



What does it mean to say that cultured meat is unnatural?

Matti Wilks^{a,*}, Matthew Hornsey^b, Paul Bloom^a

^a Department of Psychology, Yale University, USA

^b School of Business, University of Queensland, Australia

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ABSTRACT

Cultured meat offers a potential alternative to factory farming and its associated problems. Despite this, public opinion about cultured meat is mixed. One concern cited by many potential consumers is that cultured meat is “unnatural”. Although there has been much interest in this perspective, there has been virtually no research exploring the psychological factors that motivate this view. The current study ($N = 904$) examines the beliefs, worldviews, and attitudes associated with the conclusion that cultured meat is unnatural. We found little evidence that naturalness perceptions flowed from a process of analytic reasoning; rather, ratings of unnaturalness appear to be grounded in affective mechanisms such as disgust and fear. This suggests that acceptance strategies that target analytic processing (e.g. information) may have limited success, which has indeed been the case with the strategies tested to date. Our findings are informative for research programs and cultured meat marketing strategies going forward.

1. What does it mean to say that cultured meat is unnatural?

Cultured meat, also known as cell-based, clean, or cultivated meat, is produced by extracting cells from an animal via a harmless biopsy and growing them into meat cells. This process offers a potential alternative to factory farming, and may alleviate the associated ethical, environmental, and social issues (Martin et al., 2015; Petrovic et al., 2015; Singer, 1981). Despite not yet being commercially available, there has been a huge amount of interest in this new potential field, including from large investors such as Tyson Foods and Cargill (Mohorčič & Reese, 2019).

Academics have also shown great interest in this potential new technology, with social scientists and psychologists exploring the question of consumer acceptance (see Bryant & Barnett, 2018 for a review). Research generally finds that acceptance is quite high, with around two thirds of participants reporting willingness to try cultured meat in most samples (Bekker et al., 2017; Bryant & Barnett, 2018; Wilks et al., 2019; Wilks & Phillips, 2017). Acceptance levels are particularly high among those on the political left, males, younger people, those from urban areas, and those with higher levels of education (Hocquette et al., 2015; Tucker, 2014; Wilks & Phillips, 2017). Attitudes are also associated with certain psychological variables—those who are high in conspiratorial ideation, disgust sensitivity, food neophobia, and meat attachment have more negative views of cultured meat (Bryant et al.,

2019; Wilks et al., 2019). While these findings are primarily from U.S. and European samples, recent cross-cultural investigations in China and India suggest similar results (Bryant et al., 2019).

Research has also revealed several attitudes and beliefs that operate as barriers to cultured meat acceptance. These include safety concerns, health and nutrition concerns, concern for the loss of farming jobs and traditions, and the view that cultured meat is disgusting (Laestadius & Caldwell, 2015; Marcu et al., 2015; Verbeke et al., 2015; Wilks & Phillips, 2017). However, perhaps the most pervasive barrier is the perception that cultured meat is unnatural. Several studies have shown that many people perceive cultured meat to be unnatural, and that ratings of unnaturalness are strongly associated with negative attitudes to cultured meat (Siegrist et al., 2018; Siegrist & Sütterlin, 2017). For example, Siegrist and Sütterlin (2017) found that the health risk from cultured meat was less acceptable than the identical health risk from farmed meat, and that the lower acceptance was mediated by the belief that cultured meat is unnatural.

Researchers have attempted to overcome this barrier via messaging strategies, with limited success. Two studies have found that focusing on the unnatural nature of other food production yields small improvements in cultured meat attitudes (Anderson & Bryant, 2018, p. 27; Macdonald & Vivalt, 2017). Other strategies employed have proved unsuccessful, or even damaging. For example, learning about cultured meat can sometimes improve attitudes toward traditionally farmed meat

* Corresponding author. Department of Psychology, Kirtland Hall, 2 Hillhouse Avenue, New Haven, CT, 06511, USA.

E-mail address: matti.wilks@yale.edu (M. Wilks).

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(from being ambiguous to being seen as positively as organically-produced meat) (Siegrist et al., 2018).

On the basis of the existing data, then, the perception that cultured meat is unnatural appears to be a primary obstacle to community acceptance. From an applied point of view, this raises two related questions: how do people form the perception that cultured meat is unnatural, and what can be done to ameliorate this problem? The current paper – partly conceptual, partly empirical – grapples with these questions.

