Food Quality and Preference 93 (2021) 104265

Contents lists available at ScienceDirect

Food Quality and Preference

journal homepage: www.elsevier.com/locate/foodqual

Stuck in the middle with you: The role of similarity information on categorizing cultured meat

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ARTICLE INFO

Keywords:
Cultured meat
Meat
Meat substitute
Attitude
Categorization
Similarity information

ABSTRACT

Cultured meat is a potentially successful future alternative to conventional meat if consumers perceive it as similar enough to conventional meat. This paper aimed to investigate how consumers categorize cultured meat after receiving information about it being similar to meat or meat substitutes.

The first study ($N = 130$) showed that similarity information between cultured meat and meat resulted in the categorization of cultured meat as meat. This effect was not found for similarity information between cultured meat and meat substitutes. The second study ($N = 200$) ruled out that the name cultured meat influenced categorization. In contrast with study 1 similarity information between cultured meat and meat did not result in categorization, where similarity information between cultured meat and meat substitutes did. The third study ($N = 152$) suggested cultured meat was categorized as meat substitute, however, no evidence was found that providing similarity information between cultured meat and meat or meat substitutes influenced either categorization. Subsequent interviews within study 3 ($N = 10$) suggested that cultured meat overlaps substantially with the categories meat and meat substitutes and suggested that participants had difficulty to consistently categorize cultured meat. This may explain the apparently inconsistent results.

The findings of this paper thus suggest that cultured meat does not effortlessly fit into the meat or meat substitute category.

1. Introduction

The demand for sustainable food products has increased in recent years and is expected to continue to grow (Sahota, 2019). This provides opportunities to introduce new sustainable food technologies. These food technologies include, for example, vertical farming, plant breeding, animal breeding, genetic modification and tissue engineering (e.g., Despommier, 2013; Pacifico & Paris, 2016; Post, 2012; Rodrigues et al., 2017).

Consumers have been found to be more open to adopt some sustainable food product types than others. For example, in some countries consumers are more willing to replace conventionally produced meat with organic meat products (Van Loo et al., 2011; Vanhonacker et al., 2013), compared to plant-based meat substitutes (Vanhonacker et al., 2013). Plant-based meat substitutes, such as soya, fungi and lupine, have been around for a considerable time. Despite improved product quality and product diversity most consumers still prefer conventional meat products over plant-based meat substitutes, which is reflected in the small market share of the latter (De Bakker & Dagevos, 2010; Hartmann & Siegrist, 2017; Vanhonacker et al., 2013; Weinrich, 2018).

Cultured meat is the product of an emerging food technology aimed at producing meat from animal stem cells without having to breed and slaughter animals (Pluhar, 2010). Although the technology is still in its developing stages it offers the potential to produce meat on a mass scale with a relatively small ecological footprint, compared to conventional meat (Edelman et al., 2005; Mattick et al., 2015; Tuomisto, 2019; Tuomisto et al., 2014; Tuomisto & De Mattos, 2011). As cultured meat is derived from animal stem cells it has the potential to be perceived similar to conventional meat, which makes it an interesting and potentially successful sustainable future alternative to conventional meat.

The available research on consumer perceptions of cultured meat is

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https://doi.org/10.1016/j.foodqual.2021.104265
Received 17 September 2020; Received in revised form 9 April 2021; Accepted 12 April 2021
Available online 16 April 2021

growing (see Bryant & Barnett, 2018, 2020, for recent reviews). The literature reveals that consumers' initial reactions vary from being positive to being disgusted (Van der Weele & Driessen, 2013; Van der Weele & Tramper, 2014; Verbeke, Marcu, et al., 2015). Cultured meat has properties of conventional meat, properties of meat substitutes and other non-meat properties (Bekker, Tobi, et al., 2017; Van der Weele & Driessen, 2013). Several studies found that information can influence the attitude toward cultured meat (Bekker, Fischer, et al., 2017; Bryant & Dillard, 2019; Rolland et al., 2020). The chosen name for cultured meat has also been found to influence the attitude toward cultured meat (Bryant & Barnett, 2019). The majority of studies focus on willingness to try or willingness to pay. Studies from Europe, the US and Asia all found that a substantial majority was willing to try cultured meat (Bryant et al., 2019; Bryant & Dillard, 2019; Mancini and Antonioli, 2019; Mancini & Antonioli, 2020; Palmieri et al., 2020; Shaw & Mac Con Iomaire, 2019; Weinrich et al., 2020; Wilks & Phillips, 2017). Willingness to try (Verbeke, Sans, et al., 2015) and pay (Mancini & Antonioli, 2020) were found to increase after receiving positive information about cultured meat. Willingness to try cultured meat appears to be mediated by perceived naturalness of cultured meat (Siegrist et al., 2018). Nonetheless, most consumers preferred other options over cultured meat (Gómez-Luciano et al., 2019; Hocquette et al., 2015; Slade, 2018).

A successful market introduction of cultured meat poses many challenges (Stephens et al., 2018). One possible determinant for the commercial success of cultured meat is whether consumers perceive it as a viable meat substitute that resembles meat (Hoek et al., 2011; Post, 2014). If cultured meat sufficiently resembles meat, consumers are likely to categorize it as meat, and consequently infer properties and evaluations from that category. The current paper will therefore investigate categorization of cultured meat into the meat category.

In general, when consumers encounter an unfamiliar object, categorization theory explains how consumers interpret that object (Gregan-Paxton & John, 1997; Medin & Rips, 2005). Once the unfamiliar object is part of a category, category attributes are associated with the unfamiliar object and the attitude toward the unfamiliar object is inferred from the category (Gregan-Paxton & John, 1997; Medin & Rips, 2005). This has been illustrated for both persons (Crawford et al., 2002; Ranganath & Nosek, 2008) and products (Ackermann et al., 2018; Gregan-Paxton et al., 2005; Moreau et al., 2001; Ratliff et al., 2012; Shapiro et al., 2009).

