., 2006). The most commonly adopted and reliable instrument developed to tap into implicit association is the Implicit Association Test (IAT - Greenwald, McGhee and Schwartz 1998). In the next section, we provided a brief overview of the existing research on the eating of insects, then we describe the procedure and results of an experiment conducted in Denmark and Italy—two European countries different in terms of food consumption characteristics and culture—for addressing the questions discussed above.

2.2.1 Why are insects not eaten in western countries?

The practice of eating insects, known as entomophagy, is an old-age phenomenon, well documented also in Europe during the Greek and Roman ages (Bodenheimer, 1951). Nowadays, insects are an important protein sources in several areas of Central and Western Africa, South East Asia, and Central and South America (Bahuchet and Garine, 1990; Zent and Simpson, 2009). Western consumers' willingness to introduce insects and/or insect-derived proteins into their diet is generally low, and insect-based food is regarded with skepticism and disgust (Vanhonacker et al., 2013). From a psychological point of view, "Deeply embedded in the Western psyche is a view of insects as dirty, disgusting, and dangerous" (Looy et al., 2014). Disgust about something is a cultural construction, which is socialized to all members of a group, and indicates clearly the physical or cultural threat related to some object or action (Herz, 2012; Mignon, 2002). Disgust can also be easily generalized from one entity to others through contamination (Rozin and Fallon 1987). Because Westerners tend to have a stereotyped and undifferentiated perception of insects (Kellert, 1993), the association of some insects with feces and decaying matter could have led to psychological contamination of all insects, making the entire category disgusting (Looy et al., 2014). At the group level of analysis, food-related practices are part of the socialization of children, and contribute to the foundation of one's own cultural identity (Fieldhouse, 2013; Kiefner-Burmeister et al., 2014). Food practices shared by a group or a community also contribute to define its identity and distinguish it

from other groups. Research has shown, for example, that different groups choose a subset of the edible substances available to consolidate and distinguish their identity, and often ridicule the outgroup food habit (Pyke, 1968 and Diamond, 1992). Westeners' tend to consider the eating of insects as a primitive people's practice (Ramos Elorduy, 1997), and use insect metaphors in relation to social groups which are seen as "less human" (i.e., de-humanized, see Haslam, 2006). Therefore, they cannot eat insects without feeling threatened in their own identities and self-esteem. There have been few studies that addressed consumers' attitudes towards eating insects or insect-based food. In a recent study in Belgium, Vanhonacker et al. (2013) found a very low willingness to eat insects. In a study conducted in the Netherlands (de Boer et al., 2013), 79% of participants indicated the insect-based snack as the one they would least like to taste, compared to other snacks based on environmentally-friendly proteins, such as hybrid meat, lentils, beans, and seaweed. Recent studies (Hartmann et al., 2015; Schösler et al., 2012) also showed that food products with processed (not visible) insects – such as pizza with insect proteins or cookies based on cricket flour – were evaluated better than other options with visible insects by Western people. This difference between processed and not-processed insects was not relevant in the case of Chinese people instead. Scholars have identified several factors affecting individuals' willingness to eat insect based food. Gender and age are relevant factors – male and young individuals show more positive attitudes – whereas education level does not show clear effects (Schösler et al., 2012; Verbeke, 2015).

Familiarity with the topic of eating insects has been shown to be a powerful driver (Hartmann et al., 2015): In the study by Verbeke (2015), participants self-reporting awareness of what the eating of insects is about were those with more positive intentions towards eating insects. Recent studies also found Food Neophobia (Pliner and Hobden, 1992) to be an important factor influencing consumers' willingness to eat insect based food (Hartmann et al., 2015; Hoek et al., 2011; Verbeke, 2015), along with a number of studies that have proposed Food Neophobia as an important obstacle to the readiness to try novel foods (Siegrist et al., 2013).

2.3 Materials and Methods

2.3.1 Overview of experimental procedure

In each session, upon arrival participants met in a computer lab. Each participant was identified with an ID number to guarantee his/her anonymity and for the follow up. A "Insects vs. flowers" IAT was administered. After that, students were invited to watch a short video of an expert interview (see appendix 1).

The between-subjects design consists of three conditions, in which students watch one of the following videos:

1. societal benefits of introducing insects' proteins into human diet;
2. individual benefits of introducing insects' proteins into human diet;
3. benefits of introducing tablets in school (control condition).

Participants were randomly assigned to the experimental conditions. After watching the video, items on familiarity and intention were administered. After that, participants received a chocolate bar enriched with proteins from crickets. About two weeks after the end of all the experimental sessions, participants were contacted by telephone, and a short questionnaire was administered. They were asked 1) if they actually ate the choco-bar (behaviour), and, if yes, how much of it they ate; 2) the same three items on intention administered during the experimental session.

2.3.2 Participants

A total of 282 university students participated to the experiment. Half of the sample was recruited in Denmark (65 females, M_{age} = 23.35, SD_{age} = 3.40), and the other half of 141 subjects (74 females; M_{age} = 23.87, SD_{age} = 4.25) was recruited in Italy. The samples did not present significant differences as regards gender, X^2 (282) = 1.149, p > .10, age, t (280) = 1.129, p > .10, and distribution of students to the experimental groups, X^2 < 1, which was randomly made. Two weeks after the experiment a brief follow up interview was carried out. We were able to collect the responses of 264 participants, 136 Danish (61 females, M_{age} = 23.33, SD_{age} = 3.43) and 128 Italians (71 females, M_{age} = 23.94, SD_{age} = 4.33). The overall attrition rate (i.e., the percentage of participants to both sessions in relation to those who participated only to the first session) was 93.6% (96.4% for Danish, 90.8% for Italians).

2.3.3 Measures

2.3.3.1 Implicit Association Test

In our experiment, in order to assess participants' implicit associations with insects, a standard "Insects vs. Flowers" IAT was administered. Participants were asked to categorize stimuli belonging to the target categories (Insect or Flower) and stimuli belonging to two opposite attribute categories (Positive and Negative). They executed the task using the keyboard keys "A" and "L". In the next two phases, target categories and attribute categories shared the same response key (e.g. Positive and Flower); subsequently, the matching of categories was inverted (e.g. Negative and Flower share the same response key). A longer reaction time indicates that for the respondent it is more difficult to associate the target and attribute category; by contrast, a shorter reaction time means that the two categories are easily associated, indicating that the corresponding association is held by the respondent. In this study, the presentation of the combination of target and attribute categories was counterbalanced so that half of the participants were presented with "Insect and Positive" first, and the other half with "Insect and Negative" first. A feedback after categorization errors (a red cross) was given to participants, who were required to provide a correct response after any error. The IAT score was obtained using the D2 method proposed by Geenwald, Nosek and Banaji (2003). Tested for reliability, the IAT proved adequate ($\alpha_{danish} = 0.71$; $\alpha_{italian} = 0.75$). In this study, positive values of the IAT indicate positive implicit associations

about insects, whereas negative values indicate negative implicit associations.

2.3.3.2 Familiarity

We used the measure by Verbeke (2015) to assess participants' familiarity with introducing insect into the human diet. The item "Have you ever heard of the eating of insects?" was administered. Participants answered choosing among the following: 1.Yes, I have heard of the eating of insects and I know what it means; 2. I have heard of the eating of insects but actually don't know what it means; 3. No, I have never heard of the eating of insects. For the analysis, we dummy coded the item (0 = No, I have never heard; 1 = otherwise).

2.3.3.3 Intention

Three items (adapted from Balderjahn et al., 2013) were administered, asking participants' about their intention 1) to introduce insect proteins in their diet; 2) to suggest this to friends and relatives; 3) to buy products with insect proteins rather than traditional protein sources, if available on the market. The instrument was administered at the time of the experiment (intention1) and two weeks later (intention2). Participants answered on a 7-point scale. Items were averaged in a single score (intention 1: $\alpha_{Danish} = 0.92$; $\alpha_{Italian} = 0.87$; intention2: $\alpha_{Danish} = 0.90$; $\alpha_{Italian} = 0.91$).

2.3.3.4 Behaviour

Participants received a chocolate bar with peanuts enriched with proteins from

crickets (53g) as a reward for their participation in the experiment. The label of the product clearly reported all the ingredients, among them cricket proteins, and this was underlined by pictures of crickets on the packaging. We choose this kind of product because, as we reported before, previous research found a somewhat lower aversion of people to products with processed insect proteins, compared to product characterized by visible insects. Two weeks after the experiment, as explained in the Procedure section, participants were asked if they actually ate the product.

2.4 Results

2.4.1 Intention Analysis

Table 1 provides bivariate correlations between the measures used in the experiment. Consistently with the theory, the IAT significantly correlated with behaviour, but not with intention. Previous knowledge (familiarity) presented the opposite pattern of correlation, that is, it was significantly correlated with intention but not with behaviour. As expected, intention 1 and intention 2 were strongly intercorrelated, and both were correlated significantly with behaviour.

Table 1 - Summary of Intercorrelations, Means and Standard Deviations

Measures	1	2	3	4	5	6
1. IAT	0 (1)					

2. Familiarity	-0.93	0.53 (0.50)				
3. Preference	.118*	.087	22.16 (4.22)			
4. Intention 1	.043	.156**	.195**	3.96 (1.84)		
5. Intention 2	.019	.159**	.088	.661**	4.14 (1.92)	
6. Behaviour	.148*	.104	.153*	.340**	.329**	0.86 (0.35)

Note. The table shows Pearson's r correlation coefficients. Diagonal cells report the means (standard deviations in parentheses).
* = p < .05; ** = p < .01; *** = p < .001

The overall mean difference between intention 1 and intention 2 was not significant, t < 1. In order to investigate the effect of communication, nationality, familiarity, gender and their interaction on participants' intention 1 and intention 2, a series of ANOVAs were ran.

The main effect of message on intention 1 was significant F (2, 276) = 8.97, p < 0.001, d = 0.48: the mean score of intention was higher for the social benefit group and the individual benefit group compared to the control group, t (188) = 3.95, p < .001 and t (185) = 2.78, p < .01, respectively, whereas no significant difference was found between the former two groups, t (185) = 1.03, p > .10. The main effect of message was significant also on intention 2, F (2, 261) = 4.53, p = 0.012, d =

0.37. In this case, however, the mean score of intention was higher for the social benefit group compared to the control group, $t(174) = 2.99$, $p < .01$, but a significant difference was found neither between the social and individual groups, $t(176) = 1.22$, $p > .1$, nor between the individual and the control condition, $t(172) = 1.74$, $p = .083$ (see Table 2).

Table 2 - Differences in Intention Between Experimental Conditions

Experimental condition	***Intention 1***	***Intention 2***
	M (SD)	M (SD)
Social benefit	4.37^{a} (1.62)	4.74^{c} (1.57)
Individual benefit	4.09^{a} (1.80)	4.45^{cd} (1.73)
Control	3.42^{b} (1.91)	4.03^{d} (1.85)

Note. Entries are means and standard deviations (in parentheses). Mean scores with different superscript letters are significantly different at < .05 level

The main effect of nation on intention 1 was also significant, $F(1, 276) = 15.74$, $p < 0.001$, $d = 0.46$: the mean score of intention was higher for the Danish ($M = 4.37$, $SD = 1.59$) compared to the Italians ($M = 3.55$, $SD = 1.99$). The effect of nation on intention 2 was also significant $F(1, 258) = 7.07$, $p < 0.01$, $d = 0.31$: the mean score was higher for the Danish participants ($M = 4.43$, $SD = 1.87$) compared to the Italian participants ($M = 3.84$, $SD = 1.84$). The interaction between message and nation was not significant, $F_{intention1}(2, 276) = 1.69$, $p = 0.187$, $F_{intention2}(2, 258) = 1.38$, $p = 0.252$. The main effect of familiarity on intention 1 was significant F (1,

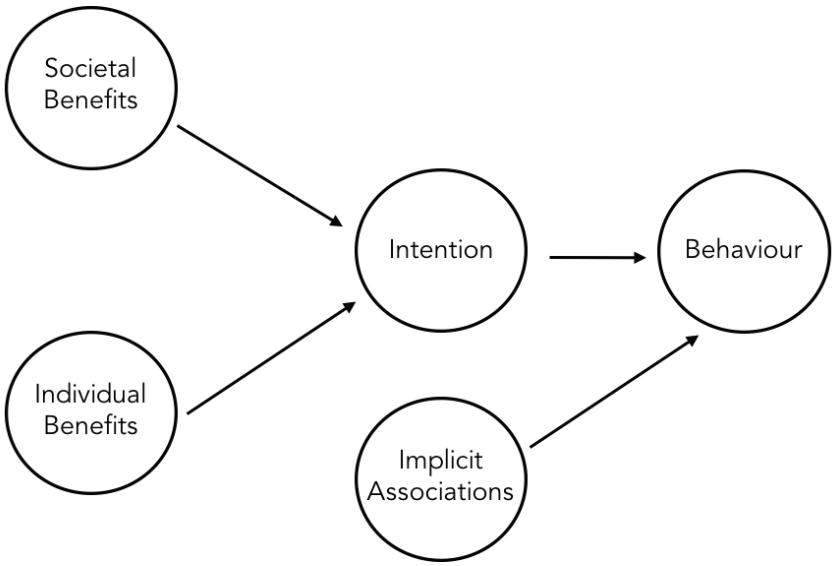
276) = 9.71, p < 0.01, d = 0.35: the mean score of intention was higher for participants with high familiarity (M = 4.23, SD = 1.88) compared with those with low familiarity (M = 3.65, SD = 1.75). The main effect of familiarity on intention 2 was also significant F (1, 258) = 8.74, p < 0.01, d = 0.35: the mean score of intention was higher for participants with high familiarity (M = 4.43, SD = 1.18) compared with those with low familiarity (M = 3.82, SD = 1.92). No significant interactive effect was exerted by message and familiarity on intention 1, F (2, 276) = 2.73, p > 0.05, and intention 2, F < 1.A significant effect of gender was also found on intention 1, F (1, 276) = 6.42, p = 0.012, d = 0.29: the average scores of male participants (M = 4.23, SD = 1.75), were higher than those of females (M = 3.68, SD = 1.89). However, this effect was not significant in the case of the intention self-reported at the follow-up, F (1, 258) = 2.00, p > 0.10. In both cases, gender had no significant interaction with nation and group, Fs < 1.

2.4.2 Behaviour Analysis

In the brief follow up interview, we asked participants if they ate the chocolate bar: 227 participants reported eating it (129 Danish, 98 Italians). A Generalised SEM (STATA 13) was carried out for investigating the effects of the messages on behaviour (eating or not the chocolate bar) via intention. Drawing on the double-path model by Strack and Deutsche (2004), we tested the significance of the direct effect of the two messages on intention, and the significance of the indirect effect on behaviour through intention (reflective system). In line with the

theoretical model, instead, we did not expect a direct effect of communication on behaviour[1]. Moreover, the implicit associations were added as a predictor of behaviour (impulsive system). The concept model is depicted in Figure 1

Figure 1- The effect of messages, intention, and implicit associations on behaviour.