Based on dual-process theories of information processing (Chaiken & Trope, 1999; Kahneman, 2011, p. 499; Slovic, 1996; Slovic et al., 2004), there are two qualitatively distinct pathways through which people could reach the conclusion that cultured meat is unnatural: an analytic and an intuitive pathway. Analytic reasoning is slow, effortful, relies on evidence, and processes in conscious awareness. Approaches such as those described above – interventions that rely on providing information about cultured meat in a bid to change people's opinions – rest on the notion that people are reaching conclusions about naturalness through an analytic process: a mental algorithm that is updated and adjusted in light of new information.

An alternative possibility is that people are reaching conclusions about naturalness through an intuitive, non-analytic process. This form of reasoning – which has variously been called experiential or system 1 thinking – is fast, intuitive, highly influenced by emotion, encoded through images, associations, and metaphors, and typically operates outside of conscious awareness (e.g., Kahneman, 2011, p. 499; Slovic, 1996; Slovic et al., 2004). From this perspective, people might reach a conclusion that cultured meat is unnatural on the basis of “gut feelings” or intuitions that lie outside conscious awareness and are infused with emotion.

Wilks et al. (2019) presented two pieces of evidence that provided a case for this process. First, they showed that disgust sensitivity and conspiratorial ideation (which is linked to threat; DiGrazia, 2017) were significant predictors of negative attitudes toward cultured meat, particularly absolutist opposition (e.g., “cultured meat would be wrong no matter how minor the risk and how great the benefits are from allowing it”).

Second, they measured participants' general predisposition toward natural things (e.g., “natural food is safer than processed food”; “natural things tend to be healthier than non-natural things”). Interestingly, participants' tendency to prefer natural things was not a significant predictor of attitudes toward cultured meat. This presents an apparent paradox: a general preference for natural things is not associated with negative attitudes to cultured meat, yet when participants are asked how “natural” cultured meat is specifically (as it is typically measured; Michel & Siegrist, 2019), the correlation with negative attitudes is large. One way of making sense of this paradox is to argue that some people have an intuitive disgust or threat response to cultured meat – one that lies outside reasoning, rationality or words. Participants may then resort to the language of “unnaturalness” as a posthoc rationalisation of this global feeling (Haidt, 2001). If correct, this suggests a broader use of the term natural, potentially analogous to “unfamiliar”.

Understanding whether naturalness perceptions are developed via an analytic process has practical as well as theoretical implications. If people are reaching a conclusion that cultured meat is unnatural based on an analytic process of reasoning, then it suggests that these perceptions are also amenable to change in light of education and new information. This would mean that education campaigns and other information-heavy interventions would be worthwhile investments in terms of changing attitudes toward cultured meat. However, to the extent that people are taking a non-analytic approach to their judgements of naturalness, it suggests that new information alone might not be sufficient to change attitudes, and that energy should be directed in addressing the more intuitive responses that are driving cultured meat aversion (e.g., disgust). This would be of relevance, given that many interventions in published research tend to employ informational

strategies.

1.1. The current project

In the current study we explore the psychological motivations that are associated with rejection of cultured meat, with a particular focus on the view that it is unnatural. We use these data to (a) elaborate on the question of how people reach conclusions about naturalness, and (b) provide practical recommendations for those who are interested in removing psychological obstacles to embracing cultured meat. This project had four main areas of investigation.

As a first step, we sought to replicate the association between naturalness and acceptability of cultured meat (e.g. Siegrist & Sütterlin, 2017; Siegrist, Sütterlin & Hartman, 2018). In addition, we measured the perceived naturalness and acceptability of a range of other technologies and processes, allowing us to benchmark the strength of the relationship against other issues. We pre-registered the hypothesis that there would be a positive correspondence between naturalness and acceptance for a range of technologies and processes, but we did not make predictions regarding whether that relationship would be especially strong when applied to cultured meat.

Second, we pre-registered the hypothesis that disgust sensitivity and conspiratorial ideation would predict negative attitudes to cultured meat. This finding has been established previously (see Wilks et al., 2019) but whether these individual difference factors also predict the view that cultured meat is unnatural is yet to be explored. If such a relationship were to emerge, it would be consistent with the notion that ratings of naturalness are infused with affective responses.