The categorization of an object is based on the similarity between the object and the category representation (Gentner & Markman, 1997; Gregan-Paxton & John, 1997). Three types of similarities between objects and category representations are distinguished: relational, mere appearance, and literal similarity (Gentner & Markman, 1997; Gregan-Paxton & John, 1997). Relational similarity occurs when the object and the category representation have a similar function, for example, providing proteins for the body. Mere appearance similarity occurs when the object and the category representation share attributes, such as name or color. Literal similarity occurs when the object and the category representation share relational and mere appearance similarities (Gentner & Markman, 1997; Gregan-Paxton & John, 1997).

Unfamiliar objects, such as cultured meat, may have similarities with more than one category (Bekker, Tobi, et al., 2017; Van der Weele & Driessen, 2013). Pointing out similarities between the unfamiliar object and one of the categories is expected to direct categorization into that category. The main hypothesis is therefore:

If similarity information between the unfamiliar object and the category is provided, then the unfamiliar object will be categorized into that category.

The main hypothesis was investigated in three studies using a sequential mixed-methods design. Study 1 was an experiment investigating whether literal similarity information between the unfamiliar object cultured meat and the categories meat and meat substitutes results in categorization into these categories. Study 2 replicated the literal similarity information conditions of the first study and extended it by investigating the effect of naming on categorization (i.e., mere appearance similarity). Study 3 replicated the similarity information conditions of the first and second study. Subsequent interviews were added in study 3 to explore observed differences between the first and second study. In the general discussion, the impact of providing similarity information on categorizing cultured meat, limitations, and directions for future research are discussed.

2. Study 1

Study 1 investigated whether literal similarity information between the unfamiliar object and the categories meat and meat substitutes direct categorization into these categories. The chosen name for the unfamiliar object was cultured meat (Dutch: kweekvlees), as this name is dominantly used in both the Dutch scientific literature and popular press (e.g., Van der Weele & Driessen, 2019; Van Dinther, 2013). Attitudes toward an unfamiliar object are theorized to be automatically inferred from the category or categories the unfamiliar object is assigned to Fazio et al. (1986), Gawronski and Bodenhausen (2006). Automatically activated implicit attitudes are an initial evaluative response toward the unfamiliar object. When the initial categorization is explicitly perceived as a good fit between the unfamiliar object and the category, the more elaborately reasoned explicit attitude is likely informed by the automatically activated implicit attitude (Fazio, 2007; Gawronski & Bodenhausen, 2006; Greenwald et al., 2009).

2.1. Methods

2.1.1. Participants

An experimental 3 group between (literal similarity information condition: similar to meat, similar to meat substitutes, no information) $\times$ 2 group within (implicit attitude measurement method, explicit attitude measurement method) subject design was used. Participants were Wageningen University students that spoke Dutch fluently. Based on approximately 7 euro per hour as participation incentive they received a 2.50 euro university canteen voucher. Data of 152 participants were collected in the fall of 2014. Data from 10 participants who reported being vegetarian were excluded from the sample, because vegetarians were expected to categorize protein sources differently compared to non-vegetarians. Another 12 participants were excluded, as they did not meet the response time requirements for the implicit attitude measurement method. The final sample consisted of 130 participants (39 male and 91 female), with age ranging from 17 to 29 years and a median of 20.

2.1.2. Materials and manipulations.

The study was conducted in individual cubicles on 2.4 GHz dual core laptops with external keyboard and mouse, using Qualtrics (Qualtrics, 2014) and Inquisit 3.0.6. Software (Inquisit, 2011). Displays were 17.3 in. with a resolution of 1600 $\times$ 900 pixels and a screen refresh rate of 60 Hz.

Participants in the similar to meat condition were provided with the following information:

> "Cultured meat is similar to meat. Comparable to meat, cultured meat is based on animal material. The structure, taste and protein content of cultured meat is similar to other meats. Cultured meat fits within the meat product range." (Translated from Dutch, see Appendix A for the original Dutch version.)

Participants in the similar to meat substitutes condition were provided with the following information:

> "Cultured meat is similar to meat substitutes. Comparable to meat substitutes, it is unnecessary to slaughter animals for cultured meat. The structure, taste and protein content of cultured meat is similar to other meat substitutes. Cultured meat fits within the meat substitute

product range." (Translated from Dutch, see Appendix A for the original Dutch version.)

Participants in the no information condition did not receive any similarity information. No information about meat or meat substitutes was provided to any participant as participants were assumed to be familiar with these categories

2.1.3. Measures

2.1.3.1. Explicit attitude measures. The explicit attitude toward cultured meat, meat and meat substitutes was measured using 19 items presented in a random order, using a 7-point semantic differential scale (with 1 indicating negative responses and 7 positive; adapted from Crites et al., 1994; see Appendix A for the explicit attitude items). The explicit attitude was a higher order construct based on the average across an eight item affective, a seven item cognitive and a four item generic subscale (all Cronbach's $\alpha > 0.81$). The Spearman-Brown reliability coefficients (Walker & Lev, 1953) averaged across five splits, were larger than 0.94 for the explicit attitude measurement of cultured meat, meat and meat substitutes.

2.1.3.2. Implicit attitude measures. The Single Target Implicit Association Test (ST-IAT; see de Liver, van der Pligt, & Wigboldus, 2007; Friese, Bluemke, & Wanke, 2007), a response time based measurement method, was used to measure implicit attitude.

The ST-IAT had four blocks, with the first and third block being practice blocks and the second and fourth block being test blocks (see Fig. 1). Each block had positive, negative and attitude object words that needed to be categorized (see Appendix A for the words). Positive or negative words had to be categorized with the 'a' key and words with the opposite valence with the '5' key on the numeric pad. Words representing the attitude object (i.e., cultured meat, meat, or meat substitutes) had to be categorized with one of these keys in block 1 and 2, and with the other key in block 3 and 4 (see Fig. 1). Key assignment of the positive and negative words, and attitude object words was counterbalanced. Practice blocks consisted of 24 words (7 attitude object and 7 positive or negative words assigned to one key, and 10 oppositely valenced words assigned to the other key). The test blocks consisted of 48 words (14 attitude object words, 14 valenced words, and 20 oppositely valenced words; see Bekker, Fischer, et al., 2017). Within a block, words were presented in random order.