For the factor message, two dummy variables were included in the model. The variable "social" had value 1 for the social benefit message condition and value 0 otherwise. The variable "individual" had value 1 for the individual benefit message condition and the value 0 otherwise. Maximum likelihood method was used with a logit model for taking into account the dichotomous nature of the criterion variable. Results are provided in Table 3. The effects of both messages on intention were significant, confirming the Anova results, as well as the effect of

intention on behaviour. The indirect effects of both messages on behaviour were also significant. Finally, the effect of implicit associations on behaviour was significant[2].

Table 3 - Generalized structural equation model

	Coefficients	***SE***	***z***	***p***
Direct effects				
Intention ← social benefit	1.021	.259	3.95	.000
Intention ← individual benefit	.762	.261	2.92	.003
Intention ← constant	3.365	.183	18.40	.000
Behaviour ← IAT	.780	.389	2.01	.045
Behaviour ← intention	.571	.116	4.91	.000
Behaviour ← constant	-.456	.401	-1.14	.255
Indirect effects				
Behaviour ← social benefit	.583	.190	3.08	.002
Behaviour ← individual benefit	.435	.173	2.51	.012
Log likelihood = -652.11378				

Results were supported by the predicted value (PPV) assessment: the model correctly predicted actual eating/non eating behaviour of the 86.7% of the

participants. As shown in table 4, the proposed logit model is able to represent with good accuracy both cases of eating (y = 1) and not eating (y = 0), whereas the baseline model can only predict one of the two modes. The model also shows a balanced distribution of the misclassified values.

Table 4 - Predicted Value Assessment

		Calculated Y		
Observed Y		Y=0	Y=1	Total
	Y=0	15	22	37
	Y=1	13	214	227
	Total	28	236	264

2.5 Discussion

In this study, we have investigated whether information about the individual and social benefits of eating insects has an impact on people's intention to eat insect-based food, as well as on their actual behaviour. We have also investigated whether these effects are contingent on a number of factors, notably nation (as a proxy for food culture), familiarity with the benefits of eating insects, gender and people's implicit attitude to insects. Our main result is that providing information about the benefits of eating insects does raise intention to eat insects, and that this intention does carry over to behaviour. It also seems that the effect on intention

persists at least for two weeks after the experiment. This main result is qualified in a number of ways. While the two types of messages – about individual and about social benefits – had similar effects when intention was measured immediately after exposure, the effect of the information on social benefits appeared to be more stable over time than the effect of information on individual benefits. As expected, our results underline the significant role of gender and familiarity, which is in line with Verbeke's (2015) result that males and people with a higher degree of familiarity are already more positive with regard to eating insect-based food. Nevertheless, it is important to highlight that the communication effects on intention remain stable across these two factors, and across nationality as well. The other major result of the study is the significant effect of implicit associations on eating behaviour. Coherent with theory (Strack and Deutsch, 2004), implicit associations have been shown to influence directly the behaviour, without the mediation of deliberative/conscious psychological processes. To our best knowledge, although the role of affective and non-conscious processes has often been emphasized as important in previous research on the eating of insects, this is the first empirical evidence about this point.

Given that this was a single-exposure experiment, the fact that an exposure to information can have an effect on both intention and behaviour is encouraging for the potential role of information in encouraging people to eat insect-based food. The provision of information about the benefits of eating insect-based food is an attempt to change behaviour that functions via conscious learning and the

volitional formation of intentions. As the resistance towards eating insect-based food is at least partly rooted in negative affective reactions acquired in early phases of socialization, such that these reactions can be assumed to be largely automatic, one could at the outset be sceptical about the potential of an information-based approach to change intentions and especially about the potential of such intentions to lead to actual behaviour. While our results on the effect of people's implicit attitudes towards insects do indicate that strong implicit negative attitudes could form a barrier against the eating behaviour, they also show that this barrier does not impede to communication strategies to be effective in promoting insect eating behaviour. In the model presented, indeed, communication has been shown to exert a significant effect on behaviour via intention also controlling for the effect of implicit associations. As noted the effect on intentions did carry over to actual behaviour. The high share of respondents in the study actually eating the chocolate bar with the insect protein is in itself an interesting result. As respondents took the chocolate bar home and could freely decide to throw it out or eat it, the high level of eaters cannot be attributed to experimental demand effects. The high level of eaters may be partly due to the fact that this was a processed product, so that the insect-based ingredient was not visible as such. This explanation would be in line with Schösler et al. (2012) finding higher acceptance for a pizza with insect-based proteins than for a salad with fried mealworms, and also with Hoek et al.'s (2011) results about consumer categorization of meat substitutes (see also Hartmann et al., 2015). However, the

packaging of our test product clearly stated that this product contained cricket protein, and this statement was underlined by pictures of crickets, reminding respondents of the insect content also during consumption. Our results thus suggest that there is a potential for experimental consumption of insect-based food when it is accompanied by information about the benefits of eating such food. Our results also underline the importance of food culture. Levels of both intentions and behaviour were higher in the Danish than in the Italian sample. A possible explanation for this difference is the pace of change of the two food cultures. The Danish food culture is not usually regarded as a very strong food culture, but has over the past decades experienced considerable changes in eating patterns, with some of the most innovative approaches to cooking and meals winning wide international acclaim (Byrkjeflot et al., 2013). In contrast, Italian food culture is widely regarded as one of the strongest in Europe, with a long-established reputation for combining gastronomic and nutritional qualities. People that have grown up and live in a strong and widely praised food culture may be less susceptible to trying new and different products than people who live in a rapidly changing food culture. The study has a range of important limitations. It is based on a student sample, implying that respondents are both young and well-educated. Verbeke (2015) found that younger people are more willing to adopt insect-based foods. He found no effect for education, but other research suggests that both age and education are related to willingness to try new food (Siegrist et al., 2013). The experiment was based on a single exposure to the

experimental stimulus and measurement of effects was limited to the two data collection points, right after exposure and two weeks later. It is possible that the effect decays over time, and it is also possible that repeated exposure could strengthen the effect. The present study thus can be seen as a proof of principle study, demonstrating that the provision of information can indeed have an effect on both intentions and behaviour regarding the consumption of insect-based food. Finally, in the follow-up we tried to collect information about participants' actual eating behaviour. Nonetheless, our criterion variable was self-reported. Therefore, we cannot exclude some effect due to social desirability. The study and its results point at several avenues for future research. As regards the implicit associations measurement, we used a standard "Flower vs. Insect" IAT, because it has been already widely used and tested for validity. The reliability of the test was very important since this was the first attempt to investigate the relations between implicit associations and the eating of insect-based food. It could be argued that a measure of implicit attitude towards insects as food could have a more direct link with the eating of insect itself, and this could be a very intriguing avenue for future research. However, using that kind of measure would pose several challenges, which need to be addressed. First, the contrast category choice – "flower" in the case of the standard Insect vs. Flowers IAT – would be not trivial. Second, also the stimuli selection should be conducted carefully, because they would not likely be words, but rather pictures of food-based insects (and pictures representing the contrast category as well), which could imply several intervening variables, such

as individuals' taste and emotional activation. Third, as we discussed, Western individuals do not consider insects as food at all; therefore, one should not assume that they hold implicit associations with insects as food. May be most importantly, replications with other populations, especially older and less educated people, would be desirable. Replications with alternative stimuli for the informational treatment would increase the external validity of the results. Multiple exposures and effect measurements could shed more light in the persistence of the effects over time. And very importantly, it would be desirable to see how the results on behaviour are related to the type of food under study. We indicated that the high rate of consumption among the respondents may be related to the type of product involved; this proposition should be supported by studies varying the type of food in a systematic way.

2.6 Appendix 1: Expert Interviews

Interview 1 – Societal benefits of introducing insects' proteins into human diet

Person 1 (Interviewer): There is a growing interest about food containing proteins derived from insects. For example, this is a chocolate bar with nuts, enriched with cricket proteins (s/he shows the chocobar). Now we are going to ask the opinion of the expert. Dear Prof. (Italian or Danish surname), according to you, what are the advantages of introducing insect proteins in the human diet?

Person 2 (Expert): Consuming insects has a number of advantages for the environment. Rearing insects requires very few amount of non-renewable resources and produces little environmental contamination. For example, insects require significantly less water than cattle rearing. A lack of water is already constraining agricultural output in many parts of the world. It is estimated that, in about ten years, one-third of the world population will be living in regions with absolute water scarcity, and two-thirds will likely be under stress. Moreover, the insects' production chain requires less energy and land use than livestock, and at the same time they emit few Greenhouse Gas, such as ammonia and CH4, which highly contributes to the Green House Effect. Finally, different from livestock rearing which requires a large amount of cereals for feeding, insects are reared exploiting waste material that would otherwise go unused.

Person 1 (Interviewer): Thank you very much Professor for sharing your knowledge with us. (Greetings)

Interview 2 – Individual benefits of introducing insects' proteins into human diet

Person 1 (Interviewer): There is a growing interest about food containing proteins derived from insects. For example, this is a chocolate bar with nuts, enriched with cricket proteins (s/he shows the chocobar). Now we are going to ask the opinion of the expert. Dear Prof. (Italian or Danish surname), according to you, what are the advantages of introducing insect proteins in the human diet?

Person 2 (Expert): Consuming insects has a number of advantages for human health. Many edible insects provide satisfactory amounts of energy and protein, with a very good nutritional profile for humans. For example, edible insects are a considerable source of fat. The oils extracted from several insects are richer in unsaturated fatty acids than meat, and frequently contain Omega 3, whose nutritional importance is well recognized for human health, mainly for the healthy development of children and infants. Also for minerals, most edible insects show a good nutritional profile. For example, they boast equal or higher iron contents than beef, and are good sources of zinc, whose deficiency is a relevant health problem, especially for child and maternal health. Finally, vitamins essential for stimulating metabolic processes and enhancing immune system functions are present in most edible insects, and for several species their content is higher than in meet.

Person 1 (Interviewer): Thank you very much Professor for sharing your knowledge with us. (Greetings)

Interview 3 - Benefits of introducing tablets in school (control condition).

Person 1 (Interviewer): There is a growing interest about using tablets in school. For example, this is a tablet, which can be used for several applications (s/he shows the tablet). Now we are going to ask the opinion of the expert. Dear Prof. (Italian or Danish surname), according to you, what are the advantages of introducing tablets in school?

Person 2 (Expert): Using tablets has a number of advantages for human learning. Schools already using tablets are reporting remarkable results in how children learn, research, interact and capture their studies. For example, students are more likely to share information and projects with each other, and with their teachers and parents. Teachers can more easily monitor progress, and give feedback on work quickly. Certain apps enable teachers to create a permanent record of each child's achievements. Also the touchscreen provides greater options for students who might struggle with traditional learning methods, easily supporting different audio, visual and kinaesthetic styles. For example, students can easily increase font size. Finally, there is a variety of apps that support difficulties such as dyslexia, without a teacher having to book extra resources, and make it easier for teachers to personalize lessons to individual student needs.

Person 1 (Interviewer): Thank you very much Professor for sharing your knowledge with us. (Greetings)

Footnotes

1. The direct effects of messages on behaviour were also tested, and as expected they were not significant (*Z*s < 1). Therefore, these effects have been excluded from the final model.

2. The variable used as outcome in the model was a dichotomous one, which represented the selected behaviour, namely participants' choice of eating versus not eating the chocolate bar with cricket proteins. Nevertheless, the choice of eating the bar could be due to the mere curiosity towards a new food, yet in principle the person who responded yes to the question about eating the bar could have tasted it and then thrown it away, thus not denoting a significant involvement. For addressing this issue, we tested the same model illustrated in figure 1 with a different outcome variable, namely the item "How much of the chocolate bar did you eat?", scoring from 1 (Not at all) to 5 (All). The model fit was excellent: NFI = .951; NNFI = .959; CFI = .979; RMSEA = .050. Previous results were fully confirmed.

3 Understanding Westerners' Disgust For The Eating Of Insects: The Role Of Food Neophobia And Implicit Associations.

Francesco La Barbera[a], Fabio Verneau[a], Mario Amato[c], Klaus Grunert[b]

[a]Department of Political Sciences, University of Naples Federico II, Italy

[b]MAPP Centre, Aarhus University, Denmark

[c]Department of Agriculture, University of Naples Federico II, Italy

3.1 Abstract

The interest for the potential introduction of insects in the human diet is progressively increasing and several benefits for both human health and the environment have been hypothesised. However, especially in Western Countries, this trend could be jeopardized by the aversion that people show for insects as food. In the present paper, we study the impact of food neo-phobia and disgust on the intention to eat insect-based food, and we look at how disgust is related to implicit attitude towards insects. Results show that both food neo-phobia and disgust make independent contributions to the intention to eat insects, and the explanatory power of disgust is considerably higher. Moreover, a significant effect of implicit attitude on disgust and an indirect effect of implicit attitude on intention mediated by disgust have been found. Implications for attempts to encourage people to incorporate insect-based foods into their diet are discussed, with special reference to the role of implicit association in determining the disgust reaction.

KEYWORDS: *Insects, Implicit attitudes; Disgust, Neo-phobia; Consumer Behaviour.*

3.2 Introduction

The interest for the potential introduction of insects in livestock feeding and in the human diet as well has dramatically increased over the last few years. A number of health and agricultural international organizations has contributed to this growing interest: the Food and Agriculture Organization (FAO), which has worked on edible insect since 2003, has hypothesised benefits for both human health and environment, and research evidence seems to provide encouraging results (Food and Agriculture Organization, 2006; 2009; 2013). Oonincx et al. (2010) indicate that greenhouse gas emissions and ammonia production from insect rearing are lower compared to conventional livestock. Oonincx and de Boer (2012) performed LCA finding a very low impact in terms of land use and global warming potential. In the same fashion, comparing different meat substitutes; Smetana, Mathys, Knoch and Heinz (2015) showed that insect-based products were the best performing in term of Life Cycle Assessment. Insects are also characterized by a low feed conversion rate, when compared with the traditional livestock such as chickens and, above all, beef (van Huis, 2013; FAO, 2015).

