

Exploring perceptions of sustainable proteins and meat attachment

Abstract

Purpose

This study sought to explore consumer perceptions of more sustainable protein alternatives to conventional meat.

Design/methodology/approach

A mixed methods design of interviews and an online survey identified key drivers and barriers to the consumption of (1) laboratory-grown meat, (2) edible insects, and (3) plant-based meat substitutes, with meat attachment accounted for in analyses. Differences between personal preference and perceptions of alternative proteins' role in addressing global environmental concerns were also explored.

Findings

Findings indicated that plant-based substitutes were favoured for personal consumption for moral and ethical reasons and edible insects were least favoured due to aversion. Meat attachment was significantly associated with personal willingness to consume alternative proteins in each of the three cases. Results challenged previous research that had proposed that when considering the effectiveness of certain alternatives in addressing global environmental issues, people may advocate them but not want to consume them personally. Results imply that the congruity of these perceptions is more complex.

Research limitations/implications

Avenues for future research, including applications for exploring tailored marketing are suggested based on the preliminary findings of this study.

Originality/value

This study asked consumers to consider three alternative proteins alongside one another for the first time, exploring how meat attachment is associated with perceptions and quantifying the congruity of consumers' personal perceptions and global perceptions of these alternative proteins.

Introduction

Conventional meat production has a significant impact on the natural environment in numerous ways, including the emission of an estimated 18% of all anthropogenic greenhouse gases, which contribute to climate change (Food and Agriculture Organisation, 2006; Steinfeld et al., 2006; Intergovernmental Panel on Climate Change, 2007). A

reduction in the consumption of meat has been suggested by a number of authors (Carlsson-Kanyama, 1998; Horrigan, Lawrence and Walker, 2002; McMichael, Powles, Butler and Uauy, 2007) as critical to creating a more sustainable food system with fewer greenhouse gas emissions, lower energy, water and land usage and less pollution and biodiversity loss. Protein remains an essential component of the human diet (British Nutrition Foundation, 2016) and so increasing consumption of a number of 'alternative' protein options could play a role in achieving such a reduction.

Alternative proteins

This study focused on three such alternative proteins that were commonly identified as 'sustainability solutions' within the literature (see e.g. Waste and Action Resources Programme, 2015). These were (1) laboratory-grown meat, (2) edible insects and (3) plant-based substitutes. We first outline each of these three alternatives, before examining previous research which has sought to uncover perceptions towards them.

Laboratory-grown (lab-grown), cultured, or in vitro meat is made through a process whereby agricultural products are grown from cell cultures (New Harvest, 2017) instead of inside an animal. Studies indicate that this process is less damaging to the environment than producing meat from livestock, requiring 45% less energy and 99% less land, and producing 96% fewer greenhouse gas emissions (Tuomisto and Teixeira de Mattos, 2011; Waste and Action Resources Programme, 2015). Lab-grown meat is not currently commercially available for consumption, and researchers are working to address the technicalities of advancing the technology (Haagsman, Hellingwerf and Roelen, 2009; Post, 2012). Similarly, edible insects, of which 96 different species are known to be consumed by humans globally (Chen et al., 1998), require less land and emit fewer greenhouse gases - up to 99% less - than ruminant livestock (Oonincx et al., 2010). In addition, many plant and fungi-based products exist as substitutes for meat (Davies and Lightowler, 1998), such as Quorn™. These too offer a more sustainable alternative to meat from farmed livestock, with plant-based diets requiring significantly less land and water than those including meat and being up to 11 times less environmentally damaging overall than meat-based diets, when studied in Life Cycle Assessments (Baroni et al., 2007; Zollitsch et al., 2007).

Perceptions of lab-grown meat

Some researchers have speculated, without asking consumers directly, that moral considerations act as a driver for consumption of lab-grown meat, as animals are not harmed to generate meat (Hopkins and Dacey, 2008). Further studies seem to support this when asking consumers, finding that the meat being perceived as "victimless" acts as a key driver to consumption (Haagsman, Hellingwerf and Roelen, 2009, p. 22), having implications for animal welfare (Van der Weele and Driessen, 2013). Building on this, Van der Weele and Tramper (2014) found that consumers perceived lab-grown meat as offering a more moral alternative to conventional meat when they analysed workshop discussions and media responses following the unveiling of the first lab-grown meat hamburger by Professor Mark Post in 2013. General positive interest in lab-grown meat has also been found from consumers (Haagsman, Hellingwerf and Roelen, 2009; Van der Weele and Driessen, 2013). Furthermore, the perceived environmental friendliness of lab-grown meat has been found to be a key driver to consumption (Van der Weele and Driessen, 2013; Verbeke, Sans and Van Loo, 2015a), particularly when participants were considering the

potential global consumption of lab-grown meat across the world; they perceived lab-grown meat as being effective for addressing food security (Verbeke et al., 2015b). Indeed, experts working on lab-grown meat suggest that environmental motivations, as well as those concerning animal welfare and health would motivate consumers to purchase lab-grown meat (Haagsman, Hellingwerf and Roelen, 2009).

