11-2023

Effects of framing, nomenclature, and aversion to tampering with nature on consumer acceptance of cultivated meat in Singapore

Mark CHONG
Singapore Management University, markchong@smu.edu.sg

Angela K. Y. LEUNG
Singapore Management University, angelaleung@smu.edu.sg

Tricia M. FERNANDEZ

Shu Tian NG

Effects of Framing, Nomenclature, and Aversion to Tampering with Nature on Consumer Acceptance of Cultivated Meat in Singapore

By

Mark Chong, Angela Leung, Tricia Marjorie Fernandez, & Ng Shu Tian
Singapore Management University

Published in Journal of Environmental Psychology (2023) 91. DOI: 10.1016/j.jenvp.2023.102140

Abstract

This paper comprises a qualitative (Study 1) and a quantitative phase (Study 2). Study 1 aimed to find out what frames and nomenclature would appeal most to meat eaters – including consumers who have eaten cultivated chicken – in Singapore. It also aimed to discover whether perceptions of cultivated meat's naturalness varied across different age groups. Study 2 assessed which message frame and nomenclature were most effective in fostering consumer acceptance of cultivated meat. In addition, it investigated if age was related to the perception of cultivated meat's naturalness and acceptance, and whether aversion to tampering with nature was negatively related to perceived benefits and willingness to consume cultivated meat. First, our analysis showed that no single frame was most effective in fostering acceptance – the exceptions were the "animal welfare/reduces animal slaughter" and "reduce carbon emissions and global warming" frames, which were found to increase acceptance among Buddhists. Second, there was no consistent relationship between age, perceived naturalness, and the acceptance of cultivated meat. Third, "cultivated meat" was the most preferred term and the one that was most significantly related to positive attitudes toward cultivated meat. Last, there was an unexpected positive relationship between aversion to tampering with nature and perceived benefits of cultivated meat, as well as between aversion to tampering with nature and the willingness to consume cultivated meat. The implications for the cultivated meat industry are discussed.

Keywords

Cultivated meat; consumer acceptance; framing; nomenclature; perceived naturalness; tampering with nature

1. Introduction

The current meat production system is resource intensive, harmful to the environment (IPCC, 2018), and cruel to the animals living on factory farms (Lymberry & Oakeshott, 2014). Moreover, there is a link between meat consumption and significant health problems, including antibiotic resistance and animal-transmitted epidemics (Mathew, Cissell, & Liamthong, 2007; Oliver, Murinda, & Jayarao, 2011). Global meat demand is projected to increase rapidly along with the growth in the world population (OECD & FAO, 2018). However, meat production at its current levels is not sustainable (Dent, 2020). Moreover, the Covid-19 pandemic has shown how vulnerable countries in the world – especially food-dependent countries (e.g., Singapore) – are to major disruptions in the global food supply chain (Teng, 2020).

Experts have proposed growing cultivated meat from animal cells as a response to these issues, as its production significantly reduces harm to human and environmental health and eliminates the need to slaughter animals (Post et al., 2020). Cultivated meat production does not require industrial farming practices. Specifically, it is produced by extracting muscle-specific stem cells and growing them into muscle tissue in a laboratory (Post et al., 2020). Such use of the in-vitro cultivation of animal cells removes the need to raise the animal itself (Datar & Betti, 2010).

Researchers have identified consumer acceptance (or the lack thereof) as the main barrier to cultivated meat development (Laestadius, 2015; Onwezen, Bouwman, Reinders, & Davegos, 2021; Pakseresht, Kaliji, & Caanavari, 2022). Among the many factors that impact consumer acceptance of cultivated meat, framing (Bryant & Barnett, 2020; Pakeresht et al., 2022), nomenclature (Bryant & Barnett, 2020; Siegrist & Hartmann, 2020), and perceived naturalness (Siegrist & Sutterlin, 2017; Siegrist, Sutterlin, & Hartmann, 2018; Wilks & Phillips, 2017) are key.

1.1. Framing

The consumer behavior literature shows that framing of information affects overall consumer perception and choice (e.g., Kahneman & Tversky, 1979; Rothman & Salovey, 1997). Research suggests that how a message is framed may be more important and impactful than what the message is about, at least in the short term (Bryant & Barnett, 2020).

In one of the few studies to date on the framing of cultivated meat, Bryant and Dillard (2019) found that two frames – one emphasizing the personal benefits of cultivated meat and another highlighting the societal benefits – led to significantly higher acceptance compared to a frame emphasizing the technology's cutting-edge nature. In addition, they found that positive framing (e.g., cultivated meat is healthier and beneficial for the environment) had positive effects on consumer attitudes toward cultivated meat. On the other hand, Rolland, Markus, and Post (2020) found that messages focusing primarily on benefits to consumers (e.g., improvements to healthiness and safety) would be more effective in promoting consumer acceptance of cultivated meat than messages emphasizing benefits to society, the environment, or animals. Messages focusing on cultivated meat's safety to consumers (e.g., avoiding antibiotic resistance and zoonotic pandemics) could be especially effective, as they compare cultivated meat production to the far-from-ideal conventional meat production system (Van Der Weele & Driessen, 2019).

However, studies on the effect of cultivated meat framing on consumer acceptance have been scant (Kantor & Kantor, 2021), especially in Asia. Framing is an important issue: as consumers often do not know what to expect of novel products, cultivated meat producers have the opportunity to create expectations by manipulating extrinsic properties such as product name and labels (Piqueras-Fiszman & Spence, 2015; Tuorila & Hartmann, 2020).

Two studies were conducted in this research. In the first qualitative study, we aimed to address the literature gap by investigating how different frames affect consumer acceptance of cultivated meat in Singapore – the world's first country to approve the sale of cultivated meat – by building on the existing literature:

RQ1: What frame – benefits to consumers, benefits to society, benefits to the environment or benefits to animals – is the most appealing to consumers of cultivated meat in Singapore?

1.2. Nomenclature

There is widespread recognition that the name given to something can affect how people evaluate it. Merely altering the names of dishes can affect consumers' perception (Bell & Paniesin, 1992) and increase the perceived authenticity of foreign dishes (Meiselman & Bell, 1991). For example, the successful renaming of the un-appetizing sounding "Patagonian toothfish" to "Chilean sea bass" helped increase its acceptance among seafood diners around the world (Sommers, 2012). Similarly, the names given to some meats may have the effect of making them more appealing: e.g., replacing the word "beef" with "cow" and the word "pork" with "pig" on a menu increased consumer empathy, disgust, and the willingness to pick an alternative vegetarian dish; the word change also decreased willingness to eat meat (Kunst & Hohle, 2016).

Nomenclature and terminology are also important to fostering greater consumer acceptance of cultivated meat (Bryant & Barnett, 2020; Siegrist & Hartmann, 2020). Bryant and Barnett (2019) found that different names had a significant effect on measures of acceptance. More specifically, they found that "clean meat" led to significantly higher acceptance than "lab-grown meat", with "cultured meat" and "animal-free meat" scoring somewhere in between. Asioli, Bazzani, and Nayga (2021) found that US consumers were less averse to the term "cultured meat" than "artificial" and "lab-grown" meat. Creating consensus around a single common name is clearly important for regulatory reasons and for shaping public perceptions and understanding of the labeled products (Hallman & Hallman, 2020). This leads to our second research question:

RQ2: Which of the terms used to describe cultivated meat are most favored by Singaporean consumers?

1.3. Perceived naturalness

Perceived naturalness also influences the acceptance of cultivated meat (Siegrist & Sutterlin, 2017; Siegrist et al., 2018; Wilks & Phillips, 2017). Across many studies, meat eaters have expressed resistance to eating cultivated meat because they perceive it to be unnatural (Siegrist & Hartmann, 2020; Siegrist & Sutterlin, 2017; Tomiyama et al., 2020; Verbeke, Sans, & Van Loo, 2015; Wilks, Hornsey, & Bloom, 2021; Bryant, Anderson, Asher, Green, & Gasteratos, 2019; Bryant & Barnett, 2018, 2019; Bryant & Dillard, 2019; Shaw & Iomaire, 2019; Laestadius, 2015; Lupton & Turner, 2018). As judgments about a food's naturalness stem strongly from the food's production process (Roman, Sanchez-Siles, & Siegrist, 2017; Rozin, 2006), cultivated meat may seem unnatural to consumers because it lacks conventional animal origin (Rosenfeld & Tomiyama, 2022).

Consumers who perceived cultivated meat as unnatural reported stronger disgust (Siegrist et al., 2018); had stronger doubts about its alleged health benefits (Palmieri, Perito, & Lupi, 2020; Verbeke et al., 2015); found the health risks to be less acceptable (Siegrist & Sutterlin, 2017) compared with conventional meat; and were more likely to reject the technology

(Palmieri, Perito, & Lupi, 2020; Verbeke et al., 2015). A plausible explanation for this reaction was that unnatural foods may appear to be inherently less desirable and potentially pathogenic (Curtis, De Barra, & Aunger, 2011).

Studies have shown that younger people are more positive towards cultivated meat (Tucker, 2014) and are more prepared to try it (Bogueva & Marinova, 2020). In fact, the effects of age (and gender) were found to be more important for acceptance than education level (Wilks, Phillips, Fielding, & Hornsey, 2019). Anecdotal accounts[1] suggest that younger consumers may be more receptive than older consumers to cultivated meat, as they are more likely than older consumers to perceive cultivated meat as being less unnatural. However, no study to date has assessed if there is a relationship between perceived naturalness, age, and consumer acceptance of cultivated meat, which leads us to our third research question:

RQ3a: Does perception of cultivated meat's naturalness (or lack thereof) vary across different age groups?

RQ3b: How does this perception influence consumers' acceptance of cultivated meat?

2. Study 1

2.1. Methods

We conducted in-depth interviews, as they enable researchers to learn as much as possible about a little-known subject and understand how it is perceived by stakeholders (Lofland & Lofland, 1995). We recruited and interviewed 20 meat eaters in Singapore in February 2022 with the help of a market research agency. 10 respondents had eaten cultivated meat whereas another 10 had not. All respondents were first pre-screened for their dietary habits to ensure that all of them were meat-eaters with no dietary restrictions (e.g., food allergies, gluten intolerance, vegan). Respondents who had tried cultivated meat before were asked where they had tried it at (e.g., 1880[2], Foodpanda @ 1880[3]). We paid careful attention to ensuring gender, ethnic, age and income diversity in the sample and achieved data saturation (Guest, Bunce, & Johnson, 2006) with this sample size (see Table 1 for participant characteristics of Study 1).

We developed an interview guide comprising 11 questions and used it consistently across all interviews (see Supplementary Material for interview guide). Before the start of the interview, we briefed all participants about the purpose of the study and obtained their informed consent. At the start of the interview, we read the following statement to respondents:

"Cultivated meat is created by feeding cells in a clean, sterile environment, mirroring how an animal grows. By only producing the meat we eat, cultivated meat has a smaller impact on the planet and avoids slaughter, antibiotics or hormones."

[1] Conversation with Josh Tetrick, CEO of Good Meat, June 13, 2022.
[2] See Phua (2020).
[3] See Foodpanda (2021).

In addition, we showed the steps involved in producing cultivated meat (https://goodmeat.co/process) to them.

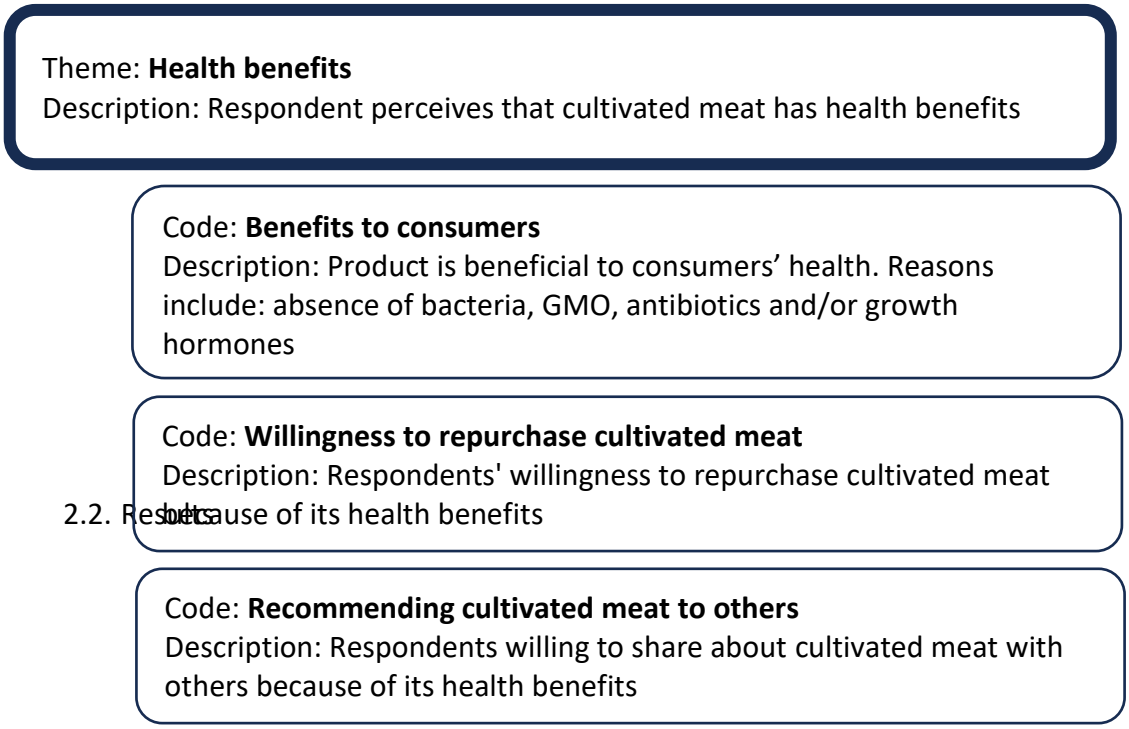
We recorded the interviews and transcribed them verbatim with the help of two research assistants and the note-taking software Otter.ai. Each interview lasted an average of 30 minutes. After the interviews, we compensated the participants based on the rate agreed between the participants and the market research agency (i.e., S$100).

Trained judges independently coded the 20 transcripts with the aid of the transcription software NVivo. The coding process of the obtained interview data in this qualitative research involves the act of transcribing, analyzing, synthesizing, and deconstructing transcripts while preserving the relationship(s) between the elements (Miles & Huberman, 1994).

The transcripts were carefully read, and every time a concept was identified, codes were created to contain relevant extracts or texts from the transcript. The extracts were highlighted, and codes were assigned to them. Hence, the codes contained extracts across transcripts that were associated with each other. If a concept had multiple dimensions, subcodes were created under the codes. The content of the codes or coding references were continuously evaluated during the coding process. The codes and subcodes were then organized into themes/top-level codes or a more general concept. All top-level codes/themes were aggregated from their respective codes, and all codes were aggregated from their respective subcodes. Hence, the top-level codes contained all coding references from its respective codes and subcodes. Coding is an iterative and non-linear process where the coding structure is constantly refined; codes can be merged with one another depending on their content. All themes/codes/subcodes were also assigned a short description or definition so that the research team was aware of the thought process of the coders. After all the 20 transcripts had been coded, a codebook or coding framework was exported from NVivo (see Fig. 1 for a sample of the coding framework and Supplementary Material for the abridged version of the coding framework).

Fig. 1

Sample of the Coding Framework.