The growing interest in insects as food, supported by the many potential benefits, increases the need for a clear and comprehensive legal framework at the international level. On this specific issue, in 2015, the European Commission requested from the ESFA a review of the current knowledge about the different risks associated with production and consumption of insects. EFSA did not show

any serious safety concerns per se, since risks of using insects as food or feed are no greater than those associated with other animals, and the main risk are the food substrates and the handling and storage of farmed insects rather than insects species themselves. A further step toward a more comprehensive legal framework has been made in December 2015 when the European Parliament and the Council have adopted the new Regulation on Novel Food (2015/2283), which explicitly aims to make it easier for food business operators to place novel foods and food ingredients on the EU market. Although insects, according to the Regulation, fall under the definition of a novel food, they could be allowed to be placed on the market on the basis of a simple notification, if the applicant is able to demonstrate that the food/ingredient has been safely consumed by a significant part of a third country's population for at least 25 years. Also the interest of the business world has gradually grown. Many insect food companies are starting up in different European countries such as France, UK, Belgium and the Netherlands, and they are awaiting the definition of the regulatory framework to compete in this new emerging market. Of course, many questions remain still unanswered, both in terms of risk assessment and evaluation of the actual benefits that the potential breeding and consumption of insects could lead to regarding human health and the environment. However, it becomes increasingly likely that insect- based food will soon enter consumers' basket. One of the crucial aspects that could jeopardize this trend is the aversion that European consumers and, more generally, those of Western countries show for insects as food (Looy, Dunkel & Wood, 2014). Indeed,

from the perspective of Western consumers, eating insects is a new phenomenon. Therefore, the larger part of the research so far carried out aimed to identify the different factors that determine the intention to introduce insects into one's own diet. Among the main drivers, individual traits such as neo-phobia have been often considered as a major barrier to adopt insects as food (Verbeke, 2015; Hartmann, Shi, Giusto & Siegrist, 2015). Also, the level of awareness and knowledge about the possibility to introduce insects in the human diet, usually measured by the authors as "familiarity", have been identified as an important factor affecting willingness to try (Verbeke, 2015; Hartman et al, 2015). Finally, among the socio-demographic characteristics, gender and age are often correlated with willingness to consume insect-based foods. However, the factor most frequently cited by previous research in order to explain the aversion that European consumers show for insects as food is disgust (Martins & Pliner, 2006; Van Huis et al., 2013; Ruby, Rozin & Chan, 2015; Verkerk, Tramper, Van Trijp & Martens, 2007). Disgust has been traditionally considered as a basic emotion, which is universal for all humans (Darwin, 1872; Ekman & Friesen, 1971; Kroeber-Riel, Weinberg & Gröppel-Klein, 2009) and protects individuals from any potential source of disease (Haidt, McCauley, & Rozin, 1994; Matsumoto & Ekman, 2009; Rozin & Fallon, 1987). Although disgust is a universal emotion, it is important to note that the factors eliciting disgust can be different across individuals and cultures (Herz, 2012; Mignon, 2002). This is very clear in the case of entomophagy, because this practice is not disgusting for at least two billion people in South and East Asia and in several African, South, and

Central American countries, whereas it elicits disgust in many others (Van Huis et al., 2013). While disgust and neo-phobia may be related, they are not identical constructs, as not all unfamiliar food products lead to disgust whilst some familiar food products may lead to disgust. There is still a lack of knowledge on how neo-phobia and disgust jointly contribute to the rejection of insects as food, and of their relative weight. In addition, little is known about the psychological factors which determine whether and to what extent the eating of insects will elicit disgust in different people. Recent theoretical and empirical studies support the importance of implicit attitudes in food related behaviours. Implicit attitudes result from associations activated by the exposure to an item (Gawronski & Bodenhausen, 2006). Recently, Verneau et al. (2016) found that implicit associations predict the consumption behaviour of insect-based food. We argue here that disgust is related to implicit attitude towards insects, which is determined by the implicit associations that people have with the disgust-eliciting object, in our case insects. Thus, in the present paper, we look at the impact of food neo-phobia and disgust on the intention to eat insect- based food, and we look at how disgust is related to implicit attitude towards insects.

3.2.1 Theoretical Approach

3.2.1.1 Food neo-phobia and disgust

Food neo-phobia is the tendency to avoid unfamiliar food; it is hence a universal construct, but what is unfamiliar is of course culturally dependent. The Food Neo-

phobia Scale (FNS) is the instrument developed and validated by Pliner and Hobden (1992) to quantify this individual characteristic. More specifically, the FNS examines the neo-phobia/neo-philia continuum in humans. Since its publication in 1992, the FNS has been applied in several studies related to consumer responses to unfamiliar foods. More recently, the FNS has also been applied to the case of the possible introduction of insects in the human diet in order to evaluate the effect of food neophobia on the intention to eat food preparations based on or containing insects (Pedersen, 2014; Verbeke, 2015; Tan, Fischer, van Trijp & Stieger, 2016; Tan, van den Berg, & Stieger, 2016; Alemu, Olsen, Vedel, Pambo & Owino, 2015). Overall, research shows that food neophobia significantly and negatively affects people's willingness to eat insect-based food. Despite the huge interest in food neophobia and disgust as factors influencing the willingness to eat insects, there is a lack of research exploring the relationships between the two factors. Disgust, however, has been shown to be an important motivation for the rejection of novel foods of animal origin (Pliner & Pelchat, 1991), such as insects. Fear of unfamiliar food, as well as feelings of disgust for eating insects, could be both related to risk avoidance (Baker, Shin, & Kim, 2016; Cederberg, Persson, Neovius, Molander & Clift, 2011). As we already noted, disgust is related to the perception of danger (Haidt et al., 1994); on the other hand, people consider novel foods dangerous, and this belief negatively affects their willingness to eat them (Pliner, Pelchat, & Grabski, 1993). Hence, we could expect that more neophobic individuals are more likely to be disgusted by the eating of insects and show

lower intentions to eat them. Therefore, we will test empirically whether FNS significantly predicts intention to eat insect-based food, and we will also test whether this effect is mediated by disgust.

3.2.1.2 Implicit associations

Research in social psychology has recently focused on implicit cognitive processes, which are assumed to affect behaviour by operating outside of conscious awareness (Banaji, 2001; Bargh & Ferguson, 2000; Blair, 2001). Strack and Deutsch (2004) distinguish the impulsive system and the reflective system: In the latter, the link between beliefs and behaviour is mediated by reasoning, whereas in the former, there are automatic associations between categories (such as "insect") and concepts ("bad" or "good"), which are directly linked to behaviour. Recourse to implicit measures — such as the Implicit Association Test (IAT - Greenwald, McGhee & Schwartz, 1998) — in addition to traditional ones, has been shown to improve the prediction of behaviour (Greenwald, Poehlman, Uhlmann & Banaji, 2009; Vantomme, Geuens, DeHouwer, & DePelsmacker, 2006). Also in the food domain, research focused on the automatic processes involved in consumers' behaviour, showing the validity of implicit measures to predict individuals' food choices (Conner, Perugini, O'Gorman, Ayres, & Prestwich, 2007; Friese, Hofmann, & Wänke, 2008; Friese, Hofmann & Schmitt, 2009; Greenwald, Poehlman, Uhlmann, & Banaji, 2009; Maison, Greenwald, & Bruin, 2001, 2004; Richetin, Perugini, Prestwich, & O'Gorman, 2007; Perugini, 2005). Importantly, Verneau et al. (2016) found that implicit associations predict the consumption behaviour of insect-based food.

Coherently with theory — which posits that implicit associations occur in the impulsive system and are directly linked to behaviour — previous research has shown that implicit measures tend to be more powerful predictors of behaviour than of intentions (Verneau, La Barbera, Del Giudice, in press). Nonetheless, the effect of implicit associations on people's willingness to eat insects could be not direct, but mediated by disgust. As we underlined, disgust is a primary emotion. Since, however, the elicitation of disgust is culture specific, the elicitation must be based on some kind of learned associations between the stimulus eliciting disgust (here, insects) and something else that is a more basic source of disgust. There is rich empirical evidence about insects being associated, by Westerners, to disgusting items (e.g., faeces, decaying matter), and often with the idea of disease transmitters (Looy et al., 2014; Van Huis et al., 2013). Therefore, the implicit attitude deriving from implicit associations with insects could affect whether the exposure to insects or insect-related items—such as insect-based food—would elicitation disgust or not. The IAT is a measure of the implicit attitudes that individuals hold in relation to a given stimulus in their impulsive system, so it should mirror the - culture specific - quality (positive or negative) and strength of the implicit associations to insects that can explain disgust in Europe. Therefore, we hypothesize that implicit attitudes (measured by IAT) affect disgust which, in turn, affects intention to eat insects. We will also explore the significance of the indirect effect of implicit attitudes on intention via disgust.

3.3 Method

3.3.1 Overview of experimental procedure

Participants met in a computer lab and each of them was identified with an ID number. A "Insects vs. flowers" IAT was administered; then, they completed the Food Neophobia Scale and the Preference Index (measures are fully described below). They were also asked about their being vegan/vegetarian, food intolerances, and previous consumption experience of insect-based food. After that, participants received a chocolate bar with peanuts enriched with proteins from crickets (53g) as a reward for their participation. The label of the product clearly reported all the ingredients, among them cricket proteins, and this was underlined by pictures of crickets on the packaging. We choose this kind of product because previous research found a lower aversion of people to products with processed insect proteins, compared to products characterized by visible insects (Schösler, de Boer, & Boersema, 2012; Hartmann et al., 2015). About two weeks after the end of the experimental sessions, participants were contacted by telephone, and a short questionnaire was administered. They were asked 1) if they actually ate the chocolate bar 2) if yes, a single-item scale on disgust was administered; 3) the Intention Scale was administered.

3.3.2 Participants

A total of 160 university students participated to the study. The data of 9

participants were dropped because they declared being vegetarian and/or vegan and/or allergic/intolerant to any ingredient of the chocolate bar enriched with cricket proteins they received for their participation. It was not possible to collect follow up data from 3 participants; also these were dropped from database. Finally, 30 people declared they did not eat the chocolate bar and their data were not included in the analysis. The final sample consists of 118 subjects (58 females; Mage = 23.95, SDage= 4.20). All participants declared they never ate insect-based food prior to the current study.

3.3.3 Measures

3.3.3.1 Implicit Association Test

A standard "Insects vs. Flowers" IAT was administered to assess participants' implicit attitudes towards insects. Participants were asked to categorize stimuli (e.g. ant, locust, lily, orchid) belonging to the target categories (Insect or Flower) and stimuli (e.g. wonderful, lovely, horrible, awful) belonging to two opposite attribute categories (Positive and Negative), using the keyboard keys "A" and "L". In the next step, target categories and attribute categories shared the same response key (e.g. Positive and Flower); subsequently, the matching of categories was inverted (e.g. Negative and Flower shared the same response key). The final index was obtained by subtracting time latency in each categorization task. A longer reaction time indicates that for the respondent it is more difficult to associate the target and attribute category; by contrast, a shorter reaction time means that the

two categories are easily associated, indicating that the corresponding association is held by the respondent. Tested for reliability, the IAT proved adequate (α = 0.75). The IAT scores were standardised. Positive values of the IAT indicate positive implicit attitudes towards insects, whereas negative values indicate negative implicit attitudes.

3.3.3.2 Food Neophobia Scale.

The FNS by Pliner and Hobden (1992) was administered. It consists of ten statements (five positively worded and five negatively worded) rated on a 7-point scale from disagree to agree. In the current study, the FNS reliability was excellent (α = 0.87).

3.3.3.3 Preference index

We built an ad hoc instrument to measure participants' preference for the main ingredients of the chocolate bar (beside cricket flour), asking to evaluate the individual preference for each ingredient by a 10-point self-anchored scale from not at all to very much. The scores of the three items used were summed to obtain a single score (the higher the score, the higher the overall preference).

3.3.3.4 Disgust

Previous research largely used the disgust sensitivity scale (Haidt et al., 1994; Olatunji, Sawchuk, de Jong & Lohr, 2007), a self-reported questionnaire which measures the individual sensitivity to disgust. However, this instrument is not useful

to measure whether a specific food elicits different levels of disgust for different individuals, which is the aim of the current study. Therefore, in the follow-up interview conducted by phone, after asking if they actually ate the chocolate bar, we used a single-item to measure self-reported disgust specifically related to the presence of insects in the food eaten: "How much were you disgusted by the fact that there were crickets inside the chocolate bar?". Participants answered by means of a self-anchoring scale from 1 (not at all) to 10 (very much).

3.3.3.5 Intention

Three items (adapted from Balderjahn, Peyer & Paulssen, 2013) were administered, asking participants' about their intention to introduce insect-based food in their diet: 1) I would be prepared to eat insect based food in my every day diet; 2) I am willing to buy insect based food if it was available on the market; 3) I would tell my friends to buy insect based food if it was available on the market. Participants answered on 10-point self-anchoring scales from disagree to agree. Items were averaged in a single score ($\alpha = 0.90$).

3.4 Results

Table 1 provides means and standard deviations for the measured variables. Participants' mean FNS score is significantly lower compared to the scale theoretical midpoint, $t(117) = 7.20$, $p < .001$. The influence of gender and income on the measured variables is not statistically significant (all $ps > .05$). The effect of

education, instead, is significant on disgust, t (117) = 3.16, p < .01, and intention, t (117) = 2.85, p < .01: in fact, more educated people show less disgust ($M_{disgust}$ = 2.48, $SD_{disgust}$ = 3.14) and higher intention to eat insect-based food (M = 4.44, SD = 1.62) compared to less educated participants ($M_{disgust}$ = 4.56, $SD_{disgust}$ = 3.78; $M_{intention}$ = 3.46, $SD_{intention}$ = 1.99). Table 1 also provides bivariate correlations between the measures used in the study. Consistently with our expectations, the IAT scores significantly correlate with disgust. The IAT scores also correlate with intention declared in the follow up, yet this could be due to the hypothesized indirect effect of implicit associations on intention via disgust, which we will test in the next section. FNS significantly correlates with intention but not with disgust. As expected, intention correlated significantly with disgust. The preference index is not significantly correlated with other variables.