Third, we examined five specific beliefs about cultured meat and correlated these beliefs with attitudes to cultured meat. Three of these beliefs relate to naturalness (e.g., the notion that cultured meat is highly processed and made with chemicals) and the other items tap into fears about safety (e.g., the belief that cultured meat producers care more about profit than health). Part of the goal in measuring these specific beliefs was simply to get access to the descriptive data, given that endorsement of these beliefs has not been examined previously. If the conclusion that cultured meat is unnatural is reached via a conscious process of reasoning, then there would be benefit in drilling down into the specific beliefs that might plausibly lead to that conclusion. From a theoretical perspective, it is also useful to examine the extent to which these beliefs are related to the global perception that cultured meat is unnatural. If perceptions that cultured meat is unnatural emerge from an analytic process, we would expect them to correlate relatively highly with beliefs that specifically tap into naturalness issues, as compared to beliefs that tap into fear and distrust.

Fourth, we asked people to rate the extent to which they considered five constituent elements of developing cultured meat to be “natural”, ranging from the extraction of cells from an animal through a biopsy to grounding up the meat into patties. On a practical level, we asked these questions to detect if there are any particular parts of the process that might be considered more unnatural than others. This knowledge would be informative for marketing strategies.

2. Method

This study was preregistered (<https://osf.io/6nxd9>) and all materials are made available (<https://osf.io/d49wq/>) on the Open Science Framework. We received human subjects approval from the Yale University Institutional Review Board for this study.

Data were collected in December 2019. Participants were recruited via an online data recruitment platform, Positly, and paid \$1.21 for participation in a short online survey. The consent form and questionnaire were hosted and administered on the online Qualtrics platform. Participants were required to be 18 years or older and living in the U.S. to participate.

2.1. Power analysis

In an *a priori* power analysis, G*Power recommended a sample of 822 participants. This allowed us to conduct a linear regression and achieve 0.80 power with an alpha of .05 to detect a small effect ($f^2 = 0.02$).

2.2. Participants

We collected 904 participants to ensure that we would meet the minimum power requirements while accounting for up to 10% exclusion for failing the attention check. Ultimately, we excluded 42 participants: 35 due to a technical error with the data collection platform and 7 for failing the attention check, leaving a final sample of 862.

As is typical with online data collection (Levy et al., 2016), our sample was more liberal than the general U.S. population, relatively low-income, and skewed young ($M_{age} = 20.4$ years; range 18–52). Full demographics are provided in supplementary materials.

2.3. Procedure and materials

After providing consent, participants completed measures of disgust sensitivity (Olatunji et al., 2007) and conspiratorial ideation (Lewandowsky et al., 2013). Disgust sensitivity comprised 27 items. Thirteen of these items involved participants rating how disgusting they would find certain scenarios; for example, “you see someone put ketchup on ice-cream, and eat it” (1 = not disgusting at all, 5 extremely disgusting). The other 14 items involved participants rating how true they found various statements such as “I never let any part of my body touch the toilet seat in public restrooms” (1 = strongly disagree, 5 = strongly agree). Together, these 27 items formed a highly reliable scale ($\alpha = 0.81$).

Conspiratorial ideation captures an individual’s tendency to believe conspiracy theories. Participants were asked how much they agreed with six conspiratorial claims such as “the Apollo Moon Landings never happened and were staged in a Hollywood film studio” and “The assassination of Martin Luther King Jr was the result of an organized conspiracy by US Government agencies such as the CIA and FBI” (1 = strongly disagree, 5 = strongly agree; $\alpha = 0.87$).

Subsequently, participants were asked how familiar they were with cultured meat on a scale from 1: *not at all familiar (I have never heard of the term)* to 5: *I am very familiar (I regularly read new articles and keep updated with new developments)*. Participants then read a brief description of cultured meat:

Cultured meat is meat made from cells instead of from a farmed animal. A small number of cells are extracted harmlessly from a living animal and grown using a growth medium. Cultured meat is also referred to as clean meat, cell-based meat, or lab-grown meat. It is different to plant-based meat, such as the impossible burger, which is made from plants. In August 2013 researchers unveiled the world’s first cultured hamburger patty. Since then over 20 companies worldwide are developing cultured meat, though it is not yet commercially available because of high production costs.

We then asked participants to share their thoughts on cultured meat in an open-text response. Subsequently, participants were asked how much they agreed with a range of beliefs about cultured meat (1 = strongly disagree, 5 = strongly agree). Three of these beliefs relate to naturalness: (1) Cultured meat is genetically modified/the same as genetically modified food (2) Cultured meat is molecularly the same as real meat, and (3) Cultured meat is highly processed/made with chemicals. The other items tap into fears about safety: (1) Cultured meat producers care more about profit than health, and (2) Cultured meat will have safety issues that we don’t know about yet.