2.2. Results

Overall, those in the CM+ group had a positive post-consumption perception of cultivated meat, while all 10 participants in the CM- group were open to trying it. The receptiveness of both groups to cultivated meat may at least be partly explained by Singaporeans' strong social image motivations, and more specifically, their motivation to project a social image of being "trailblazers" through their food choice (Chong, Leung, & Lua, 2022). More specifically, Singaporeans can be more motivated by the cultural trait of "kiasuism", which is exemplified by the fear of losing out or being left behind (Bedford & Chua, 2018).

2.2.1. Benefits to consumers, food sustainability, animal welfare, and the environment

Our study showed that half the respondents (four CM+ and six CM-) perceived cultivated meat to have health benefits for consumers (e.g., lower levels of bacteria, absence of growth hormones and GMOs):

"I think I like the fact that when you say there's no antibiotics, no GMO, because whenever we buy from the market, we don't know the process it goes through. And this shows the process. So, it's pretty interesting in the fact that, you know, it's created with healthy cells that's able to by-produce."

CM+ eaters cited health benefits as a factor for their willingness to repurchase cultivated meat and recommend it to others. Other benefits mentioned include benefits to society, animals, and the environment. First, food sustainability was often mentioned (i.e., four CM+ and three CM-) as a perceived benefit to society. More specifically, it could help increase Singapore's self-sufficiency and reduce its dependence on imported meat. Second, more than half of the sample thought that cultivated meat could help reduce animal slaughter and contribute to the more humane treatment of animals. Third, 45% of the sample (five CM+, four CM-) believed that the consumption of cultivated meat (in place of conventional meat) could benefit the environment by reducing carbon emissions, greenhouse gases, and land usage (i.e., less resource-intensive).

2.2.2. Perceived safety

Safety was the second most-mentioned benefit (in terms of number of respondents) after health benefits:

"…at least lab grown, we know where it's coming from. We know the integrity of it. We know, like it's kept under very strict conditions, just like the vaccine. The government wouldn't like willy nilly, oh, take this one. Take Pfizer. It's fine, you know. There are tests being run, it's kept in a secure [place], the formula, everything has been studied. So, I believe when and if research and data are presented to the people, people will be able to accept it more."

Both groups mentioned that trust in the food regulator's ability to implement and enforce high food safety standards was a key reason for their perception of safety. The CM- group recommended cultivated meat companies to provide more education about cultivated meat and empirical evidence of its positive environmental effects. It also mentioned that market

availability of cultivated meat for a length of time will provide consumers with an assurance of safety.

2.2.3. Perceived naturalness

Older participants (i.e., those aged 40-49 and 50-59) were more likely to mention a perceived lack of naturalness, although the differences across different age groups were minimal. Only two of the younger participants (i.e., those aged 30-39) perceived cultivated meat to be unnatural.

Despite perceptions of unnaturalness by eight respondents (i.e., two CM+ and six CM-), all 10 CM+ eaters have tried cultivated meat and all 10 CM- eaters were willing to try it. This is because of the high levels of trust in the national food regulator:

"I think it should be because I believe the Singapore authorities…for products, like consumer products. So, we are considered quite safe in that sense. Even when we import let's say, for example, when we import vegetables from Malaysia, they will do sampling testing….I mean, at least we have some form of protection…."

2.2.4. Nomenclature

Our respondents seemed to have a preference for the terms "cultured meat" and "clean meat", as shown in the following responses:

"I find it is quite mild. People don't mind, very neutral. Because the word 'cultured' gives it a 'mystery'…maybe it's processing nicely or something cultured…quite comfortable."

"Whereas when you say clean meat, what I would think about that clean meat would be...it's healthy food, like you only eat clean diet, that kind of thing. That's what I associate when we want to talk about eating…to me clean eating, clean meat will be a diet food."

Reasons given for preferring the term "cultured meat" include its allusion to the idea of nurturing the meat as well as its "comfortable" and "new age" sound. Reasons given for preferring the term "clean meat" include the impression of healthiness it gives and the curiosity it induces.

Overall, respondents most disliked the term "lab-grown meat", mainly because it sounded clinical or scientific:

"Lab grown meat sounds a bit...It sounds like it's still at a clinical trial stage…it is still at a testing stage."

An equal number of respondents from both groups mentioned that the term "animal-free meat" was an inaccurate representation of cultivated meat – the term could be misleading to vegetarians, as cultivated meat still contains animal cells. On the other hand, an equal number from both groups believed that the term would cater to vegans or vegetarians.

2.3. Discussion of Study 1

Study 1 aimed to examine what message frames (RQ1) and nomenclature (RQ2) were most preferred by Singaporean consumers. In addition, it aimed to find out if perception of cultivated meat's naturalness varied across age groups (RQ3a) and whether this perception influenced consumer acceptance (RQ3b). In summary, we found that "health benefits to consumers" was the most preferred frame while "clean meat" and "cultured meat" were the most preferred terms. In addition, we found that older participants were minimally more likely to mention perceived naturalness as an issue, although this perception did not affect their acceptance of cultivated meat – all 20 respondents had eaten (or were willing to eat) cultivated meat.

First, our findings support previous studies (e.g., Bryant & Dillard, 2019; Rolland et al., 2020) which showed that frames emphasizing personal benefits to consumers were most effective in fostering consumer acceptance of cultivated meat. Second, they support prior research which showed that "cultured meat" was the term most preferred by consumers (Bryant & Barnett, 2019). Third, we found that perceived naturalness varied only minimally across age groups, and did not inhibit willingness to try cultivated meat.

This study suggests that framing cultivated meat primarily in terms of its benefits to personal health may be most effective in fostering greater acceptance of the product in Singapore. In addition, the potential of cultivated meat to boost Singapore's food sustainability may become more salient to consumers given the escalating inflation of imported food prices. This is related to our earlier discussion that participants recognized the benefit of cultivated meat to society because it can help increase Singapore's self-sufficiency in food supplies and reduce its vulnerability by reducing dependence on imported meat. Accordingly, the "good for society" frame may become more salient – and effective – if current conditions persist. With regard to nomenclature, our study suggests that "clean meat" and "cultured meat" are the most appropriate terms for the Singapore market.

3. Study 2

In our second study, we aimed to test and validate the preliminary findings from our qualitative research in Study 1 by conducting a quantitative survey. Our first key finding from Study 1 was that "health benefits to consumers" was the most preferred frame. Thus, we developed the following hypothesis:

H1: The "health benefits to consumers" frame has the most significant influence on consumer acceptance of cultivated meat.

Our second key finding from Study 1 was that younger participants were less likely to perceive cultivated meat to be unnatural. This leads to our second hypothesis:

H2: Younger consumers perceive cultivated meat to be less unnatural and are hence more accepting of it.

Our third key finding from Study 1 was that "clean meat" and "cultured meat" were the most preferred terms. However, in the time between our first and second studies, a consensus had started to emerge in the food industry around the new term "cultivated meat" (Good Food Institute, 2021). Given the new primacy of the term "cultivated meat", we developed the following third hypothesis (while also testing the terms "clean meat" and "cultured meat"):

H3a: The term "cultivated meat" is the most preferred term.

Moreover, as different names have been found to significantly affect measures of consumer acceptance (Bryant & Barnett, 2019), we added the following hypothesis:

H3b: The term "cultivated meat" is positively related to acceptance of cultivated meat.

Aversion to tampering with nature[4] is an area that has received limited attention in the literature on cultivated meat acceptance . Discomfort with tampering with nature has been found to strongly predict perceived risk (Sjoberg, 2000) and increase resistance to novel technologies (Dragojlovic & Einsiedel, 2013; Vandermoere, Blanchemanche, Bieberstein, Marette, & Roosen, 2010; Wolske, Raimi, Campbell-Arvai, & Hart, 2019). In fact, Hoogendoorn, Sutterlin, and Siegrist (2021) noted that "the more a technology or behavior is seen as tampering with nature, the less people accept this technology or behavior" (p. 150). Rozin (2005) and Rozin et al. (2004) found that products whose natural states have been adulterated by humans are distrusted, while natural products (i.e., those that are not the results of human intervention) are more strongly preferred. More recently, Raimi et al. (2020) reported a positive relationship between aversion to tampering with nature and a bias towards natural products. Tampering with nature has been found to influence the acceptance of geoengineering (Braun, Merk, Ponitzsch, Rehdanz, & Schmidt, 2018), synthetic biology (Dragojlovic & Einsiedel, 2013), genetic testing (Henneman, Timmermans, & Van Der Wal, 2006), and biotechnological applications (Knight, 2007). To date, however, no study has looked into the influence of aversion to tampering with nature on the acceptance of cultivated meat. Therefore, the current research offers the first evidence to shed light on the link between aversion to tampering with nature and attitude towards cultivated meat. This discussion leads to our fourth hypothesis:

H4: Aversion to tampering with nature is negatively related to perceived benefits and willingness to consume cultivated meat.

3.1. Methods

[4] It has been defined as "discomfort with human activities that alter some aspect of the nature in a way that invites risk" (Raimi, Wolske, Hart, & Campbell-Arvai, 2020, p. 638).

3.1.1. Participants

A total of 1451 Singaporeans who were 18 years old or above were recruited for an online survey, which took about nine minutes to complete, through InVeritas Research, a market research company. To ensure that the ethnicity composition of the sample approximately reflects Singapore's population (Singapore Department of Statistics, 2021), ethnicity quotas were implemented at the start of the survey to recruit Chinese (75%), Malays (13%), Indians (10%) and other ethnicity participants (2%). 66 respondents were not eligible to complete the survey because the ethnicity quotas were full. These respondents were hence redirected out of the survey. Respondents who failed an attention check (*n*=353) that was embedded into the survey were also excluded from the final analyses.

Several steps were taken to ensure that data quality was enhanced. Towards the end of the survey, respondents were asked if they were comfortable speaking or communicating in English. Respondents who indicated "no" (*n*=19) were removed from the final analyses after data collection was completed. At the end of the survey, respondents were required to answer an honesty check question. This question asked respondents if they had responded to the survey in a reasonably careful and honest manner such that their data would be considered valid. Respondents were given an explanation that their honest answer to the question can help improve the validity of the data and conclusions. Respondents were also assured that their responses were anonymous, and their answer to the question would not affect their research participation compensation. Respondents who failed the honesty check (*n*=14) or indicated that they were not honest were removed from the final analyses after data collection was completed.

Additionally, duplicate responses (*n*=28) that were manually identified based on their identical IP addresses and identical responses to questions were excluded. Participants who gave meaningless responses to an open-ended question asking them to indicate their occupation (*n*=11) and response outliers (>2 *SD* of mean duration) in terms of time taken to complete the survey (*n*=12) were also excluded. All these responses were removed from the final analyses after the end of data collection.

This resulted in a final sample of 948 participants (see Table 2 for participant characteristics of Study 2 and Appendix A for participant characteristics across conditions). Based on a power analysis conducted in G*Power, this sample size was sufficient for detecting significant differences in means across the five experimental conditions at 80% power, assuming a small-to-medium effect size (*f* = 0.20).

3.1.2. Procedure

Data was collected through an online survey that was hosted on Qualtrics (see Supplementary Material for questionnaire). The survey was approved by the university's Institutional Review Board. Participants were briefed that the study examined people's perceptions of cultivated meat. To ensure that participants had the same understanding of cultivated meat, the definition was given:

> *Cultivated meat is real meat which is grown in a sterile, controlled environment from a single animal cell, removing the need to raise animals. Cultivated meat should not*

be confused with plant-based meats such as Impossible and Beyond. Since it is real animal meat, it has similar taste, texture, and the same or better nutritional content as conventionally produced meat.

After reading the definition of cultivated meat and after informed consent was obtained, participants were asked to indicate their ethnicity to ensure that they met the quota requirements to continue. Subsequently, participants were randomly assigned by the randomizer tool on Qualtrics (Qualtrics, 2022) to read one of the five message frames that highlighted some of the benefits of consuming cultivated meat. The randomizer tool presented the message frames with roughly equal frequency. Each message frame was presented in bold and large text on the screen to ensure that it sufficiently captured participants' attention. Additionally, we prompted participants to take time to consider the message and set a timer of 20 seconds before they could proceed with the rest of the survey.

The five message frames are:

Frame A: Cultivated meat enables consumers to avoid undesirable elements that are found in some food products (e.g., foodborne diseases, growth hormones, or GMOs)
Frame B: Cultivated meat enables the nutritional value of meat to be enhanced
Frame C: Cultivated meat contributes to animal welfare and reduces animal slaughter
Frame D: Cultivated meat helps reduce carbon emissions and global warming
Frame E: Cultivated meat helps ensure that the country's meat supply is stable and sufficient

Whereas Frames A and B presented the benefits of cultivated meat to consumers, Frames C, D, and E presented the benefits of cultivated meat to animals, the environment, and society, respectively.

After being exposed to the message frames, participants completed several scales measuring their attitudes and acceptance of cultivated meat. The survey also included attention check and honesty check items to screen out low-quality responses. Lastly, participants answered some demographic questions. After completing the survey, participants were compensated based on the rate as agreed between them and InVeritas Research.

3.1.3. Measures

3.1.3.1. Acceptance of cultivated meat

Acceptance of cultivated meat was operationalised by participants' general attitude towards cultivated meat and their willingness to eat cultivated meat, which were two of our main dependent variables used for this study.

3.1.3.1.1. General attitude

Participants were asked to rate their general attitude towards cultivated meat on a single-item seven-point scale (1 = *Very unfavorable*; 2 = *Unfavorable*; 3 = *Somewhat unfavorable*; 4 = *Neutral*; 5 = *Somewhat favorable*; 6 = *Favorable*; 7 = *Very favorable).*

3.1.3.1.2. Willingness to eat

Participants were asked to rate their willingness to eat cultivated meat, willingness to buy cultivated meat regularly, willingness to eat cultivated meat as a replacement for conventionally produced meat, willingness to eat cultivated meat as a supplement to conventionally produced meat, and willingness to eat cultivated meat instead of plant-based meat substitutes (adapted from Bryant & Dillard, 2019; Wilks & Phillips, 2017). These items were rated on a seven-point scale (1 = *Definitely no;* 2 = *No*; 3 = *Probably no*; 4 = *Neutral*; 5 = *Probably yes*; 6 = *Yes*; 7 = *Definitely yes*). The scores of all five items were aggregated to form a composite measure (mean score of all items), where higher scores indicated greater willingness to consume cultivated meat. The scale demonstrated high internal consistency (α = .94).

3.1.3.2. Concerns

Participants were also asked to rate their concerns about the following elements of cultivated meat: Cost, taste, naturalness, safety, and nutritional value. These items were rated on a seven-point scale (1 = *Not at all concerned*; 2 = *Not concerned*; 3 = *Somewhat not concerned*; 4 = *Neutral*; 5 = *Somewhat concerned*; 6 = *Concerned*; 7 = *Extremely concerned*). The scores of all items were mean aggregated to form a composite measure. Higher scores indicated greater levels of concerns about cultivated meat. The measure demonstrated high internal consistency (α = .86).

3.1.3.3. Perceived benefits

Participants were asked to rate their level of agreement on six items which depicted the perceived benefits of cultivated meat – Cultivated meat is … "healthy", "safe for human beings", "environmentally friendly", "has the same sensory quality as real meat", "has benefits for society", and "is animal friendly" – on a seven-point scale (1 = *Strongly disagree*; 2 = *Disagree*; 3 = *Somewhat disagree*; 4 = *Neutral*; 5 = *Somewhat agree*; 6 = *Agree*; 7 = *Strongly agree*). The scores of all items were aggregated to form a composite measure, where higher scores indicated higher agreement levels of the perceived benefits of cultivated meat. The measure also demonstrated high internal consistency (α=.91).

