

Consumer perceptions of conventional and alternative protein sources: A mixed-methods approach with meal and product framing

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ABSTRACT

Understanding consumer perceptions of meat alternatives is key to facilitating a shift toward more sustainable food consumption. Importantly, these perceptions may vary according to the characteristics of the consumer (e.g., preferences, motivations), the product (e.g., sensory attributes) and the encounter (e.g., how the meat alternative is presented/framed). Qualitative and quantitative methods were applied to examine consumer perceptions of five proposed alternatives to meat: legumes, tofu, seitan, lab-grown meat, and insects. In Study 1, 138 participants provided free associations with regards to conventional animal proteins (e.g., red/white meat, fish) and the five alternatives. Three profiles of consumers were identified: (1) hedonically motivated meat eaters uninterested in meat substitutes; (2) health-oriented meat eaters open to some meat substitutes; and (3) ethically conscious meat avoiders positively oriented to most meat alternatives. In Study 2, the presentation of the product was experimentally manipulated: 285 participants evaluated the same five meat alternatives along several dimensions (e.g., edibility, healthiness), either when framed as an individual product or as part of a larger meal. Overall, most meat alternatives benefited from a meal framing, with the notable exception of legumes, which benefited from an individual framing, and insects which were evaluated quite negatively regardless of framing. The present findings suggest that there is not a single way to frame all meat alternatives that will improve their appeal to all consumers.

1. Introduction

Transitioning away from animal-sourced proteins towards greater use of plant-based foods may help reduce the negative impact of current food systems on the environment (Aiking, 2011; Godfray et al., 2018; Poore & Nemecek, 2018; Willett et al., 2019) and public health (Tilman & Clark, 2014; Willett et al., 2019). Despite these concerns, global meat consumption continues to rise annually (FAO, 2018), and large segments of consumers are not willing to change their meat-eating habits (Hartmann & Siegrist, 2017). One challenge to enable transitions toward healthier and more sustainable food consumption is to develop pathways (e.g., through campaigns, advertisements, public policies) that promote plant-based eating as increasingly accessible and appealing to greater numbers of consumers (de Boer & Aiking, 2017, 2018; Godfray et al., 2018; Graça, Truninger, et al., 2019, 2020). To help inform these efforts, the current work: (1) explores consumers' perceptions of meat

and meat alternatives; and (2) provides a test of framing as a strategy to increase the appeal of meat alternatives.

1.1. Alternatives to meat consumption

Meat represents an important and valued source of protein in human diets (Leroy & Praet, 2015). Consumer perceptions of meat are influenced both by psychological factors and qualities of the meat itself (Font-i-Furnols & Guerrero, 2014; Verbeke, Pérez-Cueto, Barcellos, Krystallis, & Grunert, 2010). Consumer attitudes towards meat are shaped by sensory aspects of meat (e.g., appearance, texture, flavour; Font-i-Furnols & Guerrero, 2014), the type of meat (e.g., red meat, white meat, fish; Clifton & Tapsell, 2013), marketing factors (e.g., price, label, brand; Font-i-Furnols & Guerrero, 2014), as well as health and ethical concerns (Berndsen & van der Pligt, 2005; Verbeke, Pérez-Cueto, Barcellos, Krystallis, & Grunert, 2010).

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Several alternative products to meat have been proposed to reduce the current reliance on meat-based proteins (Alexander et al., 2017; Kumar et al., 2017; Smetana, Mathys, Knoch, & Heinz, 2015). These products differ in terms of their nutritional value, the technological challenges required for production, and their current acceptance as alternatives to meat (van der Weele et al., 2019). These products also differ in terms of their origins: they can be sourced from plants, such as legumes (i.e., plants with seeds in a pod, such as beans or peas; Lemken, Spiller, & Schulze-Ehlers, 2018, 2019), tofu (i.e., a soft, pale high-protein food, made from the seed of the soya plant; Ottenfeld, Bernstein, & Wittle, 2008), seitan (i.e., a meat substitute made from wheat which can often resemble meat in texture; Véron, 2016); or they can be sourced from animals, such as insects (i.e., crickets, earthworms; Hartmann & Siegrist, 2016) and lab-grown meat (i.e., meat that is cultivated based on animal cells; Bryant & Barnett, 2018).

Studies of consumer perceptions of meat substitutes has been increasing in recent years, yet data is still relatively scarce (for recent reviews, see Graça, Godinho, & Truninger, 2019; Hartmann & Siegrist, 2017; van der Weele et al., 2019). Relevant studies on meat alternatives tend to focus on evaluations of a single product, treated in isolation from conventional sources of animal protein, such as meat and fish, and other meat alternatives. This individuated approach has produced a fragmented body of evidence regarding consumer perceptions of meat substitutes. A more comprehensive approach that assesses multiple perceptions across a range of conventional and unconventional products could yield new insights, as could the adoption of a 'grounded' approach to consumer perceptions.

The Grounded-Cognition Theory of Desire (Papies, Barsalou, & Rusz, 2020) articulates how people's appetite for food tends to occur within rich, multisensory "eating" situations. Appetitive cues, such as the look or smell of a product, within such contexts trigger approach and reward responses. Revisiting these appetitive cues, for example, when viewing an image of a product or hearing a description of a meal, can trigger mental simulations of prior consumption experiences. These simulations motivate behavior, often without conscious awareness. This perspective suggests that food presentations that facilitate positive consumption simulations, for example, by including factors that resemble prior eating contexts, are likely to enhance consumer desires. Hence, the present work considered how grounding (potentially unfamiliar) meat alternatives within a meal context might enhance consumer attitudes towards such products.

1.2. Impact of framing on food perception

Introducing meat alternatives poses several barriers, including the enjoyment people derive from the taste and texture of meat, the unfamiliarity and lower sensory attractiveness of meat substitutes, and the lack of knowledge and skills to prepare them (Graça et al., 2019). Framing may be one way to help address some of the barriers associated with meat replacement. A study by Bryant and Barnett (2019) assessed consumer perceptions of lab-grown meat under different monikers – "clean meat", "cultured meat", "animal-free meat", or "lab-grown meat". Participants reported more positive attitudes towards the product when it was labelled as "clean meat" and "animal-free meat" than when the term "lab-grown meat" was applied. Additionally, when the product was described as "clean meat" participants reported greater willingness to sample the product than when it was labelled "lab-grown meat" (Bryant & Barnett, 2019). Associating meat with lab technology appears to be off-putting to many consumers. Bryant and Dillard (2019) investigated the acceptance of lab-grown meat under different frames, highlighting either: the societal benefits of its consumption ("reducing harm to the environment and helping animals"), its technological novelty ("high tech"), or that cultured and conventional meat are the "same". The authors found that the high-tech framing group reported the least positive attitudes toward lab-grown meat and its consumption.