The implicit attitude was operationalized as the *D* score. Following Greenwald et al. (2003) the *D* score was calculated by dividing the difference of the mean response latencies between the positive and negative test block by the standard deviation of all test block response latencies. Response latency was measured as the time a participant took to correctly categorize a word from the first moment it was presented. Individual trials with response latencies greater than 10,000 ms were removed. Participants who had a response latency smaller than 300 ms in more than 10% of their trials were excluded from the sample. Spearman-Brown reliability coefficients ranged from 0.68 to 0.72. Behavioral intention measure

A behavioral intention measure was included as additional measure. Instead of merely asking participants whether they were interested in consuming cultured meat at some time in the future, participants were asked to make an initial commitment by actively registering their e-mail address for a future tasting study. Participants were told that the development of cultured meat was at a very advanced stage and that the researchers were therefore looking for people to participate in a tasting study. Participants interested in participating were invited to fill in their e-mail address. The researchers would contact them to make an appointment. Behavioral intention to try cultured meat was operationalized as the act of submitting one's e-mail address.

2.1.3.3. Background measures. Self-reported familiarity with cultured meat was measured by the item "prior to this study, to what extent were you familiar with cultured meat" with the answer options unfamiliar, a little bit familiar and familiar.

2.1.4. Procedure

Participants started the experiment in Qualtrics and first read an electronic consent form. They were informed that the research concerned their opinion on several topics. After consent, participants were randomly assigned to one of three conditions using block randomization with block size 6. In the similar to meat and similar to meat substitutes conditions, participants received similarity information. To ensure a lower limit to participants' reading time, the continue button appeared

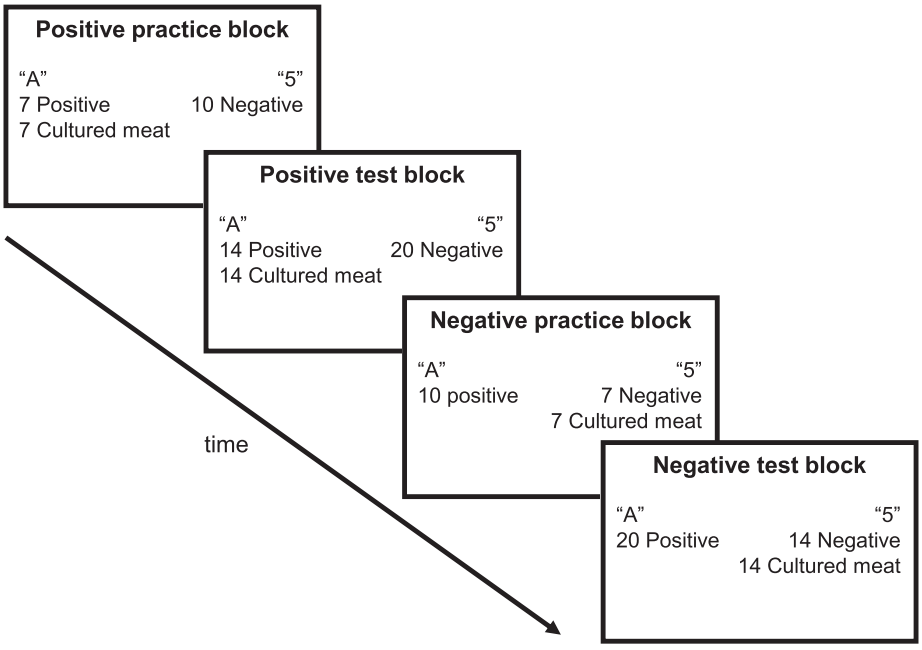

Fig. 1. Schematic example of the ST-IAT consisting of four consecutive blocks, with key assignment and number of words that need to be categorized (from Bekker, Fischer, et al., 2017).

after 15 s. The study continued by measuring the explicit attitude toward cultured meat. Participants in the no information condition started with the measurement of the explicit attitude toward cultured meat and they were reassured that it did not matter whether they were familiar with cultured meat. To provide category benchmarks for the meat and meat substitute category all conditions continued with the measurement of the explicit attitude toward meat and meat substitutes. The order in which the explicit attitude toward meat and meat substitutes were measured was randomized to rule out order effects.

After the explicit attitude measurements were completed participants notified the study supervisor. The study supervisor then started the ST-IAT in Inquisit and participants began with the measurement of the implicit attitude toward cultured meat, followed by the measurement of the implicit attitude toward meat and meat substitutes. The order in which the implicit attitude toward meat and meat substitutes were measured equaled that of the explicit attitude measurement. After completion of the ST-IAT Inquisit automatically terminated and participants continued in Qualtrics with demographic and background questions. The study was concluded with the measurement of behavioral intention. Afterwards participants were debriefed, received their reward and were thanked for participating in the study.

2.1.5. Statistical analyses

The hypothesized categorization outcome resulting from similarity information, was operationalized as the magnitude of the standardized linear regression coefficient ($\widehat{\beta}$) of the interaction between experimental condition (similar to meat, similar to meat substitutes) and category attitude variables (meat, meat substitutes) explaining the explicit or implicit attitude score of cultured meat (see Table 1). The similarity information variable was dummy coded, with the no information condition as reference category. The explicit and implicit attitude scores were centered.

To investigate to what extent explicit and/or implicit attitudes are relevant to behavior, an additional analysis investigated whether the explicit and implicit attitude score of cultured meat explain behavioral intention to try cultured meat. This was analyzed using binomial logistic regression. In the first model the explicit and implicit attitude score of cultured meat were included. To see whether the variables mentioned in Table 1 were correlated with behavioral intention, these variables were included in the second model.

2.2. Results

The mean explicit attitude score was 4.34 (SD = 1.02) for cultured meat, 4.81 (SD = 0.84) for meat and 4.86 (SD = 0.92) for meat substitutes. The mean implicit attitude scores of cultured meat (M = -0.13; SD = 0.35) and meat (M = -0.10; SD = 0.37) were slightly negative, where the mean implicit attitude score of meat substitutes (M = 0.16; SD = 0.33) was slightly positive. Investigating the correlations between the implicit and explicit attitude scores revealed a significant correlation between the explicit and implicit attitude score of cultured meat, $r(128) = 0.18$, $p = .046$, while the correlations between the explicit and implicit attitude score of meat, $r(128) = 0.08$, $p = .325$, and meat substitutes, $r(128) = 0.12$, $p = .164$, were not significant.