3.1.3.4. Nomenclature

Participants were asked to pick one term that they liked best out of six terms that are usually used to refer to cultivated meat: "cultivated meat", "cultured meat", "lab-grown meat", "animal free meat", "cell-based meat", and "clean meat".

3.1.3.5. Aversion to tampering with nature

Participants answered a five-item scale by Raimi et al. (2020) that measured their discomfort towards activities that involve altering nature. The items, rated on a seven-point scale (1 = *Strongly disagree*; 2 = *Disagree*; 3 = *Somewhat disagree*; 4 = *Neutral*; 5 =

Somewhat agree; 6 = *Agree*; 7 = *Strongly agree*), include "Human beings have no right to meddle with the natural environment" and "Altering nature will be our downfall as a species." One of the items[5] was removed from analysis because of reverse loading, likely due to the negative phrasing of the statement. The ratings of the items were aggregated to create a composite score. A higher score indicated a stronger aversion to tampering with nature (α = .79).

3.1.3.6. Demographic covariates

Demographic variables (gender, ethnicity, age, religion, highest educational qualification, and household income levels) were included as covariates in our analyses. Gender was dummy coded with males/prefer not to say as the reference category and ethnicity was dummy coded with the minority race (i.e., non-Chinese) as the reference category. Age was reported in years but was re-coded into categories (18-29, 30-39, 40-49, 50-59, 60-69 years old) for further analyses, with 18-29 as the reference category. Religion was re-coded under three main categories: Abrahamic, Dharmic, and "no religion/Agnostic/Atheist/others" as the reference category. To further analyze the effect of Buddhism, religion was also dummy coded with non-Buddhists as the reference category. As for the highest educational qualification, the responses were also re-coded under three main categories: Vocational certificate, academic degree, and "no tertiary/primary or secondary school/junior college/others" as the reference category. Annual household income was measured on an eight-point scale (1 = *SGD 15,000 or less*; 2 = *SGD15,001 – SGD25,000*; 3 = *SGD25,001 – SGD 35,000*; 4 = *SGD35,001 – SGD50,000*; 5 = *SGD50,001 – SGD75,000*; 6 = *SGD75,001 – SGD100,000*; 7 = *SGD100,001 – SGD150,000*; 8 = *More than SGD 150,000*).

3.1.4. Analytical methods

All analyses were conducted in IBM SPSS Statistics 28.0. In the regression models, the framing conditions were dummy coded with Frame E ("Cultivated meat helps ensure that the country's meat supply is stable and sufficient") being the reference category. Nomenclature was also dummy coded with the term "cultured meat" serving as the reference category. The Spearman bivariate correlation table for all variables measured in the study are presented in Appendix B. Continuous variables included in moderation analysis were mean centred to facilitate interpretation of coefficients.

3.2. Results

3.2.1. The effect of framing condition on acceptance of cultivated meat

To investigate which frame – benefits to consumers, benefits to society, benefits to the environment, or benefits to animals – was the most appealing to participants (H1), we examined the effect of the message frames on acceptance of cultivated meat. We conducted a one-way ANOVA (Table 3) with framing conditions as the predictor. Our results

[5] The item removed was "People who say we shouldn't tamper with nature are just being naïve." The item loaded negatively after reverse coding the statement. With this item included, the scale's Cronbach's α was 0.59, below what is considered satisfactory internal consistency.

showed no significant differences between the different framing conditions in their impact on attitudes (F (4, 943) = 0.26, p = .905) and willingness to consume cultivated meat (F (4, 943) = 0.33, p = .857).

To investigate if age, gender, and religion moderated the effect of the framing conditions on willingness to consume cultivated meat, we conducted a three-step hierarchical multiple regression. We entered demographic variables (i.e., gender, religion, income, age, ethnicity, education) in Step 1 of the regression as covariates. We then entered the framing conditions in Step 2. In Step 3, we entered the interaction terms between framing conditions and age, gender, and religion in separate models.

We coded religion in two different ways. In the first coding of religion (Table 4), we classified participants as being of an Abrahamic religion, Dharmic religion or other (e.g., atheists and agnostics). In the second coding of religion, we classified participants as either Buddhists or non-Buddhists (see Appendix C).

Both ways of coding religion yielded largely similar results. For brevity, we will report coefficients from the first model (Table 4, Step 3). Across most models, being older (B = -0.01, SE = 0.00, p = .018, 95% C.I. = [-0.02, -0.00]) or female (B = -0.25, SE = 0.09, p = .006, 95% C.I. = [-0.42, -0.07]) predicted lower willingness to consume cultivated meat, whereas having a higher academic qualification (i.e., bachelor's degree and above; B = 0.53, SE = 0.12, p < .001, 95% C.I. = [0.29, 0.77]) predicted greater willingness to consume cultivated meat. There was no main effect of message frame on willingness to consume cultivated meat in any model.

As for the interaction effects, only the Religion by Condition interaction terms were significant. For the first method of coding (Table 4, Step 3), we found a significant interaction term between Abrahamic religion and Frame C ("Cultivated meat contributes to animal welfare and reduces animal slaughter"; B = -0.76, SE = 0.36, p = .037, 95% C.I. = [-1.47, -0.05]). In other words, participants from an Abrahamic religion were less willing to consume cultivated meat after reading Frame C, compared to participants of other religions. As for the second method of coding religion (Appendix C, Step 3), Buddhism significantly moderated the effect of Frames C and D, such that Buddhists who read that "cultivated meat contributes to animal welfare and reduces animal slaughter (Frame C; B = 0.66, SE = 0.31, p = .031, 95% C.I. = [0.06, 1.26]) or read that "cultivated meat helps reduce carbon emissions and global warming" (Frame D; B = 0.60, SE = 0.30, p = .046, 95% C.I. = [0.01, 1.18]) became more willing to consume cultivated meat as compared to their non-Buddhist counterparts.

3.2.2. Relationship between age, concerns about naturalness, attitudes toward, and willingness to consume cultivated meat

To investigate if there was an association between age group and naturalness concerns about cultivated meat, we conducted a one-way ANOVA with age group as the predictor. There was no significant effect of age group on concerns about naturalness, F (4, 943) =

2.39, p = .049, η^2 = 0.01, 95% C.I. = [0.00, 0.02]. Post-hoc analyses with Tukey's HSD further confirmed that there were no significant differences between the different age groups and concerns about the naturalness of cultivated meat.

We conducted further moderation analyses to find out if age moderated the effect between naturalness concerns and attitudes toward cultivated meat, as well as between naturalness concerns and willingness to consume cultivated meat. A two-step hierarchical multiple regression was carried out separately on attitudes toward and willingness to consume cultivated meat (Table 5) as the dependent variables. We entered demographic covariates (i.e., gender, religion, income, age, ethnicity, education), framing conditions, and concerns about naturalness in Step 1 of the regression model, and the interaction term between age and concerns about naturalness in Step 2. Results showed that age group (30-39 and 50-59) moderated the effect of concerns about perceived naturalness on attitudes toward cultivated meat (Table 5). For those aged 30 to 39 years old, an increase in concerns about naturalness was associated with more favorable attitudes (B = 0.24, SE = 0.08, p = .003, 95% C.I. = [0.08, 0.39]), while for those aged 50 to 59, an increase in concerns about naturalness was associated with less favorable attitudes (B = -0.26, SE = 0.11, p = .018, 95% C.I. = [-0.47, -0.04]), as compared to those aged 18 to 29 years old.

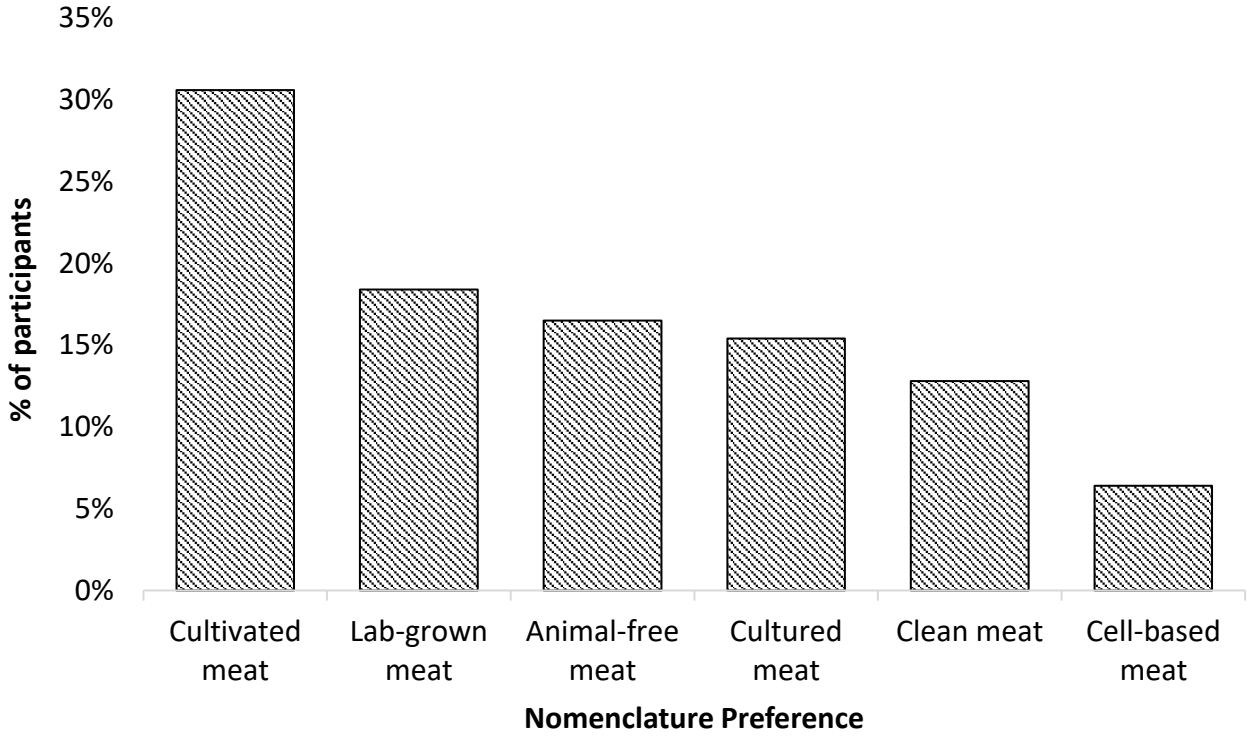
Similarly, results also showed that age group (30-39 and 50-59) moderated the effect of concerns about perceived naturalness on willingness to consume cultivated meat (Table 5). For those aged 30 to 39 years old, an increase in concerns about naturalness was associated with a higher level of willingness to consume cultivated meat (B = 0.18, SE = 0.08, p = .020, 95% C.I. = [0.03, 0.32]). For those aged 50 to 59 years old, an increase in concerns about naturalness was associated with a lower level of willingness (B = -0.31, SE = 0.10, p = .002, 95% C.I. = [-0.52, -0.11]), as compared to those aged 18 to 29 years old.

3.2.3. Nomenclature preference

To investigate the most favored terms used to describe cultivated meat (H3a), we conducted a frequency analysis (see Fig. 2). The most preferred term amongst participants was "cultivated meat" (30.6%), followed by "lab-grown meat" (18.4%), "animal-free meat" (16.5%), "cultured meat" (15.4%), and "clean meat" (12.8%). The least preferred term was "cell-based meat" (6.4%).

Fig. 2

Participants' Preferred Nomenclature (N = 948).



3.2.4. Relationship between nomenclature and attitudes toward/willingness to consume cultivated meat

To examine whether there was an association between nomenclature preference and attitudes toward or willingness to consume cultivated meat (H3b), we conducted a linear regression. We dummy coded nomenclature, with the term "cultured meat" serving as the reference category. We entered demographic covariates (i.e., age, gender, income, ethnicity, education, religion), framing conditions, and the five nomenclature terms (i.e., cultivated meat, lab-grown meat, animal-free meat, cell-based meat and clean meat) into the model. Results revealed that the preference for the term "cultivated meat" was associated with more favorable attitudes toward cultivated meat, $B = 0.36$, $SE = 0.14$, $p = .011$, 95% C.I. = [0.08, 0.64], as compared to the term "cultured meat". Additionally, preference for the term "lab-grown meat" was associated with less favorable attitudes, $B = -0.38$, $SE = 0.16$, $p = .017$, 95% C.I. = [-0.68, -0.07], as compared to the term "cultured meat" (Table 6).

The analyses also showed that preference for the terms "lab-grown meat" and "clean meat" was associated with decreased willingness to consume cultivated meat, $B = -0.71$, $SE = 0.15$, $p < .001$, 95% C.I. = [-0.99, -0.42] and $B = -0.57$, $SE = 0.16$, $p < .001$, 95% C.I. = [-0.89, -0.26], respectively, as compared to the term "cultured meat" (Table 6).

3.2.5. Relationship between aversion to tampering with nature and perceived benefits or willingness to consume cultivated meat

To examine if aversion to tampering with nature was negatively related to perceived benefits or willingness to consume cultivated meat (H4), we performed a linear regression. We entered demographic covariates (i.e., age, gender, income ethnicity, education, religion), framing conditions, aversion to tampering with nature, and concerns about naturalness into the model. Different from the hypothesis, results showed that aversion to tampering with nature was positively associated with both willingness to consume cultivated meat, $B = 0.24$, $SE = 0.04$, $p < .001$, 95% C.I. = [0.16, 0.32], and perceived benefits of cultivated meat, $B = 0.18$, $SE = 0.04$, $p < .001$, 95% C.I. = [0.11, 0.25] (Table 7).

3.3. General Discussion

This research aimed to investigate the effects of framing, nomenclature, and perceived tampering with nature on consumer acceptance of cultivated meat in Singapore. Given the absence of research on these topics in any Asian country, we first conducted a qualitative study (Study 1) to derive preliminary findings. In turn, we used these preliminary discoveries to inform and develop related hypotheses using a nationally representative quantitative survey in Study 2. Both studies represent a contribution to the limited literature on framing, nomenclature, and aversion to tampering with nature as important drivers of acceptance of cultivated meat in Asia.

First, our studies showed that no single frame was more effective than others in increasing general consumer acceptance of cultivated meat (H1). In other words, there were no significant differences between the five message frames in their impact on overall consumer acceptance. The exceptions were the "animal welfare/reduces animal slaughter" and "reduce carbon emissions and global warming" frames, which were found to increase acceptance among Buddhists. Second, there was no consistent relationship between age, perceived naturalness, and the acceptance of cultivated meat (H2). Third, we found "cultivated meat" to be the most preferred term and the one that was most significantly related to positive attitude towards cultivated meat (H3). Fourth and last, our findings revealed an unexpected positive relationship between aversion to tampering with nature and perceived benefits of cultivated meat, as well as between aversion to tampering with nature and the willingness to consume cultivated meat (H4) (see Appendix D for an overview of Study 2).