Other recent studies have examined the impact of framing on plant-

based food choices and found that avoiding the label "vegetarian" within a menu can make meat-free products more desirable, compared to frames that avoid this term (e.g., describing a dish as "environmentally friendly"; Krpan & Houtsma, 2020). However, these effects differ as a function of the consumer, with non-vegetarian consumers responding more positively to such frames compared to vegetarians, who prefer vegetarian dishes to be labelled as such (Bacon & Krpan, 2018). Another approach to framing meat substitutes involves considering the way people represent the product as either a product in isolation or a constituent part of a meal. Studies by Elzerman and colleagues (Elzerman, Hoek, van Boekel, & Luning, 2011, 2015) have shown that the meal context may play a critical role for perceptions of meat alternatives. For instance, in line with a grounded cognition framework, they found that consumers were most positive toward meat substitutes that were similar in appearance to meat and when served with foods that were familiar to consumers (thus, likely to elicit consumption simulations). This suggests that framing meat substitutes within a broader context of an appealing meal may lead to more positive attitudes toward the product. Yet, as the authors recognized, more research is needed to test the potential benefits of meal framing when introducing novel or unfamiliar foods to consumers.

1.3. The present work: aim and objectives

In two studies, the present work aims to contribute to an increased understanding of consumer perceptions of meat and meat alternatives, with the ultimate goal of gaining insights to help inform transitions toward healthier and more sustainable diets. Study 1 used an integrative bottom-up approach (free-association task) to uncover how consumers perceive a set of conventional and alternative sources of protein: red meat, white meat, fish and seafood, insects, legumes, tofu, seitan, and lab-grown meat. This set of meat alternatives covers a range of contemporary plant- and animal-protein sources of varied levels of availability. Multiple correspondence analysis was used to identify patterns of association (and opposition) within the data. Study 1 provided an integrative assessment of how consumers perceive meat alternatives vis-à-vis conventional animal proteins rather than focusing on evaluations of a single product or assessing meat alternatives in isolation from other sources of animal and plant-based protein. The consumer perception dimensions identified in Study 1 were then used to inform the approach of Study 2, which addressed experimentally how consumers perceive the same set of meat substitutes under different product frames.

In Study 2, a second sample of consumers evaluated the products along nine evaluative dimensions: taste, edibility, healthiness, caloric content, naturalness, degree of processing, expensiveness, ethics and sustainability. These dimensions were either derived from Study 1 or previous research on meat and food selection (e.g., Bleichert et al., 2014; Bryant et al., 2019; Prada et al., 2017). Study 2 examined how consumer perceptions differ as a function of whether the meat alternative was framed as a stand-alone food (individual frame) versus integrated within a meal (meal frame). Based on the findings of Elzerman, Hoek, van Boekel, & Luning, 2011, 2015), it was expected that presenting meat alternatives within a meal frame (e.g., tofu scramble) would promote more positive evaluations of the products than when presenting them as individual items (e.g., tofu). Consistent with a grounded cognition perspective (Papies, Barsalou, & Rusz, 2020), the reasoning was that meal frames provide a richer illustration to consumers of how a potentially unfamiliar food item, such as tofu or seitan, might be cooked and eaten, thus, increasing its appeal as an alternative to meat.

2. Study one: consumers' bottom-up representations of conventional and alternative protein sources

2.1. Method

2.1.1. Participants and procedure

The sample included 138 Portuguese participants (58.1% female) aged between 18 and 52 years old ($M_{\text{age}} = 26.77$, $SD = 8.89$). More than half of the sample (58.9%) had a higher education degree (Bachelor's, Master's or Doctorate degree), 38.8% completed secondary education and 2.3% completed primary education. Most participants included animal products (meat or fish) in their diets (82.8%), whereas 3.7% followed a vegetarian diet and 6% a vegan diet; 7.5% reported to have "other" dietary orientations (e.g., flexitarian). More detailed information about their eating habits is presented in the results section. Participants were invited to take part in a study of consumer perceptions of different foods via social networking websites (e.g., Facebook) and mailing lists. The data collection took place between 5th December 2018 and 7th January 2019. By clicking on a hyperlink, participants were directed to a secure webpage hosted by Qualtrics©. The opening page informed participants about the goals of the study (i.e., perceptions about food options), its expected duration (approximately 10 min), and ethical considerations (i.e., anonymity, confidentiality and the right to withdraw at any point by closing the browser, without their responses being considered for analysis). After participants gave their informed consent, they were directed to the survey.

2.1.2. Measures

Participants were asked to write what they "think, feel or imagine" about the consumption of eight different food products: red meat, white meat, fish and seafood, insects, legumes, tofu, seitan, and lab-grown meat (e.g., "Eating insects makes me think, feel or imagine..."; five text boxes were provided per item to write associations). Each product was presented in a random order on a separate page. Afterwards, participants were asked to categorize their diet (e.g., omnivorous, pescatarian, ovo-lacto vegetarian, strict vegetarian/vegan). They also provided basic sociodemographic information, including age, gender, nationality, and education. Finally, participants were debriefed and thanked.

2.1.3. Data analyses

Data retrieved from the word association task was converged using NVivo 11 software, based on the same procedure used in Graça et al. (2015). A total of 3994 words/phrases were retrieved. Separate word lists were generated for each food category. To ensure that the meanings expressed by the participants were maintained, words with the same meaning were grouped together (e.g., "delicious" with "appetising"). In a second step, words from the same family were merged (e.g., "sea" with "beach", and "summer"). Infrequent words, with only one occurrence, were then dropped. In step three, the words were grouped into 102 categories (mentioned 2124 times). All responses were then coded according to the presence or absence of each category (*mentioned* or *not mentioned*). To avoid residual categories, only categories mentioned by at least 10% of the participants were retained for analysis and interpretation. This reduced the category system to 56 categories that were mentioned 1781 times (see Supplemental Material, Table S1). A multiple correspondence analysis (MCA) was then performed to explore the interrelationships between the categorical variables. This was followed by a hierarchical cluster analysis (HCA) to validate the MCA pattern solution. MCA standardised object scores were used as input variables. The HCA was suited by a k-means algorithm, a non-hierarchical clustering method. Analyses were performed using SPSS Statistics (version 23, IBM©).