Within the same studies, several barriers to consumption of lab-grown meat have been found. Personal disgust was a negative reaction from consumers (Haagsman, Hellingwerf and Roelen, 2009; Verbeke et al., 2015b), despite consumers advocating the consumption of lab-grown meat across the world to address issues of global food security (Verbeke et al., 2015b). This global advocacy and personal aversion response to lab-grown meat could be interpreted as a type of contradictory 'Not In My Backyard' or NIMBY attitude (see Schively, 2007). This could be further explored by investigating the congruity of consumers' perceptions when considering alternative proteins for (1) personal consumption and (2) consumption by others around the world. Lab-grown meat has also been found to be perceived as unnatural (Van der Weele and Tramper, 2014; Alvarez and Preble, 2014; Verbeke et al., 2015b, Tucker, 2014), unhealthy (Tucker, 2014) and low in sensory attractiveness (Verbeke, Sans and Van Loo, 2015a; Tucker, 2014). Cost was also identified as a key barrier in terms of making lab-grown meat an affordable alternative to conventional meat (Van der Weele and Tramper, 2014).

These studies have explored the perceptual barriers and drivers that discourage or motivate consumption of lab-grown meat. However, they have not explored perceptions of lab-grown meat compared to other alternative proteins in a way that is more representative of real-world consumer decision-making between products.

Perceptions of edible insects

Several studies have explored UK consumer perceptions to edible insects where they are consumed as a novel source of protein, yet, as for lab-grown meat, few studies compare perceptions of edible insects alongside other alternative proteins. Key barriers to the global adoption of insect consumption include the strong emotional and psychological response of disgust, or the 'Yuck Factor' (Schmidt, 2008; Cicatiello et al., 2016), issues with preparation and cooking (Tucker, 2014) and insects being perceived as unappealing to the senses (Tucker, 2014), particularly when compared to conventional meat (Verbeke, 2015c). Knowing more about insects and having an increased exposure to them, including opportunities to try them (Vernon and Berenbaum, 2004; Looy and Wood, 2006; Barsics et al., 2017) has been shown to help reduce negative perceptions regarding their edibility.

Perceptions of plant-based meat substitutes

Research has been carried out on consumer perceptions of plant-based meat substitutes, yet, like with lab-grown meat and edible insects, no comparative study has been conducted. The context in which plant-based substitutes are consumed (i.e. whether they are presented on their own or within a meal) has been shown to have an influence on perceptions (Elzerman et al., 2011, Schosler, 2011). How perceptions change over time when plant-based substitutes are repeatedly consumed as part of a meal has also been studied (Hoek et al., 2012), with participants experiencing boredom towards the plant-based substitutes over time. The main barriers and drivers to consumption of plant-based

substitutes have been explored. Barriers included lack of information about the products and cost (Elzerman et al., 2013) as well as plant-based substitutes being perceived as unfamiliar and having lower sensory attractiveness compared to conventional meat in terms of taste and texture (Hoek et al., 2011; Elzerman et al., 2013). Drivers that motivated consumption of plant-based substitutes included moral and ethical reasons (Hoek et al., 2011), health considerations, the perception that they were easy to prepare and, conversely, sensory attractiveness (Elzerman et al., 2013). This highlights the heterogeneity of consumers' perceptions of alternative proteins.

The potential role of meat attachment

In their study exploring the drivers and barriers to consumption of lab-grown meat, Verbeke, Sans and Van Loo (2015a) found that vegetarians in particular perceived lab-grown meat as being unhealthy. This suggests a potential interaction between how alternative proteins are perceived and current consumption, or lack of consumption in the case of vegetarians, of conventional meat. It remains to be seen whether the extent to which participants consume conventional meat influences perceptions of alternative proteins. For example, participants highly attached to conventional meat could either favour 'meaty' alternatives like lab-grown meat or perceive it as a poor substitute for 'real' meat. Constructs of meat attachment, such as Graça et al.'s (2015a, 2015b, 2016) questionnaire have been implemented in research studying reductions in conventional meat consumption and the adoption of plant-based diets, but are yet to be used in a study on alternative proteins.

The current study

The current study aimed to build upon existing literature on psychological perceptions towards alternative proteins. The main aims of this study were (1) to develop a more in-depth understanding of the key drivers and barriers to perceived personal consumption of three alternative proteins. In particular, exploring these perceptions when the alternative proteins are compared alongside each other for the first time, instead of considered in isolation, as has been the case in previous studies. This study also sought (2) to explore the influence of meat attachment on consumer perceptions, and (3) to gain a more detailed understanding of whether personal perceptions (i.e. how that individual feels about themselves personally consuming the alternative protein) and global perceptions (i.e. how that individuals feels about the alternative protein being consumed across the world to solve global environmental and food security issues) are congruent or incongruent. This aim explores the NIMBY style global advocacy and personal aversion response to alternative proteins identified in Verbeke et al.'s (2015b) study on lab-grown meat, where participants' personal and global perceptions were incongruent. If alternative proteins are to become viable and more sustainable substitutions for conventional meat, then consumer perceptions toward them need to be more fully understood.

In the remainder of this paper the study design and research methods are first outlined, followed by the results of (1) personal perceptions and key drivers and barriers, (2) the influence of meat attachment and (3) the congruity of personal and global perceptions. Finally, a discussion of these findings is presented in terms of their application to future marketing research.

Methods

A mixed methods approach was taken using an exploratory sequential design where the findings generated from individual and small group interviews informed an online survey.