Our first key finding – i.e., "animal welfare/reduces animal slaughter" and "reduce carbon emissions and global warming" frames increased acceptance among Buddhists – may have three explanations. First, Buddhism is the dominant religion in Singapore, with 33.2% of the population identifying themselves as Buddhists (Office of International Religious Freedom, 2020). One of the central tenets of Buddhism is compassion for all sentient beings, which may help to explain why the "animal welfare/reduce animal slaughter" frame resonates more strongly with the Buddhist participants than the other two "benefits to consumers" frames. Second, media coverage on cultivated meat's potential to boost Singapore's food sustainability[6] (e.g., Laboutka, 2022; Chew, 2022; Tan, 2020) may have increased the salience of the "food sustainability" frame. This media coverage happened during a period when consumers experienced food price inflation and the shortage of certain food items. By determining what issues are the most important and featuring them in the news, media

[6] Singapore depends on imports for 90% of its food needs (Teng, 2020).

outlets can influence what people think about – an effect referred to as agenda setting (Dearing & Rogers, 1988). Third, the same agenda-setting effects of media coverage on record-breaking temperatures in Singapore (e.g., Begum, 2022) in recent years may have amplified the risks associated with global warming and increased the salience of the issue in consumers' minds. As an island state situated very close to the equator, Singapore is especially vulnerable to the consequences of climate change. In summary, our findings suggest that cultivated meat companies could use message frames focusing on how cultivated meat "reduces animal slaughter" and "reduces global warming" to foster consumer acceptance in Asian countries with significant Buddhist populations (e.g., Japan, Singapore, South Korea, and Thailand). As there was no significant difference in the influence of the five frames on overall consumer acceptance, it may seem that each of the five frames could be used interchangeably to promote cultivated meat in Singapore. Nonetheless, we highlight that "health benefits to consumers" emerged as the preferred frame in Study 1, a finding also reported by Gomez-Luciano et al. (2019) in their four-country study. Furthermore, the health frame is often effective in motivating people to reduce or change their conventional meat consumption in accordance with both sustainability and health concerns (Lai, Tirotto, Pagliaro, & Fornara, 2020). Thus, we recommend erring on the side of caution and prioritizing the "health benefits to consumers" frame over others when communicating about cultivated meat to Singaporean consumers.

Our second key result showed that the relationship between age and concerns about the naturalness of cultivated meat was not significant (H2). Contrary to expectation, we found that increased concerns about naturalness associated with increased age was not inversely related to the acceptance towards cultivated meat. There was no clear pattern, as the interaction between age on the one hand, and attitudes toward/willingness to consume cultivated meat on the other, fluctuated across the different age ranges.

Our third key finding – i.e., "cultivated meat" was the most preferred term (H3a) – reiterates the same finding in an industry study conducted by the Good Food Institute (GFI, 2021). Moreover, respondents who preferred the term "cultivated meat" had significantly more positive attitudes toward cultivated meat compared to those who preferred the term "cultured meat" (H3b). The terms "lab-grown meat" and "clean meat" were associated with decreased willingness to consume cultivated meat. In addition, the term "lab-grown meat" was associated with less favorable attitudes, a finding echoed in previous studies conducted by Bryant and Barnett (2019) and Asioli et al. (2021). Hence, cultivated meat companies should consider avoiding the terms "lab-grown meat" and "clean meat" in their labelling. Together, our studies, being consistent with the findings from the GFI study, make a strong case for the term "cultivated meat" to be advanced as the industry standard. Having a single, universally accepted term to describe this novel food technology can not only help to foster greater consumer understanding and acceptance but also reduce confusion about this new food source.

Our fourth finding – i.e., aversion to tampering with nature was positively related to perceived benefits and willingness to eat cultivated meat (H4) – is novel in the literature. Just as Bryant et al. (2019) found that those who learnt about the unnaturalness of conventional meat showed a significant increase in some measures of cultivated meat acceptance compared to those who learnt about the naturalness of cultivated meat, our

survey items may have led respondents to consider some of the undesirable elements of conventional meat (versus the desirable elements of cultivated meat) and made them realize that conventional meat production has its downsides (Van der Weele & Driessen, 2019; Bryant et al., 2019). This finding has a practical implication for cultivated meat companies' marketing communication – they can consider highlighting not just the benefits of cultivated meat but also the undesirable elements of conventional meat in their messaging.

This research has a few limitations. Similar to other published research to date, our second study was based on hypothetical consumption situations and surveyed attitudes or intended behaviors. Our research lab is planning a study to examine consumers' actual consumption of cultivated meat to address this limitation in this field of research. Second, this study focused on only consumer acceptance of cultivated meat. Future studies could focus on other cell-based products such as cultivated milk and cultivated seafood, both of which are under development in various countries around the world (including Singapore). Last, our research did not assess taste as a potential message frame. Prior research highlights the importance of taste in consumer decision-making about food (Fotopoulos, Krystallis, Vassallo, & Pagiaslis, 2009; Januszewska, Pieniak, & Verbeke, 2011) and in predicting purchase intent (Mancini & Antonioli, 2019).

Future studies could investigate the effects of mainstream and social media coverage on consumer perception and acceptance of cultivated meat. The media often plays the role of introducing and explaining new science to consumers, and media reports have been found to influence public perception and consumer behavior related to novel food technologies (McCluskey, Kalaitzandonakes, & Swinnen, 2016). Another understudied research topic is the impact of social-context factors, such as a country's food dependency or self-sufficiency: an earlier study showed that national food self-sufficiency may affect stakeholder's perception and acceptance of genetically modified crops (Chong & Scheufele, 2002).

Conclusion

Based on both qualitative and quantitative methodologies, the current studies showed that the term "cultivated meat" is more preferred and has the potential to induce more positive reactions and higher receptivity towards this novel food source. In addition, when considering the demographic composition of prospective consumers, the present research offers some empirical support for cultivated meat companies to consider applying the "animal welfare/reduces animal slaughter" and "reduce carbon emissions and global warming" message frames when introducing cultivated meat products. This would be relevant if their market segments are likely to comprise consumers with a Buddhist religious orientation.

There was no consistent relationship between age and perceived naturalness of cultivated meat products in predicting individuals' willingness to consume such products. This suggests that the perception of (un)naturalness of cultivated meat is not age-specific. Rather, such a perception tends to be applicable to different age groups. In addition, participants' aversion to tampering with nature was found to be positively correlated with their perceived benefits of – and willingness to consume – cultivated meat. Cultivated meat companies can translate

this finding into their messaging and emphasize both the benefits of cultivated meat as well as the downsides of conventional meat. Together, the current findings point to some exciting research avenues that await more empirical investigations on the psychology of cultivated meat.

Ethical Statement

Ethical approval for the involvement of human subjects in this study was granted by Singapore Management University Institutional Review Board, reference numbers IRB-21-188-E063-M1(222), 24 February 2022 and IRB-21-188-E063-M3(622), 17 June 2022.

Data Availability

The data that support the findings of this study are available from the authors upon request.

Declaration of Interest

None.

Funding Source

The work was funded by the Singapore Ministry of Education AcRF Tier 2 grant (T2EP40121-0014) and funds from Singapore Management University's School of Social Sciences. The funding sources had no involvement in the study design; in the collection, analysis and interpretation of data; in the writing of the report; and in the decision to submit the article for publication.

Acknowledgments

The authors would like to acknowledge the assistance of Shanice Tan and Grace Ng who helped in transcribing and coding the qualitative interviews in Study 1.

References

Asioli, D., Bazzani, C., & Nayga, R.M. (2021). Are consumers willing to pay for in-vitro meat? An investigation of naming effects. *Journal of Agricultural Economics, 73*(2), 356-375. https://doi.org/10.1111/1477-9552.12467

Bedford, O., & Chua, S. H. (2018). Everything also I want: An exploratory study of Singaporean Kiasuism (fear of losing out). *Culture & Psychology*, *24*(4), 491–511. https://doi.org/10.1177/1354067X17693831

Begum, S. (2022, May 19). Warmer and drier days ahead as Singapore records highest temperature of 36.7 deg C for May. *The Straits Times*. Retrieved from https://www.straitstimes.com/singapore/environment/warmer-and-drier-days-ahead-as-singapore-records-its-highest-ever-temperature-for-may

Bell, R., & Paniesin, R. (1992). The influence of sauce, spice and name on the perceived ethnic origin of selected culture-specific foods. In L. S. Wu & A. D Gelinas (Eds.), *Product testing with consumers for research guidance: Special consumer groups*, *second volume* (pp. 22-36). American Society for Testing and Materials.

Bogueva, D., & Marinova, D. (2020). Cultivated meat and Australia's Generation Z. *Frontiers in Nutrition*, *7*, Article 148. https://doi.org/10.3389/fnut.2020.00148

Braun, C., Merk, C., Ponitzsch, G., Rehdanz, K., & Schmidt, U. (2018). Public perception of climate engineering and carbon capture and storage in Germany: Survey evidence. *Climate Policy*, *18*(4), 471-484. https://doi.org/10.1080/14693062.2017.1304888

Bryant, C., & Barnett, J. (2018). Consumer acceptance of cultivated meat: A systematic review. *Meat Science*, *143*, 8-17. https://doi.org/10.1016/j.meatsci.2018.04.008

Bryant, C., & Barnett, J. (2019). What's in a name? Consumer perceptions of in vitro meat under different names. *Appetite*, *137*, 104-113. https://doi.org/10.1016/j.appet.2019.02.021

Bryant, C., & Dillard, C. (2019). The impact of framing on acceptance of cultivated meat. *Frontiers in Nutrition*, *6*, Article 103. https://doi.org/10.3389/fnut.2019.00103

Bryant, C., Anderson, J. E., Asher, K. E., Green, C., & Gasteratos, K. (2019). Strategies for overcoming aversion to unnaturalness: The case of clean meat. *Meat Science*, *154*, 37-45. https://doi.org/10.1016/j.meatsci.2019.04.004

Bryant, C., & Barnett, J. (2020). Consumer acceptance of cultivated meat: An updated review (2018-2020). *Applied Sciences*, *10*(15), Article 5201. https://doi.org/10.3390/app10155201

Chew, H. M. (2022, Jun 10). Largest cultivated chicken meat facility in Asia breaks ground in Singapore. *ChannelNewsAsia*. Retrieved from https://www.channelnewsasia.com/singapore/cultivated-cultivated-lab-chicken-good-meat-josh-tetrick-singapore-2739016

Chong, M., & Scheufele, D. (2002). Rhetoric and reality: Public acceptance of Golden Rice in Thailand. *Journal of Development Communication*, *13*(1), 58-69.

Chong, M., Leung, A. K., & Lua, V. (2022). A cross-country investigation of social image motivation and acceptance of lab-grown meat in Singapore and the United States. *Appetite*, *173*, Article 105990. https://doi.org/10.1016/j.appet.2022.105990

Curtis, V., De Barra, M., & Aunger, R. (2011). Disgust as an adaptive system for disease avoidance behavior. *Philosophical Transactions of the Royal Society B: Biological Scien*ces, *366*(1563), 389-401. https://doi.org/10.1098/rstb.2010.0117

Datar, I., & Betti, M. (2010). Possibilities for an in vitro meat production system. *Innovative Food Science and Emerging Technologies, 11*(1), 13-22. https://doi.org/10.1016/j.ifset.2009.10.007

Dearing, J., & Rogers, E. (1988). Agenda-setting research: Where has it been, where is it going? *Communication Yearbook*, *11*, 555–594.

Dent, M. (2020, March 25). *The meat industry is unsustainable*. IDTEchEx. Retrieved from https://www.idtechex.com/en/research-article/the-meat-industry-is-unsustainable/20231. Accessed June 6, 2022.

Dragojlovic, N., & Einsiedel, E. (2013). Framing synthetic biology. *Science Communication*, *35*(5), 547-571. https://doi.org/10.1177/1075547012470707

Foodpanda. (2021, April 20). *Eat Just and Foodpanda partner on world's first home delivery of cultured meat.* Retrieved from https://www.foodpanda.com/2021/04/eat-just-and-foodpanda-partner-on-worlds-first-home-delivery-of-cultured-meat/

Fotopoulos. C., Krystallis, A., Vassallo, M., & Pagiaslis, A. (2009). Food Choice Questionnaire (FCQ) revisited. Suggestions for the development of an enhanced general food motivation model. *Appetite*, *52*(1), 199-208.https://doi.org/10.1016/j.appet.2008.09.014

Gomez-Luciano, C.A., de Aguiar, L.K., Vriesekoop, F., & Urbano, B. (2019). Consumers' willingness to purchase three alternatives to meat proteins in the United Kingdom, Spain, Brazil and the Dominican Republic. *Food Quality and Preference*, *78*, Article 103732. https://doi.org/10.1016/j.foodqual.2019.103732

https://doi.org/10.24818/EA/2019/51/393

Good Food Institute (2021, September 29). *Cultivated meat: A growing nomenclature consensus*. Retrieved from https://gfi.org/blog/cultivated-meat-a-growing-nomenclature-consensus/. Accessed August 18, 2022.

Guest, G., Bunce, A., & Johnson, L. (2006). How many interviews are enough? An experiment with data saturation and variability. *Field Methods, 18*(1), 59-82. https://doi.org/10.1177/1525822X05279903

Hallman, W. K., & Hallman II, W. K. (2020). An empirical assessment of common or usual names to label cell-based seafood products. *Journal of Food Science*, *85*(8), 2267-2277. https://doi.org/10.1111/1750-3841.15351

Henneman L., Timmermans, D. R., & Van Der Wal, G. (2006). Public attitudes toward genetic testing: Perceived benefits and objections. *Genetic Testing*, *10*(2), 139-145. https://doi.org/10.1089/gte.2006.10.139

Hoogendoorn, G., Sutterlin, B., & Siegrist, M. (2021). Tampering with nature: A systematic review. *Risk Analysis*, *41*(1), 141-156. https://doi.org/10.1111/risa.13619

IPCC. (2018). *Global warming of 1.5°C. An IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty*. https://www.ipcc.ch/site/assets/uploads/sites/2/2019/06/SR15_Full_Report_High_Res.pdf

Januszewska, R., Pieniak, Z., & Verbeke, W. (2011). Food choice questionnaire revisited in four countries. Does it still measure the same? *Appetite*, *57*(1), 94-98. https://doi.org/10.1016/j.appet.2011.03.014

Knight, A. (2007). Do worldviews matter? Post-materialist, environmental, and

scientific/technological worldviews and support for agricultural biotechnology applications. *Journal of Risk Research*, *10*(8), 1047-1063. https://doi.org/10.1080/13669870701603004

Kunst, J. R., & Hohle, S. M. (2016). Meat eaters by dissociation: How we present, prepare and talk about meat increases willingness to eat meat by reducing empathy and disgust. *Appetite*, *105*, 758–774. https://doi.org/10.1016/j.appet.2016.07.009

Laboutka, T. (2022, Jul 9). Commentary: How to make room for alternative proteins on Singapore menus. *ChannelNewsAsia*. Retrieved from https://www.channelnewsasia.com/commentary/malaysia-chicken-ban-lab-grown-plant-based-meat-alternative-proteins-2796401

Laestadius, L. I. (2015). Public perceptions of the ethics of in-vitro meat: Determining an appropriate course of action. *Journal of Agricultural and Environmental Ethics*, *28*(5), 991-1009. https://doi.org/10.1007/s10806-015-9573-8

Lai, A. E., Tirotto, F. A., Pagliaro, S., & Fornara, F. (2020). Two sides of the same coin: Environmental and health concern pathways toward meat consumption. *Frontiers in Psychology*, 11, Article 578582. https://doi.org/10.3389/fpsyg.2020.578582

Lofland, J., & Lofland, L. H. (1995). *Analyzing social settings: A guide to qualitative observation and analysis*. Wadsworth.