Table 1 - Summary of Intercorrelations, Means and Standard Deviations

Measures	***1***	***2***	***3***	***4***	***5***
1. IAT	0(1)				
2. FNS	-.046	3.19 (1.22)			
3. Preference Index	.006	-.036	17.49 (3.59)		
4. Disgust	-.407***	.144	-.050	3.67	

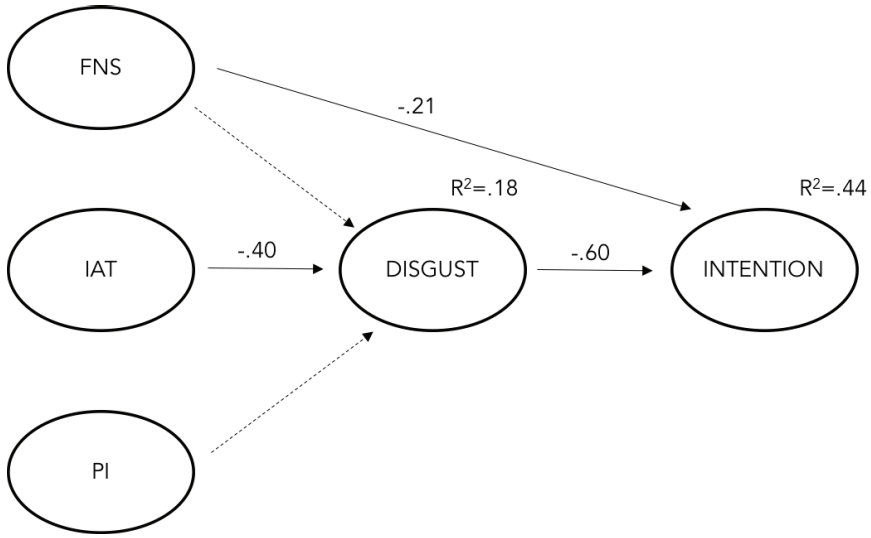
				(3.67)	
5. Intention	.231*	-.302***	-.060	-.623***	3.88 (1.90

Note. The table shows Pearson's *r* correlation coefficients. Diagonal cells report the means (standard deviations in parentheses).
* = p < .05; ** = p < .01; *** = p < .001;

The relationships between food neo-phobia, implicit associations, preference, disgust and intention were further studied by means of PLS Path Modeling (XLSTAT software). PLS Path Modelling is a component-based estimation method (Tenenhaus, 2008) that separately solves out the blocks of the measurement model and then, in a second step, estimates the path coefficients in the structural model. PLS Path Modelling is considered as an exploratory rather than confirmatory approach, very useful when no strong assumptions (e.g., as regards to the distributions) are present (Esposito Vinzi et al., 2010). PLS Path Modelling is considered very useful in explaining complex consumer behaviour in marketing research (Hair, Sarstedt, Ringle & Mena, 2012). Therefore, we choose a component-based estimation method, instead of a covariance-based approach, because it seems more suited to our sample size and to the study approach, which is more oriented to explore several relationships—on which there is a lack of scientific previous knowledge—than to confirm a theoretical model. A PLS-PM analysis was carried out for studying the direct effect of FNS on intention and disgust, as well as the indirect effect of FNS on intention *via* disgust. We also

entered in the model the direct effect of implicit attitude on disgust and intention, and the indirect effect of implicit attitude on intention *via* disgust. Finally, as a control, we tested the effect of the preference index on disgust as well. The model is depicted in figure 1.

Figure 1 - Partial Least Square Path Model (PLS-PM) of the Relationships Between FNS, IAT, PI, Disgust, and Intention.



From a cross-loading check it emerges that all items show a stronger loading on the respective construct than on other constructs (Table 2). The average variance extracted (AVE) is above the value of 0.5 for all constructs, which indicates that the items explain the main portion of the construct variance (Hair, Hult, Ringle & Sarstedt, 2014). The goodness of fit (GOF) indices suggest that the model fits the data very well (Esposito Vinzi et al., 2010): measurement model, GOF = .996;

structural model, GOF = .947; relative GOF = .943.

Table 2 - Item factors loading

Item	*Intension*	*IAT*	*Disgust*	*FNS*	*Preference Index*
Intention 1	***0,942***	0,205	-0,643	-0,276	-0,019
Intention 2	***0,962***	0,216	-0,625	-0,333	-0,067
Intention 3	***0,831***	0,213	-0,428	-0,207	-0,114
IAT	0,231	***1,000***	-0,407	-0,045	-0,005
Disgust	-0,624	-0,407	***1,000***	0,143	-0,046
FNS (parcel 1)	-0,320	-0,056	0,156	***0,956***	-0,002
FNS (parcel 2)	-0,255	-0,031	0,118	***0,956***	-0,049
Ingredient 1	-0,105	-0,009	0,040	0,018	***0,885***
Ingredient 2	-0,111	0,007	-0,070	0,023	***0,900***
Ingredient 3	0,071	-0,011	-0,098	-0,135	***0,678***

Note. For each item, the highest factor loading is evidenced in italic bold.

The effect of FNS on intention was significant, β = -.21, t = 3.03, f^2 = 08, p < .01, as well as the effect of implicit associations on disgust, β = -.40, t = 4.74, f^2 = .20, p < .001, which was medium to large. The effect of disgust on intention was significant and very large, β = -.60, t = 7.77, f^2 = .53, p < .001. We also found a

significant indirect effect of implicit attitude on intention mediated by disgust, β = .23, 95% CI (0.133, 0.367). No significant direct effect was exerted on disgust by FNS and preference index; the indirect effects of the last two variables on intention *via* disgust were non-significant as well (CI containing zero).

3.5 Discussion

Both food neophobia and disgust have been shown to be related to Westerners' lack of willingness to eat insects (Alemu et al., 2015; Pedersen, 2014; Tan et al., 2016a,b; Verbeke, 2015), with some researchers suggesting that these two constructs may in fact be related (Hartmann et al., 2015). Food neo-phobia is defined as an individual trait that involves the rejection of unfamiliar or novel food. People scoring high on food neo-phobia will reject eating insects to the extent they find insects an unfamiliar, novel and unusual food, implying that such people will be willing to eat insects when these are not perceived as unfamiliar, novel and unusual. The rejection of a food because of high food neo-phobia therefore requires an appraisal of the food in terms of its familiarity. Disgust, on the other hand, is traditionally considered an emotion. The fact that insects can elicit disgust in Western people has been related to the fact that they associate insects with broader categories of disgusting items like faeces and decaying matter (Looy et al., 2014; Van Huis et al., 2013). Rejection of eating insects because of disgust thus is dependent on the existence of associations between insects and other disgust-eliciting objects. The two constructs, food neo-phobia and disgust, have not been

clearly distinguished in previous research on eating insects, and the assumption that both are related to some kind of culturally-dependent appraisal mechanism suggest that they should at least be correlated. However, the results of this study show this not to be the case. Both food neo-phobia and disgust make independent contributions to the intention to eat insects in the future, and the explanatory power of disgust is considerably higher than the explanatory power of food neo-phobia. This difference may be partly attributable to the fact that food neo-phobia is a general trait and was measured as such, whereas disgust is elicited by a specific stimulus and was measures in this study as disgusted resulting specifically from consuming the chocolate bar containing cricket protein. Our finding has interesting implications for attempts to encourage people to incorporate insect-based foods into their diet. Food neo-phobia, as noted above, leads to the rejection of food when it is perceived as unfamiliar. Encouraging consumption of insect-based food also by people scoring high on food neo-phobia therefore implies making insect-based food more familiar. This will be a gradual process, which involves that more insect-based food products are introduced on the market, these products are discussed in public and private arenas, and more and more less neophobic people start eating them. Eventually, this will result in insect-based food being regarded as familiar, and even a higher degree of food neo-phobia will then no longer lead to rejection. This is a slow process that could take a generation to complete. However, making insect-based food more familiar does not necessarily imply that people will not be disgusted by

it. In our study, none of the participants had consumed insect-based food before. The provision and subsequent consumption of the chocolate bar containing cricket protein will have increased participants' familiarity with insect-based foods, but has, at the same time, resulted in the elicitation of disgust for some of the participants. Given that the effect of disgust on the intention to eat insect-based food in the future is much larger than the effect of neo-phobia, it becomes clear that just increasing familiarity may not result in the adoption of insect-based food. We also need to understand the basis for disgust and find ways of reducing the elicitation of disgust. It has been suggested that social learning plays a significant role in disgust (Rozin, Haidt, & McCauley, 2009), and adults attitudes' towards food affect children's food habit and preferences (Haidt et al., 1994, Rozin et al., 1998). Therefore, disgust-eliciting associations tend to be transmitted between generations, reinforcing cultural differences in what elicits disgust. In trying to reduce the basis for the elicitation of disgust by eating insects, we can draw on our result showing that disgust is related to implicit attitudes towards insects, and reducing the disgust reaction therefore requires changes in those implicit attitudes. The dominant paradigm for analysing the formation and change of implicit attitudes has been evaluative conditioning (see Hofmann, DeHouwer, Perugini, Baeyens, & Crombez, 2010 for a review). Evaluative conditioning of implicit attitudes to food items and to food preparation methods has been shown to be related to sensory perception of the food (Grunert, Bredahl & Brunsø, 2004), but can be achieved also just by pairing with images (Loebnitz & Grunert, 2015).

In the food domain, pairing stimuli such as sensory information or valenced images with food items has been shown to change implicit attitudes towards the food items (Hollands, Prestwich, & Marteau, 2011; Lebens et al., 2011; Verhulst, Hermans, Baeyens, Spruyt & Eelen, 2006). This suggests that a more positive implicit attitude to eating insects and hence a lower incidence of disgust reactions could be achieved by developing insect-based products that are tasty, by embedding them in positive gastronomic experiences, and also by just pairing them with image and verbal stimuli that are known to be positively valenced. Another procedure that has been shown to be effective in changing implicit attitudes is the Self-Referencing (SR) task (Perkins & Forehand, 2012; Prestwich, Perugini, Hurling & Richetin, 2010), that is an associative paradigm which uses the self as a positivity source (Perugini, Zogmaister, Richetin, Prestwich & Hurling 2013).The results of a recent study provides initial evidence that the positive effect of pairing the self with food brands and products persist also after the pairing is removed, suggesting the resistance of the implicit attitude change at least in the short span (Richetin, Mattavelli, & Perugini, 2016). The present study is a single country study and our results require replication in different cultural contexts that differ in both degree of familiarity of insect-based food and in implicit associations to insects, building on existing cross-cultural studies like Hartmann et al. (2015). It should then be complemented by studies investigating changes in implicit attitude to insects by different forms of inducing new evaluative associations. This should involve the investigation of the role of the

sensory properties of the food, of differently valenced eating contexts, and of pairing with image and verbal stimuli as could be done in different forms of market communication.

4 Assessing The Role of Food Related Lifestyle in Predicting Intention Towards Edible Insects: A Case Study

Mario Amato[a], Fabio Verneau[b]; Francesco La Barbera[b], Klaus Grunert[c]

[a]*Department of Agriculture, University of Naples Federico II, Italy*

[b]*Department of Political Sciences, University of Naples Federico II, Italy*

[c]*MAPP Centre, Aarhus University, Denmark*

4.1 Abstract

Albeit the benefits of switching to insect-based foods lay not only the nutritional value, but also the positive environmental, economic and ecologic impacts, the potential growth of insects as everyday food is still unclear. Despite a growing literature on consumer acceptance and product preference for insect-based food, a segmentation of this future and possible market has never been analysed. Therefore, in the present paper, a market segmentation via the Food Related Lifestyle Scale (Grunert, 1993), was performed in order to predict consumers' behaviour towards edible insects. Moreover, the role of perceived behavioural control is taken into account. Results shows that the novelty and benefits of insect consumption have generated much interest in edible insects amongst consumers belonging to Rational cluster, who showed the highest intention to perform the behaviour, therefore confirming the presence of a niche of "early adopters" Implications for attempts to encourage people to incorporate insect-based foods into their diet are discussed, with special reference to the role of marketing campaigns.

KEYWORDS: *Insects, FRL; Perceived Behavioural Control, Intention; Consumer Behaviour.*

4.2 Introduction

The unsustainability of food production and consumption have been and continue to be a major contributor to climate change (Urry, 2011; Berners-Lee et al., 2012). A rampant land grabbing has led to the conversion of natural ecosystems to farmland and pastures, becoming one of the biggest cause of biodiversity loss. If the nowadays challenges are difficult to face, in the next future humanity will face ever greater challenges and environment-unsustainable methods should be abandoned. The discovery of new and sustainable approaches for food production, with reduced impacts on atmosphere, land and oceans, is a global priority.

According to Tukker and Jansen, 2006, between 20% and 30% of the total human's environmental impact is caused by food production. A change of consumers' lifestyle could lead to a zero impact future, e.g. reducing or replacing animal protein consumption, well known for having a larger environmental impact (Aiking, 2011). As suggested by Premalatha et al., 2011, an extreme approach would be replacing beef or pork by edible insects, which have a comparable protein yield with considerable less feed (Deroy et al., 2015). In addition, insect proteins possess nutritional advantages in total protein level and/or essential amino-acid over plant proteins such as cereal, legumes, beans or soybean (Rumpold & Schlüter, 2014). The benefits of switching to insect-based foods lay not only the nutritional value, but also the positive environmental, economic and ecologic impacts. In fact, compared with conventional livestock

farming approach, farming insects has many advantages including increased feed-conversion efficiency, decreased GHG emissions, reduced water pollution and smaller land use with low environmental contamination (Oonincx & de Boer, 2012). Despite these benefits, the potential growth of insects as everyday food is still unclear (Srivastava et al., 2009), since widespread consumers' acceptance of insects as an alternative food source remains a concern. Edible insects have been part of the human diet for thousands of years (Bodenheimer, 1951), although their consumption is now uncommon in Western societies. According to Hartmann & Siegrist, 2017, there is a growing literature on consumer acceptance and product preference for insect-based food. Huge differences in perception, acceptance and willingness to experiment exists between Eastern countries, where insects have been traditionally used thereby recognising the nutritional, ecological and economic benefits of entomophagy (Yen, 2015), and Western societies, where a public aversion towards consuming insects exist, since this act is not deeply rooted in traditional diet and insects are generally perceived as "unclean", "mere pests", "disgusting nuisances" or "disease transmitters" (Pimentel, 1991; Kellert, 1993; Looy et al., 2014). But in Western countries and in particular in Europe, something is changing, in fact the recent European regulation 2015/2283 includes insects in the novel food list, making great strides towards a comprehensive and international legal framework (EFSA, 2015). Consumers' attitudes towards novel food differ noticeably and are guided by factors such as age, gender, food familiarity, food neophobia, food choice motives, convenience and environment

(Dovey et al., 2008). According to Martins and Pliner, 2005, consumers' initial perception of a new food is a crucial factor that affects their willingness to consume. Thus, convincing an insect phobic culture to recognize the value of insects in sustainable food supply chains is not only a matter of mere sustainable production but includes creating consumers demand by increasing their acceptance. In the last few years, a growing literature investigated westerners' willingness to accept and adopt insect-based food (Hartmann et al., 2015; Ruby et al., 2015, De Magistris et al., 2015) or their willingness to substitute meat products with insects (Hartmann et al., 2015; Schösler et al., 2012; Vanonhacker et al., 2013), usually in connection to traits such as food neophobia (Looy and Wood, 2006; Gmuer et al., 2015; Baker et al., 2016; Laureati et al., 2016; Tan et al., 2016; Alemu et al., 2017; Le Goff and Delarue, 2017), disgust sensitivity (Hamermann, 2016; Balzan et al., 2016; Sheppard and Frazer, 2015; Hartmann and Siegrist, 2016), previous instances of consumption (Tan et al., 2015; 2016a,b; Piha et al., 2016;:, Alemu et al., 2015; Wit and Fischer, 2015; Cicatiello et al., 2016; Caparros Megido et al., 2014; Lensvelt and Steenbekkers, 2014), indirect measures as implicit associations (Verneau et al., 2016) and other general characteristics such as demographic (Ruby et al., 2015) and general or food-related attitudes (Hartmann et al., 2015; Verbeke, 2015; Sogari et al., 2016). From a scientific point of view, future research should aim to develop a more integrated approach to the study of the antecedents of the willingness to eat insects, whereas, on the practical side, studies addressing market segmentation and communication

strategies are needed. The Food Related Lifestyle (Grunert, 1993) could answer to both those needs, because instead of focusing on single specific factors, they propose a more holistic approach to understanding and forecasting consumer behaviour in relation to food choices. In addition, FRL could be useful for market segmentation and cross-cultural comparisons. To the best of our knowledge, this is the first study utilizing lifestyles, in particular a market segmentation via the Food Related Lifestyle Scale (Grunert, 1993), in order to predict consumers' behaviour towards edible insects. Furthermore, albeit consumers' intention to introduce insect-based food into their diet has been widely investigated, at present, insect-based food market actually does not exist. As mentioned before, since previous research mainly focused on familiarity and/or food neophobia, research should investigate issues related to difficulties that consumers would face if they actually try to introduce this kind of food into their diet (e.g. for the unavailability of insect-based food). Therefore, in the current study, this topic was hit by measuring participants' perceived behavioural control (Ajzen, 1991; Fishbein & Ajzen, 2010) about eating insects, namely their beliefs about the possibility to be autonomous in this choice (autonomy) and the perceived difficulty of the task (capacity). In the following sections, a brief description of Food Related Lifestyle is proposed, followed by an overview of the experiment and a discussion upon the obtained results.