Semi-structured interviews

An opportunistic sample of participants for semi-structured interviews was recruited by placing flyers widely around the university campus in Cambridge (UK) and posting adverts on the social media (i.e. Facebook and Twitter) profiles of the first author. These adverts invited those interested in being interviewed as part of a study on the 'future of food' to complete an online recruitment survey by following a URL webpage link. The authors aimed to address any potential pro-environmental self-selection bias by advertising the interviews as 'food-related discussions' with no mention of alternative proteins or sustainability. The recruitment survey first measured participants' level of meat attachment, here defined as the extent to which eating conventional meat forms part of one's identity. The authors used a condensed construct of meat attachment initially developed through previous pilot work, measured through extent of agreement on a seven-point Likert scale to ten brief statements and simple scenarios about conventional meat. For example, "I like eating meat", "I would be pleased if I were given meat as part of a roast dinner" and "eating meat is part of my identity." Participants could have a total meat attachment score between 10 and 70. This measure of meat attachment demonstrated very good scale reliability, $\alpha = 0.92$, according to DeVellis' (2012) recommendations for scale reliability, when a Cronbach's alpha scale reliability analysis was run. Participants' meat attachment scores were accounted for to ensure there was a variety of perspectives included in the interviews. The authors acknowledge that future studies could use a validated measure of meat attachment, such as Graça et al.'s (2015a, 2015b, 2016) construct.

The survey then asked participants to indicate their availability at lunchtimes and evenings in a typical working week. This was then used to select and invite participants to attend an interview. As the availability of participants differed, some participants were interviewed individually and others in small groups. A total of seven participants were interviewed for an average duration of 46 minutes. Their meat attachment scores ranged between 16 to 63 with two participants consuming meat, one avoiding meat at certain times, such as on specific days for environmental reasons, two following other meat-excluding diets such as avoiding meat and dairy but consuming fish and eggs for health and religious reasons, and two following a vegan diet for environmental and animal welfare reasons. Sociodemographic information about participants was not collected, which the authors acknowledge as a limitation.

In the interviews, participants first provided their initial 'top of mind' reactions to lab-grown meat, edible insects and plant-based substitutes, including whether they had heard of them or knew what they were. The phrase 'lab-grown meat' was used deliberately, as this was deemed more commonly understood than the potentially more neutral (Tuomisto, 2017), yet specialist term of 'cultured' meat. Participants were then provided with information sheets based on literature (see e.g. Waste and Action Resources Programme, 2015) about the three alternative proteins. These described each alternative, how it was

made and how it compared environmentally to conventional meat in terms of greenhouse gas emissions, energy, water and land use. In addition, sensory descriptions, approximate protein per 100 grams, whether it was vegetarian or vegan or not, cost per portion, availability, example products and three photos were provided. Participants were asked to discuss which alternatives they would or would not consider consuming and why, and whether they thought any of the alternatives would be effective in addressing issues relating to the environment and global food security. A range of 16 prompt phrases adapted from key themes identified in Verbeke, Sans and Van Loo's (2015a) study (i.e. acceptability, cost, effectiveness, environmental friendliness, ethics, feasibility, healthiness, longevity, morality, nutrition, safety, sustainability, tastiness, willingness to pay more for, willingness to purchase, willingness to try) were placed in front of participants approximately halfway through the interviews to prompt further discussion. The interviews were audio-recorded, and the recordings transcribed verbatim by the first author.

Generating driver and barrier categories

Transcript data from the individual and group interviews were used to generate the detailed and nuanced response options of the online survey. The first author generated transcripts from the audio-recordings of the individual and small group interviews, and then read through the transcripts several times to become immersed in the data. A thematic data analysis was carried out manually on the transcript data. Any phrase that was mentioned as (1) a personal reason for wanting or not wanting to consume any of the three alternative proteins, or (2) a global reason for them being deemed effective or ineffective in addressing issues relating to the environment and global food security was highlighted. An iterative process of categorisation of the resultant phrases for each alternative protein was then carried out where similar individual drivers and barriers were grouped into overarching categories; we note that in many cases these categories were the same across several of the proteins, and some issues were cited as both drivers and barriers. The two authors discussed the categories before finalising them in order to ensure consistency across groupings and the descriptions used for each category. For example, the barrier of *aversion* was used to include guttural and instinctual ("yuck!") reactions to the alternative protein as well as verbal descriptions of negative associations and feelings of disgust or discomfort.

This process of thematic data analysis generated; 5 personal drivers, 12 personal barriers, 4 global drivers and 8 global barriers for lab-grown meat, 6 personal drivers, 9 personal barriers, 7 global drivers and 6 global barriers for edible insects, and 9 personal drivers, 9 personal barriers, 5 global drivers and 8 global barriers for plant-based substitutes.