Lupton, D., & Turner, B. (2018). Food of the future? Consumer responses to the idea of 3D-printed meat and insect-based foods. *Food and Foodways*, *26*(4), 269-289. https://doi.org/10.1080/07409710.2018.1531213

Lymberry, P., & Oakeshott, I. (2014) *Farmageddon: The true cost of cheap meat.* Bloomsbury Publishing.

Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica*, *47*(2), 263-292. https://doi.org/10.2307/1914185

Kantor, B. N., & Kantor, J. (2021). Public attitudes and willingness to pay for cultivated meat: A cross-sectional experimental study. *Frontiers in Sustainable Food Systems*, *5*, Article 594650. https://doi.org/10.3389/fsufs.2021.594650

Mancini, M. C., & Antonioli, F. (2019). Exploring consumers' attitude towards cultivated meat in Italy. *Meat Science*, *150*, 101-110. https://doi.org/10.1016/j.meatsci.2018.12.014

Mathew, A. G., Cissell, R., & Liamthong, S. (2007). Antibiotic resistance in bacteria associated with food animals: A United States perspective of livestock production. *Foodborne Pathogens and Disease*, *4*(2), 115-133. https://doi.org/10.1089/fpd.2006.0066

McCluskey, J. J., Kalaitzandonakes, N., & Swinnen, J. (2016). Media coverage, public perceptions, and consumer behavior: Insights from new food technologies. *Annual Review of Resource Economics*, *8*, 467–486. https://doi.org/10.1146/annurev-resource-100913-012630

Meiselman, H. L., & Bell, R. (1991). The effects of name and recipe on the perceived ethnicity and acceptability of selected Italian foods by British subjects. *Food Quality and Preference*, *3*(4), 209-214. https://doi.org/10.1016/0950-3293(91)90035-D

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook*. Sage Publishing.

OECD & FAO. (2018). *OECD/FAO Agricultural Outlook 2018-2027*. https://stats.oecd.org/Index.aspx?DataSetCode=HIGH_AGLINK_2018

Office of International Religious Freedom (U.S. Department of State) (2020). *2020 report on international religious freedom: Singapore*. Retrieved from https://www.state.gov/reports/2020-report-on-international-religious-freedom/singapore/

Oliver, S., Murinda, S. E., & Jayarao, B. M. (2011). Impact of antibiotic use in adult dairy cows on antimicrobial resistance of veterinary and human pathogens: A comprehensive review. *Foodborne Pathogens and Disease*, *8*(3), 337-355. https://doi.org/10.1089/fpd.2010.0730

Onwezen, M., Bouwman, E., Reinders, M., & Davegos, H. (2021). A systematic review on consumer acceptance of alternative proteins: Pulses, algae, insects, plant-based meat alternatives, and cultivated meat. *Appetite*, *159*, Article 105058. https://doi.org/10.1016/j.appet.2020.105058

Palmieri, N., Perito, M.A., & Lupi, C. (2020). Consumer acceptance of cultivated meat: Some hints from Italy. *British Food Journal*, *123*(1), 109-123. https://doi.org/10.1108/BFJ-02-2020-0092

Pakseresht, A., Ahmadi Kaliji, S., & Canavari, M. (2022). Review of factors affecting consumer acceptance of cultured meat. *Appetite*, *170*, 105829. https://doi.org/10.1016/j.appet.2021.105829

Phua, R. (2020, December 21). Lab-grown chicken dishes to sell for S$23 at private members' club 1880 next month. ChannelNewsAsia. Retrieved from https://www.channelnewsasia.com/singapore/lab-grown-chicken-nuggets-1880-eat-just-price-customers-495251

Piqueras-Fiszman, B., & Spence, C. (2015). Sensory expectations based on product-extrinsic food cues: An interdisciplinary review of the empirical evidence and theoretical accounts. *Food Quality and Preference*, *40*, 165-179. https://doi.org/10.1016/j.foodqual.2014.09.013

Post, M. J., Levenberg, S., Kaplan, D., Genovese, N., Fu, J., Bryant, C. J., Negowetti, N., Verzijden, K., & Moutsatsou, P. (2020). Scientific, sustainability and regulatory challenges of cultivated meat. *Nature Food*, *1*(7), 403-415. https://doi.org/10.1038/s43016-020-0112-z

Qualtrics. (2022). *Randomizer.* https://www.qualtrics.com/support/survey-platform/survey-module/survey-flow/standard-elements/randomizer/. Accessed August 18, 2022.

Raimi, K.T., Wolske, K. S., Hart, P. S., & Campbell-Arvai, V. (2020). The Aversion to Tampering with Nature Scale: Individual differences in "discomfort" with altering the natural world. *Risk Analys*is, *40*(3*)*, 638-656. https://doi.org/10.1111/risa.13414

Rolland, N. C. M., Markus, C. R., & Post, M. J. (2020). The effect of information content on acceptance of cultivated meat in a tasting context. *PLoS ONE*, *15*(4), Article e0231176. https://doi.org/10.1371/journal.pone.0231176

Roman, S., Sanchez-Siles, L. M., & Siegrist, M. (2017). The importance of food naturalness for consumers: Results of a systematic review. *Trends in Food Science and Technology*, *67*, 44-57. https://doi.org/10.1016/j.tifs.2017.06.010

Rosenfeld, D. L., & Tomiyama, A. J. (2022). Would you eat a burger made in a petri dish? Why people feel disgusted by cultivated meat. *Journal of Environmental Psychology*, *80*, Article 101758. https://doi.org/10.1016/j.jenvp.2022.101758

Rothman, A. J., & Salovey, P. (1997). Shaping perceptions to motivate healthy behavior: The role of message framing. *Psychological Bulletin*, *121*(1), 3-19. https://doi.org/10.1037/0033-2909.121.1.3

Rozin, P., Spranca, M., Krieger, Z., Neuhaus, R., Surillo, D., Swerdlin, A., & Wood, K. (2004). Preference for natural: Instrumental and ideational/moral motivations, and the contrast between foods and medicines. *Appetite*, *43*(2), 147-154. https://doi.org/10.1016/j.appet.2004.03.005

Rozin, P. (2005). The meaning of "natural": Process more important than content. *Psychological Science*, *16*(8), 652-658. https://doi.org/10.1111/j.1467-9280.2005.01589.x

Rozin, P. (2006). Naturalness judgments by lay Americans: Process dominates content in judgments of food or water acceptability and naturalness. *Judgment and Decision Making*, *1*(2), 91-97.

Shaw, E., & Iomaire, M.M.C. (2019). A comparative analysis of the attitudes of rural and urban consumers towards cultivated meat. *British Food Journal*, *121*(8), 1782-1800. https://doi.org/10.1108/BFJ-07-2018-0433

Siegrist, M., & Sutterlin, B. (2017). Importance of perceived naturalness for acceptance of food additives and cultivated meat. *Appetite*, *113*, 320-326. https://doi.org/10.1016/j.appet.2017.03.019

Siegrist, M., Sutterlin, B., & Hartmann, C. (2018). Perceived naturalness and evoked disgust influence acceptance of cultivated meat. *Meat Science*, *139*, 213-219. https://doi.org/10.1016/j.meatsci.2018.02.007

Siegrist, M., & Hartmann, C. (2020). Consumer acceptance of novel food technologies. *Nature Food*, *1*(6), 343-350. https://doi.org/10.1038/s43016-020-0094-x

Singapore Department of Statistics. (2021). *Census of Population 2020 Statistical Release 1- Key findings.* https://www.singstat.gov.sg/-/media/files/publications/cop2020/sr1/findings.pdf

Sjoberg, L. (2000). Perceived risk and tampering with nature. *Journal of Risk Research*, *3*(4), 353-367. https://doi.org/10.1080/13669870050132568

Sommers, S. (2012, July 13). *What's in a name? What your name says about you (and how it says it)*. Psychology Today. Retrieved from https://www.psychologytoday.com/sg/blog/science-small-talk/201207/whats-in-name. Accessed July 25, 2022.

Tan, A. (2020, Dec 5). Cultivated meat: No-kill products may be food for the future. *The Straits Times*. Retrieved from https://www.straitstimes.com/singapore/environment/debrief-cultivated-meat-may-be-food-for-the-future

Teng, P. (2020). Assuring food security in Singapore, a small island state facing Covid-19. *Food Security, 12*(4), 801-804. https://doi.org/10.1007/s12571-020-01077-0

Tomiyama, A. J., Kawecki, N. S., Rosenfeld, D. L., Jay, J. A., Rajagopal, D., & Rowat, A. C. (2020). Bridging the gap between the science of cultivated meat and public perceptions. *Trends in Food Science and Technology*, *104*, 144-152. https://doi.org/10.1016/j.tifs.2020.07.019

Tuorila, H., & Hartmann, C. (2020). Consumer responses to novel and unfamiliar foods. *Current Opinion in Food Science*, *33*, 1-8. https://doi.org/10.1016/j.cofs.2019.09.004

Tucker, C.A. (2014). The significance of sensory appeal for reduced meat consumption. *Appetite*, *81*, 168-179. https://doi.org/10.1016/j.appet.2014.06.022

Vandermoere, F., Blanchemanche, S., Bieberstein, A., Marette, S., & Roosen, J. (2010). The

morality of attitudes toward nanotechnology: About God, techno-scientific progress, and interfering with nature. *Journal of Nanoparticle Research*, *12*(2), 373-381. https://doi.org/10.1007/s11051-009-9809-5

Van Der Weele, C., & Driessen, C. (2019). How normal meat becomes stranger as cultivated meat becomes more normal: Ambivalence and ambiguity below the surface of behavior. *Frontiers in Sustainable Food Systems*, *3*, Article 69. https://doi.org/10.3389/fsufs.2019.00069

Verbeke, W., Sans, P., & Van Loo, E. J. (2015). Challenges and prospects for consumer acceptance of cultivated meat. *Journal of Integrative Agriculture*, *14*(2), 285-294. https://doi.org/10.1016/S2095-3119(14)60884-4

Wilks, M., & Phillips, C. J. C. (2017). Attitudes to *in vitro* meat: A survey of potential consumers in the United States. *PLoS ONE*, *12*(2), Article e0171904. https://doi.org/10.1371/journal.pone.0171904

Wilks, M., Phillips, C. J. C., Fielding, K., & Hornsey, M. J. (2019). Testing potential psychological predictors of attitudes towards cultivated meat. *Appetite*, *136*, 137-145. https://doi.org/10.1016/j.appet.2019.01.027

Wilks, M., Hornsey, M., & Bloom, P. (2021). What does it mean to say that cultivated meat is unnatural? *Appetite*, *156*, Article 104960. https://doi.org/10.1016/j.appet.2020.104960

Wolske, K. S., Raimi, K. T., Campbell-Arvai, V., & Hart, P. S. (2019). Public support for carbon dioxide removal strategies: The role of tampering with nature perceptions. *Climatic Change*, *152*(3), 345-361. https://doi.org/10.1007/s10584-019-02375-z

Table 1
Participant characteristics of CM+ and CM- eaters (Study 1).

	CM+ eaters *n*=10 *n* (%)	CM- eaters *n*=10 *n* (%)
Gender		
Male	6 (60%)	4 (40%)
Female	4 (40%)	6 (60%)
Ethnicity		
Chinese	8 (80%)	6 (60%)
Non-Chinese (Malay, Indian, Others)	2 (20%)	4 (40%)
Age group		
18-29	1 (10%)	1 (10%)
30-39	4 (40%)	4 (40%)
40-49	4 (40%)	3 (30%)
50-59	1 (10%)	2 (20%)
Monthly household income		
SGD $4,000 to SGD $4,999	0 (0%)	1 (10%)
SGD $5,000 to SGD $5,999	0 (0%)	0 (0%)
SGD $6,000 to SGD $6,999	0 (0%)	1 (10%)
SGD $7,000 to SGD $7,999	1 (10%)	1 (10%)
SGD $8,000 to SGD $8,999	3 (30%)	0 (0%)
SGD $9,000 to SGD $9,999	1 (10%)	1 (10%)
SGD $10,000 and above	5 (50%)	6 (60%)

Table 2
Participant characteristics (Study 2).

	Total Sample Size *N*=948 *n* (%)
Gender	
Male (Includes 'prefer not to say')	496 (52.3%)
Female	452 (47.7%)
Ethnicity	
Chinese	711 (75.0%)
Non-Chinese (Malay, Indian, Others)	237 (25.0%)
Age group	
18-29	307 (32.4%)
30-39	281 (29.6%)
40-49	225 (23.7%)
50-59	106 (11.2%)
60-69	29 (3.1%)
Religion	
Abrahamic (Christian, Islam, Jewish)	373 (39.3%)
Dharmic (Buddhist, Hindu)	358 (37.8%)
None, Agnostic, Atheist, Taoist, Others	217 (22.9%)
Educational level	
Vocational cert (Diploma, NITEC, ITE, associate degree, professional cert)	175 (18.5%)
Academic degree (Bachelors, Masters, Doctorate)	590 (62.2%)
No tertiary (Secondary school, PSLE, A levels, undergraduate, others)	183 (19.3%)
Annual household income	
SGD15,000 or less	91 (9.6%)
SGD15,001 - SGD25,000	63 (6.6%)
SGD25,001 - SGD35,000	64 (6.8%)
SGD35,001 - SGD50,000	104 (11.0%)
SGD50,001 - SGD75,000	164 (17.3%)
SGD75,001 - SGD100,000	172 (18.1%)
SGD100,001 - SGD150,000	191 (20.1%)
More than SGD150,000	99 (10.4%)

Table 3

Perceptions of cultivated meat and aversion to tampering with nature scores across conditions.