2.2. Results

A preliminary description of the answers to the free-association task is presented in [Supplementary Material Table S1](#) (i.e., frequencies and semantic content). Here is presented the interpretation of the dimensions identified in the MCA, the topological representation of the relationships between categories, and the results from the HCA.

2.2.1. Dimensions identified in the MCA and topological representation

MCA was used to identify different clusters of consumers, based on the pattern of their association responses across the eight food products. The MCA identified two relevant dimensions accounting for 7.2% and 6.7% of the total variance, respectively. Discrimination measures of each variable for the two dimensions are presented in [Supplementary Material \(Table S1, see the "Dimensions" column\)](#). [Fig. 1](#) depicts the topological configuration of the intersection between Dimension 1 (affect dimension) and Dimension 2 (health/nourishment dimension), along with the variables that contributed the most to the definition of the two dimensions (i.e., variables that had a discrimination measure greater than the inertia value for the respective dimension and the categories that had higher-than-average contributions – in this case, contributions greater than $0.018 = 1/56$, 1 being the sum of the contributions for each dimension, and 56 the total number of categories). Because there was a great number of categories, the results of the MCA were spread across four separate frames to avoid overloading the figure. Nonetheless, all frames refer to the same MCA.

The first dimension (horizontal axis in [Fig. 1](#)) differentiated individuals largely in terms of the affective and hedonic aspects of food, related to taste/disgust, wellbeing, and awareness of the ethical implications of animal products. Along this horizontal dimension, on one side (< 0), included associations referring to negative evaluations of meat alternatives (e.g., tofu disgust) and positive evaluations of (red) meat consumption related to pleasure, taste and wellbeing. On the other side of this dimension (> 0) were positive associations with tofu and seitan, feelings of disgust and negativity towards (red) meat, references to animals as victims, and ethical concerns associated with animal products.

The second dimension (vertical axis in [Fig. 1](#)) differentiated individuals in terms of more practical and functional aspects of food related to nourishment, nutritional value, and health, and perceptions of which groups/cultures eat certain foods. Along this vertical dimension, on one side (< 0), were categories related to the nutritional aspect of animal protein and legumes, the perception that white meat, fish, legumes, tofu and seitan are healthy, that tofu and seitan are associated with vegetarian or vegan diets, that red meat and lab-grown meat have health risks, that lab-grown meat is perceived as artificial, and that eating insects is associated with Asian cultures. On the opposite side of this dimension (> 0) were categories referring to the taste and wellbeing aspects of legumes, the wellbeing benefits of fish, the tastiness of white meat, the strangeness and unfamiliarity of tofu and seitan, and curiosity about lab-grown meat.

2.2.2. Projection of clusters

The results of the HCA validated the MCA solution and yielded three clusters of participants matching the three groups that emerged on the MCA (see [Frame 4](#)). Cluster 1 included more than half of the participants (55.8%). It included those participants with positive, hedonic orientations towards eating meat and reported disgust towards plant-based meat alternatives. Cluster 2 included around a fourth of the participants (26.1%) and captured a profile of meat-eaters more focused on health, nutrition and the functional value of eating. Cluster 3 included a minority of participants (18.1%), who tended to avoid and felt disgust towards meat, displayed ethical concerns with regard to meat consumption, and had positive orientations toward plant-based products. [Table 1](#) characterizes each of the three clusters in terms of demographic variables and eating habits. Chi-square (χ^2), Kruskal-Wallis (H), and independent samples t-tests revealed significant differences between the