Online survey

Adverts on the social media (i.e. Facebook and Twitter) profiles of the first author and flyers placed widely around the university campus in Cambridge (UK) were used to invite an opportunistic sample of participants via a URL webpage link to complete an online survey discussing 'the future of food'. The authors aimed to address any potential pro-environmental self-selection bias by emphasising that the survey was about food and different sources of protein, with no mention of sustainability. The survey was completed by 139 participants. Meat eaters accounted for 46.8% of participants, with 20.9% following a

vegan diet, 12.9% a vegetarian diet, 6.9% a pescetarian diet, 5.0% avoiding meat at certain times, 2.9% avoiding certain types of meat and 5.0% following another type of meat-excluding diet. We acknowledge the high percentage and overrepresentation of participants excluding meat from their diet in our sample, compared to the general population. The 53.2% of participants following a special meat-excluding diet did so for animal welfare (54.1%), environmental (21.6%), personal preference (10.8%), health (8.1%), religious (2.7%) and other (2.7%) reasons. The authors acknowledge the limitations of not collecting sociodemographic information from participants.

Participants were first provided with the information sheet content for the three alternative proteins. The survey then asked participants whether they would personally eat each of the three alternatives as part of an everyday meal and to select up to three reasons to explain their choice. These response options were derived from the interview data. Participants then considered whether each of the three alternatives might be effective in addressing issues relating to the environment and global food security, and to select up to three reasons to explain their choice. Participants then responded to items measuring meat attachment, with this measure once again demonstrating very good (DeVellis, 2012) scale reliability, $\alpha = 0.90$.

Results

This study aimed to (1) provide in-depth insight into key personal barriers and drivers to consumption of three alternative proteins, (2) explore the role of meat attachment in influencing these perceptions, and (3) explore the congruity of personal and global considerations. The results of the personal perceptions of survey participants are first outlined, regarding which alternative proteins they would or would not eat, and the top three drivers and barriers for each protein cited. Secondly, the influence of meat attachment on these personal perceptions is examined. Finally, whether personal and global perceptions of alternative proteins are congruent or incongruent, exploring the NIMBY style global advocacy yet personal aversion response, is detailed.

Personal perceptions: key drivers and barriers

The most favoured alternative for personal consumption was plant-based substitutes, with 90.6% of survey participants stating that they would consume them, followed by lab-grown meat at 41.0% and edible insects at 25.9%. The top three most commonly selected drivers and barriers to wanting or not wanting to consume the three alternative proteins, as well as the percentage survey responses are presented below in Table 1 (note that participants could select up to three reasons for their choice).

Table 1.

A further seven reasons were cited in the interviews for wanting or not wanting to consume lab-grown meat, edible insects and plant-based substitutes, including: availability, cost, economic impacts, preference for other actions (e.g. nutrition education), preparation or cooking reasons, safety reasons and social or cultural reasons.

The role of meat attachment

A Ward's method cluster analysis was conducted to establish cluster membership of meat attachment scores in order to explore whether there was an association between meat attachment and personal preference to consume the three alternative proteins. The Ward's method cluster analysis identified two significant clusters, of 'low' and 'high' meat attachment. The 'low' category included 55 (39.6%) participants, who had meat attachment scores ranging between 10 and 25. Within this 'low' category 52.7% of participants were following a vegan diet, 27.3% a vegetarian diet, 12.7% a pescetarian diet, 1.8% avoiding certain types of meat and 5.5% following another type of meat-excluding diet. Participants followed a special meat-excluding diet for animal welfare (65.5%), environmental (20.0%), personal preference (7.3%), health (3.6%) and other (3.6%) reasons. The 'high' category included 84 (60.4%) participants, who had meat attachment scores ranging between 27 and 65. Of the 'high' category participants, 77.4% consumed meat, with 8.3% avoiding meat at certain times, 3.6% avoiding certain types of meat, 3.6% following a vegetarian diet, 2.4% following a pescetarian diet and 4.8% following another type of meat-excluding diet. The 22.6% of participants following a special meat-excluding diet did so for environmental (26.3%), animal welfare (21.1%), health (21.1%), personal preference (21.1%) and religious (10.5%) reasons.

The effect of cluster membership on meat attachment score was found to be significant following a one-way ANOVA, $F(1,137) = 466.01, p < .001$. This was supported by a histogram of meat attachment scores which displayed two clear clusters of a low and a high population. Contingency tables (see Table 2) were generated that displayed the counts for the 'low' and 'high' meat attachment category and for personal willingness to consume lab-grown meat, edible insects and plant-based substitutes.

Table 2.

A 2x2 Pearson's chi-squared test indicated that there was a significant association between meat attachment cluster and personal preference to want to consume lab-grown meat, $\chi^2(1, N = 139) = 22.85, p < .001$. The majority (84%) of the 'low' meat attachment group did not want to consume lab-grown meat personally, with the majority (59%) of the 'high' meat attachment group wanting to consume lab-grown meat personally. A 2x2 Pearson's chi-squared test indicated that there was a significant association between meat attachment cluster and personal preference to want to consume edible insects, $\chi^2(1, N = 139) = 23.51, p < .001$. Thus even though the majority (96%) of the 'low' meat attachment group and the majority (60%) of the 'high' meat attachment group both did not want to consume edible insects personally, the likelihood of being willing to consume insects was affected by meat attachment. A 2x2 Pearson's chi-squared test indicated that there was also a significant association between meat attachment cluster and personal preference to want to consume plant-based substitutes, $\chi^2(1, N = 139) = 9.39, p = .002$. All (100%) of the 'low' meat attachment group and the majority (85%) of the 'high' meat attachment group wanted to consume plant-based substitutes personally.