Table 1
Variables included in the multiple linear regression models of study 1 to explain the explicit/implicit attitude score of cultured meat.

Variables
Information CM is similar to M
Information CM is similar to MS
Explicit/implicit attitude score M
Explicit/implicit attitude score MS
Information CM is similar M * explicit/implicit attitude score M[a]
Information CM is similar MS * explicit/implicit attitude score MS[a]
Self-perceived familiarity CM
Constant

Note. CM = cultured meat; M = meat; MS = meat substitutes.
[a] The main hypothesis that providing similarity information leads to categorization of cultured meat as meat or meat substitute is tested by means of these interactions.

2.2.1. Explicit attitude

The multiple linear regression model for the explicit attitude score of cultured meat is presented in Table 2. Neither similarity information nor the explicit attitude scores of meat and meat substitutes did significantly contribute to the explanation of the explicit attitude score of cultured meat. In line with the main hypothesis, the interaction between the similar to meat information condition and the explicit attitude score of meat, was found to significantly explain the explicit attitude score of cultured meat. When participants were told that cultured meat was similar to meat, the explicit attitude score of meat explained the explicit attitude score of cultured meat. The interaction between the similar to meat substitutes information condition and the explicit attitude score of meat substitutes did not significantly explain the explicit attitude score of cultured meat. Self-perceived familiarity with cultured meat was found to be significantly related with the explicit attitude score of cultured meat. More self-perceived familiarity was related with a more positive explicit attitude score of cultured meat.

2.2.2. Implicit attitude

Similarity information and the implicit attitude scores of meat and meat substitutes did not significantly explain the implicit attitude score of cultured meat (see Table 3). The interaction effect between the similar to meat information condition and the implicit attitude score of meat was significant. No significant interaction effect was found between the similar to meat substitutes information condition and the implicit attitude score of meat substitutes. Finally, self-perceived familiarity with cultured meat was not significantly related with the implicit attitude score of cultured meat.

2.2.3. Behavioral intention

The binomial logistic regression model, $R^2_{\text{Nagelkerke}} = 0.15$, $\chi^2(2) = 14.57$, $p = .001$, revealed that the explicit attitude score of cultured meat significantly explained behavioral intention, $OR = 2.08$, Wald $\chi^2 = 11.68$, $p < .001$. A more positive explicit attitude score of cultured meat resulted in a higher likelihood to sign up for a cultured meat tasting study. The implicit attitude score of cultured meat did not significantly contribute to the explanation of behavioral intention, $OR = 1.23$, Wald $\chi^2 = 0.13$, $p = .714$. The inclusion of the variables explaining the explicit and implicit attitude score of cultured meat did not result in an improved model fit, $\Delta\chi^2(11) = 7.04$, $p = .796$, which suggests that these variables may have influenced behavioral intention indirectly through the explicit

Table 2
Multiple linear regression model with variables explaining the explicit attitude score of cultured meat in study 1.

Variable	b	$SE\ b$	$\widehat{\beta}$	p value of t statistic
Information CM is similar to M	0.03	0.22	0.02	0.877
Information CM is similar to MS	0.32	0.21	0.15	0.135
Explicit attitude score M	−0.10	0.12	−0.08	0.414
Explicit attitude score MS	0.18	0.12	0.16	0.134
Information CM is similar M * explicit attitude score M[a]	0.47	0.23	0.21	0.044
Information CM is similar MS * explicit attitude score MS[a]	−0.01	0.20	−0.01	0.957
Self-perceived familiarity CM	0.43	0.15	0.25	0.004
Constant	4.25	0.15		
R^2	0.14			
F (7, 122)	2.95			0.007

Note. CM = cultured meat; M = meat; MS = meat substitutes.
[a] The main hypothesis is tested by means of these interactions.

Table 3
Multiple linear regression model with variables explaining the implicit attitude score of cultured meat in study 1.

Variable	*b*	*SE b*	$\widehat{\beta}$	*p* value of *t* statistic
Information CM is similar to M	−0.02	0.08	−0.02	0.841
Information CM is similar to MS	−0.03	0.08	−0.04	0.724
Implicit attitude score M	0.04	0.10	0.04	0.692
Implicit attitude score MS	−0.01	0.11	−0.01	0.943
Information CM is similar M * implicit attitude score M [a]	0.40	0.18	0.24	0.028
Information CM is similar MS * implicit attitude score MS [a]	0.21	0.19	0.12	0.284
Self-perceived familiarity CM	0.03	0.05	0.04	0.628
Constant	−0.12	0.06		
R^2	0.09			
F (7, 122)	1.68			0.119

Note. CM = cultured meat; M = meat; MS = meat substitutes.
[a] The main hypothesis is tested by means of these interactions.

attitude score of cultured meat.

2.3. Discussion

Study 1 suggested that providing information about cultured meat being similar to meat may enhance the categorization of cultured meat as meat, but this effect was not found when information was provided about cultured meat being similar to meat substitutes. These findings provide mixed evidence for the main hypothesis. Study 1 suggested that the explicit but not the implicit attitude score of cultured meat explained behavioral intention to try cultured meat.

The interaction between similarity information and the explicit attitude toward meat suggests that cultured meat is more readily categorized as meat than as meat substitute. This is to some extent at odds with Bekker, Tobi, et al. (2017), who found that consumers doubted whether cultured meat was meat or a meat substitute. The interaction in the present study could be the result of the word "meat" used. Naming effects have been found for cultured meat when different words than "cultured" were used (Bryant & Barnett, 2019). In study 2 an alternative word for meat was included to investigate the effect of naming on categorization.