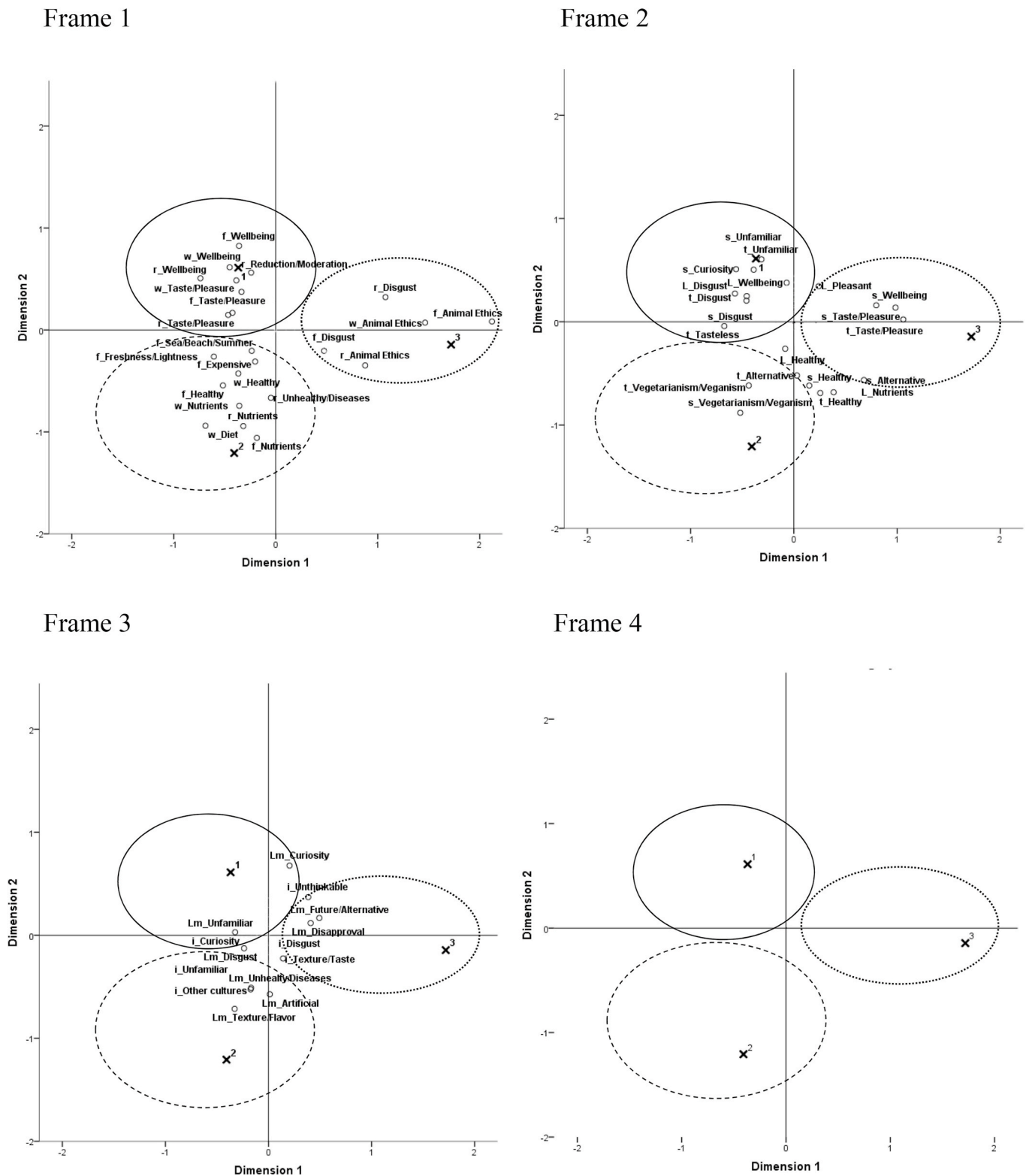


Fig. 1. Associations of meat consumption and meat alternatives; topological configuration and projection of clusters. Each cluster represents a “profile” of participants with similar associations. Note: The border of each group is represented by a specific pattern (cluster 1 —; cluster 2 - - -; cluster 3 ····). Frame 1: r = red meat; w = white meat; f = fish. Frame 2: L = legumes; t = tofu; s = seitan. Frame 3: i = insects; Lm = lab-grown meat. Frame 4 displays the coordinates from the three clusters identified in the MCA; these are passive variables, defined *a posteriori*, thus, they do not actively contribute to the association patterns. Dimension 1 (horizontal axis): Affect dimension; < 0 refers to negative evaluations of meat alternatives (e.g., tofu disgust) and positive evaluations of meat products (e.g., red meat taste), > 0 refers to positive evaluations of meat alternatives (e.g., fish taste) and negative evaluations of meat products (e.g., fish animal ethics); Dimension 2 (vertical axis): Health/nourishment dimension; < 0 refers to positive associations with meat alternatives (e.g., tofu healthy), white meat and fish (e.g., healthy), and negative associations with red meat (e.g., disease) and lab-grown meat (e.g., artificial), > 0 refers to positive associations with legumes (e.g., wellbeing) and lab-grown meat (e.g., curiosity), the unfamiliarity of tofu and seitan, and positive associations with red meat (e.g., nutrients), white meat or fish (e.g., healthy).

Table 1
Chi-square Comparisons regarding Participants' Demographic Characteristics and Self-reported Diet.

		Cluster 1		Cluster 2		Cluster 3		χ^2
		N	%	N	%	N	%	
Participants ^a	N	77	55.8	36	26.1	25	18.1	
Gender	Male	32	44.4	14	41.2	8	34.8	0.68
	Female	40	55.6	20	58.8	15	65.2	
Age	<25	35	48.6	21	61.8	10	43.5	2.51
	25–40	30	41.7	11	32.4	10	43.5	
	>40	7	9.7	2	5.9	3	13	
Education	Basic	3	4.2	0	0	0	0	7.69
	Secondary	29	40.3	11	32.4	10	43.5	
	Higher	40	55.5	23	67.6	13	56.5	
Self-reported Diet	Meat-eaters ^b	69	98.6	34	100	8	40	62.35***
	Meat avoiders	1	1.4	0	0	12	60	

^a $n = 129$ (except for Self-reported diet, $n = 124$); ^bMeat-eaters included omnivores and pescatarians; ^aMeat-avoiders included vegetarians and vegans.

*** $p < .001$.

three clusters in self-reported diet, frequency of food consumption (Table 2), and place of residence (with residence ranging from predominantly rural to predominantly urban).

In sum, three profiles of consumers emerged. One profile referred to a group of hedonically motivated meat eaters uninterested in meat substitutes. Another profile referred to a group of health-oriented meat eaters open to some meat substitutes. The other profile referred to a smaller group of ethically conscious meat avoiders positively oriented to most meat alternatives (primarily, the plant-based ones), residing mainly in urban areas. Additionally, a set of key evaluative dimensions were identified, which informed the methods used in Study 2.

3. Study two: examining the role of meal framing on meat alternatives

Study 2 sought to extend the insights uncovered in Study 1 by comparing consumer attitudes towards the same meat alternatives, but here the products were presented either as stand-alone products or as components of a meal. The framing of each food item was manipulated, between-subjects, to test the impact of meal framing on consumer perceptions related to nine evaluative dimensions, most of which emerged in Study 1 (e.g., healthiness, tastiness, sustainability, edibility, ethics), and some additional dimensions that have been identified in past work on food choices (e.g., caloric content, degree of processing).

3.1. Method

3.1.1. Participants and design

The sample included 285 Portuguese participants (68% female) aged 18–66 years ($M = 30.21$, $SD = 10.19$). More than half of the sample (56.8%) had a higher education degree (Bachelor's, Master's or Doctorate degree), 41.1% completed secondary education, and 2.1%

completed primary education. Most participants were employed (60.4%) or were students (22.1%). Most participants included meat or fish in their diets (59.6%), whereas 15.1% followed a vegetarian diet, 21.1% had a vegan diet, and 4.2% reported "other" dietary orientations. Single-sample t-tests against the scale midpoint of 4 revealed that, on average, participants lived in predominantly urban areas ($M = 5.24$, $SD = 1.91$), $t(284) = 11.01$, $p < .001$.

The study used a 2 (framing: individual vs. meal) \times 5 (food categories: legumes, insects, lab-grown, tofu, seitan) mixed-measures design, with framing as a between-participants factor and food category as within-participants factor. Participants were randomly distributed across framing conditions, with 56% of participants assigned, at random, to the *individual frame condition* ($n = 159$) and 44% to the *meal frame condition* ($n = 126$).