4.2.1 Food-Related Lifestyle

Typically, in marketing research, lifestyle research is a method used for market segmentation (Vyncke, 2002). When the development of today's consumer society made socio-demographic characteristics less and less predictive of consumer behaviour, a segmentation following the lifestyles was proposed to fill this gap and divide, thus, consumers in relatively homogeneous groups. Studies around lifestyle segmentation proposed the result an interconnection between lifestyles exist in every consumer. Researcher suggested the existence of "domain specific lifestyle" (Van Raaji & Verhallen, 1994), of which food-related have been deeply studied (Grunert, 1993). A food-related lifestyle model, described by the author as a deductive and cognitive approach on lifestyle research, was proposed by Grunert, 1993, and, since then, it has been applied in a wide range of studies all over the world (Grunert, et al., 2001; Grunert et al. 2011; Nie & Zepeda, 2011). In Grunert, Brunsø, e Bisp, 1993, pag. 13, domain-related lifestyles are described as "the system of cognitive categories, scripts, and their associations, which relate a set of products to a set of values". The FRL model, inspired by the psychological means-end chain theory proposed by Gutman in 1982, sees the lifestyles as part of a hierarchical, cognitive-behavioural structure that operate as an organizational and guidance construct in a person's life. Thus lifestyles are perceived as an appliance to reach mayor objective or values (such as hedonism, tradition, self-direction), which are more abstract and trans-situational cognitive categories (Rokeach, 1973; Schwartz, 1992; Schwartz, 1994). Lifestyles, in certain

situations, turn out to be what frames consumers' perception regarding products and services, guiding her/his choices and behaviours (Thøgersen, 2017). The cognitive structure that lays beyond a FRL is expected to comprehend five main domains. Two are associated with food purchase motives and food quality aspects, while the other three are connected to food provision, cooking methods and consumption situations. These five cognitive elements are presumed to catch the key characteristics of an individual's food related lifestyle. The whole model is a system of interacting elements in which personal values are (part of) the underpinning from which purchasing motives are derived; quality aspects, consumption situations, ways of shopping and cooking methods frame our view of food products, services, and other food-related activities and thus affect our behaviour, including food choices and preparation and how we, for example, deal with food and food-related waste (Thøgersen, 2017). The European studies on FRL identified a number of basic cross-cultural food consumer segments that can be found across national borders. These segments count the uninvolved food consumer, the careless food consumer, the conservative food consumer, the rational food consumer and the adventurous food consumer. Analysis has shown that different segments have different preferences, different perception of food quality and are interested in different types of product information revealing a need for adapting marketing communication towards the specific consumer segments (Grunert, Brunsø, Bredahl & Bech, 2001). The instrument has so far been applied in a number of European countries with the purpose of predicting a range

of specific food-related behaviours, including how consumers respond to new food products (Cullen & Kingston, 2009), meat consumption (Grunert, 2006), and preferences for a vegetarian diet (Hoek, et al., 2004).

4.3 Method

The study has been conducted in two different European countries, Italy and Denmark, where 300 subjects (150 Danish and 150 Italians) were recruited in the university canteen by a researcher, who approached subjects individually and introduced him/herself as an academic marketing researcher from the local institution (University of Naples Federico II in Italy, Aarhus University in Denmark). After the agreement, participants were conducted in the lab were computer-based questionnaire was administered. The total procedure took approximately 15 minutes for each participant to complete. Prior to answer the questions, and in line with Verbeke (2015), participants were informed that insects "are a good source of high-value proteins, their production requires little space, their feed conversion is efficient, and therefore the eating of insects provides benefits in terms of sustainability". The questionnaire contained the FRL inventory, the Intention scale and Perceived Behavioural Control scale. At the very end, information about gender and level of education were collected. Moreover, bystanders were also asked about their being vegan/vegetarian and previous consumption experience of insect-based food.

4.3.1 FRL

The food-related lifestyle instrument (Grunert, 1993) translated in both languages, was used as a tool to measure attitudes to food. This 69-item questionnaire (seven-point scales, from 'totally disagree' to 'totally agree') measures 23 lifestyle dimensions, that cover the assessment, preparation and actual consumption of food products: ways of shopping, quality aspects, cooking methods, consumption situations and purchasing motives.

4.3.2 Perceived Behavioural Control Scale

Drawing on previous research (Ajzen, 1991; Fishbein and Ajzen, 2010), three items were used for measuring perceived behavioural control: 1) I think it is very difficult, for people like me, to introduce insect-based food in their diet (reverse coded); 2) I think that even if I tried, I would not be able to introduce insect-based food into my diet (reverse coded); 3) In the everyday life, each of us could easily introduce insect-based food in her/his diet. Participants answered on 7-point self-anchoring scales from disagree to agree. Items were averaged in a single score ($\alpha = 0.81$). The higher the score, the higher the perceived behavioural control.

4.3.3 Intention

Three items (adapted from Balderjahn et al., 2013) were used for measuring participants' intention to introduce insect food in their diet: 1) I would be prepared

to eat insect based food in my every day diet; 2) I am willing to buy insect based food if it was available on the market; 3) I would tell my friends to buy insect based food if it was available on the market. Participants answered on seven-point self-anchoring scales from disagree to agree. Items were averaged in a single score ($\alpha = 0.90$), therefore higher the score, higher the intention.

4.4 Results

A total of 300 subjects (150 Danish, 150 Italians) participated to the study. The data of 20 participants were excluded from the analysis, 18 because they declared being vegetarian and/or vegan, and 2 because they failed to complete the questionnaire. Final sample consists of 280 subjects (138 females; M_{age} = 23.61, SD_{age} = 3.86). The two national sub-samples were not significantly different as regards gender (Denmark: 64 females; Italy, 74 females; X^2 (280) = 1.161, p = .281). Education was dummy-coded (0=undergraduates, 1= degree) and was found to be not significantly different in the two subsamples (Denmark: 75 undergraduates; Italy, 85 undergraduates; X^2 (280) = 1.144, p = .285).

4.4.1 Food Related Lifestyle Scale

Two dimensions were dropped for being not satisfactory (Taste = 0.43; Social Event = 0.36). The scores of the remaining 21 FRL dimensions were used to classify participants by using hierarchical cluster analysis with Ward's method. A 5 cluster solution was chosen based on analysis of cluster means, interpretability, and

comparability with earlier analyses of FRL data (e.g., Grunert et al., 2001). The five clusters emerging are labelled uninvolved, careless, rational, conservative, and adventurous food consumers. There are considerable differences in the incidence of members of these five groups in the two countries, as can be seen in table 1.

Table 1 - Distribution of FRL clusters over countries

	Uninvolved	***Careless***	***Conservative***	***Rational***	***Adventurous***
Italy	10,6%	19,1%	29,8%	19,1%	21,3%
Denmark	39,7%	5,7%	1,4%	22,0%	31,2%
Total	25,2%	12,4%	15,6%	20,6%	26,2%

While the share of rational food consumers among the participants is almost equal in both countries, and the share of adventurous food consumers is comparable, almost all participants classified as conservative food consumers are in the Italian sample, whereas by far most of the uninvolved food consumers are in Denmark. In table 2, a comparison between the 21 dimensions mean value for the five cluster is proposed.

Table 2 – Mean comparison of the 21 FRL dimensions among clusters

	Uninvol.	***Careless***	***Conservative***	***Rational***	***Adventurous***
Product Info	4.55^{a}	$5.56^{b,c}$	$6.06^{b,c}$	6.21^{c}	5.48^{b}

Advertise Attitude	4.01[b]	3.23[a]	3.25[a]	2.96[a]	4.00[b]
Enjoy Shopping	4.22[a]	4.28[a]	5.07[b]	5.61[b]	5.18[b]
Speciality Shops	3.89[a]	4.74[b]	5.53[c]	5.60[c]	4.19[a]
Price Criteria	5.15	5.30	5.47	5.65	5.47
Shop List	4.36[a]	5.12[a,b]	5.55[b,c]	6.04[c]	4.59[a]
Health	3.46[a]	5.59[b]	5.51[b]	5.85[b]	3.99[a]
Price Quality	4.55[a]	5.72[b,c]	6.14[c]	6.13[c]	5.37[b]
Novelty	4.33[a]	4.16[a]	3.80[a]	5.51[b]	5.18[b]
Organic	3.13[a]	5.34[b]	4.93[b]	5.51[b]	3.28[a]
Freshness	4.43[a]	6.29[c]	6.45[c]	6.00[c]	5.22[b]
Cooking Int.	4.32[b]	3.33[a]	5.95[c]	6.16[c]	5.84[c]
New Way	3.96[a]	4.13[a,b]	4.80[b]	6.16[c]	5.66[c]
Convenience	2.87[c]	2.51[b,c]	1.64[a]	1.75[a]	2.17[a,b]
WholeFamily	3.74[a]	3.50[a]	4.80[b,c]	5.24[c]	4.30[a,b]
Planning	3.91[b]	3.15[a]	3.28[a,b]	3.67[a,b]	3.47[a,b]
Woman Task	2.26[a]	3.16[b]	3.35[b]	1.55[a]	1.88[a]
Snack Meal	2.90[a,b]	4.30[c]	3.66[b,c]	2.52[a]	3.51[b,c]

Fulfilment	4.07[a]	4.12[a]	5.27[b]	5.84[b]	5.26[b]
Security	3.06[a]	4.19[b]	4.36[b]	2.61[a]	3.00[a]
Social	5.18[a]	5.85[b]	6.05[b]	6.25[b]	6.00[b]
N	71	35	44	58	74

Note: equal apexes equal mean, per line – Bonferroni method

According to our data, the five clusters are characterized as follows:

- *The Uninvolved food consumer*

These consumers are quite uninterested in most aspects of shopping and score below average on importance of product information, enjoyment from shopping, use of speciality shops, use of shopping lists, and use of the price criterion. On the other hand, for this segment, labels and price tags are especially important; other potentially influential factors (e.g. salespersons, advertising, and friends) are rarely considered by them. They have stronger price sensitivity and their demand for novelties is limited; therefore, these consumers are quite uninterested in most aspects of food, and they hardly use food to achieve basic values.

- *The careless food consumer*

The consumers of this segment under-evaluate all the factors in the model by giving the lowest marks in all of the five segments. They do not care about product information or food labels, do not believe in advertisements, and listen to others

only very rarely. They are not interested in shopping for food at all; they do their shopping as need dictates, mechanically and spontaneously.

- *The conservative food consumer*

This segment ascribes great importance to product information, a fact primarily shown in their attitudes to advertisements. People of this segment trust those products better that are intensely promoted; the messages of advertisements help them to make proper shopping decisions. This segment consists of open-minded consumers who do not even mind being influenced by others while shopping. Health consciousness and naturalness are values for them. They rarely try exotic food recipes and cannot be regarded as novelty-seekers.

- *The Rational food consumer*

A person belonging to this cluster consider about all life-style dimensions more important than other consumers do, giving rise to an interested while critical shopping behaviour. Among these dimensions' product information is especially important to them, and this is important mainly for dietary considerations, moreover they look after prices, use shopping list and enjoy shopping. Regarding cooking methods, they have an above average tendency to look for new ways in the kitchen. Food and food products are in important part of these consumers' lives and are essential for achieving basic values such as self-fulfilment. According to table X, this is valid both in the Italian case and in the Danish.

- *The adventurous food consumer*

This segment is more concerned about food labels and nutritional information; the choices among brand names are the reasons for this. They less frequently believe in advertisements or promotional messages, but they are more likely to take suggestions from other consumers. They are strongly motivated to try exotic recipes and to buy foods that they have never tried before (they are responsive to novelty). They put nutritional benefits foremost; therefore, they are willing to dismiss high sensory appeal (deliciousness), excellent flavour, and freshness.

4.4.2 Intention

In order to deeper understand how the intention varies among the five clusters, an ANOVA was performed (table 3). The effect of the factor *FRL clusters* on the intention to introduce insect food in the diet was significant, $F(4, 275) = 5.001$, $p = .001$. Post hoc test (method: Bonferroni) showed that the mean scores of rational consumers were significantly higher compared with those of careless and conservative.

Table 3 – Mean scores of Intention per clusters

FRL Clusters	***M***	***SD***	***N***
Uninvolved	$4.00^{a,b}$	1.58	70

Careless	3.39[a]	1.86	35
Conservative	3.26[a]	1.91	44
Rational	4.70[b]	1.92	57
Adventurous	4.01[a,b]	1.78	74
Total	3.95	1.84	280

Note: equal apex letter means equal mean score – Bonferroni method

In addition, and in line with expectations, a medium significant negative correlation between the scores of intention and perceived behavioural control (r = - .389, p < 001) was found. Therefore, next step was to apprehend which variables have influenced consumers' intention, that's why a linear regression model was performed, specified as follows:

$$Intention_i = \alpha + \beta_1 * Nation_i + \beta_2 * Gender_i + \beta_3 * Education_i + \beta_4 * Perceived\ Control_i + \beta_5 * Rational_i + \beta_6 * Conservative_i + \beta_7 * Careless_i + \beta_7 * Adventurous_i + \varepsilon_i$$

The clusters were dummy coded (keeping uninvolved as the reference category) while perceived control is the main value of the three item scale. Moreover, as explanatory socio-demographic variables, we introduced Nation, a dummy variable equals to 0 if the bystander was Italian, 1 if Danish; Gender, a dummy variable equal to 1 if the subject was female and Education as a dummy variable

equal to 1 if the participants possessed a degree. The model expressed was estimated using STATA 13 software and results are provided in table 4.