Congruity of personal and global perceptions

This study also explored the congruity of personal and global perceptions to three alternative proteins compared alongside each other through a quantitative survey for the first time, building on Verbeke et al.'s (2015b) findings of a NIMBY style response to lab-grown meat. In all three cases, personal willingness to try an alternative protein was found to be significantly associated with perceptions of whether the alternative protein would be effective in addressing global food sustainability issues. A 2x2 Pearson's χ^2 was carried out and found a significant association between the personal and global responses to lab-grown meat, $\chi^2(1, N = 139) = 11.03, p < .001$. Similarly, a 2x2 Pearson's χ^2 found a significant association between the personal and global responses to edible insects, $\chi^2(1, N = 139) = 9.49, p = .002$ and the personal and global responses to plant-based substitutes, $\chi^2(1, N = 139) = 12.01, p < .001$.

Inspection of Table 3 indicated that with lab-grown meat, the most popular (37%) response was to not want to consume it personally, but to perceive it as effective in addressing global environmental and food security issues. Despite the most popular individual response to lab-grown meat being not wanting to consume it personally but perceiving it as effective globally, a *larger* majority (58%) of participants had congruent personal and global responses. The majority either wanted to consume lab-grown meat personally and thus advocated it globally, or did not want to consume it personally, and so did not advocate it globally. Inspection of Table 3 indicated that similarly with edible insects, the most popular individual response (40%) was to not want to consume them personally, but to perceive them as effective in addressing global environmental and food security issues. However, like with lab-grown meat, a larger majority (55%) was congruent with their personal and global perceptions of edible insects. Conversely, with plant-based substitutes (see Table 3), the most popular individual response (73%) was to want to consume them personally *and* to perceive them as effective in addressing global environmental and food security issues. Thus similarly, with lab-grown meat and edible insects, the majority (79%) had congruent personal and global perceptions.

Table 3.

These findings indicate that global advocacy despite personal aversion was a popular individual response to lab-grown meat and edible insects, but not to plant-based substitutes. However, a larger majority of participants instead had congruent responses when considering personal to global perceptions for all three alternative proteins. This analysis has shown that the congruity of personal and global perceptions is more complex than previously thought.

Discussion

This study sought to explore the key drivers and barriers to perceived personal consumption of three alternatives to conventional meat when compared alongside each other for the first time. The study also sought to quantify the influence of meat attachment on those perceptions and aimed to gain deeper insight in to the congruity of personal and global perceptions.

Personal perceptions: key drivers and barriers

Key drivers and barriers to consumption of lab-grown meat, edible insects and plant-based substitutes were identified. Edible insects were least popular for personal consumption with plant-based substitutes most popular. For lab-grown meat, the most common drivers for consumption were environmental friendliness, moral or ethical reasoning and it being considered interesting. These findings supported previous research that indicated that moral and environmental reasons would be strong motivators for consumers (Hopkins and Dacey, 2008; Haagsman, Hellingwerf and Roelen, 2009; Van der Weele and Tramper, 2014; Verbeke, Sans and Van Loo, 2015a; Verbeke et al., 2015b) as well as a general interest in the concept of lab-grown meat (Haagsman, Hellingwerf and Roelen, 2009; Van der Weele and Driessen, 2013). Moral and ethical reasons were also cited as a key barrier. Research showing that consumers also have concerns over lab-grown meat's perceived unnaturalness was also supported (Van der Weele and Tramper, 2014; Alvarez and Preble, 2014; Verbeke et al., 2015b, Tucker, 2014) as this was a commonly cited barrier. Cost did not emerge as a prominent barrier to consumption of lab-grown meat (Van der Weele and Tramper 2014) in this study, despite its relatively high cost communicated in the information sheets.

Research indicating that strong disgust responses and aversion, act as key barriers to the consumption of edible insects was supported by this study. Other previously identified barriers included the perception of insects being unappealing to the senses and difficult to prepare and cook (Tucker, 2014), however these did not emerge in the findings of this study.

Previous research on perceptions of plant-based substitutes was also supported by the findings of this study, as key motivators for their consumption included health considerations (Elzerman et al., 2013) and moral or ethical reasons (Hoek et al. 2011). The issue of aesthetic appeal did emerge as a key barrier to the consumption of meat substitutes in support of previous research (Hoek et al., 2011; Elzerman et al., 2013), however it did not also emerge as a driver as it had in previous studies. The driver of easy preparation also did not emerge as important (Elzerman et al., 2013) as well as the barriers of lack of information and cost (Elzerman et al., 2013), previously identified as important in other studies.

The role of meat attachment

Accounted for the first time in a study on alternative proteins, meat attachment was found to be significantly associated with personal willingness to want to consume lab-grown meat, edible insects and plant-based substitutes. In terms of majority of popularity, lab-grown meat was favoured by the 'high' meat attachment group who mostly consumed meat, with edible insects favoured by neither, and plant-based substitutes favoured by both the 'high' and the 'low' meat attachment groups who mostly followed vegan and vegetarian diets. Existing literature on meat attachment (Graça, Calherios and Oliveira; 2015a; 2015b; 2016) has only ever studied this construct in relation to consumers reducing their meat consumption and not how meat attachment might influence perceptions of alternative proteins.