The explicit and implicit attitude score of cultured meat were found to be related. This finding suggests that the initial categorization of cultured meat was explicitly perceived as a good fit and that the explicit attitude was therefore informed by the implicit attitude (Fazio, 2007; Gawronski & Bodenhausen, 2006; Greenwald et al., 2009). As (1) the explicit attitude appears to be informed by the implicit attitude and (2) there was only evidence for the explicit attitude score to explain behavioral intention, the remainder of this paper will focus on the explicit attitude.

3. Study 2

In the second study naming similarity conditions that did or did not include the word "meat" were introduced to investigate the effect of naming (i.e., mere appearance similarity). In addition, the literal similarity information conditions from study 1 were replicated. Information conditions, explicit attitude measures and the behavioral intention measure were equal to study 1.

3.1. Methods

3.1.1. Participants

An experimental 3 group (literal similarity information condition: similar to meat, similar to meat substitutes, no information) × 2 group (naming similarity condition: name is cultured meat versus name is cultured tissue) between subject design was applied. Participants were Wageningen University students that spoke fluent Dutch. They received a snack as reward for participating in the study. In addition, 25 euro gift certificates for a large Dutch internet shop were randomly assigned to nine participants. Data of 221 participants were collected in the fall of 2014. Twenty-one respondents were excluded, as they reported being vegetarian. The final sample consisted of 200 respondents, (79 male and 121 female), age ranged from 17 to 33 years with a median of 19.

3.1.2. Data collection

Alternative names for cultured meat were piloted on Wageningen University students ($N = 26$). Cultured tissue [Dutch: kweekweefsel] was found to be the most suitable alternative name. On a scale from 1 to 7, cultured tissue was found to be believable ($M = 5.19$; $SD = 1.44$) and only somewhat related to meat ($M = 2.92$; $SD = 1.72$). Used materials, measures and procedures (including consent and data analysis) were identical to those in study 1.

3.2. Results

The mean explicit attitude score was 4.65 ($SD = 0.90$) for cultured meat, 4.94 ($SD = 0.82$) for meat and 4.74 ($SD = 0.94$) for meat substitutes.

The multiple linear regression model to explain the explicit attitude score of cultured meat is presented in Table 4. Neither naming similarity nor similarity information had a statistically significant effect. Only the interaction between the similar to meat substitutes information condition and the explicit attitude score of meat substitutes did significantly explain the explicit attitude score of cultured meat. This suggests that cultured meat was categorized as meat substitute after receiving information about cultured meat being similar to meat substitutes. Self-perceived familiarity with cultured meat was found to be significantly

Table 4
Multiple linear regression model with variables explaining the explicit attitude score of cultured meat in study 2.

Variable	*b*	*SE b*	$\widehat{\beta}$	*p* value of *t* statistic
Information CM similar to M	−0.20	0.15	−0.10	0.184
Information CM similar to MS	0.03	0.15	0.02	0.841
Name is CM	−0.20	0.12	−0.11	0.098
Explicit attitude score M	0.10	0.09	0.09	0.270
Explicit attitude score MS	0.15	0.08	0.16	0.054
Information CM is similar M * explicit attitude score M [a]	−0.04	0.17	−0.02	0.790
Information CM is similar MS * explicit attitude score MS [a]	0.46	0.14	0.25	0.002
Name is CM * explicit attitude score M [b]	−0.12	0.18	−0.05	0.510
Name is CM * explicit attitude score MS [b]	0.03	0.16	0.01	0.870
Name is CM * Information CM is similar M * explicit attitude score M [c]	−0.19	0.34	−0.04	0.576
Name is CM * Information CM is similar MS * explicit attitude score MS [c]	0.11	0.29	0.03	0.700
Self-perceived familiarity CM	0.29	0.11	0.18	0.008
Constant	4.72	0.10		
R^2	0.19			
F (12, 187)	3.60			< 0.001

Note. CM = depending on the name condition: cultured meat or cultured tissue; M = meat; MS = meat substitutes.
[a] The main hypothesis that providing similarity information leads to categorization of cultured meat as meat or meat substitute is tested by means of these interactions.
[b] The alternative hypothesis that naming similarity leads to categorization of cultured meat as meat or meat substitute is tested by means of these interactions.
[c] The alternative hypothesis that naming similarity in combination with similarity information leads to categorization of cultured meat as meat or meat substitute is tested by means of these interactions.

related to the explicit attitude score of cultured meat. More self-perceived familiarity was associated with a more positive explicit attitude score of cultured meat.

The binomial logistic regression model, $R^2_{\text{Nagelkerke}} = 0.04$, $\chi^2(1) = 6.17$, $p = .013$, revealed that the explicit attitude score of cultured meat significantly explained behavioral intention, $OR = 1.5$, Wald $\chi^2 = 5.88$, $p = .015$. A more positive explicit attitude score of cultured meat resulted in a higher likelihood to sign up for a study to taste cultured meat.

3.3. Discussion

The findings in study 2 revealed that after receiving information about cultured meat being similar to meat substitutes, cultured meat was categorized as meat substitute. This was not found for information about cultured meat being similar to meat. These findings are, however, contradictory to the findings of study 1, where information about cultured meat being similar to meat, but not about cultured meat being similar to meat substitutes, resulted in the categorization of cultured meat. Study 2 confirmed the finding of study 1 that the explicit attitude score of cultured meat (partly) explains behavioral intention to try cultured meat. The conflicting results of study 1 and 2 will be investigated in study 3.

No effect of naming similarity was found, the remainder of this paper will therefore continue to use the common term cultured meat for the unfamiliar product.

4. Study 3

The conflicting results of studies 1 and 2 may indicate that the findings in study 1, study 2, or both studies were due to chance. To investigate this possible explanation, the experiment in study 3 replicated the similarity information conditions and subsequent explicit attitude measure of study 1 and 2. To explore potential reasons for the inconsistent results found in studies 1 and 2, interviews were conducted. The interviews explored similarities between cultured meat and the categories meat and meat substitutes that may influence the categorization of cultured meat.