Table 4 – Regression model

Model	***Coefficient***	***t***	***P***
Nation	-.178	-2.976	.003
Gender	.122	2.286	.023
Education	.159	3.058	.002
Perceived Control	.379	7.213	.000
Rational	.172	2.655	.008
Conservative	-.060	-.862	.390
Careless	-.035	-.560	.576
Adventurous	.018	.283	.777
(Constant)		14.603	.000

Note. Dependent variable: Intention. $R^2 = .28$, $F(1, 271) = 13.16$, $p < 001$.

Results shows that many independent variables exerted a statistically significant effect upon intention, in particular being Danish rather than Italian, being male and being graduates, as regards sociodemographic characteristics. In addition, perceived behavioural control has a strong positive effect upon intention to consume insect based foods. Among the FRL clusters, only being Rational exerted a positive and statistically significant effect upon intention.

4.5 Discussion and conclusions

The present study has investigated the potential role of market segmentation in order to single out consumers who are willing to adopt insects as food. Theoretically, the study is based on Grunert's (1993) well-established cognitive approach to food related lifestyle segmentation, in two different European Countries, Italy and Denmark. Five relevant and clearly distinct consumer segments with a meaningful segment size have been defined, in line with previous studies on the FRL, confirming the cross-country validity of the method (Brunsø et al. 2004). In particular, the share of rational food consumers is almost equal in both countries, 19,1% in Italy and 22% in Denmark, and the share of adventurous food consumers is comparable. Main differences can be found among the other three cluster, in fact almost all participants classified as conservative food consumers belong to the Italian sample, whereas by far most of the uninvolved food consumers are in Danes. Earlier applications of the FRL in Denmark found conservative food consumers mainly among older consumers, so the dearth of this type in this Danish sample – which consists of young people – is not surprising; finding them in the Italian sample might be related to the conservatism inherent in a strong food culture with considerable heritage and inertia.

The outcomes of this study have shown that the novelty and benefits of insect consumption have generated much interest in edible insects amongst consumers belonging to Rational cluster, who showed the highest intention to perform the

behaviour, differently from Conservative and Careless, as the regression model has confirmed. This information might be due to the fact that Rational consumers has critical while interested shopping behaviours. According to results, they look after prices and actually enjoy shopping in order to satisfy their need to find new cooking methods or recipe. Moreover, they have a strong interest in healthy products and novelties, and they are more willing to gather information while shopping compared to other clusters. Therefore, this higher level of intention might be explained by the information note that consumers received at the beginning of the experiment, in which insect's properties were described, increasing and stimulating, probably, the interest of Rational consumers. Of course a link between reported intention to consume edible insect and actual future consumption cannot be stated, even though "early adopters", as rational consumers can be defined, merit attention and further research. In addition, behavioural control refers to the ease or difficulty of obtaining or consuming a specific product. Although the intention to consume edible insect's products has been reported as mildly-high, it might be impossible to perform the behaviour because of edible insects' low availability on the market and little/no knowledge regarding both the product itself and how it can be utilized. A demand for new foodstuff is affected by increases in supply (Ellis et al., 2015; Mintz, 1986), therefore "a particular food must be widely available if it is to become an accepted and integrated part of people's diet" (House, 2016). Therefore, taking into account that perceived behavioural control can affect behaviour indirectly by its impact on intention

(Ajzen, 2002), major marketing strategies could address this issues by increasing the positive and distinctive attributes of edible insects, both from an environmental perspective but also focusing on their availability on the market, stimulating the seek for novelties by proposing new recipes, ergo arousing the curiosity. Considering the fact that a new foods gain popularity in one small segment of society first, before diffusing further, as it has been the case with tea (Ellis et al., 2015) or sushi (Corson, 2009), pointing to a group of early adopters, as could be the Rational consumers (20% of our sample), can lay the foundation for a broader commercial development with a higher degree of acceptance among consumers.

This research has many limitations. First and foremost, despite studies in the literature have demonstrated that students do not intrinsically pose a problem for a study's external validity (Druckman & Kam, 2011), a broader and more stratified sample is required in further research. In addition, in this work it was not explored the role of the disgust in general and, more importantly, disgust towards insect as food since the lack in literature of an explicit scale that directly addresses this issue. This research, therefore, should foster new studies in other European Countries, maybe analysing the different perception of edible insects between East and West, replicating the use of Food Related Lifestyle in order to confirm our data.

5 Summary of Main Findings

This PhD thesis explored consumers' attitude, intention and behaviour towards edible insects. A series of conclusions can be drawn from the papers constituting the work. From a literature perspective, it is clear that the reported benefits of the human consumption of insects as an alternative to conventional food animals are numerous, including comparable levels of protein, and relatively high although variable levels of nutrients and unsaturated fat coupled with a lower environmental impact due to lower emissions of greenhouse gasses and lower land requirements during production. Yet despite the apparent viability of insects as a sustainable alternative to conventional protein sources, a number of obstacles to their widespread use as human food in the West remain. The ecological benefit and healthiness of food insects relative to conventional sources of animal-based protein are debated and the issue of consumer acceptance remains problematic.

Going deeply in this issue, it was investigated the possibility to foster people's willingness to eat insect-based food through communication, also comparing messages based on individual vs. societal benefits of the eating of insects. Communication proved to be effective on intention and behaviour, and the societal message appeared to be more robust over time. The communication effect is significant across nation, gender, and previous knowledge about the topic. In addition, it was investigated the impact of non-conscious negative associations with insects on the choice to eat vs. not eat insect-based food. Implicit attitudes

proved to be a powerful factor in relation to behaviour, yet they did not impede the effectiveness of communication.

In addition, the impact of food neo-phobia and disgust on consumers' intention to eat insect-based food was investigated, focusing on how disgust is related to implicit attitude towards insects. Results show that both food neo-phobia and disgust make independent contributions to the intention to eat insects, and the explanatory power of disgust is considerably higher. Moreover, a significant effect of implicit attitude on disgust and an indirect effect of implicit attitude on intention mediated by disgust have been found.

Lastly, a market segmentation has been performed in order to highlight the presence of a niche of consumers more willing to try insect based food, via the food related lifestyle scale. Results shows that, verified the presence of this segment of "early adopters", the role of perceived behavioural control is still of major concern. In order to avoid this issue, structured marketing operations are needed, in order to lay the foundation for a broader commercial development with a higher degree of acceptance among consumers.

From these main findings it is clear that there are a lot of factors that interact within and outside the consumer while he is making a choice or gathering information to build an attitude toward a new food product. It is clear that consumers' acceptance of insects as food is not simply a case of whether or not an individual will eat a particular product once, but also the extent to which that food becomes an accepted and integrated part of their established culinary regimes. This to a

large extent depends on product attributes as well as much broader considerations of the diverse, intersecting and habituated social practices in which an individual takes part, including their food provisioning and consumption practices. Therefore, consumers need to be educated about all the features that characterize the product, in order to match the perspective on quality and security as supported by European Union with the one that the consumers appreciate. In turn, enhancing the familiarity and the knowledge of the consumer toward edible insects will allow to have less heterogeneous results in terms of preferences of the consumers and to better focus the development of products toward what can guarantee to this product the success on the market.

6 References

Aiking, H. (2011). Future protein supply. *Trends in Food Science & Technology*, *22*(2), 112-120.

Ajzen, I. (2002). Perceived behavioral control, Self-Efficacy, locus of control, and the theory of planned Behavior1. *Journal of applied social psychology*, *32*(4), 665-683.

Ajzen, I. (1991). The theory of planned behavior. *Organizational behavior and human decision processes*, *50*(2), 179-211.

Aldridge, V., Dovey, T. M., & Halford, J. C. (2009). The role of familiarity in dietary development. *Developmental Review*, *29*(1), 32-44.

Alemu, M. H., Olsen, S. B., Vedel, S. E., Pambo, K. O., & Owino, V. O. (2015). Consumer acceptance and willingness to pay for edible insects as food in Kenya: the case of white winged termites (No. 2015/10). University of Copenhagen, Department of Food and Resource Economics.

Asgar, M. A., Fazilah, A., Huda, N., Bhat, R., & Karim, A. A. (2010). Nonmeat protein alternatives as meat extenders and meat analogs. *Comprehensive Reviews in Food Science and Food Safety*, *9*(5), 513-529.

Baker, M. A., Shin, J. T., & Kim, Y. W. (2016). An Exploration and Investigation of Edible Insect Consumption: The Impacts of Image and Description on Risk Perceptions and Purchase Intent. *Psychology & Marketing*, *33*(2), 94-112.

Bahuchet, S., & Garine, I. (1990). The art of trapping in the rainforest. In: C. M. Hladik, S. Bahuchet & I. Garine (Eds), Food and nutrition in the african rainforest, (pp.25–49) UNESCO, Paris.

Balderjahn, I., Peyer, M., & Paulssen, M. (2013). Consciousness for fair consumption: conceptualization, scale development and empirical validation. *International Journal of Consumer Studies*, *37*(5), 546-555.

Balzan, S., Fasolato, L., Maniero, S., & Novelli, E. (2016). Edible insects and young adults in a north-east Italian city an exploratory study. *British Food Journal*, *118*(2), 318-326.

Banaji, M. R. (2001). Implicit attitudes can be measured. In H. L. Roediger, J. S. Nairne, I. Neath, and A. Surprenant (Eds.) *The nature of remembering: Essays in honor of Robert G. Crowder* (pp. 117–150). Washington, DC: American Psychological Association.

Bargh, J. A., & Ferguson, M. J. (2000). Beyond behaviorism: on the automaticity of higher mental processes. *Psychological bulletin*, *126*(6), 925.

Barrena, R., & Sánchez, M. (2013). Neophobia, personal consumer values and novel food acceptance. Food Quality and Preference, 27, 72–84.

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.

Belluco, S., Losasso, C., Maggioletti, M., Alonzi, C., Ricci, A., & Paoletti, M. G. (2015). Edible insects: a food security solution or a food safety concern. *Anim Front*, *5*(2), 25-30.

Bentler, P. M. (2006). *EQS 6 Structural equation program manual*. Encino, CA: Multivariate Software.

Berners-Lee, M., Hoolohan, C., Cammack, H., & Hewitt, C. N. (2012). The relative greenhouse gas impacts of realistic dietary choices. *Energy Policy*, *43*, 184-190.

Bharucha, Z., & Pretty, J. (2010). The roles and values ofwild foods in agricultural systems.Philosophical Transactions of the Royal Society B, 365, 2913–2926.

Blair, I. V. (2001). Implicit Stereotypes and Prejudice. In G. B. Moskowitz (Ed.), *Cognitive social psychology: The Princeton Symposium on the Legacy and Future of Social Cognition* (359–374). Mahwah, NJ: Lawrence Erlbaum Associates Publishers.

Bodenheimer, F. S. (1951). *Insects as human food*. The Hague: W Junk.

Boons, F., & Lüdeke-Freund, F. (2013). Business models for sustainable innovation: state-of-the-art and steps towards a research agenda. *Journal of Cleaner Production*, *45*, 9-19.

Broekman, H., Knulst, A., Jager, S. D. H., Gaspari, M., De Jong, G., Houben, G., & Verhoeckx, K. (2015). Shrimp allergic patients are at risk when eating mealworm proteins. *Clinical and Translational Allergy*, *5*(S3), P77.

Brunsø, K., Scholderer, J., & Grunert, K. G. (2004). Closing the gap between values and behavior - a means-end theory of lifestyle. Journal of Business Research, 57,

665–670.Byrkjeflot, H., Pedersen, J. S., & Svejenova, S. (2013). From label to practice: The process of creating new nordic cuisine. *Journal of Culinary Science & Technology*, *11*(1), 36-55.

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

Cederberg, C., Persson, U. M., Neovius, K., Molander, S., & Clift, R. (2011). Including carbon emissions from deforestation in the carbon footprint of Brazilian beef. *Environmental Science & Technology*, *45*(5), 1773-1779.

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), 2271-2286.

Conner, M. T., Perugini, M., O'Gorman, R., Ayres, K., & Prestwich, A. (2007). Relations between implicit and explicit measures of attitudes and measures of behavior: Evidence of moderation by individual difference variables. *Personality and Social Psychology Bulletin*, *33*(12), 1727-1740. 18

Corson, T. (2009). *The Story of Sushi: An Unlikely Saga of Raw Fish and Rice*. Harper Collins.

Costa-Neto, E. M. (2003). Considerations on the man/insect relationship in the state of Bahia, Brazil. *Les "insectes" dans la tradition orale*, 95-104.

Costa-Neto, E. M. (2014). Insects as human food: an overview. *Amazônica-Revista de Antropologia*, *5*(3), 562-582.

Cox, D. N., & Evans, G. (2008). Construction and validation of a psychometric scale to measure consumers' fears of novel food technologies: The food technology neophobia scale. Food Quality and Preference, 19, 704–710.

Cullen, F., & Kingston, H. (2009). Analysis of rural and urban consumer behavior toward new food products using a food-related lifestyle instrument. Journal of Foodservice Business Research, 12(1), 18–41

Darwin, C. (1872). *On the Expression of the Emotions in Man and Animals* (London, England: John Murray, 1872), 257-262.

de Boer, J., Schösler, H., & Boersema, J. J. (2013). Motivational differences in food orientation and the choice of snacks made from lentils, locusts, seaweed or "hybrid" meat. *Food Quality and Preference*, *28*(1), 32-35.

DeFoliart, G. R. (1992). Insects as human food: Gene DeFoliart discusses some nutritional and economic aspects. *Crop protection*, *11*(5), 395-399.

DeFoliart, G. R. (1999). Insects as food: why the western attitude is important. *Annual review of entomology*, *44*(1), 21-50.

DeFoliart, G. R., Dunkel F. V., & Gracer, D. (2009). *The food insects newsletter–chronicle of changing culture*. Salt Lake City: Aardvark Global Publishing.

Delgado, C. L. (2003). Rising consumption of meat and milk in developing countries has created a new food revolution. *The Journal of nutrition*, *133*(11), 3907S-3910S.

Del Giudice, T., La Barbera, F., Vecchio, R., Verneau, F. (2015). Anti-waste labeling and consumers' willingness to pay. *International Journal of Food and Agribusiness Marketing*. DOI: 10.1080/08974438.2015.1054057

de-Magistris, T., Pascucci, S., & Mitsopoulos, D. (2015). Paying to see a bug on my food: How regulations and information can hamper radical innovations in the European Union. *British Food Journal*, *117*(6), 1777-1792.

Deroy, O., Reade, B., & Spence, C. (2015). The insectivore's dilemma, and how to take the West out of it. *Food Quality and Preference*, *44*, 44-55.

DESA, U. (2015). World population prospects: The 2015 revision, key findings and advance tables. *Working PaperNo*.