Congruity of personal and global perceptions

Personal and global perceptions of lab-grown meat, edible insects and plant-based substitutes were found to be significantly associated, with a popular response being global advocacy despite personal aversion in the case of lab-grown meat and edible insects. This finding supports Verbeke et al.'s (2015) finding that participants did not want to consume lab-grown meat personally, but could see the benefits of its consumption globally. However, *overall* participants personal and global perceptions of all three alternative proteins tended to be congruent, where if they wanted to consume the alternative protein personally then they advocated it globally, or if they did not want to consume the alternative protein personally then they did not advocate it globally. Through a more detailed quantitative analysis, findings indicate that the interaction between personal preference of alternative proteins and perceptions of their effectiveness globally is perhaps more complex than previously found (Verbeke et al., 2015b).

Application to tailored marketing research

The findings of this study could be used to inform research exploring tailored marketing strategies that promote alternative proteins as sustainable options to conventional meat. Appropriate marketing strategies have been emphasised as crucial for consumer acceptance of alternative proteins (Haagsman, Hellingwerf and Roelen, 2009). Further research is needed to explore how such marketing strategies could emphasise key drivers whilst simultaneously deemphasising key barriers that might discourage consumption. For example, how to emphasise the interesting concept underpinning lab-grown meat without highlighting the perceived unnaturalness of the process. Alternative proteins could also be marketed to different consumer segments based on their attachment to consuming conventional meat, such as lab-grown meat to 'highly attached' consumers and plant-based substitutes to all consumers, beyond typical vegan and vegetarian markets. Again, further research exploring effective marketing strategies would need to be carried out.

Limitations

Somewhat abstract decisions were posed to consumers throughout this study. This low ecological validity could be improved upon by questioning consumers in real-world contexts, such as in a supermarket or restaurant, or in future studies by providing consumers with sample products (Vernon and Berenbaum, 2004; Looy and Wood, 2006; Barsics et al., 2017).

Perceptions may have been somewhat influenced by the information sheets about each alternative protein, such as the consideration of environmental friendliness. However, to ensure that participants all had a basic understanding of each alternative protein and could make informed judgements, it was deemed necessary to use information sheets, particularly considering that some of the alternatives like lab-grown meat are not yet available for consumption.

Future studies could address methodological issues within this study by collecting sociodemographic information from participants and having a more representative sample, as participants who excluded meat from their diets were heavily overrepresented. Future studies could also benefit from using a validated construct of meat attachment, such as Graça et al.'s (2015a, 2015b, 2016) measure.

Conclusion

This study sought to explore consumer perceptions towards more sustainable alternatives to conventional meat. Building on an existing body of research, this study has identified key drivers and barriers that influence the perceptions of lab-grown meat, edible insects and plant-based substitutes. This study has demonstrated an association between one's attachment to conventional meat and perception of alternative proteins and has highlighted the complexity of interactions between personal preference and more global perspectives. The findings of this study could be used in future research exploring tailored marketing of alternative proteins as viable and more sustainable options to conventional meat.

References

- Alvarez, J.B and Preble, M.G. (2014) Disrupting the meat industry: tissue culture beef. *Harvard Business School Case*.
- Baroni, L., Cenci, L., Tettamanti, M., and Berati, M. (2007) Evaluating the environmental impact of various dietary patterns combined with different food production systems. *European Journal of Clinical Nutrition*, 61(2), 279-286.
- Barsics, F., Barsics, F., Caparros Megido, R., Caparros Megido, R., Brostaux, Y., Brostaux, Y., Barsics, C., Barsics, C., Blecker, C., Blecker, C. and Haubruge, E. (2017) Could new information influence attitudes to foods supplemented with edible insects? *British Food Journal*, 119(9), 2027-2039.
- British Nutrition Foundation (2016) *Protein*. [online] Available at: <<https://www.nutrition.org.uk/nutritionscience/nutrients-food-and-ingredients/protein.html>> [Accessed 29 September 2016].
- Chen, P.P., Wongsiri, S., Jamyanya, T., Rinderer, T.E., Vongsamanode, S., Matsuka, M., Sylvester, H.A. and Oldroyd, B.P. (1998) Honey bees and other edible insects used as human food in Thailand. *American Entomologist*, 44(1), 24-29.
- Carlsson-Kanyama, A. (1998) Climate change and dietary choices - how can emissions of greenhouse gases from food consumption be reduced? *Food policy*, 23(3), 277-293.
- Cicatiello, C., Cicatiello, C., De Rosa, B., De Rosa, B., Franco, S., Franco, S., Lacetera, N. and Lacetera, N. (2016) Consumer approach to insects as food: barriers and potential for consumption in Italy. *British Food Journal*, 118(9), 2271-2286.
- Davies, J. and Lightowler, H., (1998) Plant-based alternatives to meat. *Nutrition & Food Science*, 98(2), 90-94.
- DeVellis., R.F. (2012) *Scale development: Theory and applications* (3rd ed.). London: Sage publications.
- Elzerman, J. E., Hoek, A. C., Van Boekel, M. A., and Luning, P. A. (2011) Consumer acceptance and appropriateness of meat substitutes in a meal context. *Food Quality and Preference*, 22(3), 233-240.