4.1. Methods

4.1.1. Experiment

4.1.1.1. Participants. An experimental 3 group (literal similarity information condition: similar to meat, similar to meat substitutes, no information) between subject design was used. Participants were fluent Dutch speaking Wageningen University students. They received a fair-trade chocolate bar for participating. The a priori power calculation based on the smallest effect size of study 1 and 2 (i.e., $R^2 = 0.14$), a critical p value of 0.05 and a power of 95%, prescribed a minimum sample size of 144. Experimental data of 180 participants were collected in the spring of 2018. Twenty-eight participants were excluded, as they reported being vegetarian. The final sample consisted of 152 participants (49 male and 103 female), with age ranging from 16 to 34 years and a median age of 20.

4.1.1.2. Data collection. Materials, measures and procedures were identical to the explicit attitude part of study 1 and 2.

4.1.2. Interview

4.1.2.1. Participants. Ten participants (5 males, 5 females) with a median age of 20.5 years (min = 19; max = 25) from the no information condition participated in a subsequent interview and received a 3 euro reward.

4.1.2.2. Data collection. Data was collected per participant using a semi-structured interview approach with an introduction followed by four consecutive steps. After signing an informed consent form, the audio recorder was turned on and the interview started. To appeal to the interviewee's personal perception cultured meat was discussed as a consumer product. Participants first read an introductory text on cultured meat (from Bekker, Tobi, et al., 2017; see Appendix A). After this introduction, to gain insight in participants' spontaneous associations with cultured meat the interview started with freelisting "everything that comes to mind when you think about cultured meat. If you cannot describe something in one word, you may write it in two or three words.". Second, participants were asked whether they would place the product cultured meat on the meat or meat substitute shelf in the supermarket and they were then asked to deliberate on similarities between cultured meat and the chosen product group. Third, participants were asked to deliberate on similarities between cultured meat and the not chosen product group. For both product groups, similarities with respect to technology and sustainability were probed when not spontaneously mentioned. Finally, participants were asked to state their main reason for placing cultured meat into one of the product groups. Afterwards the audio recording was stopped, participants were thanked and given the reward. Interviews were transcribed and anonymized.

4.1.2.3. Data analysis. Freelist task entries and similarities mentioned in the interview were bottom-up coded and then grouped into themes by the first author. In several iterations the first, second and third author discussed and finalized grouping into themes. Based on semantic relations mentioned anytime in the interviews, the first, second and third author then assigned these themes to the spheres of cultured meat, meat and/or meat substitutes.

4.2. Results

4.2.1. Experiment

The mean explicit attitude score was 5.00 ($SD = 0.88$) for cultured meat, 4.63 ($SD = 0.95$) for meat and 5.29 ($SD = 0.85$) for meat substitutes.

The multiple linear regression model for the explicit attitude score of cultured meat is presented in Table 5. The information condition similar to meat and the explicit attitude score of meat did both not significantly explain the explicit attitude score of cultured meat. The similar to meat substitutes information condition and the explicit attitude score of meat substitutes significantly explained the explicit attitude score of cultured meat. No significant interaction effects were found. Again, self-perceived familiarity with cultured meat was found to significantly contribute to the explicit attitude score of cultured meat.

An overview of the standardized regression coefficients from all

Table 5
Multiple linear regression model with variables explaining the explicit attitude score of cultured meat in the experiment of study 3.

Variable	b	$SE\ b$	$\widehat{\beta}$	p value of t statistic
Information CM is similar to M	0.27	0.15	0.14	0.067
Information CM is similar to MS	0.48	0.15	0.25	0.001
Explicit attitude score M	0.12	0.08	0.12	0.152
Explicit attitude score MS	0.30	0.09	0.29	<0.001
Information CM is similar M * explicit attitude score M [a]	−0.24	0.14	−0.14	0.103
Information CM is similar MS * explicit attitude score MS [a]	0.07	0.16	0.04	0.671
Self-perceived familiarity CM	0.56	0.10	0.40	<0.001
Constant	4.76	0.10		
R^2	0.31			
F (7, 122)	9.43			< 0.001

Note. CM = cultured meat; M = meat; MS = meat substitutes.
[a] The main hypothesis is tested by means of these interactions.

three experiments is provided in Table 6. It shows that cultured meat was categorized as meat or as meat substitutes in all three studies, but even though experiment protocols were identical, categorization outcomes differed between studies.

4.2.2. Interview

To provide insight in the inconsistent results of studies 1, 2 and 3, the authors identified 18 themes and their relation to the spheres of cultured meat, meat and meat substitutes. Most themes overlapped across two or three spheres (see Fig. 2).

The theme *legislation* only appeared in the cultured meat sphere. The theme legislation was about obstacles for a market introduction of specifically cultured meat; sufficient regulation and legislation were expected to be required.

The themes *product attribute, animal origin, economic costs, consumer acceptance, impact on industry* and *religion* appeared in both the cultured meat and meat sphere. The theme *product attribute* was based on meat attributes, such as, nutrients, taste and appearance as can be illustrated by the following quote:

> [Compared to meat] well, it just seems that it [cultured meat], it eventually will look the same. That it will taste the same and that it will have the same structure. In principle it is the same, but one is made in the body of an animal, whereas the other is made in a laboratory. (Participant 74)

The theme *animal origin* refers to the animal cells that both cultured meat and meat are made of. A majority of participants indicated this overlap was the main reason for having categorized cultured meat into the meat category, or as one participant put it:

> I mainly think that they are still cells of animal origin. So that makes it, in principle, the same product and they are not vegetable cells or something like that. (Participant 68)

The themes *meat alternative, no animal origin* and *fake* appeared in both the cultured meat and meat substitutes sphere. The theme *meat alternative* was based on cultured meat being a substitute for meat, just as other meat substitutes. The theme *no animal origin* was based on cultured meat not originating from a once living animal just like meat substitutes.