Diamond, J. (1992). *The third chimpanzee*. New York: HarperCollins,.

Dovey, T. M., Staples, P. A., Gibson, E. L., & Halford, J. C. (2008). Food neophobia and 'picky/fussy'eating in children: a review. *Appetite*, *50*(2), 181-193.

Druckman, J. N., & Kam, C. D. (2011). Students as Experimental Participants. *Cambridge Handbook of Experimental Political Science*, 41.

EFSA Scientific Committee. (2015). Risk profile related to production and consumption of insects as food and feed. *EFSA Journal*, *13*(10).

Ekman P., & Friesen, W. V. (1971). Constants across Cultures in the Face and Emotion. *Journal of Personality and Social Psychology* 17(2), doi:10.1037/h0030377.

Ellis, M., Coulton, R., & Mauger, M. (2015). Empire of tea: The Asian leaf that conquered the world. London: Reaktion Books.

Esposito Vinzi, V., Trinchera, L., & Amato, S. (2010). PLS Path Modeling: From Foundations to Recent Developments and Open Issues for Model Assessment and Improvement. In V. Esposito Vinzi, W. W. Chin, J. Henseler, H. Wang (Eds.), *Handbook of Partial Least Squares. Concepts, Methods and Applications* (pp. 47-82). Berlin, Germany: Springer.

Fallon, A. E., & Rozin, P. (1983). The psychological bases of food rejections by humans. *Ecology of Food and Nutrition*, 13(1), 15–26.

FAO (2005). Pollution from industrialized livestock production. *Livestock Policy Briefs*, *2*, Rome, Italy.

FAO (2006). *The state of food insecurity in the world,* Rome

FAO (2006). Livestock's long shadow: environmental issues and options. Food and Agriculture Organization of the United Nations, Rome.

FAO (2009). How to Feed the World in 2050. Insights from an Expert Meeting at FAO. http://www.fao.org/fileadmin/templates/wsfs/docs/expert_paper/How_to_Feed_the_World_in_2050.pdf.

FAO (2013). Edible insects: Future prospects for food and feed security. Forestry paper, 171:1-154.

FAO (2015). http://www.fao.org/docrep/018/i3253e/i3253e.pdf

FAO/WUR (2014). Insects to feed the world. Wageningen, The Netherlands

FAVV (2014). *Omzendbrief betreffende het kweken en in de handel brengen van insecten en levensmiddelen op basis van insecten voor humane consumptive [[Circular concerning the production and trade of insects and food stuffs based on insects for human consumption]]. (dated May 21, 2014)* Brussels: Federaal Agentschap voor de Veiligheid van de Voedselketen (FAVV)

Finke, M. D. (2002). Complete nutrient composition of commercially raised invertebrates used as food for insectivores. *Zoo Biology*, *21*(3), 269-285.

Finke, M. D., Rojo, S., Roos, N., van Huis, A., & Yen, A. L. (2015). The European Food Safety Authority scientific opinion on a risk profile related to production and consumption of insects as food and feed.

Fishbein, M., & Ajzen, I. Predicting and changing behavior: The reasoned action approach. 2010.

Fleurence, J. (1999). Seaweed proteins: biochemical, nutritional aspects and potential uses. *Trends in Food Science & Technology*, *10*(1), 25-28.

Friese, M., Hofmann, W., & Wänke, M. (2008). When impulses take over: Moderated predictive validity of explicit and implicit attitude measures in predicting

food choice and consumption behaviour. *British Journal of Social Psychology*, *47*(3), 397-419.

Friese, M., Hofmann, W., & Schmitt, M. (2009). When and why do implicit measures predict behaviour? Empirical evidence for the moderating role of opportunity, motivation, and process reliance. *European Review of Social Psychology*, *19*(1),

Garnett, T. (2011). Where are the best opportunities for reducing greenhouse gas emissions in the food system (including the food chain)?. *Food policy*, *36*, S23-S32.

Gawronski, B., & Bodenhausen, G. V. (2006). Associative and propositional processes in evaluation: an integrative review of implicit and explicit attitude change. *Psychological bulletin*, *132*(5), 692. 19

Gmuer, A., Guth, J. N., Hartmann, C., & Siegrist, M. (2016). Effects of the degree of processing of insect ingredients in snacks on expected emotional experiences and willingness to eat. *Food Quality and Preference*, *54*, 117-127.

Greenwald, A., McGhee, D. E., & Schwartz, J. K. (1998). Measuring individual differences in implicit cognition: The implicit association test. *Journal of Personality and Social Psychology*, *74*, 1464–1480.

Greenwald, A. G., Poehlman, T. A., Uhlmann, E. L., & Banaji, M. R. (2009). Understanding and using the Implicit Association Test: III. Meta-analysis of predictive validity. *Journal of personality and social psychology*, *97*(1), 17.

Grunert, K. G. (1993). Towards a concept of food-related life style. *Appetite*, *21*(2), 151-155.

Grunert, K. G., Bredahl, L., & Brunsø, K. (2004). Consumer perception of meat quality and implications for product development in the meat sector—a review. *Meat science*, *66*(2), 259-272.

Grunert, K. G., Brunsø, K., & Bisp, S. (1993). Food-related life style: Development of a cross-culturally valid instrument for market surveillance. Aarhus: MAPP; The Aarhus School of Business.

Grunert, K. G., Brunsø, K., Bredahl, L., & Bech, A. C. (2001). Food-related lifestyle: A segmentation approach to European food consumers. In L. J. Frewer, E. Risvik, H. N. J. Schifferstein, & R. von Alvensleben (Eds.), Food, people and society: A European perspective of consumers' food choices (pp. 211–230). London: Springer

Grunert, K. G., Perrea, T., Zhou, Y., Huang, G., Sørensen, B. T., & Krystallis, A. (2011). Is food-related lifestyle (FRL) able to reveal food consumption patterns in non- Western cultural environments? Its adaptation and application in urban China. Appetite, 56, 357–367Verlag.

Gutman, J. (1982). A means-end chain model based on consumer categorization processes. Journal of Marketing, 46(Spring), 60–72.

Haidt, J., McCauley, C., & Rozin, P. (1994). Individual differences in sensitivity to disgust: A scale sampling seven domains of disgust elicitors. *Personality and Individual differences*, *16*(5), 701-713.

Hair, J. F., Hult, T. M., Ringle, C. M., & Sarstedt, M. (2014), A primer on partial least square structural equation modeling (PLS-SEM): Sage Publications.

Hair, J. F., Sarstedt, M., Ringle, C. M., & Mena, J. A. (2012), "An assessment of the use of partial least squares structural equation modeling in marketing research", Journal of the Academy of Marketing Science, 40(3), pp. 414-433.

Halloran, A., & Münke, C. (2014). Discussion paper: regulatory frameworks influencing insects as food and feed. *Food and Agriculture Organization of the United Nations, Rome, Italy*.

Halloran, A., Vantomme, P., Hanboonsong, Y., & Ekesi, S. (2015). Regulating edible insects: the challenge of addressing food security, nature conservation, and the erosion of traditional food culture. *Food Security*, *7*(3), 739-746.

Halloran, A., & Vantomme, P. (2013). The contribution of insects to food security, livelihoods and the environment. *FAO, Rome*.

Hamerman, E. J. (2016). Cooking and disgust sensitivity influence preference for attending insect-based food events. *Appetite*, *96*, 319-326.

Hanboonsong Y. (2010). Edible insects and associated food habits in Thailand. Forest insects as food: humans bite back, 173-182.

Hartmann, C., Shi, J., Giusto, A., & Siegrist, M. (2015). The psychology of eating insects: a cross-cultural comparison between Germany and China. *Food Quality and Preference*, 44, 148-156.

Hartmann, C., & Siegrist, M. (2016). Becoming an insectivore: Results of an experiment. *Food Quality and Preference*, *51*, 118-122.

Hartmann, C., & Siegrist, M. (2017). Consumer perception and behaviour regarding sustainable protein consumption: A systematic review. *Trends in Food Science & Technology*.

Haslam, N. (2006). Dehumanization: An integrative review. *Personality and Social Psychology Review*, *10*, 252–264.

Herz, R. (2012). *That's disgusting: Unraveling the mysteries of repulsion*. WW Norton & Company.

Hobbs, J. E., & Young, L. M. (2001). *Vertical linkages in agri-foods supply chains in Canada and the United States*. The Branch.

Hoek, A. C., Luning, P. A., Stafleu, A., & de Graaf, C. (2004). Food-related lifestyle and health attitudes of Dutch vegetarians, non-vegetarian consumers of meat substitutes, and meat consumers. *Appetite*, 42, 265–272.

Hoek, A. C., Luning, P. A., Weijzen, P., Engels, W., Kok, F. J., & de Graaf, C. (2011). Replacement of meat by meat substitutes. A survey on person-and product-related factors in consumer acceptance. *Appetite*, *56*(3), 662-673.

Hoekstra, A. Y. (2008). The water footprint of food.

Hoekstra, A. Y., & Wiedmann, T. O. (2014). Humanity's unsustainable environmental footprint. *Science*, *344*(6188), 1114-1117.

Hofmann, W., De Houwer, J., Perugini, M., Baeyens, F., & Crombez, G. (2010). Evaluative conditioning in humans: a meta-analysis. *Psychological bulletin*,*136*(3), 390.

Hollands, G. J., Prestwich, A., & Marteau, T. M. (2011). Using aversive images to enhance healthy food choices and implicit attitudes: An experimental test of evaluative conditioning. *Health Psychology*, *30*(2), 195. 20

House, J. (2016). Consumer acceptance of insect-based foods in the Netherlands: academic and commercial implications. *Appetite*, *107*, 47-58.

Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural equation modeling: a multidisciplinary journal*, *6*(1), 1-55.

Kellert, S. R. (1993). Values and perceptions of invertebrates. *Conservation Biology: The Journal of the Society for Conservation Biology*, *7*, 845–855.

Kiefner-Burmeister, A. E., Hoffmann, D. A., Meers, M. R., Koball, A. M., & Musher-Eizenman, D. R. (2014). Food consumption by young children: A function of parental feeding goals and practices. *Appetite*, *74*, 6-11.

Kinyuru, J. N., Kenji, G. M., & Njoroge, M. S. (2009). Process development, nutrition and sensory qualities of wheat buns enriched with edible termites (Macrotermes subhylanus) from Lake Victoria region, Kenya. *African Journal of Food, Agriculture, Nutrition and Development*, *9*(8).

Kremer S., Shimojo R., Holthuysen N., K.ster E., Mojet J. (2013). Consumer acceptance of salt-reduced "soy sauce" foods over rapidly repeated exposure. *Food Quality and Preference*, 27(2): 179-190.

Kroeber-Riel, W., Weinberg, P., & Gröppel-Klein, A. (2009). Konsumentenverhalten, 9., überarbeitete, aktualisierte und ergänzte Auflage.*München: Verlag Franz Vahlen*.

Kummu, M., De Moel, H., Porkka, M., Siebert, S., Varis, O., & Ward, P. J. (2012). Lost food, wasted resources: Global food supply chain losses and their impacts on freshwater, cropland, and fertiliser use. *Science of the total environment*, *438*, 477-489.

Lähteenmäki-Uutela, A., & Grmelová, N. (2016). European Law on Insects in Food and Feed. *European Food and Feed Law Review: EFFL*, *11*(1), 2.

Laos (2010). *Agenda item 13: Comments of Lao PDR: Proposal for the new work and development of regional standard for edible crickets and their products (CRD 8) 17th session of the FAO/WHO coordinatign committee for Asia (CCASIA)*. Indonesia: Bali.

Larson, N., & Story M. (2009). A review of environmental influences on food choices. *Annals of Behavioral Medicine* 38, S56–S73.

Laureati, M., Proserpio, C., Jucker, C., & Savoldelli, S. (2016). New sustainable protein sources: consumers' willingness to adopt insects as feed and food. *Italian Journal of Food Science*, *28*(4), 652-668.

Lebens, H., Roefs, A., Martijn, C., Houben, K., Nederkoorn, C., & Jansen, A. (2011). Making implicit measures of associations with snack foods more negative through evaluative conditioning. *Eating behaviors*, *12*(4), 249-253.

Le Goff, G., & Delarue, J. (2017). Non-verbal evaluation of acceptance of insect-based products using a simple and holistic analysis of facial expressions. *Food Quality and Preference*, *56*, 285-293.

Lensvelt, E. J., & Steenbekkers, L. P. A. (2014). Exploring consumer acceptance of entomophagy: a survey and experiment in Australia and the Netherlands. *Ecology of food and nutrition*, *53*(5), 543-561.

Loebnitz, N., & Grunert, K. G. (2015). The effect of food shape abnormality on purchase intentions in China. *Food Quality and Preference*, *40*, 24-30.

Looy, H., Dunkel, F. V., & Wood, J. R. (2014). How than shall we eat? Insect-eating attitudes and sustainable foodways. *Agriculture and Human Values*, *31*, 131–141.

Looy, H., & Wood, J. R. (2006). Attitudes Toward Invertebrates: Are Educational" Bug Banquets" Effective?. *The journal of environmental education*, *37*(2), 37-48.

Lundy, M. E., & Parrella, M. P. (2015). Crickets are not a free lunch: protein capture from scalable organic side-streams via high-density populations of Acheta domesticus. *PloS one*, *10*(4), e0118785.

Maison, D., Greenwald, A. G., & Bruin, R. (2001). The Implicit Association Test as a measure of implicit consumer attitudes. *Polish Psychological Bulletin*, *32*(1).

Maison, D., Greenwald, A. G., & Bruin, R. H. (2004). Predictive validity of the Implicit Association Test in studies of brands, consumer attitudes, and behavior. *Journal of consumer psychology*, *14*(4), 405-415.

Martins, Y., & Pliner, P. (2005). Human food choices: An examination of the factors underlying acceptance/rejection of novel and familiar animal and nonanimal foods. *Appetite*, *45*(3), 214-224.

Martins, Y., & Pliner, P. (2006). "Ugh! That's disgusting!": Identification of the characteristics of foods underlying rejections based on disgust. *Appetite*, *46*(1), 75-85.

Matsumoto, D., & Ekman, P. (2009). Basic emotions. *Oxford companion to affective sciences*, 69-72.

Meyer-Rochow, V. B., Okui, K., Henshall, K., & Brook, D. L. (2000). The mental concept of "worm/bug" in Japanese and English idioms. J. Finn. Anthropol. Soc., 25, 29–40.

Mignon, J. (2002). *L'entomophagie: une question de culture? Tropicultura*, *20*, 151–156.

Mintz, S. (1986). Sweetness and power: The place of sugar in modern history. New York: Penguin.

Murcott, A. (2001). Public beliefs about GM foods: more on the makings of a considered sociology. *Medical Anthropology Quarterly*, *15*(1), 9-19.