- Elzerman, J. E., Van Boekel, M. A., and Luning, P. A. (2013) Exploring meat substitutes: consumer experiences and contextual factors. *British Food Journal*, 115(5), 700-710.
- Food and Agriculture Organisation (2006) *Livestock's Long Shadow – Environmental Issues and Options*. Rome: Food and Agriculture Organisation.
- Graça, J., Calheiros, M.M. and Oliveira, A. (2015b) Attached to meat?(Un) Willingness and intentions to adopt a more plant-based diet. *Appetite*, 95, 113-125.
- Graça, J., Oliveira, A. and Calheiros, M.M. (2015a) Meat, beyond the plate. Data-driven hypotheses for understanding consumer willingness to adopt a more plant-based diet. *Appetite*, 90, 80-90.
- Graça, J., Calheiros, M.M. and Oliveira, A. (2016) Situating moral disengagement: Motivated reasoning in meat consumption and substitution. *Personality and Individual Differences*, 90, 353-364.
- Haagsman, H.P., Hellingwerf, K.J. and Roelen, B.A.J. (2009). Production of animal proteins by cell systems: desk study on cultured meat ('Kweekvlees'). Faculty of Veterinary Medicine: Utrecht University.
- Hoek, A.C., Luning, P.A., Weijzen, P., Engels, W., Kok, F.J. and 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.
- Hoek, A. C., Elzerman, J. E., Hageman, R., Kok, F. J., Luning, P. A., and de Graaf, C. (2013) Are meat substitutes liked better over time? A repeated in-home use test with meat substitutes or meat in meals. *Food Quality and Preference*, 28(1), 253-263.
- Hopkins, P.D. and Dacey, A. (2008) Vegetarian Meat: could technology save animals and satisfy meat eaters, *Journal of Agriculture Environment Ethics*, 21, 579 – 596.
- Horrigan, L., Lawrence, R. S., and Walker, P. (2002). How sustainable agriculture can address the environmental and human health harms of industrial agriculture. *Environmental health perspectives*, 110(5), 445.
- Intergovernmental Panel on Climate Change (2007). *Climate Change 2007: Synthesis Report*. [pdf] Geneva: Intergovernmental Panel on Climate Change. Available at: <https://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf> [Accessed 29 September 2016].
- Looy, H. and Wood, J.R., (2006). Attitudes Toward Invertebrates: Are Educational "Bug Banquets" Effective?. *The journal of environmental education*, 37(2), 37-48.
- McMichael, A. J., Powles, J. W., Butler, C. D., and Uauy, R. (2007). Food, livestock production, energy, climate change, and health. *The Lancet*, 370(9594), 1253-1263.
- New Harvest (2017) *Mission & Vision*. [online] Available at: <<http://www.new-harvest.org/about>> [Accessed 14 December 2017].
- Oonincx, D.G., van Itterbeeck, J., Heetkamp, M.J., van den Brand, H., van Loon, J.J. and 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), 14445.

- Post, M.J. (2012). Cultured meat from stem cells: Challenges and prospects. *Meat Science*, 92(3), 297-301.
- Schively, C. (2007). Understanding the NIMBY and LULU phenomena: Reassessing our knowledge base and informing future research. *Journal of planning literature*, 21(3), 255-266.
- Schmidt, C.W. (2008). The yuck factor when disgust meets discovery. *Environmental Health Perspectives*, 116(12), 524.
- Schösler, H., De Boer, J., and Boersema, J. J. (2012). Can we cut out the meat of the dish? Constructing consumer-oriented pathways towards meat substitution. *Appetite*, 58(1), 39-47.
- Steinfeld, H., Gerber, P., Wassenaar, T., Castel, V., Rosales, M. and De Haan, C. (2006). *Livestock's long shadow* Rome: Food and Agriculture Organisation.
- Tucker, C. A. (2014). The significance of sensory appeal for reduced meat consumption. *Appetite*, 81, 168-179.
- Tuomisto, H.L. (2017) *Are laboratory-grown meat and dairy products the future?* The University of Sheffield. 20 March 2017.
- Tuomisto, H.L. and Teixeira de Mattos, M.J. (2011). Environmental impacts of cultured meat production. *Environmental science & technology*, 45(14), 6117-6123.
- Van der Weele, C. and Driessen, C. (2013). Emerging profiles for cultured meat; ethics through and as design. *Animals*, 3(3), 647-662.
- Van der Weele, C. and Tramper, J. (2014). Cultured meat: every village its own factory? *Trends in biotechnology*, 32(6), 294-296.
- Verbeke, W. (2015c). Profiling consumers who are ready to adopt insects as a meat substitute in a Western society. *Food Quality and Preference*, 39, 147-155.
- Verbeke, W., Marcu, A., Rutsaert, P., Gaspar, R., Seibt, B., Fletcher, D. and Barnett, J. (2015b). 'Would you eat cultured meat?': Consumers' reactions and attitude formation in Belgium, Portugal and the United Kingdom. *Meat science*, 102, 49-58.
- Verbeke, W., Sans, P. and Van Loo, E.J. (2015a). Challenges and prospects for consumer acceptance of cultured meat. *Journal of Integrative Agriculture*, 14(2), 285-294.
- Vernon, L.L. and Berenbaum, H. (2004). A naturalistic examination of positive expectations, time course, and disgust in the origins and reduction of spider and insect distress. *Journal of anxiety disorders*, 18(5), 707-718.
- Waste and Action Resources Programme (2015). *Food Futures*. [pdf] Available at: <http://www.wrap.org.uk/sites/files/wrap/Food_Futures_%20report_0.pdf> [Accessed 29 September 2016].
- Zollitsch, W., Winckler, C., Waiblinger, S. and Haslberger, A. (2007). *Sustainable Food Production and Ethics*. The Netherlands: Wageningen Academic Publishers.