The themes *ecological footprint, research and development, animal welfare, health, food security, production, ethics* and *judgment* appeared in all three spheres. The theme *ecological footprint* reflects that the expected lower ecological footprint of cultured meat compared to meat, made cultured meat similar to meat substitutes and, simultaneously, dissimilar to meat. This is shown by the following quote:

> If you look at the meat industry, they are responsible for a great deal of environmental damage. In that sense it [cultured meat] would be an interesting alternative. […] you would prefer to eat cultured meat over traditional meat, but in that sense, you could just as well eat soy-based products. (Participant 31)

The theme *research and development* was derived from expressions of the believe that the production of cultured meat requires more technology compared to meat and meat substitutes. To quote one participant:

> [Compared to meat] I think that cultured meat requires very very much more technology. I think that regular meat, well, you just feed the cow. […] [compared to meat substitutes] I think that cultured meat requires much more technology, because in the case of a vegetarian burger, you just put the vegetables, beans, corn, or other things together. It is not so much technology, it is just putting the right flavors together. (Participant 146)

These results suggest that cultured meat does not distinctly belong to either the meat or meat substitute category. As one participant said:

> I think that you need to reason in two ways. On the one hand, concerning nutritional values. it is still meat, but on the other hand, when you look at environmental aspects and what its origins are, it is a meat substitute. (Participant 31)

This finding is further illustrated by two participants who changed their mind during the interview on whether the product cultured meat should be placed on the meat or meat substitute shelf in the supermarket.

4.3. Discussion

Experiment 3 found no evidence that providing information about cultured meat being similar to meat or meat substitutes, results in the categorization of cultured meat. The analysis of the interviews suggested that cultured meat has important overlap with both meat and meat substitutes. Cultured meat and meat both have animal origins and they share attributes, such as, nutrients, taste and appearance. Cultured meat and meat substitutes are both meat alternatives that did not originate from living animals. The overlap that cultured meat has with both categories, which is consistent with Bekker, Tobi, et al. (2017), at least partially explains categorization difficulties and apparently inconsistent results from the experiments presented in this paper.

5. General discussion

This paper investigated how consumers categorized cultured meat after receiving information about it being similar to meat or meat substitutes. The set of experiments provided no consistent support for the main hypothesis that provided similarity information between cultured meat and the meat or meat substitute category results in cultured meat being categorized as meat or meat substitute respectively. The interviews suggested that the categorization of cultured meat into the meat or meat substitute category was difficult and unstable, as cultured meat overlaps with both categories.

Results of the current paper contrast other studies on categorization of new products (Ackermann et al., 2018; Gregan-Paxton et al., 2005; Moreau et al., 2001; Ratliff et al., 2012). Several of these studies used novel hybrid products that looked like one existing product with features of another existing product (Ackermann et al., 2018; Gregan-Paxton et al., 2005; Moreau et al., 2001). Ackermann et al. (2018), for example, used the hybrid product crisps made from fruit, which was framed as a fruit or crisp product. Ratliff et al. (2012) used novel products that were a brand extension, for example, orange juice added to apple juice brand. In comparison with the aforementioned novel products, cultured meat is argued to be more ambiguous. Cultured meat has important similarities with the meat and meat substitute category, but it also has similarities with other categories. Cultured meat has similarities

Table 6
Comparison between the multiple linear regression model variables explaining the explicit attitude score of cultured meat in the experiments of study 1, 2 and 3.

Variable	$\widehat{\beta}$*experiment 1*	$\widehat{\beta}$*experiment 2*	$\widehat{\beta}$*experiment 3*
Information CM is similar to M	0.02	−0.10	0.14
Information CM is similar to MS	0.15	0.02	0.25**
Explicit attitude score M	−0.08	0.09	0.12
Explicit attitude score MS	0.16	0.16	0.29***
Information CM is similar M * explicit attitude score M [a]	0.21*	−0.02	−0.14
Information CM is similar MS * explicit attitude score MS [a]	−0.01	0.25**	0.04
Self-perceived familiarity CM	0.25**	0.18**	0.40***

Note. CM = cultured meat (in experiment 2, depending on the naming condition, cultured meat or cultured tissue); M = meat; MS = meat substitutes.
* $p < .05$. ** $p < .01$. *** $p < .001$.
[a] The main hypothesis is tested by means of these interactions.