	Frame A *n*=193 *M* (*SD*)	Frame B *n*=197 *M* (*SD*)	Frame C *n*=175 *M* (*SD*)	Frame D *n*=190 *M* (*SD*)	Frame E *n*=193 *M* (*SD*)	Total *N*=948 *M* (*SD*)	*F*
Attitude towards cultivated meat	4.53 (1.44)	4.50 (1.56)	4.50 (1.47)	4.42 (1.41)	4.42 (1.43)	4.47 (1.46)	0.26
Perception of benefits of cultivated meat							
Composite score (Mean)	4.92 (1.19)	4.87 (1.18)	4.92 (0.99)	4.85 (1.14)	4.83 (1.15)	4.88 (1.13)	0.26
Healthy	4.72 (1.38)	4.60 (1.36)	4.63 (1.21)	4.61 (1.32)	4.55 (1.34)	4.62 (1.32)	0.40
Safe for human beings	4.87 (1.40)	4.77 (1.43)	4.83 (1.24)	4.79 (1.37)	4.78 (1.30)	4.81 (1.35)	0.19
Environmentally friendly	5.21 (1.38)	5.15 (1.38)	5.32 (1.20)	5.23 (1.34)	5.12 (1.38)	5.20 (1.34)	0.59
Same sensory quality as real meat	4.55 (1.50)	4.46 (1.42)	4.27 (1.43)	4.32 (1.48)	4.36 (1.46)	4.39 (1.46)	1.18
Benefits for society	5.04 (1.35)	5.02 (1.35)	5.03 (1.30)	4.92 (1.26)	5.00 (1.32)	5.00 (1.31)	0.25
Animal friendly	5.12 (1.42)	5.25 (1.38)	5.47 (1.23)	5.21 (1.39)	5.17 (1.37)	5.24 (1.36)	1.76
Concerns about cultivated meat							
Composite score (Mean)	5.27 (1.06)	5.30 (1.13)	5.13 (1.15)	5.22 (1.12)	5.07 (1.25)	5.20 (1.14)	1.40
Cost	5.22 (1.36)	5.36 (1.30)	5.16 (1.24)	5.27 (1.28)	5.02 (1.49)	5.21 (1.34)	1.70
Taste	5.25 (1.33)	5.23 (1.33)	5.06 (1.46)	5.16 (1.41)	5.10 (1.43)	5.16 (1.39)	0.61
Naturalness	5.26 (1.43)	5.20 (1.43)	5.01 (1.40)	5.13 (1.43)	5.01 (1.54)	5.12 (1.45)	1.11
Safety	5.44 (1.53)	5.59 (1.53)	5.42 (1.54)	5.34 (1.57)	5.21 (1.61)	5.40 (1.56)	1.61
Nutritional value	5.21 (1.36)	5.13 (1.43)	4.98 (1.43)	5.23 (1.39)	5.02 (1.57)	5.11 (1.44)	1.10
Willingness to consume cultivated meat							
Composite score (Mean)	4.39 (1.41)	4.37 (1.42)	4.25 (1.29)	4.27 (1.39)	4.32 (1.32)	4.32 (1.37)	0.33
Eat cultivated meat	4.70 (1.49)	4.74 (1.55)	4.58 (1.44)	4.62 (1.51)	4.73 (1.37)	4.68 (1.47)	0.42
Buy cultivated meat regularly	4.19 (1.58)	4.19 (1.55)	3.99 (1.46)	4.02 (1.53)	4.06 (1.51)	4.09 (1.53)	0.75
Eat cultivated meat as a replacement for conventionally produced meat	4.15 (1.61)	4.08 (1.63)	4.04 (1.50)	4.09 (1.62)	4.13 (1.56)	4.10 (1.58)	0.13
Eat cultivated meat as a supplement to conventionally produced meat	4.44 (1.55)	4.34 (1.55)	4.33 (1.45)	4.29 (1.59)	4.30 (1.47)	4.34 (1.52)	0.26

Eat cultivated meat instead of plant-based meat substitutes	4.47 (1.59)	4.48 (1.59)	4.33 (1.50)	4.34 (1.51)	4.38 (1.53)	4.40 (1.55)	0.40
Aversion to tampering with nature							
Composite score (Mean)	4.83 (1.09)	4.89 (1.08)	4.85 (0.99)	4.80 (1.04)	4.82 (1.04)	4.84 (1.05)	0.19

Note. Item 2 was removed for aversion to tampering with nature scale due to negative loading. All ANOVAs with framing condition as the independent variable were not significant. *$p < .05$; **$p < .01$; ***$p < .001$.

Table 4

Hierarchical multiple regression predicting willingness to consume cultivated meat with religion coded as Abrahamic/Dharmic/other.

	B (*SE*)	*p*	*B* (*SE*)	*p*	*B* (*SE*)	*p*	*B*(*SE*)	*p*	*B* (*SE*)	*p*
Step 1: Individual characteristics										
Age	-0.01 (0.00)*	.014	-0.01 (0.00)*	.015	0.00 (0.01)	.967	-0.01 (0.00)*	.014	-0.01 (0.00)*	.018
Gender (ref = male/not say)	-0.24 (0.09)**	.006	-0.24 (0.09)**	.006	-0.24 (0.09)**	.006	-0.30 (0.20)	.130	-0.25 (0.09)**	.006
Income	0.03 (0.02)	.271	0.02 (0.02)	.304	0.03 (0.02)	.287	0.03 (0.02)	.285	0.02 (0.02)	.378
Ethnicity (ref = non-Chinese)	-0.19 (0.11)	.086	-0.19 (0.11)	.093	-0.19 (0.11)	.097	-0.19 (0.11)	.095	-0.17 (0.11)	.133
Education (ref = no tertiary)										
Vocational cert	0.21 (0.14)	.140	0.20 (0.14)	.161	0.20 (0.14)	.171	0.21 (0.14)	.154	0.21 (0.14)	.142
Academic degree	0.54 (0.12)***	<.001	0.53 (0.12)***	<.001	0.53 (0.12)***	<.001	0.53 (0.12)***	<.001	0.53 (0.12)***	<.001
Religion (ref = none/agnostic etc.)										
Abrahamic	0.01 (0.12)	.923	0.02 (0.12)	.901	0.01 (0.12)	.931	0.02 (0.12)	.906	0.25 (0.25)	.323
Dharmic	-0.16 (0.12)	.181	-0.15 (0.12)	.187	-0.16 (0.12)	.175	-0.15 (0.12)	.193	-0.40 (0.26)	.125
Step 2: Experimental condition (ref = ensure stable supply)										
A: Safety (no undesirable elements)			0.08 (0.14)	.563	0.07 (0.14)	.628	0.01 (0.19)	.966	0.09 (0.28)	.743
B: Enhanced nutritional value			0.05 (0.14)	.726	0.03 (0.14)	.836	0.02 (0.19)	.912	-0.05 (0.27)	.869
C: Reduces animal slaughter			0.00 (0.14)	.985	-0.02 (0.14)	.907	0.05 (0.20)	.796	0.28 (0.29)	.325
D: Reduces carbon emissions			-0.02 (0.14)	.875	-0.04 (0.14)	.790	-0.10 (0.19)	.623	-0.11 (0.30)	.704
Step 3: Interaction terms										
Age*Frame A					-0.01 (0.01)	.253				
Age*Frame B					-0.02 (0.01)	.163				
Age*Frame C					-0.01 (0.01)	.509				
Age*Frame D					-0.01 (0.01)	.368				
Gender*Frame A							0.14 (0.27)	.601		
Gender*Frame B							0.05 (0.27)	.843		
Gender*Frame C							-0.10 (0.28)	.720		
Gender*Frame D							0.15 (0.28)	.584		
Abrahamic*Frame A									-0.09 (0.36)	.805
Abrahamic*Frame B									-0.14 (0.34)	.690

Abrahamic*Frame C					-0.76 (0.36)*	.037
Abrahamic*Frame D					-0.21 (0.37)	.562
Dharmic*Frame A					0.14 (0.36)	.704
Dharmic*Frame B					0.46 (0.36)	.203
Dharmic*Frame C					0.08 (0.37)	.835
Dharmic*Frame D					0.50 (0.38)	.184
Adjusted R^2	0.040	0.037	0.035	0.034	0.042	
N	948	948	948	948	948	
F	5.988***	4.037***	3.166***	3.088***	3.053***	

*$p < .05$; **$p < .01$; ***$p < .001$.

Table 5

Multiple regression model predicting attitude towards and willingness to eat cultivated meat, with interactions between age group and naturalness concerns.

	B (*SE*)	*p*	*B* (*SE*)	*p*	*B* (*SE*)	*p*	*B* (*SE*)	*p*
	Attitude towards cultivated meat				Willingness to eat cultivated meat			
Step 1: Individual characteristics								
Age group (ref=18-29)								
30-39	0.01 (0.12)	.962	-0.01 (0.12)	.952	0.12 (0.12)	.289	0.11 (0.11)	.328
40-49	-0.25 (0.13)	.054	-0.26 (0.13)*	.046	0.02 (0.12)	.849	0.01 (0.12)	.953
50-59	-0.66 (0.16)***	<.001	-0.66 (0.16)***	<.001	-0.31 (0.15)*	.043	-0.31 (0.15)*	.043
60-69	-1.07 (0.28)***	<.001	-1.02 (0.28)***	<.001	-0.50 (0.26)	.058	-0.41 (0.27)	.129
Gender (ref = male/prefer not to say)	-0.28 (0.09)**	.003	-0.27 (0.09)**	.004	-0.21 (0.09)*	.020	-0.19 (0.09)*	.029
Income	0.05 (0.03)	.055	0.05 (0.03)*	.029	0.03 (0.02)	.278	0.03 (0.02)	.188
Ethnicity (ref = non-Chinese)	-0.18 (0.12)	.133	-0.22 (0.12)	.060	-0.12 (0.11)	.298	-0.16 (0.11)	.143
Education (ref = no tertiary)								
Vocational cert (e.g., diploma, NITEC)	0.05 (0.15)	.732	0.08 (0.15)	.616	0.16 (0.14)	.271	0.19 (0.14)	.185
Academic degree (Bachelor's & up)	0.42 (0.13)**	.002	0.45 (0.13)***	<.001	0.47 (0.13)***	<.001	0.50 (0.13)***	<.001
Religion (ref = none, agnostic, atheist)								
Abrahamic (e.g., Christian, Islam)	0.09 (0.13)	.496	0.09 (0.13)	.482	0.02 (0.12)	.871	0.01 (0.12)	.918
Dharmic (e.g., Buddhist, Hindu)	-0.08 (0.12)	.521	-0.05 (0.12)	.691	-0.15 (0.12)	.209	-0.12 (0.12)	.311
Naturalness concern	-0.11 (0.03)***	<.001	-0.19 (0.06)***	<.001	-0.10 (0.03)**	.002	-0.16 (0.05)**	.003
Experimental condition (ref = ensure stable supply)								
A: Safety (no undesirable elements)	0.14 (0.15)	.319	0.16 (0.14)	.275	0.08 (0.14)	.554	0.09 (0.14)	.489
B: Enhanced nutritional value	0.12 (0.14)	.391	0.18 (0.14)	.213	0.07 (0.14)	.611	0.12 (0.14)	.364
C: Reduces animal slaughter	0.17 (0.15)	.243	0.21 (0.15)	.161	-0.01 (0.14)	.930	0.01 (0.14)	.923
D: Reduces carbon emissions	0.04 (0.14)	.791	0.03 (0.14)	.849	-0.01 (0.14)	.922	-0.03 (0.14)	.828
Step 2: Interaction terms								
Age group30-39*Naturalness concerns			0.24 (0.08)**	.003			0.18 (0.08)*	.020

Age group40-49*Naturalness concerns		0.12 (0.09)	.164	0.16 (0.08) .054
Age group50-59*Naturalness concerns		-0.26 (0.11)*	.018	-0.31 (0.10)** .002
Age group60-69*Naturalness concerns		0.20 (0.18)	.283	0.29 (0.17) .095
Adjusted R^2	.073	.091	.047	.071
N	948	948	948	948
F	5.627***	5.730***	3.926***	4.595***

*$p < .05$; **$p < .01$; ***$p < .001$.

Table 6

Multiple regression model predicting attitude towards and willingness to eat cultivated meat, accounting for preferred nomenclature.

	B (*SE*)	*p*	*B* (*SE*)	*p*
	Attitude towards cultivated meat		Willingness to eat cultivated meat	
Individual characteristics				
Age	-0.02 (0.00)***	<.001	-0.01 (0.00)*	.014
Gender (ref = male/not say)	-0.31 (0.09)***	<.001	-0.23 (0.09)**	.008
Income	0.03 (0.03)	.166	0.01 (0.02)	.644
Ethnicity (ref = non-Chinese)	-0.22 (0.12)	.055	-0.16 (0.11)	.145
Education (ref = no tertiary)				
Vocational cert	0.06 (0.15)	.700	0.15 (0.14)	.296
Academic degree	0.43 (0.13)***	<.001	0.44 (0.12)***	<.001
Religion (ref = none, agnostic, atheist)				
Abrahamic	0.06 (0.13)	.652	-0.01 (0.12)	.923
Dharmic	-0.12 (0.12)	.344	-0.19 (0.11)	.085
Experimental condition (ref = ensure stable supply)				
A: Safety (no undesirable elements)	0.13 (0.14)	.358	0.07 (0.13)	.610
B: Enhanced nutritional value	0.10 (0.14)	.491	0.06 (0.13)	.654
C: Reduces animal slaughter	0.20 (0.15)	.184	0.02 (0.14)	.896
D: Reduces carbon emissions	0.01 (0.14)	.943	-0.04 (0.13)	.769
Nomenclature (ref=Cultured meat)				
Cultivated meat	0.36 (0.14)*	.011	0.22 (0.13)	.094
Lab-grown meat	-0.38 (0.16)*	.017	-0.71 (0.15)***	<.001
Animal-free meat	-0.04 (0.16)	.813	-0.17 (0.15)	.268
Cell-based meat	-0.00 (0.21)	.984	-0.02 (0.20)	.922
Clean meat	-0.23 (0.17)	.179	-0.57 (0.16)***	<.001
Adjusted R^2	.094		.099	
N	948		948	
F	6.773***		7.142***	

*p < .05; **p < .01; ***p < .001.

Table 7

Multiple regression model predicting willingness to consume and perceived benefits of cultivated meat, accounting for concerns about naturalness and aversion to tampering with nature.

	B (*SE*)	*p*	*B* (*SE*)	*p*
	Willigness to consume cultivated meat		Perceived benefits of cultivated meat	
Individual characteristics				
Age	-0.01 (0.00)*	.018	-0.01 (0.00)	.051
Gender (ref = male/not say)	-0.20 (0.09)*	.023	-0.11 (0.07)	.136
Income	0.03 (0.02)	.289	0.04 (0.02)*	.045
Ethnicity (ref = non-Chinese)	-0.11 (0.11)	.314	-0.04 (0.09)	.664
Education (ref = no tertiary)				
Vocational cert	0.13 (0.14)	.375	-0.11 (0.12)	.349
Academic degree	0.52 (0.12)***	<.001	0.18 (0.10)	.072
Religion (ref = none, Atheist, Agnostic)				
Abrahamic	0.02 (0.12)	.854	0.05 (0.10)	.654
Dharmic	-0.13 (0.11)	.261	-0.04 (0.10)	.720
Experimental condition (ref = ensure stable supply)				
A: Safety (no undesirable elements)	0.11 (0.14)	.436	0.11 (0.11)	.348
B: Enhanced nutritional value	0.05 (0.13)	.689	0.05 (0.11)	.659
C: Reduces animal slaughter	-0.01 (0.14)	.938	0.11 (0.12)	.327
D: Reduces carbon emissions	-0.01 (0.14)	.950	0.03 (0.11)	.768
Belief				
Aversion to tampering with nature	0.24 (0.04)***	<.001	0.18 (0.04)***	<.001
Naturalness concern	-0.11 (0.03)***	<.001	-0.08 (0.03)**	.002
Adjusted R^2	.076		.045	
N	948		948	
F	6.532***		4.192***	

*$p < .05$; **$p < .01$; ***$p < .001$.

Appendix A.

Participant characteristics across conditions (Study 2).