3.1.2. Procedure and measures

Procedures regarding data collection were similar to Study 1 and the data was collected between 14th March and 5th April 2019. After providing their consent, participants completed a task which consisted of evaluating the five meat alternatives from Study 1 (legumes, tofu, seitan, insects, lab-grown meat) on nine subjective dimensions using 7-point rating scales (for details of each dimension, see Table 3). Participants were randomly assigned to one of two framing conditions (individual vs. meal) such that participants were presented all five food items according to the frame they were assigned to (see Table 4). The food items were presented in a random order, each on a single page. The order of the nine evaluative dimensions was randomised for each food item. Next, participants completed three measures that assessed their general attitudes, knowledge and level of familiarity with the five meat alternatives and three conventional meats (red meat, white meat, fish) (see Table 3). Participants then reported their diet and sociodemographic information, as in Study 1, pertaining to age, gender,

Table 2
Kruskal-Wallis H and Independent t-test Comparisons regarding Participants' Eating Habits and Place of Residence.

		Cluster 1		Cluster 2		Cluster 3		H
		M	SD	M	SD	M	SD	
Frequency of consumption ^a	Red meat	3.49	1.25	3.71	1.29	1.75	1.42	26.88***
	White meat	4.31	1.23	4.59	1.33	1.79	1.18	44.44***
	Fish/seafood	3.32	1.11	3.65	0.92	2.04	1.37	22.28***
	Fruits/vegs	5.21	1.4	5.15	1.54	6.33	1.01	12.76**
	Legumes	3.94	1.41	4.35	1.45	5.17	1.58	10.61**
	Tofu	1.33	0.53	1.79	0.91	2.92	1.61	29.75***
	Seitan	1.22	0.63	1.88	1.04	2.46	1.21	40.14***
Residence	Rural - Urban	4.82	1.98	5.71	1.47	6.00	1.78	t 5.00**

** $p < .010$; *** $p < .001$.

^a Frequency of consumption, $n = 130$; scale: 1 = Never, 2 = Less than once a month, 3 = 1 to 2 times a month, 4 = 3 to 4 times a week, 5 = 5 to 6 times a week, 6 = 7 to 8 times a week, 7 = 9 or more times a week. Residence scale: 1 = Predominantly rural to 7 = Predominantly urban.

Table 3
Evaluative Dimensions and Scale Anchors.

Dimensions	Response Scale
Please indicate your opinion regarding the consumption of the following foods...	
1. Tastiness	1 = <i>Not at all appetising</i> to 7 = <i>Extremely appetising</i>
2. Edibility	1 = <i>Not at all edible</i> to 7 = <i>Extremely edible</i>
3. Healthiness	1 = <i>Not at all healthy</i> to 7 = <i>Extremely healthy</i>
4. Caloric content	1 = <i>Not at all caloric</i> to 7 = <i>Extremely caloric</i>
5. Naturalness	1 = <i>Not at all natural</i> to 7 = <i>Extremely natural</i>
6. Processing	1 = <i>Not at all processed</i> to 7 = <i>Extremely processed</i>
7. Expensiveness	1 = <i>Not at all expensive</i> to 7 = <i>Extremely expensive</i>
8. Ethics	1 = <i>Not at all ethical</i> to 7 = <i>Extremely ethical</i>
9. Sustainability	1 = <i>Not at all sustainable</i> to 7 = <i>Extremely sustainable</i>
Attitude	1 = <i>Very negative</i> to 7 = <i>Very positive</i>
Knowledge	1 = <i>I have little knowledge</i> to 7 = <i>I have a lot of knowledge</i>
Familiarity	1 = <i>Never found</i> to 7 = <i>I found frequently</i>

Table 4
Manipulation of Food Categories Presented by Framing Condition (Individual vs. Meal).

Food Category	Description task: "Please indicate your opinion regarding the consumption of (food category)..."	
	Individual Frame	Meal Frame
Legumes	...for example, chickpeas, beans, peas, lentils.	...for example, chickpea burger with potato chips, peas curry.
Tofu	...i.e., a plant-based product produced from leguminous plants.	...for example, grilled tofu with vegetables, pasta with sautéed tofu.
Seitan	...i.e., a plant-based product produced from cereals.	...for example, roast seitan with potatoes, seitan breaded with salad.
Insects	...for example, crickets, grasshoppers, earthworms, caterpillars.	...for example, fried rice with crickets, sautéed vegetables with grasshoppers.
Lab-grown meat	...i.e., meat produced in the laboratory from animal cells.	...for example, grilled laboratory meat with mashed potatoes, laboratory meatballs stuffed with rice.

nationality, educational level, and current occupational status. Finally, participants were thanked and debriefed.

3.1.3. Data analyses

Data analyses were performed using SPSS Statistics v.23 (IBM©). Zero-order correlations were calculated to examine relationships between the evaluative dimensions. Means scores of the food categories – legumes, insects, lab-grown meat, tofu and seitan – were compared using a repeated-measures ANOVA for each evaluative dimension. Greenhouse-Geisser correction was used whenever the assumption of Sphericity was violated. Based on post hoc comparisons with Bonferroni correction, categories with the highest and lowest score in each dimension were identified. Post-hoc analyses were used to explore any interaction effects observed between food category and framing condition.

3.2. Results

3.2.1. Correlations between evaluative dimensions

Overall, evaluative dimensions were highly correlated (see Table 5). Tastiness, edibility, healthiness, naturalness, ethics and sustainability were all positively correlated. Level of processing was positively correlated with expensiveness. Tastiness, edibility and sustainability were negatively (but not as strongly) correlated with expensiveness. Healthiness, naturalness and ethics were negatively correlated with processing. Caloric content was positively correlated with expensiveness and processing.

3.2.2. Food categories for evaluative dimensions

Food ratings across dimensions were analyzed as a function of framing condition (see Table 6).

Regarding the main effects of food category, legumes were the product considered the most natural, appetising, healthy, edible, ethical, sustainable and the least processed, independent of framing, all $ps \leq .026$ (see Table 6). Insects were rated as the least appetising, healthy, edible, ethical, expensive and the least caloric, all $ps \leq .013$. Lab-grown meat was rated as the least natural, sustainable, the most expensive, the most caloric and the most processed, all $ps \leq .019$.

Regarding the main effects of framing, overall, products were considered as more natural, appetising, healthy, edible, ethical and sustainable when framed as a component of a meal, than when described as an individual product, all $ps \leq .001$ (see Table 6). Conversely, products were rated as more expensive and processed when presented in an individual frame compared to a meal frame, all $ps \leq .001$.