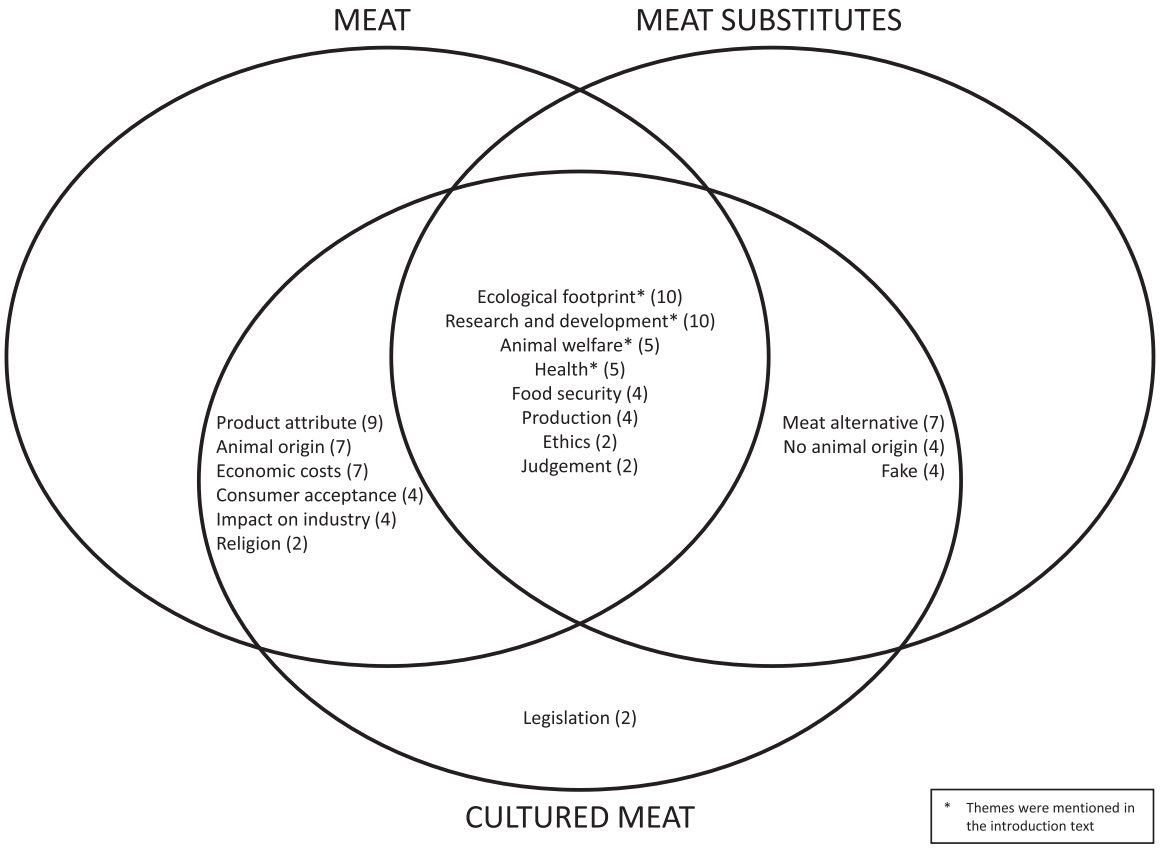

Fig. 2. Themes and their co(occurrences) across spheres identified from the interviews (N = 10). Note. Numbers between brackets inform on the number of participants who mentioned something related to the theme.

with the biomedical domain, as the production process of cultured meat is based on tissue engineering technologies, uncommon to meat and meat substitute production (Edelman et al., 2005; Post, 2014). Cultured meat has perceptual similarities with the sustainable product category as shown by the influence of information about solar panels on cultured meat attitude (Bekker, Fischer, et al., 2017). Hence it appears that cultured meat is not dominantly assigned to one category and therefore steering it into a specific category using similarity information is less straightforward.

Although similarity has been argued to be important in the categorization process (Gentner & Markman, 1997; Gregan-Paxton & John, 1997), other studies have shown that attitude valence and extremity influence the categorization outcome as well (Fazio et al., 2004; Shook et al., 2007). Negative category attitudes have been found to more easily transferred to an unfamiliar object compared to positive category attitudes (Fazio et al., 2004; Shook et al., 2007). In addition, more extreme negative and positive category attitudes have been found to be more easily transferred to an unfamiliar object (Shook et al., 2007). In the current study we found approximately neutral attitudes for the meat and meat substitute category. This may explain why there was no clear and stable attitude transfer.

In recent years alternative names for cultured meat have received attention. In addition to cultured meat, scientific literature, advocacy groups and the media used various names, such as lab-grown meat, clean meat, in-vitro meat and synthetic meat (see Bryant & Barnett, 2019, for a more comprehensive overview). These name variants have in common that they differ in the word that indicates the origin of cultured meat. Variations in origin names have been found to influence consumer attitudes, probably as a result of anchoring (Bryant & Barnett, 2019). The current paper, focused on the use of the word "meat" following doubt on whether cultured meat is perceived as meat (Bekker, Tobi, et al., 2017). Although we did not find conclusive results, future research on whether the use of the word meat does, or does not, influence consumer perceptions of cultured meat is recommended. Such research may inform the current regulatory debate (Stephens et al., 2018) on whether the use of the name meat should be limited to products produced through livestock slaughter.

Statistical power or lack thereof does not explain the mixed results of study 1 and 2. The sample size of the experiment in study 3 was based on an a priori power calculation based on the smallest effect size of study 1 and 2 and a power of 95%. As the minimum number of participants for the experiment in study 3 was acquired it is unlikely that the unconfirmed main hypothesis is the result of insufficient power. Time between studies can also not explain the conflicting results from the set of experiments. Study 1 and 2 were both conducted in the fall of the same year. All three studies were conducted after the tasting event of the first cultured meat product in summer 2013 (Jha, 2013). No major breakthroughs in production or marketing of cultured meat were reported between the three studies. In addition, differences between participants in familiarity with cultured meat were controlled for by including self-perceived familiarity as a control variable in all studies. In all studies the (expected) value of participant rewards was equal to about 7 euro per hour. There were some differences between the specific rewards of the studies though. Study 1 offered a canteen voucher; studies 2 and 3 offered a snack supplemented with a lottery ticket (study 2) or cash for participants who were also interviewed (study 3). All studies used student samples from the same university. While this may influence generalizability, it does not explain differences between conditions or between studies.

Another possible explanation for the presented results is that the experimental manipulations were text based, where other studies used an image combined with text (Ackermann et al., 2018; Gregan-Paxton et al., 2005; Moreau et al., 2001). The current paper made no use of images as many meat and meat substitute products are similar in their

appearance. After all, many meat substitutes are designed to imitate meat products.

The research was designed as a sequential mixed-methods design, including a series of experiments. The last study was designed based on findings of the first and second study and it included interviews to explore reasons for observed differences between those studies. The series of experiments showed mixed results that were most likely the result of chance. The additional interviews helped to interpret the mixed results. The findings of the current paper underline once again the importance of replicating studies, as stopping after the first study would have led to premature and incorrect conclusions.

In summary, the findings suggest that although cultured meat showed associations with the meat and meat substitute category, it could not be consistently steered into either one of these categories by providing similarity information.

Funding

Research of the current paper was funded by the Dutch Ministry of Economic Affairs. The Dutch Ministry of Economic Affairs had no further role in study design, data collection, data analysis and interpretation of results, nor in the writing of the report and the decision to submit the paper for publication.

Ethical clearance

Research of the current paper was done in accordance to the ethical guidelines of the Royal Netherlands Academy of Arts and Sciences and the social science ethical committee of Wageningen University. Prior to analysis, submitted e-mail addresses were replaced by an anonymous code identifying whether the respondent provided an e-mail address. As the research adhered to ethical guidelines and data management assured anonymity, no formal approval was required.

CRediT authorship contribution statement

Gerben A. Bekker: Conceptualization, Methodology, Formal analysis, Investigation, Writing - original draft. Conceptualization, Methodology, Writing - review & editing. **Hilde Tobi:** Conceptualization, Methodology, Writing - review & editing, Funding acquisition. **Hans C. M. van Trijp:** Conceptualization, Methodology, Writing - review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.foodqual.2021.104265.

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