	Frame A *n*=193 *n* (%)	Frame B *n*=197 *n* (%)	Frame C *n*=175 *n* (%)	Frame D *n*=190 *n* (%)	Frame E *n*=193 *n* (%)	Total Sample Size *N*=948 *n* (%)
Gender						
Male (Includes 'prefer not to say')	98 (50.8%)	111 (56.3%)	90 (51.4%)	99 (52.1%)	98 (50.8%)	496 (52.3%)
Female	95 (49.2%)	86 (43.7%)	85 (48.6%)	91 (47.9%)	95 (49.2%)	452 (47.7%)
Ethnicity						
Chinese	137 (71.0%)	158 (80.2%)	135 (77.1%)	141 (74.2%)	140 (72.5%)	711 (75.0%)
Non-Chinese (Malay, Indian, Others)	56 (29.0%)	39 (19.8%)	40 (22.9%)	49 (25.8%)	53 (27.5%)	237 (25.0%)
Age group						
18-29	55 (28.5%)	73 (37.1%)	45 (25.7%)	61 (32.1%)	73 (37.8%)	307 (32.4%)
30-39	58 (30.1%)	51 (25.9%)	55 (31.4%)	59 (31.1%)	58 (30.1%)	281 (29.6%)
40-49	58 (30.1%)	46 (23.4%)	43 (24.6%)	39 (20.5%)	39 (20.2%)	225 (23.7%)
50-59	18 (9.3%)	19 (9.6%)	21 (12.0%)	29 (15.3%)	19 (9.8%)	106 (11.2%)
60-69	4 (2.1%)	8 (4.1%)	11 (6.3%)	2 (1.1%)	4 (2.1%)	29 (3.1%)
Religion						
Abrahamic (Christian, Islam, Jewish)	71 (36.8%)	78 (39.6%)	64 (36.6%)	77 (40.5%)	83 (43.0%)	373 (39.3%)
Dharmic (Buddhist, Hindu)	79 (40.9%)	69 (35.0%)	70 (40.0%)	78 (41.1%)	62 (32.1%)	358 (37.8%)
None, Agnostic, Atheist, Taoist, Others	43 (22.3%)	50 (25.4%)	41 (23.4%)	35 (18.4%)	48 (24.9%)	217 (22.9%)
Educational level						
Vocational cert (Diploma, NITEC, ITE, associate degree, professional cert)	38 (19.7%)	46 (23.4%)	31 (17.7%)	26 (13.7%)	34 (17.6%)	175 (18.5%)
Academic degree (Bachelors, Masters, Doctorate)	123 (63.7%)	121 (61.4%)	103 (58.9%)	122 (64.2%)	121 (62.7%)	590 (62.2%)
No tertiary (Secondary school, PSLE, A levels, undergraduate, others)	32 (16.6%)	30 (15.2%)	41 (23.4%)	42 (22.1%)	38 (19.7%)	183 (19.3%)

Annual household income						
SGD15,000 or less	13 (6.7%)	18 (9.1%)	14 (8.0%)	19 (10.0%)	27 (14.0%)	91 (9.6%)
SGD15,001 - SGD25,000	11 (5.7%)	11 (5.6%)	10 (5.7%)	19 (10.0%)	12 (6.2%)	63 (6.6%)
SGD25,001 - SGD35,000	12 (6.2%)	12 (6.1%)	13 (7.4%)	13 (6.8%)	14 (7.3%)	64 (6.8%)
SGD35,001 - SGD50,000	22 (11.4%)	23 (11.7%)	19 (10.9%)	19 (10.0%)	21 (10.9%)	104 (11.0%)
SGD50,001 - SGD75,000	33 (17.1%)	34 (17.3%)	34 (19.4%)	35 (18.4%)	28 (14.5%)	164 (17.3%)
SGD75,001 - SGD100,000	35 (18.1%)	38 (19.3%)	30 (17.1%)	31 (16.3%)	38 (19.7%)	172 (18.1%)
SGD100,001 - SGD150,000	42 (21.8%)	38 (19.3%)	37 (21.1%)	40 (21.1%)	34 (17.6%)	191 (20.1%)
More than SGD150,000	25 (13.0%)	23 (11.7%)	18 (10.3%)	14 (7.4%)	19 (9.8%)	99 (10.4%)

Appendix B.

Spearman bivariate correlations of all variables used in the study (*N* = 948).

	α	1	2	3	4	5	6	7	8	9	10
1. Age		-									
2. Gender (Female)		-0.04	-								
3. Income		0.19***	-0.05	-							
4. Ethnicity (Chinese)		0.03	-0.05	0.20***	-						
5. Religion: Abrahamic		0.08*	0.13***	-0.03	-0.35***	-					
6. Religion: Dharmic		-0.01	-0.08*	-0.03	0.15***	-0.63***	-				
7. Religion (Buddhist)		0.01	-0.09**	0.01	0.39***	-0.55***	0.87***	-			
8. Education: Vocational		-0.11**	0.04	-0.23***	-0.10**	0.04	0.01	0.01	-		
9. Education: Academic		0.10**	-0.08*	0.42***	0.17***	-0.09**	0.05	0.05	-0.61***	-	
10. Aversion to tampering	0.79	-0.01	-0.01	0.07*	-0.09**	0.06*	-0.04	-0.07*	0.07*	0.01	-
11. Concerns	0.86	0.05	0.09**	0.15***	0.07*	0.00	0.01	0.04	-0.06	0.10**	0.19***
12. Naturalness concern		0.06	0.10**	0.16***	0.06	0.02	0.01	0.03	-0.07*	0.11***	0.18***
13. Perceived benefits	0.91	-0.03	-0.10**	0.12***	-0.01	0.03	-0.04	-0.02	-0.07*	0.12***	0.20***
14. Willingness to eat	0.94	-0.03	-0.13***	0.11***	-0.03	0.02	-0.05	-0.05	-0.06	0.16***	0.21***
15. Attitude		-0.13***	-0.14***	0.11***	-0.04	0.03	-0.05	-0.06*	-0.07*	0.17***	0.18***
16. Nomenclature: Cultivated meat		0.00	-0.02	0.12***	-0.04	0.06	-0.01	-0.00	-0.02	0.10**	0.09**
17. Nomenclature: Lab-grown meat		-0.01	-0.05	-0.03	0.04	0.02	-0.04	-0.05	0.05	-0.08*	0.02
18. Nomenclature: Animal-free meat		-0.01	-0.00	-0.02	0.01	-0.09**	0.06	0.07*	-0.01	-0.01	-0.01
19. Nomenclature: Cell-based meat		0.02	0.02	-0.04	0.01	-0.04	0.01	-0.01	0.03	-0.01	-0.02
20. Nomenclature: Clean meat		-0.02	0.11***	-0.09**	-0.06	0.04	-0.02	-0.04	-0.02	-0.05	-0.08*

	α	11	12	13	14	15	16	17	18	19	20
1. Age		-									

2. Gender (Female)		-									
3. Income		-									
4. Ethnicity (Chinese)		-									
5. Religion: Abrahamic		-									
6. Religion: Dharmic		-									
7. Religion (Buddhist)		-									
8. Education: Vocational		-									
9. Education: Academic		-									
10. Aversion to tampering	0.79	-									
11. Concerns	0.86	-									
12. Naturalness concern		0.83***	-								
13. Perceived benefits	0.91	0.02	-0.03	-							
14. Willingness to eat	0.94	0.04	-0.05	0.74***	-						
15. Attitude		-0.03	-0.08*	0.69***	0.70***	-					
16. Nomenclature: Cultivated meat		-0.01	0.00	0.20***	0.20***	0.18***	-				
17. Nomenclature: Lab-grown meat		0.04	0.08*	-0.14***	-0.17***	-0.12***	-0.32***	-			
18. Nomenclature: Animal-free meat		-0.04	-0.04	-0.02	-0.03	-0.03	-0.30***	-0.21***	-		
19. Nomenclature: Cell-based meat		0.03	-0.02	0.02	0.03	-0.00	-0.17***	-0.12***	-0.12***	-	
20. Nomenclature: Clean meat		-0.04	-0.06	-0.13***	-0.13***	-0.08*	-0.25***	-0.18***	-0.17***	-0.10**	-

Note. Gender, ethnicity, religion, educational level, and nomenclature were dummy coded with males, non-Chinese, no religion, no tertiary, and cultured meat serving as reference categories. *$p < .05$; **$p < .01$; ***$p < .001$.

Appendix C.

Hierarchical multiple regression predicting willingness to consume cultivated meat with religion coded as non-Buddhist/Buddhist.

	B (*SE*)	*P*	*B* (*SE*)	*p*	*B* (*SE*)	*p*	*B* (*SE*)	*p*	*B* (*SE*)	*p*
Step 1: Individual characteristics										
Age	-0.01 (0.00)*	.015	-0.01 (0.00)*	.016	0.00 (0.01)	.945	-0.01 (0.00)*	.015	-0.01 (0.00)*	.018
Gender (ref = male/not say)	-0.24 (0.09)**	.006	-0.24 (0.09)**	.006	-0.24 (0.09)**	.007	-0.29 (0.19)	.136	-0.24 (0.09)**	.007
Income	0.03 (0.02)	.263	0.03 (0.02)	.294	0.03 (0.02)	.278	0.03 (0.02)	.276	0.02 (0.02)	.333
Ethnicity (ref = non-Chinese)	-0.16 (0.11)	.150	-0.16 (0.11)	.156	-0.16 (0.11)	.170	-0.16 (0.11)	.160	-0.15 (0.11)	.178
Education (ref = no tertiary)										
Vocational cert	0.21 (0.14)	.141	0.20 (0.14)	.162	0.20 (0.14)	.172	0.21 (0.14)	.155	0.21 (0.14)	.143
Academic degree	0.53 (0.12)***	<.001	0.53 (0.12)***	<.001	0.53 (0.12)***	<.001	0.53 (0.12)***	<.001	0.53 (0.12)***	<.001
Religion (ref = non-Buddhist)										
Buddhist	-0.14 (0.10)	.163	-0.14 (0.10)	.166	-0.15 (0.10)	.158	-0.14 (0.10)	.176	-0.57 (0.22)*	.010
Step 2: Experimental condition (ref = ensure stable supply)										
A: Safety (no undesirable elements)			0.07 (0.14)	.591	0.06 (0.14)	.657	0.01 (0.19)	.970	-0.00 (0.16)	.989
B: Enhanced nutritional value			0.05 (0.14)	.743	0.03 (0.14)	.854	0.02 (0.19)	.923	-0.11 (0.16)	.503
C: Reduces animal slaughter			-0.00 (0.14)	.982	-0.02 (0.14)	.875	0.05 (0.20)	.804	-0.20 (0.17)	.245
D: Reduces carbon emissions			-0.03 (0.14)	.850	-0.04 (0.14)	.765	-0.10 (0.19)	.606	-0.20 (0.17)	.228
Step 3: Interaction terms										
Age*Frame A					-0.02 (0.01)	.239				
Age*Frame B					-0.02 (0.01)	.165				
Age*Frame C					-0.01 (0.01)	.503				
Age*Frame D					-0.01 (0.01)	.372				
Gender*Frame A							0.13 (0.28)	.627		
Gender*Frame B							0.05 (0.27)	.845		
Gender*Frame C							-0.11 (0.28)	.700		
Gender*Frame D							0.15 (0.28)	.583		
Buddhist*Frame A									0.31 (0.30)	.297

Buddhist*Frame B					0.55 (0.30)	.068
Buddhist*Frame C					0.66 (0.31)*	.031
Buddhist*Frame D					0.60 (0.30)*	.046
Adjusted R^2	0.040	0.037	0.035	0.034	0.039	
N	948	948	948	948	948	
F	6.666***	4.289***	3.294***	3.211***	3.579***	

*$p < .05$; **$p < .01$; ***$p < .001$.

Appendix D.

Overview of Study 2

H1	H2	H3	H4
• H1: The "health benefits to consumers" frame has the most significant influence on consumer acceptance of cultivated meat. • Findings: No single frame was more effective than others in increasing general consumer acceptance of cultivated meat. However, the "animal welfare/reduces animal slaughter" and "reduce carbon emissions and global warming" frames were found to increase acceptance among Buddhists.	• H2: Younger consumers perceive cultivated meat to be less unnatural and are hence more accepting of it. — • Findings: There was no consistent relationship between age, perceived naturalness, and the acceptance of cultivated meat.	• H3a and H3b: The term "cultivated meat" is the most preferred term, and the term "cultivated meat" is positively related to acceptance of cultivated meat. • Findings: We found "cultivated meat" to be the most preferred term and the one that was most significantly related to positive attitudes towards cultivated meat.	• H4: Aversion to tampering with nature is negatively related to perceived benefits and willingness to consume cultivated meat. • Findings: There was an unexpected positive relationship between aversion to tampering with nature and perceived benefits of cultivated meat, as well as between aversion to tampering with nature and the willingness to consume cultivated meat.

Supplementary Materials

S1. Interview guide

A. Non-Cultivated Meat Eaters

The interviewer will start by introducing the participant to the objective of the study, before proceeding to ask the following questions:

1. What are your most important considerations when trying a new food product?

2. How familiar are you with cultivated meat?

The interviewer will then introduce the following definition of cultivated meat:

“Cultivated meat is created by feeding cells in a clean, sterile environment, mirroring how an animal grows. By only producing the meat we eat, cultivated meat has a smaller impact on the planet and avoids slaughter, antibiotics or hormones”. In addition, the steps involved in producing cultivated meat (https://goodmeat.co/process) will be shown to the participants.

3. Can you describe how you feel about cultivated meat?

4. How do you think it will taste?

5. What about its nutrition value?

6. What do you perceive to be the benefits (if any) of cultivated meat? Note: The interviewer will probe for benefits to: consumers, society, environment, and animals.

7. What do you perceive to be the risks (if any) of cultivated meat? Note: The interviewer will probe for risk to: consumers, society, environment, and animals.

8. Given what you know now about cultivated meat, would you buy and eat it?

9. If you had to promote cultivated meat to people in Singapore, what would your message focus on?

10. How do you feel about the term “cultured meat” itself? What about “lab-grown meat” and “animal-free meat? “Clean meat”? “Cell-based meat?”

11. Is there anything else you wish to add to this discussion?

B. Cultivated Meat Eaters

The interviewer will start by introducing the participant to the objective of the study, before proceeding to ask the following questions:

1. What are your most important considerations when trying a new food product?

The interviewer will then introduce the following definition of cultivated meat:

“Cultivated meat is created by feeding cells in a clean, sterile environment, mirroring how an animal grows. By only producing the meat we eat, cultivated meat has a smaller impact on the planet and avoids slaughter, antibiotics or hormones”. In addition, the steps involved in producing cultivated meat (https://goodmeat.co/process) will be shown to the participants.

2. When and where did you try cultivated meat?

3. How did you learn about it?

4. Can you describe how you feel about cultivated meat?

5. What do you perceive to be the benefits (if any) of cultivated meat? Note: The interviewer will probe for benefits to: consumers, society, environment, and animals.

6. What do you perceive to be the risks (if any) of cultivated meat? Note: The interviewer will probe for risk to: consumers, society, environment, and animals.

7. Would you try cultivated meat again? Why or why not? Would you recommend it to family and friends?

8. If you were responsible for promoting cultivated meat to more Singaporeans, what would you do?

9. How do you feel about the term “lab-grown meat” itself? What about “cultured meat” “animal-free meat, “clean meat” and “cell-based meat?”? Which one do you feel would be the most universally relevant to consumers?