There were also multiple interaction effects between food category and framing, with certain food products being more affected by framing condition than other products. There was an interaction between food category and framing on all dimensions, $p < .001$, except caloric content, $p = .108$. Specifically, legumes were perceived as more edible, healthier, more natural and more sustainable when presented in an individual frame than a meal frame, all $ps \leq .022$, whereas lab-grown meat was perceived as more edible, more appetising, healthier, more natural, less processed, more sustainable, more ethical and less expensive when presented in a meal frame than in an individual frame, all $ps < .001$. Tofu was also perceived as healthier and more ethical when presented in the context of a meal, all $ps \leq .028$ (see Table 6).

3.2.3. Food categories for attitude, knowledge and familiarity

Table 7 presents food category ratings on attitude, knowledge and familiarity by framing condition, for conventional meat products and the five alternatives. As can be seen, participants rated legumes as the most positive and familiar, compared to all other food categories, all $ps \leq .001$. Legumes were the meat alternative that participants had the greatest knowledge of, all $ps \leq .001$, with mean scores on par with red meat, white meat, and fish. Insects were considered the least familiar category, all $ps \leq .001$. Additionally, insects were rated the least positive category, along with lab-meat, and the product that participants had the least knowledge about, all $ps \leq .001$. When averaging across food category, there were no significant main effects of framing on ratings of attitude, knowledge, and familiarity. Interaction effects between food category and framing were not found either, $p \leq .142$. Follow-up analyses revealed three significant simple effects of framing within the food categories of legumes and tofu. Legumes bucked the trend for most food categories and were rated more positive, $p = .047$, and more familiar, $p < .001$, when presented as an individual product than a meal component. By contrast, tofu was rated as more positive when presented as part of meal than when presented as an individual product, $p = .036$ (see Table 7).

4. Discussion

In two studies, consumer perceptions of meat and meat alternatives

Table 5
Pearson's Correlations between Evaluative Dimensions.

	1	2	3	4	5	6	7	8
1. Tastiness	–							
2. Edibility	.71***	–						
3. Healthiness	.47***	.57***	–					
4. Naturalness	.42***	.49***	.65***	–				
5. Processing	-.18**	-.12*	-.26***	-.23***	–			
6. Caloric content	.07	.15*	.06	.06	.27***	–		
7. Expensiveness	-.23***	-.13*	-.04	-.11	.41***	.24***	–	
8. Ethics	.51***	.61***	.63***	.55***	-.13*	.11	-.11	–
9. Sustainability	.47***	.55***	.65***	.63***	-.19***	.08	-.12*	.70***

***. $p < .001$; ** $p < .010$; * $p < .050$.

Table 6
Food Ratings for each Evaluative Dimension by Food Category and Framing (Individual vs. Meal).

Dimensions	Framing	Food categories						Total
		Legumes	Tofu	Seitan	Insects	Lab meat	Total	
		<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>	
Tastiness	Individual	6.22 (1.17)	4.64 (1.90)	4.58 (1.74)	1.96 (1.53)	3.14 (1.77)*	4.11 ¹ (0.88)	
	Meal	6.12 (1.35)	5.01 (1.80)	4.92 (1.62)	1.94 (1.48)	6.12 (1.35)*	4.82 ² (1.00)	
	Total	6.18 (1.25)	4.80 (1.86)	4.73 (1.69)	1.95 (1.51)	4.46 (2.18)	4.42 (1.00)	
Edibility	Individual	6.60 (.83)	5.53 (1.55)	5.26 (1.45)	2.60 (1.96)	3.48 (1.90)*	4.70 ¹ (0.87)	
	Meal	6.29 (1.28)	5.63 (1.58)	5.39 (1.55)	2.55 (1.88)	6.29 (1.28)*	5.23 ² (0.99)	
	Total	6.46 (1.06)	5.58 (1.56)	5.32 (1.49)	2.58 (1.92)	4.73 (2.16)	4.93 (0.96)	
Healthiness	Individual	6.48 (0.78)	5.27 (1.34)*	4.98 (1.21)	3.64 (1.84)	2.87 (1.67)*	4.65 ¹ (0.74)	
	Meal	6.05 (1.22)	5.62 (1.30)*	5.16 (1.32)	3.57 (1.87)	6.05 (1.22)*	5.29 ² (0.82)	
	Total	6.29 (1.02)	5.42 (1.33)	5.06 (1.26)	3.61 (1.85)	4.27 (2.17)	4.93 (0.84)	
Naturalness	Individual	6.35 (1.05)*	4.84 (1.57)	4.87 (1.43)	4.33 (2.32)	1.92 (1.47)*	4.46 ¹ (0.85)	
	Meal	5.99 (1.36)*	5.01 (1.48)	4.82 (1.41)	4.30 (2.34)	5.99 (1.36)*	5.22 ² (0.83)	
	Total	6.19 (1.21)	4.91 (1.53)	4.85 (1.41)	4.32 (2.32)	3.72 (2.47)	4.80 (0.92)	
Processing	Individual	2.74 (2.03)	4.42 (1.32)	4.21 (1.36)	2.43 (1.83)	5.77 (1.62)*	3.91 ¹ (0.83)	
	Meal	3.11 (1.86)	4.25 (1.51)	4.29 (1.40)	2.79 (1.80)	3.11 (1.86)*	3.51 ² (1.05)	
	Total	2.90 (1.96)	4.35 (1.41)	4.24 (1.38)	2.59 (1.82)	4.59 (2.18)	3.74 (0.95)	
Caloric content	Individual	3.96 (1.53)	3.85 (1.18)	3.91 (1.16)	3.57 (1.48)	4.45 (1.18)	3.95 ¹ (0.71)	
	Meal	4.21 (1.38)	3.84 (1.34)	4.13 (1.09)	3.73 (1.61)	4.21 (1.38)	4.03 ¹ (0.85)	
	Total	4.07 (1.47)	3.85 (1.25)	4.01 (1.14)	3.64 (1.54)	4.34 (1.28)	3.98 (0.78)	
Expensiveness	Individual	2.79 (1.80)	4.35 (1.34)	4.31 (1.30)	3.30 (1.72)	4.99 (1.51)*	3.95 ¹ (0.81)	
	Meal	2.94 (1.78)	4.38 (1.57)	4.21 (1.48)	3.34 (1.79)	2.94 (1.78)*	3.56 ² (1.09)	
	Total	2.86 (1.79)	4.36 (1.44)	4.27 (1.38)	3.32 (1.75)	4.08 (1.92)	3.78 (0.96)	
Ethics	Individual	6.26 (1.18)	5.57 (1.43)*	5.50 (1.41)	2.74 (1.88)	3.32 (1.98)*	4.68 ¹ (0.84)	
	Meal	6.18 (1.25)	5.95 (1.44)*	5.75 (1.43)	2.87 (1.95)	6.18 (1.25)*	5.39 ² (0.91)	
	Total	6.22 (1.21)	5.74 (1.44)	5.61 (1.42)	2.80 (1.91)	4.59 (2.21)	4.99 (0.94)	
Sustainability	Individual	6.21 (1.02)	5.05 (1.31)	4.97 (1.46)	3.72 (2.21)	3.65 (2.01)*	4.72 ¹ (0.93)	
	Meal	5.90 (1.24)	5.36 (1.37)	5.23 (1.35)	3.87 (2.15)	5.90 (1.24)*	5.25 ² (0.85)	
	Total	6.08 ^a (1.13)	5.19 ^c (1.34)	5.08 ^c (1.42)	3.79 ^b (2.18)	4.65 ^b (2.05)	4.96 (0.93)	