Nie, C., & Zepeda, L. (2011). Lifestyle segmentation of US food shoppers to examine organic and local food consumption. Appetite, 57, 28–37.

Nijhoff-Savvaki, R., Trienekens, J. H., & Omta, S. W. F. (2012). Drivers for innovation in niche pork netchains: a study of United Kingdom, Greece, and Spain. *British Food Journal*, *114*(8), 1106-1127.

Olatunji, B. O., Sawchuk, C. N., de Jong, P. J., & Lohr, J. M. (2007). Disgust sensitivity and anxiety disorder symptoms: Psychometric properties of the disgust emotion scale. *Journal of Psychopathology and Behavioral Assessment*, *29*(2), 115-124.

Oonincx, D. G. A. B., & de Boer, I. J. M. (2012). Environmental impact of the production of mealworms as a protein source for humans e a life cycle assessment. PLoS One, 7. http://dx.doi.org/10.1371/journal.pone.0051145. 21

Oonincx, D. G. A. B., van Itterbeeck, J., Heetkamp, M. J., van den Brand, H., van Loon, J. J. A., & van Huis, A. (2010). An exploration on greenhouse gas and ammonia production by insect species suitable for animal or human consumption. PloS one, 5(12).

Paoletti, M. G. (2005). *Ecological implications of minilivestock: potential of insects, rodents, frogs and snails*. Science, Enfield.

Pascucci, S., & Magistris, T. D. (2013). Information Bias Condemning Radical Food Innovators? The Case of Insect-Based Products in the Netherlands. *International Food and Agribusiness Management Review*, *16*(3).

Payne, C. L., Scarborough, P., Rayner, M., & Nonaka, K. (2016). A systematic review of nutrient composition data available for twelve commercially available edible insects, and comparison with reference values. *Trends in Food Science & Technology*, *47*, 69-77.

Pedersen, J. A. (2014). Disgusting or Delicious. In EuroSense 2014: A Sense of Life. University of Copenhagen.Pyke, M. 1968. *Food and society*. London: Murray.

Perkins, A. W., & Forehand, M. R. (2012). Implicit self-referencing: The effect of nonvolitional self-association on brand and product attitude. *Journal of Consumer Research*, *39*(1), 142-156.

Perugini, M. (2005). Predictive models of implicit and explicit attitudes. *British Journal of Social Psychology*, *44*(1), 29-45.

Perugini, M., Zogmaister, C., Richetin, J., Prestwich, A., & Hurling, R. (2013). Changing implicit attitudes by contrasting the self with others. *Social Cognition*,*31*(4), 443.

Piha, S., Pohjanheimo, T., Lähteenmäki-Uutela, A., Křečková, Z., & Otterbring, T. (2016). The effects of consumer knowledge on the willingness to buy insect food: An exploratory cross-regional study in Northern and Central Europe. *Food Quality and Preference*.

Pimentel, D. (1991). Ethanol fuels: Energy security, economics and the environment. Journal of Agricultural and Environmental Ethics, 4(1), 1–13.

Pliner P. (1982). The effects of mere exposure on liking for edible substances. *Appetite*, 3(3): 283-290.

Pliner, P., & Hobden, K. (1992). Development of a scale to measure the trait of food neophobia in humans. *Appetite*, *19*(2), 105-120.

Pliner, P., & Pelchat, M. L. (1991). Neophobia in humans and the special status of foods of animal origin. *Appetite*, *16*(3), 205-218.

Pliner, P., Pelchat, M., & Grabski, M. (1993). Reduction of neophobia in humans by exposure to novel foods. *Appetite*, *20*(2), 111-123.

Porcherot C., Issanchou S. (1998). Dynamics of liking for flavoured crackers: Test of predictive value of a boredom test. *Food Quality and Preference*, 9(1): 21-29.

Porter, M. E., & Van der Linde, C. (1995). Toward a new conception of the environment-competitiveness relationship. *The journal of economic perspectives*, *9*(4), 97-118.

Premalatha, M., Abbasi, T., Abbasi, T., & Abbasi, S. A. (2011). Energy-efficient food production to reduce global warming and ecodegradation: The use of edible insects. *Renewable and Sustainable Energy Reviews*, *15*(9), 4357-4360.

Prestwich, A., Perugini, M., Hurling, R., & Richetin, J. (2010). Using the self to change implicit attitudes. *European Journal of Social Psychology*, *40*(1), 61-71.

Pyke, M. 1968. *Food and society*. London: Murray.

Ramos-Elorduy B.J. (1997). The importance of edible insects in the nutrition and economy of people of the rural areas of Mexico. Ecology of Food and Nutrition, 36(5): 347-366.

Ramos-Elorduy, J. (1997). Insects: A sustainable source of food? *Ecology of Food and Nutrition*, *36*, 247-276

Ramos-Elorduy, J. (2006). Estudio comparativo del valor nutritivo de varios coleoptera comestibles de México y Pachymerus nucleorum (Fabricius, 1792) (Bruchidae) de Brasil. *Interciencia*, *31*(7), 512-516.

Richetin, J., Perugini, M., Prestwich, A., & O'Gorman, R. (2007). The IAT as a predictor of food choice: The case of fruits versus snacks. *International Journal of Psychology*, *42*(3), 166-173.

Richetin, J., Mattavelli, S., & Perugini, M. (2016). Increasing implicit and explicit attitudes toward an organic food brand by referencing to oneself. *Journal of Economic Psychology*.

Rokeach, M. (1973). The nature of human values. New York, NY: Free Press.

Rozin P., Fallon A. (1980). The psychological categorization of foods and non-foods: A preliminary taxonomy of food rejections. Appetite, 1(3): 193-201.

Rozin, P., & Fallon, A. E. (1987). A perspective on disgust. *Psychological Review*, *94*(1), 23-41. 22

Rozin P., Fallon A., Augustoni-Ziskind M. (1985). The child's conception of food: The development of contamination sensitivity to" disgusting" substances. Developmental Psychology, 21(6): 1075.

Rozin, P., Fallon, A., & Mandell, R. (1984). Family resemblance in attitudes to foods. *Developmental Psychology*, *20*(2), 309.

Rozin, P., Haidt, J., & McCauley, C. R. (2009), "Disgust" in *Oxford Companion to Affective Sciences*, eds. David Sanders and Klaus R. Scherer, (Oxford University Press, 2009).

Ruby, M. B., Rozin, P., & Chan, C. (2015). Determinants of willingness to eat insects in the USA and India. *Journal of Insects as Food and Feed*, *1*(3), 215-225.

Rumpold, B. A. & Schlüter, O. K. (2013). Potential and challenges of insects as an innovative source for food and feed production. *Innovative Food Science & Emerging Technologies*, *17*, 1–11.

Schabel, H. G. (2010). Forest insects as food: A global review. *Forest insects as food: Humans bite back*, 37-64.

Schösler, H., de Boer, J., & Boersema, J. (2012). Can we cut meat out of the dish? Constructing consumer-oriented pathways towards meat substitution, *Appetite*, *58*, 39–47.

Schwartz, S. H. (1994). Are there universal aspects in the structure and content of human values? Journal of Social Issues, 50(4), 19–45.

Schwartz, S. H. (1992). Universals in the content and structure of values: Theoretical advances and empirical tests in 20 countries. In M. P. Zanna (Ed.), Advances in experimental social psychology (pp. 1–65). San Diego, CA: Academic Press.

Shan, H., Tan, G., Fischer, A. R. H., Tinchan, P., Stieger, M., Steenbekkers, L. P. A., & van Trijp, H. C. M. (2015). Insects as food: Exploring cultural exposure and individual experience as determinants of acceptance. Food Quality and Preference, 42, 78–89.

Sheppard, B., & Frazer, P. (2015). Comparing Social and Intellectual Appeals to Reduce Disgust of Eating Crickets. *Studies in Arts and Humanities*, *1*(2), 4-23.

Shockley, M., & Dossey, A. T. (2014). Insects for human consumption. *Morales-Ramos JA, Rojas MG, Shapiro-Ilan DI. Mass Production of Beneficial Organisms. Academic Press*, *1*, 764.

Siegrist, M., Hartmann, C. & Keller, C. (2013). Antecedents of food neophobia and its association with eating behavior and food choices. *Food Quality and Preference*, *30*, 293–298.

Smetana, S., Mathys, A., Knoch, A., & Heinz, V. (2015). Meat Alternatives: Life Cycle Assessment of Most Known Meat Substitutes. *The International Journal of Life Cycle Assessment,* 20 (9), 1254–67. doi:10.1007/s11367-015-0931-6.

Soares, S., & Forkes, A. (2014). Insects Au gratin-an investigation into the experiences of developing a 3D printer that uses insect protein based flour as a building medium for the production of sustainable food. In *DS 78: Proceedings of the 16th International conference on Engineering and Product Design Education (E&PDE14), Design Education and Human Technology Relations, University of Twente, The Netherlands, 04-05.09. 2014*.

Sogari, G., Menozzi, D., & Mora, C. (2016). Exploring young foodies' knowledge and attitude regarding entomophagy: A qualitative study in Italy. *International Journal of Gastronomy and Food Science*.

Sogari, G., & Vantomme, P. (2014). *A tavola con gli insetti*. Mattioli 1885.

Strack, F., & Deutsch, R. (2004). Reflective and impulsive determinants of social behavior, *Personality and Social Psychology Review*, *8*, 220–247.

Srivastava, S. K., Babu, N., & Pandey, H. (2009). Traditional insect bioprospecting–As human food and medicine.

Tan, H. S. G., Fischer, A. R., Tinchan, P., Stieger, M., Steenbekkers, L. P. A., & van Trijp, H. C. (2015). Insects as food: exploring cultural exposure and individual experience as determinants of acceptance. *Food Quality and Preference*, *42*, 78-89.

Tan, H. S. G., Fischer, A. R., van Trijp, H. C., & Stieger, M. (2016). Tasty but nasty? Exploring the role of sensory-liking and food appropriateness in the willingness to eat unusual novel foods like insects. *Food Quality and Preference*, 48, 293-302.

Tan, H. S. G., van den Berg, E., & Stieger, M. (2016). The influence of product preparation, familiarity and individual traits on the consumer acceptance of insects as food. *Food Quality and Preference*, 52, 222-231.

Tenenhaus, M. (2008). Component-based structural equation modelling. *Total quality management*, *19*(7-8), 871-886.

Testa, M., Stillo, M., Maffei, G., Andriolo, V., Gardois, P., & Zotti, C. M. (2016). Ugly but tasty: A systematic review of possible human and animal health risks related to entomophagy. *Critical reviews in food science and nutrition*, (just-accepted), 00-00.

Thøgersen, J. (2017). Sustainable food consumption in the nexus between national context and private lifestyle: A multi-level study. *Food Quality and Preference*, *55*, 16-25.

Tukker, A., & Jansen, B. (2006). Environmental impacts of products: A detailed review of studies. *Journal of Industrial Ecology*, *10*(3), 159-182.

Tuorila H., Meiselman H.L., Bell R., Cardello A.V., Johnson W. (1994). Role of sensory and cognitive information in the enhancement of certainty and linking for novel and familiar foods. Appetite, 23(3): 231-246.

Urry, J. (2011). *Climate change and society*. Polity.

Vanhonacker, F., Van Loo, E. J., Gellynck, X., & Verbeke, W. (2013). Flemish consumer attitudes towards more sustainable food choices. *Appetite*, *62*, 7-16.

van Huis, A. (2013). Potential of insects as food and feed in assuring food security. *Annual Review of Entomology,* 58, 563-583.

van Huis, A., Van Itterbeeck, J., Klunder, H., Mertens, E., Halloran, A., Muir, G., & Vantomme, P. (2013). *Edible insects: Future prospects for food and feed security*. FAO Forestry Paper 171. Food and Agriculture Organization of the United Nations, Rome. 23

van Raaij, W. F., & Verhallen, T. M. M. (1994). Domain-specific market segmentation. *European Journal of Marketing*, 28(10), 49–66.

Vantomme, D., Geuens, G., DeHouwer, J., & DePelsmacker, P. (2006). Explicit and Implicit Determinants of Fair-Trade Buying Behaviour. In *Advances in consumer research*, 699-703. Association for Consumer Research.

Verbeke, W. (2015). Profiling consumers who are ready to adopt insects as a meat substitute in a Western society. *Food Quality and Preference*, *39*, 147–155.

Verkerk, M. C., Tramper, J., Van Trijp, J. C. M., & Martens, D. E. (2007). Insect cells for human food. *Biotechnology advances*, *25*(2), 198-202.

Verneau, F., La Barbera, F., Del Giudice, T. (in press). The role of implicit associations in the hypothetical bias. *The Journal of Consumer Affairs*, DOI: 10.1111/joca.12116

Verneau, F., La Barbera, F., Kolle, S., Amato, M., Del Giudice, T., & Grunert, K.G. (2016). The effect of communication and implicit associations on consuming insects: an experiment in Denmark and Italy. *Appetite*, DOI: 10.1016/j.appet.2016.02.006

Verhulst, F., Hermans, D., Baeyens, F., Spruyt, A., & Eelen, P. (2006). Determinants and predictive validity of direct and indirect measures of recently acquired food attitudes. *Appetite*, *46*(2), 137-143.

Verneau, F., La Barbera, F., Kolle, S., Amato, M., Del Giudice, T., & Grunert, K. (2016). The effect of communication and implicit associations on consuming insects: An experiment in Denmark and Italy. *Appetite*, *106*, 30-36.

Vyncke, P. (2002). Lifestyle segmentation: from attitudes, interests and opinions, to values, aesthetic styles, life visions and media preferences. European Journal of Communication, 7, 445–463.

Wackernagel, M. & Rees, W. (1996). *Our ecological footprint*. Gabriola Island: New Society Publishers.

Weber, C. L., & Matthews, H. S. (2008). Food-miles and the relative climate impacts of food choices in the United States.

de Wijk R.A., Kooijman V., Verhoeven R.H., Holthuysen N.T., de Graaf C. (2012). Autonomic nervous system responses on and facial expressions to the sight, smell, and taste of liked and disliked foods. Food Quality and Preference, 26(2): 196-203.

Wit, J., & Fischer, A. (2015). Different Approaches to Positioning Edible Insect Products on the Western Market.

Wood, J. R., & Looy, H. (2000). My ant is coming to dinner: Culture, disgust, and dietary challenges. *PROTEUS-SHIPPENSBURG-*, *17*(1), 52-56.

Yen A.L. (2009). Edible insects: Traditional knowledge or western phobia? Entomological Research, 39(5): 289-298.

Yen, A. L. (2015). Insects as food and feed in the Asia Pacific region: current perspectives and future directions. *Journal of Insects as Food and Feed*, *1*(1), 33-55.

Zent, E. L., & Simpson, B. B. (2009). The importance of traditional ecological knowledge for palm-weevil cultivation in the Venezuelan Amazon. *Journal of Ethnobiology*, *29*(1), 113-128.