10. Is there anything else you wish to add to this discussion?

S2. Coding framework (abridged version of coding framework to facilitate reading)

Theme/code/subcode	Description
Health benefits	Respondent perceives that cultivated meat has health benefits
Benefits to consumers	Product is beneficial to consumers' health. Reasons include: absence of bacteria, GMO, antibiotics and/or growth hormones
Willingness to repurchase cultivated meat	Respondents' willingness to repurchase cultivated meat because of its health benefits
Recommending cultivated meat to others	Respondents willing to share about cultivated meat with others because of its health benefits
Perceived safety	Respondents' perception of safety of cultivated meat
Benefit to consumers	Respondents perceive that cultivated meat is safe for consumption and this is a benefit to consumers
Assurance of safety	How can consumers be assured of cultivated meat's safety
Endorsed by Singapore government and relevant food agencies	Approval by Singapore government and food agencies will assure consumers that cultivated meat is safe for consumption
Greater awareness and education about cultivated meat	Information is provided to educate the consumers about the product
The market availability of cultivated meat for a length of time	The product exists for a longer period of time
Evidence of positive environmental effects	Empirical evidence that consuming cultivated meat contributes to positive environmental effects like reduced global warming
Benefits to society	How cultivated meat can benefit the society
Food sustainability	About reduction of dependency on other sources of food, imports, how Singapore can sustainably produce food by itself
Benefits to animals	How cultivated meat can benefit animals
More humane treatment of animals	Animals will be treated more humanely
Reducing animal slaughter	No animals are killed in the production of cultivated meat
Benefits to environment	How cultivated meat can benefit the environment
Reducing carbon emissions and greenhouse gases	Cultivated meat can contribute to the reduction of carbon emissions and greenhouse gasses

Reducing land usage	Producing cultivated meat is less resource-intensive
Perceived unnaturalness	Respondent perceives cultivated meat to be unnatural
Cultivated meat does not sound natural	Cultivated meat does not sound natural to the respondent
Playing God	Why is one becoming God and messing with nature
Too much alteration	Cultivated meat gives the perception of altering things too much
Not convinced they are eating real meat	Respondent is not convinced that eating cultivated meat is really eating real meat
Other food products are also considered not purely natural	Respondents caveats their preconception of other food products to lack of naturalness as well
Safety Concerns	There are concerns with regards to safety because cultivated meat is unnatural
Long-term health issues due to perceived lack of naturalness	Long term health issues due to cultivated meat's unnatural production process
Similar to cloning	The production of cultivated meat is similar to cloning and therefore unnatural
There should be a natural cycle of slaughtering and producing	Respondent believes there should be a natural ecosystem of slaughtering and producing
Willingness to try	How open respondents are to trying cultivated meat
Availability of normal meat	Normal meat is already readily available hence respondent has not thought about trying cultivated meat
Catering to requirements of religion	Need to meet requirements of one's religion (e.g., Is it halal?)
Catering to a certain market segment	Only a certain market segment would be willing to try cultivated meat
Convenience	Will try cultivated meat If it is convenient
Curiosity	Respondent is willing to try cultivated meat out of curiosity
Health Benefits	Respondent is willing to try because of its perceived health benefits
Ability to eat clean	Consuming cultivated meat is equivalent to eating clean
Clean Food	Respondent believes cultivated meat is clean food
If taste is good	Respondent will try cultivated meat if the taste is good

Interested in what cultivated meat would taste like	Respondent is interested in finding out the taste of cultivated meat
May not be able to accept the taste	Respondent is unsure if the taste of cultivated meat will be acceptable
Novelty	Respondent would try it because it is new and different
Presence of a promotion	There would be a presence of a promotion and this would incentivise one to try cultivated meat
Price	Price of cultivated meat will affect one's willingness to try
Appropriate price point (price point as a barrier)	Will be willing to try if the price point is good (Consumers might not want to try cultivated meat if the price is too high)
Demand and Supply	Price will depend on demand and supply
Willingness to pay	Respondent is willing to pay for cultivated meat
Safety	Respondent is willing to try because of the safety of cultivated meat
Spreading awareness on it	Respondent wants to bring awareness to cultivated meat
Treat from friend	Respondent is willing to try cultivated meat because it is a treat from a friend
Trust in Singapore government and relevant food agencies	Approval by Singapore government and food agencies will entice consumers to try cultivated meat
Versatility	Respondent would be willing to try cultivated meat if it comes in different forms (e.g., chicken thigh on top of breast meat)
Will try if other people (e.g., friends and family) try it first	Will be open to trying it if friends and family have already tried it.
Would be willing to try	Respondent expresses a general willingness to try cultivated meat
NOMENCLATURE	
Preference of the term "cultured meat"	Reasons why respondents prefer the term "cultured meat"
Comfortable	Respondent perceives the term "cultured meat" to be comfortable
Cultured meat sounds better	The term "cultured meat" sounds better
Curation is associated with it	Similar to curated meat/carefully selected
Giving off an impression of greater control	The process is more controlled because the best parts of the animal are selected
Having a reference to growing and nurturing the meat	Sounds like one is growing the meat

High-grade origins	Respondent perceives cultured meat to have come from a high-grade source
More effort taken	More effort taken to produce the meat
Piquing curiosity	The term makes respondents curious
Seems more natural	The process sounds more natural
Sounds like a new age term	It is similar to a new age term
Sounds similar to Yakult	Respondent perceives the term "cultured meat" and Yakult (a cultured milk drink) to be similar
Used in general	Respondent prefers the term "cultured meat" because it is used in general
Dislike of the term "cultured meat"	Reasons why respondents dislike the term "cultured meat"
Difficult to comprehend	This term is difficult to understand
Definition is unclear	The term does not describe the meat clearly
Raises Questions	Respondent dislikes the term because it raises questions
Sounds similar to yoghurt	Respondent dislikes the term "cultured meat" because it sounds similar to yoghurt
Unfavourable with consumers	Consumers would not like to use the term
Other impressions of the term "cultured meat"	Other impressions of the term "cultured meat" (neither positive nor negative)
Cultured meat not considered vegan	Respondent perceives cultured meat to be non-vegan
Making one feel fat	Gives off an impression that it is quite fattening
More "high-end"	Respondent perceives the term "cultured meat" to be more "cultured" (literal definition)
Meat is being grown in the lab	Respondent feels that the meat will be grown in the lab
Processing is needed	Need to go through a lot of processes to derive the meat
Resembling cured meat	Has similarities to cured meat
Similar to lab-grown meat	Respondent deems "cultured meat" to be similar to the term "lab-grown meat"
Sounds neutral	The term sounds neutral

Preference of the term "clean meat"	Reasons why respondents prefer the term "clean meat"
Akin to impossible meat	Respondent prefers the term "clean meat" as it is akin to impossible meat
Eating clean or similar to clean diet	Respondent prefers the term "clean meat" as it signals that one is eating clean
Not harsh	Respondent feels that the term "clean meat" is not harsh
Sounds Clean	Respondent perceives that the term "clean meat" sounds clean e.g. free of animal faeces
Sounds Healthy	Respondent prefers the term "clean meat" as it sounds healthy
Sounds Organic and Vegan	Respondent perceives the term "clean meat" to be organic and vegan
Will Pique Interest	Respondent deems the term "clean meat" to be capable of piquing consumers' interest
Dislike of the term "clean meat"	Reasons why respondents dislike the term "clean meat"
Difficult to understand	The term is difficult to understand, especially for older generations
Least effective of terms	Respondent believes it is the least effective term
Raising a lot of questions	The term might be unclear and sounds a bit weird
Other impressions of the term "clean meat"	Other impressions of the term "clean meat" (neither positive nor negative)
Already clean	Most people think that meat should already be clean
Healthier alternative	Respondent perceives "clean meat" to be the healthier version of regular meat
No preservatives, No GMO	Respondent perceives the term "clean meat" to have no preservatives or GMO
Questions about meat not being clean	Questions about meat not being clean will be raised
Sounds organic	The term sounds organic
Sounds plain	"Clean meat" sounds plain
Sterile	Clean is equivalent to being sterile
Washing the meat	Gives one the perception that the meat is being washed

Preference of the term "animal-free meat"	Reasons why respondents prefer the term "animal-free meat"
Abstinence from harming animals	No animal cruelty occurs
Can understand it better	Respondent prefers the term "animal-free meat" as it is easier to understand
Piquing curiosity	Incites curiosity in respondent
Sounds like you are eating for a good cause	The term makes it sound like you are eating for a good cause
Dislike of the term "animal-free meat"	Reasons why respondents dislike the term "animal-free meat"
Inaccurate representation	Term is not representative of the product and its processes, may lead to misconceptions, especially to vegetarians
Sounds similar to impossible or plant-based meat	The term sounds similar to plant-based meat
Other impressions of the term "animal-free meat"	Other impressions of the term "animal-free meat" (neither positive nor negative)
Coming from lobbyists	The term might have come from lobbyists
Catering to vegetarians or vegans	Known to be catered to vegetarians and vegans
It is not like meat at all	Respondent feels that it is not meat
Mock meat	Participant perceives "animal-free meat" to be mock meat
Same as plant-based meat	The term is associated with plant-based meat
Preference of the term "lab-grown meat"	Reasons why respondents prefer the term "lab-grown meat"
Impression of healthiness	Gives one the impression that it is healthier
Suggesting how it's made	Respondent believes the term "lab-grown meat" is suggestive of how it's made e.g. clear explanation - people would have a basic understanding of what it is)
Grown in a lab	Expects it to be grown in a lab
Dislike of the term "lab-grown meat"	Reasons why respondents dislike the term "lab-grown meat"
Lab-grown meat sounds clinical or scientific	The term "lab-grown meat" sounds like it's still at testing stage or the term sounds scientific
Potential harm to animals	Respondent perceives the term "lab-grown meat" to have caused harm to animals through testing
Seems unnatural	The term seems unnatural/not real/artificial

Raising a lot of questions	Unfamiliar about the processes and therefore dislike the term.
Sounds Scary	Respondent thinks that the term sounds scary
Sounds like GMO	The term sounds genetically modified
Unfavorable towards consumers	The term would probably not work on consumers
Other impressions of the term "lab-grown meat"	Other impressions of the term "lab-grown meat" (neither positive nor negative)
Meat is grown in a lab	Meat is thought to grow in a lab
Mock meat	Respondent perceives "lab grown meat" to be mock meat
Scientific	Participant perceives the term "lab-grown meat" to be scientific
Similar to cloning	The term is similar to cloning
Preference of the term "cell-based meat"	Reasons why respondents prefer the term "cell-based meat"
Intuitive or logical	The term is more intuitive
Most effective out of all terms	The term is the most effective
Dislike of the term "cell-based meat"	Reasons why respondents dislike the term "cell-based meat"
Alien sounding	It sounds like an alien term
Dubious term or unfamiliar with the term	Bound to raise a lot of questions
Similar to lab-grown meat	Similar to the term "lab-grown meat"
Other impressions of the term "cell-based meat"	Other impressions of the term "cell-based meat" (neither positive nor negative)
Sounds scientific	The term sounds scientific
Sounds technical	The term sounds technical
Takes reference to cells	Makes reference to cells in a lab

S3. Questionnaire for Study 2

Introduction
We are a team of researchers from Singapore Management University (SMU) who are interested in finding out more about people's perceptions of cultivated meat. This survey will take no more than 15 minutes of your time to complete. Results of this survey will be kept entirely confidential and no identifiable information will be collected.

Cultivated meat is real meat which is grown in a sterile, controlled environment from a single animal cell, removing the need to raise animals.

Cultivated meat should not be confused with plant-based meats such as Impossible and Beyond. Since it is real animal meat, it has similar taste, texture, and the same or better nutritional content as conventionally produced meat.

Informed consent portion

Ethnicity screening
Please indicate your ethnicity.
a. Chinese
b. Malay
c. Indian
d. Others (Please specify) _____

Experimental Conditions (to be assigned randomly)
a. Cultivated meat enables consumers to avoid undesirable elements that are found in some food products (e.g., foodborne diseases, growth hormones or GMOs).
b. Cultivated meat enables the nutritional value of meat to be enhanced.
c. Cultivated meat contributes to animal welfare and reduces animal slaughter.
d. Cultivated meat helps reduce carbon emissions and global warming.
e. Cultivated meat helps ensure that the country's meat supply is stable and sufficient.

Attitude
Please rate your attitude towards cultivated meat.
a. Very unfavorable
b. Unfavorable
c. Somewhat unfavorable
d. Neutral
e. Somewhat favorable
f. Favorable
g. Very favorable

Perceived benefits of cultivated meat
Please rate your agreement with the following statements: (1 = Strongly disagree; 2 = Disagree; 3 = Somewhat disagree; 4 = Neutral; 5 = Somewhat agree; 6 = Agree; 7 = Strongly agree)
a. Cultivated meat is healthy.

b. Cultivated meat is safe for human beings.
c. Cultivated meat is environmentally friendly.
d. Cultivated meat has the same sensory quality as real meat.
e. Cultivated meat has benefits for society.
f. Cultivated meat is animal friendly.
g. This is an attention check. Please select “Disagree” for this item.

Concerns
Please rate your concerns about the following elements of cultivated meat: (1 = Not at all concerned; 2 = Not concerned; 3 = Somewhat not concerned; 4 = Neutral; 5 = Somewhat concerned; 6 = Concerned; 7 = Extremely concerned)
a. Cost
b. Taste
c. Naturalness
d. Safety
e. Nutritional value

Willingness to consume
How willing would you be to: (1 = Definitely no; 2 = No; 3 = Probably no; 4 = Neutral; 5 = Probably yes; 6 = Yes; 7 = Definitely yes)
a. Eat cultivated meat?
b. Buy cultivated meat regularly?
c. Eat cultivated meat as a replacement for conventionally produced meat?
d. Eat cultivated meat as a supplement to conventionally produced meat?
e. Eat cultivated meat instead of plant-based meat substitutes?

Nomenclature
Many terms are currently being used to refer to cultivated meat. Which of the following terms do you like best (pick one)?:
a) Cultivated meat
b) Cultured meat
c) Lab-grown meat
d) Animal-free meat
e) Cell-based meat
f) Clean meat

Aversion to tampering with nature
Please rate your agreement with the following statements: (1 = Strongly disagree; 2 = Disagree; 3 = Somewhat disagree; 4 = Neutral; 5 = Somewhat agree; 6 = Agree; 7 = Strongly agree)
a. People who push for technological fixes to environmental problems are underestimating the risks.
b. People who say we shouldn’t tamper with nature are just being naïve.
c. Human beings have no right to meddle with the natural environment.
d. I would prefer to live in a world where humans leave nature alone.
e. Altering nature will be our downfall as a species.

Demographics

Age
What is your age? (Number input)

Gender
Please indicate your gender.
a. Male
b. Female
c. Prefer not to say

Religion
What is your religion?
a. Protestant
b. Catholic
c. Other Christian
d. Muslim
e. Jewish
f. Hindu
g. Buddhist
h. Atheist
i. Agnostic
j. No religion
k. Others (please specify) _____

Education
Please indicate your highest educational degree.
a. Secondary school
b. Associate's degree
c. Bachelor's degree
d. Master's degree
e. Doctorate degree
f. Others (please specify) _____

Income
How much is your current annual household income?
a. SGD15,000 or less
b. SGD15,001 – SGD25,000
c. SGD25,001 – SGD 35,000
d. SGD35,001 – SGD50,000
e. SGD50,001 – SGD75,000
f. SGD75,001 – SGD100,000
g. SGD100,001 – SGD150,000
h. More than SGD150,000

Occupation

Please indicate your occupation. Please indicate clearly if you are unemployed or do not wish to disclose your occupation. (Open ended)

Comfortable in speaking English
Do you feel comfortable speaking/communicating in English?
a. Yes
b. No

Honesty check
Have you responded to the survey in a reasonably careful and honest manner such that your data will be reasonably valid?

Your honest answer to this question can help improve the validity of our data and conclusions. Please be assured that your responses are anonymous, and **your answer to this question will not affect your research participation compensation.**
a. Yes
b. No