Note. Different superscripts (^{1,2}) indicate differences according to framing (i.e., main effect of condition), all $ps \leq .001$. (*) Indicates a significant mean difference due to framing within a food category, all $ps < .028$. Results are presented with Bonferroni correction.

were examined, using mixed methods, to better understand pathways and barriers to adopting meat alternatives. Study 1 explored consumers' free associations with different types of meat (red meat, white meat, and fish) and meat alternatives (insects, legumes, tofu, seitan, and lab-grown meat) with the aim of identifying distinct consumer profiles. Study 2 used an experimental design to test how framing meat alternatives as either isolated products or components of a meal can affect how consumers perceive these products.

The findings from the first study revealed the presence of three profiles of consumers. The first group was comprised of committed meat eaters who had a uniformly positive orientation towards meat consumption, expressed an aversion towards plant-based alternatives, but also reported some curiosity about lab-grown meat. This profile of consumers is similar to the profile of "high meat attachment" found by Graça et al. (2015) in their exploration of consumer representations of meat. It also shares aspects in common with the personality profiles of individuals who tend to rationalize meat eating as "natural" and "nice" (see Hopwood & Bleidorn, 2019). The second group of consumers involved meat eaters concerned largely with health issues, nutrition and the functional value of eating. This group associated tofu and seitan with

vegetarian and vegan diets, and considered white meat and fish as healthier options than red meat – a belief that has been found consistently in past studies (e.g., Clifton & Tapsell, 2013). In this group, consumers were also concerned about the potential negative impact of lab-grown meat on health, which is a concern documented in other studies as well (e.g., Laestadius & Caldwell, 2015; Siegrist et al., 2018; Verbeke et al., 2015). Finally, a third cluster of participants was observed characterized by disgust towards meat and ethical concerns for animals. This third group included participants that exclude meat from their diets, experience disgust towards meat and fish, display ethical concerns about meat consumption, find pleasure in plant-based meat alternatives (e.g., tofu, seitan), and tend to reside in urban areas. These findings align with the results from Graça et al. (2015), who identified a group of consumers that excluded meat from their diet, experienced disgust towards meat, and perceived farmed animals as victims. The present research extends these observations by showing that this group of consumers tends to reject animal-sourced meat alternatives, such as lab-grown meat and insects.

The findings from Study 2 supported and extended those uncovered with the free association method used in Study 1. In Study 2, legumes

Table 7
Food Product Ratings for Attitude, Knowledge and Familiarity by Food Category and Framing (Individual vs. Meal).

Dimension	Framing	Food categories									
		Red Meat	White Meat	Fish	Legumes	Tofu	Seitan	Insects	Lab meat	Total	
		M (SD)	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)	
Attitude	Individual	2.82 (2.01)	3.71 (2.48)	3.89 (2.44)	6.56 (0.99)*	5.23 (1.78)*	4.92 (1.82)	2.29 (1.69)	2.48 (1.70)	3.99 (0.09) [†]	
	Meal	2.98 (2.12)	3.97 (2.56)	4.07 (2.45)	6.29 (1.26)*	5.66 (1.65)*	5.31 (1.80)	2.30 (1.84)	2.64 (1.81)	4.15 (0.87) [†]	
	Total	2.89 (2.06)	3.82 (2.51)	3.97 (2.44)	6.44 (1.13)	5.42 (1.73)	5.09 (1.82)	2.29 (1.76)	2.55 (1.75)	4.06 (0.89)	
Knowledge	Individual	5.61 (1.67)	5.74 (1.54)	5.79 (1.49)	6.13 (1.25)	4.55 (2.20)	4.23 (2.33)	2.12 (1.57)	2.22 (1.63)	4.55 (1.13) [†]	
	Meal	5.71 (1.58)	5.88 (1.57)	5.67 (1.62)	5.81 (1.58)	4.64 (2.12)	4.25 (2.38)	2.32 (1.73)	2.54 (1.90)	4.60 (1.18) [†]	
	Total	5.66 (1.63)	5.80 (1.55)	5.74 (1.55)	5.99 (1.41)	4.59 (2.16)	4.24 (2.35)	2.21 (1.65)	2.36 (1.76)	4.57 (1.15)	
Familiarity	Individual	4.67 (2.54)	4.97 (2.45)	4.94 (2.40)	6.31 (1.36)*	4.21 (2.21)	3.81 (2.27)	1.19 (0.76)	1.47 (1.12)	3.95 (0.91) [†]	
	Meal	4.46 (2.46)	4.91 (2.46)	4.72 (2.28)	5.59 (1.86)*	4.25 (2.28)	3.73 (2.28)	1.33 (2.28)	1.79 (1.69)	3.85 (0.87) [†]	
	Total	4.58 (2.51)	4.95 (2.45)	4.85 (2.35)	5.99 (1.64)	4.22 (2.23)	3.77 (2.27)	1.25 (2.27)	1.61 (1.41)	3.90 (0.89)	

Note: Different superscripts ([†],^{*}) indicate significant framing differences, i.e., main effect of condition. (*) indicates a significant mean difference due to framing within a food category, all *ps* ≤ .047. Results are presented with Bonferroni correction.