Table 1: Top personal drivers and barriers for consumption of the three alternative proteins			
<i>Alternative protein</i>	<i>Top 3 personal drivers and barriers</i>	<i>Example quote from interviews</i>	<i>% survey response (N = 139)</i>
Lab-grown meat	Driver: <i>Environmental friendliness</i>	"I knew it was better ecologically compared to normal meat, but I didn't quite realise how much. I mean ninety six percent fewer greenhouse gases emissions, that seems absolutely incredible"	33.3%
	Driver: <i>Moral or ethical reasons</i>	"It seems like it would be very few animals that would be harmed"	27.3%
	Driver: <i>Interesting idea or good concept</i>	"I like the idea and principal"	18.7%
	Barrier: <i>Moral or ethical issues</i>	"That one, probably the morality has got some sort of attachment to that...so you're growing it from a dead thing in the first instant. I dunno, there might be issues around that"	19.4%
	Barrier: <i>Too processed, unnatural or artificial</i>	"You'd have to do masses to it, to make it, it's so fiddled with...I don't want my food to be played with"	16.7%
	Barrier: <i>Preference for other sources of protein</i>	"I've got no problems with eating meat that's been well reared"	12.5%
Insects	Driver: <i>Environmental friendliness</i>	"All of [the three options presented] are more sustainable options than intensive livestock rearing"	29.3%
	Driver: <i>Easy to grow, rear and manage</i>	"Insects have that capacity to reproduce and grow at a phenomenal rate"	23.9%
	Driver: <i>Health or nutrition reasons</i>	"It's not got a lot of fat in terms of meat...it's quite protein rich"	18.5%
	Barrier: <i>Aversion (i.e. strong, instinctual response)</i>	"People just psychologically don't want to eat wriggly maggots"	24.9%
	Barrier: <i>Aesthetic appeal (i.e. individual taste)</i>	"There's something not very appealing about them [to me]"	20.8%
	Barrier: <i>Preference for other sources of protein</i>	"I would think that it would be much better to eat something that's local"	18.9%
Plant-based substitutes	Driver: <i>Moral or ethical reasons</i>	"Meat substitutes could make more ethical contributions to people's diets"	19.8%
	Driver: <i>Health or nutrition reasons</i>	"I would eat it, if I needed something like that to boost my nutrition up"	15.2%

	Driver: <i>Environmental friendliness</i>	"All of [the three options presented] are more sustainable options than intensive livestock rearing"	14.0%
	Barrier: <i>Preference for other sources of protein</i>	"[considering why some people prefer conventional meat to meat substitutes] People who eat meat don't ...eat meat substitutes because they see a meat substitute as a lesser product...so why would you have something lesser?"	25.0%
	Barrier: <i>Aesthetic appeal</i>	"I don't want a...weirdy...reconstituted sausage"	25.0%
	Barrier: <i>Too processed, unnatural or artificial</i>	"And meat substitutes, again, it's taking away the direct link between what we're eating and where it comes from"	18.75%

Table 2: Contingency tables of meat attachment cluster and personal willingness to consume the three alternative proteins

<i>Lab-grown meat</i>	Low meat attachment	High meat attachment	Total
Would eat personally	9 (6.5%)	48 (34.5%)	57
Would not eat personally	46 (33.1%)	36 (25.9%)	84
Total	55 (39.6%)	82 (59.0%)	139
<i>Edible insects</i>	Low meat attachment	High meat attachment	Total
Would eat personally	2 (1.4%)	34 (24.5%)	36
Would not eat personally	53 (38.1%)	50 (36.0%)	103
Total	55 (39.6%)	84 (60.4%)	139
<i>Plant-based meat substitutes</i>	Low meat attachment	High meat attachment	Total
Would eat personally	55 (39.6%)	71 (51.1%)	126
Would not eat personally	0 (0.0%)	13 (9.4%)	13
Total	55 (39.6%)	84 (60.4%)	139

Table 3: Contingency tables of personal and global perceptions of the three alternative proteins			
<i>Lab-grown meat</i>	Effective for addressing global issues	Not effective for addressing global issues	Total
Would eat personally	50 (40.0%)	7 (5.0%)	57
Would not eat personally	51 (36.7%)	31 (22.3%)	82
Total	101 (72.6%)	38 (27.3%)	139
Edible insects	Effective for addressing global issues	Not effective for addressing global issues	Total
Would eat personally	30 (21.6%)	6 (4.3%)	36
Would not eat personally	56 (40.3%)	47 (33.8%)	103
Total	86 (61.9%)	53 (81.2%)	139
Plant-based meat substitutes	Effective for addressing global issues	Not effective for addressing global issues	Total
Would eat personally	102 (73.4%)	24 (17.3%)	126
Would not eat personally	5 (3.6%)	8 (5.8%)	13
Total	107 (77.0%)	32 (23.0%)	139