were considered the most natural, appetising, healthy, edible, ethical, sustainable and the least processed of the meat alternatives, which coincided with the free associations reported of legumes with regards to health and taste. In Study 2, insects were rated as the least appetising, healthy, edible, caloric, and ethical, but also the least expensive. These negative perceptions of insects were also observed in the free associations task and align with findings that consumers in Western cultures tend to reject insects as a food source (Hartmann et al., 2017). Lab-grown meat was also viewed quite negatively. In Study 2, lab-grown meat was perceived as the least natural and most processed of all the meat alternatives, and, in Study 1, it was associated with risks to health and artificiality. These findings converge with consumer concerns that lab-grown meat is unnatural and artificial (Bryant & Barnett, 2018; Laestadius & Caldwell, 2015; Siegrist et al., 2018; Verbeke et al., 2015). In addition, Study 2 found that lab-grown meat was perceived as the least sustainable, most expensive and highest-caloric food from all the meat alternatives. One potential factor reinforcing feelings of aversion to lab-grown meat may be the way in which it is labelled. Both studies used the term “lab-grown meat,” which may evoke imagery of scientists working in a laboratory to construct an artificial product. Recent findings from Bryant et al. (2019) suggest that such technological framings reduce consumer interest in cultured meat, compared to alternative labels (e.g., clean meat), which evoke thoughts of the environmental benefits of this product.

Consumer appraisals of some products were highly contingent on how the products were presented, particularly lab-grown meat and legumes. Overall, meal framing had a more positive impact on consumer appraisals, compared to presenting meat alternatives as individual products. Food categories were considered as more natural, appetising, healthy, edible, ethical and sustainable, and less expensive and processed, when presented in the meal frame than in the individual frame, but this main effect seemed to be driven mostly by lab-grown meat. Meal frames may be generally beneficial because one prerequisite for the acceptance of meat substitutes is that consumers must recognize them as alternatives to meat (Elzerman, Hoek, van Boekel, & Luning, 2011). This representational task may be easier when the product is presented as a meat replacement within a meal context than when reflecting on the product alone. These findings are also meaningful in light of the Grounded-Cognition Theory of Desire, which suggests that food stimuli may appear more appealing when situated in familiar eating contexts than when abstracted from such contexts (Papies, Barsalou, & Ruz, 2020).

Lab-grown meat particularly benefitted from a meal framing. It was perceived as more edible, more appetising, healthier, more natural, less processed, more sustainable, more ethical and less expensive when presented as part of a meal. Tofu was also perceived as healthier and more ethical when presented in a meal context. Legumes were an interesting exception to the rule. Legumes were appraised more positively (i.e., edible, healthier, natural, sustainable) when presented as an individual product. This contrast might relate to the perceived familiarity of this meat alternative. Legumes seemed to be the most familiar meat alternative for participants in the present studies, which may explain their positive ratings. By contrast, insects and lab-grown meat were the least familiar foods, which may explain their highly negative ratings. Interestingly, legumes were perceived as more familiar and more positive when presented as an individual product than when presented within a meal. By contrast, tofu was rated more positively when presented in a meal frame than as an individual product. Seitan also received more positive ratings in a meal context, though the levels were not statistically significant. Presenting insects in the context of a meal did not improve the very low ratings this product received. Insects seemed to be the least promising meat alternative based on consumer appraisals. Taken together, these results suggest that familiarity may be an important moderator to consider when deciding how best to introduce a meat alternative to market. A hypothesis to address in future studies is that meal frames may be useful for novel products, such as lab-

grown meat, as they help ground unfamiliar products within a wider appetitive context, but they may lose their value as products gain acceptance and familiarity, and thus can trigger rich, multisensory simulations on the basis of the product alone.

4.1. Limitations and future directions

One limitation of the present research is that it only considered a limited set of meat substitutes. Future studies should widen the scope of investigation to include and compare other protein alternatives, including alternatives to dairy and cow's milk (e.g., soymilk), gaining popularity in many Western cultures (Sizter, 2019; Villegas, Carbonell, & Costell, 2008), and products derived from algae, jackfruit, and mushrooms. Furthermore, in Study 2, the meal frames always paired the meat alternative with other plant-based foods, usually carbohydrates or other legumes. Arguably, some meal frames may be more beneficial than others. For instance, pairing a food with potato chips may elicit a different appraisal, in terms of perceived tastiness, healthiness and caloric content, then when pairing the same food with rice or sautéed vegetables. Thus, an important direction for future research would be to examine the impact of combining different ingredients within a meal framing.

It should also be noted that Portugal has a strong meat-eating culture, particularly seafood (Almeida, Karadzic, & Vaz, 2015), and the current samples had a disproportionate number of self-identified vegetarians and vegans. On the one hand, given the aims of the current work, there was value in sampling participants with a wider range of experiences with meat substitutes. On the other hand, to strengthen confidence in the current findings and test their generalisability there is a clear a need for replication of both studies in diverse cultural settings, preferably with large representative samples to reinforce external validity. Finally, the present research relied on preexisting consumer knowledge and beliefs about the different meat alternatives, rather than attempting to manipulate their perceptions of the qualities of the product via descriptive information or visuals. Future studies should also investigate how consumer evaluations may be affected by the provision of such additional information pertaining to, for example, the nutritional content or visual presentation of different meat alternatives.

5. Conclusion

The current findings point to several directions for improving the marketing of meat alternatives to promote healthier and more sustainable diets. Three consumer profiles were observed towards meat alternatives and meal framing was found to improve consumer perceptions of these products, especially lab-grown meat and tofu. These findings suggest that promoting meat alternatives may benefit from acknowledging and targeting different profiles of consumers. More specifically, it was possible to identify segments of consumers that have quite different associations with meat substitutes, from those who have already adopted many alternatives to the most challenging segment of consumers with largely negative attitudes towards meat substitution. It was also observed that meal framing can help promote meat alternatives, either by highlighting well-known products within individual frames (e.g., legumes), or by demonstrating how less familiar products (e.g., tofu) can be incorporated into a meal. The current findings suggest that there is not a single way to frame all meat alternatives that will improve their appeal to all consumers. Further studies are warranted to explore how specific frames can be tailored for different meat alternatives, while accounting for distinctive consumer profiles and cultural particularities.

Ethics

The research was conducted in compliance with all APA Ethical Guidelines for the treatment of human participants. Neither the

manuscript nor the data have been published previously, nor are they under consideration for publication elsewhere, and its publication is approved by all authors.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.appet.2020.104860>.

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