Participants were then presented with five key stages of the cultured meat process: extracting the cells, growing the cells, allowing the cells to

develop into muscle fibres, layering the fibres together, and grinding them into meat. They were asked to rate how natural they found each process to be from 1 = very unnatural to 5 = very natural.

Next, participants evaluated a range of technologies on naturalness (1 = very unnatural, 5 = very natural) and acceptability (1 = very unacceptable, 5 = very acceptable). The full list of technologies and processes are listed in Table 1.

Participants then responded to four questions about their attitudes to cultured meat, each of which was presented on a 1–5 scale. One of these – “Do you think that cultured meat is unnatural?” (definitely not—extremely unnatural) – was measured as a single-item scale. The three other items all measured the acceptability of cultured meat: “Do you consider that cultured meat is a good thing?” (definitely not—definitely yes); “Would you be willing to try cultured meat?” (definitely not—definitely yes); and “cultured meat would be wrong no matter how small the risks and how great the benefit” (strongly disagree—strongly agree). After reversing the last item, these three items formed a highly reliable scale of *positive attitudes* to cultured meat ($\alpha = 0.92$). Note that all effects reported below are replicated when we use the individual items of positive attitudes instead of the single scale.

Finally, participants responded to demographic questions: age, sex (0 male, 1 female, 2 other), political orientation (1 conservative—9 liberal), education (1 nursery school only—8 doctorate degree), income (1 less than \$9999–9 \$200,000 or more), diet (1 eat red and white meat—5 vegan; 6 other). For variables with “other” codes (gender, diet), we treated the “other” responses as missing data in analyses. A full copy of the survey and all data and syntax is made freely available on the Open Science Framework: <https://osf.io/d49wq/>. Note that two questions included in the survey are not reported here, given that they were not directly relevant to the current research question. These items – and the associated descriptive statistics – are reported in the Supplementary file.

3. Results

In line with our first aim, a strong negative correlation ($r = -0.72, p < .001$) emerged between the item “Do you think that cultured meat is unnatural?” and positive attitudes. The more unnatural people perceive cultured meat to be, the less positive their attitudes towards it.

We also conducted correlations to examine the relationship between naturalness and acceptability for 17 processes and technologies, including two processes that relate to cultured meat (see Table 1).

Table 1
Correlations between acceptability and naturalness.

Item	Correlation
Growing an animal then slaughtering it for meat	.66***
Growing an apple on a tree in your backyard	.62***
Growing a human baby by a male and female having sexual intercourse and the woman becoming pregnant	.55***
Implanting a chip in someone to monitor their location and record personal information about them, without their consent	.55***
Creating a human-monkey hybrid	.52***
Growing meat from cell-culturing using a naturally occurring growth medium (such as yeast)	.48***
Growing a calf by artificially inseminating a cow	.46***
Growing meat from cell-culturing using an artificial serum	.45***
Growing a human baby by artificially inseminating a woman (with consent)	.42***
Gene-splicing potatoes to protect them from disease	.42***
Growing an apple from cell-culturing	.42***
Growing a human heart inside a pig for an organ transplant	.41***
Growing a calf inside an artificial uterus	.38***
Mixing ingredients in a factory to create ramen (packet) noodles	.30***
Growing a human heart in a laboratory for an organ transplant	.29***
Transplanting a human heart from a person who has died	.28***
Using vision-correcting technology to improve one’s ability to see (glasses)	.18***

Note: *** $p < .001$. Technologies associated with cultured meat are bolded.

Bonferroni corrections were included to account for multiple comparisons ($p = .003$). In support of our preregistered hypothesis, all correlations were significant ($p < .001$): the more natural the processes and technologies, the more accepting participants were of them. We have organized the table in descending order of the strength of correlations, with the cultured meat processes in bold. Notably, cultured meat is around the middle of the list while growing an animal and slaughtering it for meat (traditionally produced meat) is at the top.

In line with our second aim, we conducted two linear regressions to examine whether disgust sensitivity and conspiratorial ideation predicted (1) positive attitudes to cultured meat and (2) the belief that cultured meat is unnatural. Each analysis had eight predictors: (1) familiarity with cultured meat, (2–6) demographics (age, sex, education, income, political orientation, diet), (7) disgust sensitivity, and (8) conspiratorial ideation. The model explained a significant amount of variance in both general positive attitudes ($R^2 = 0.28, p < .001$) and the view that cultured meat is unnatural ($R^2 = 0.17, p < .001$). Beta scores for individual predictors are summarized in Table 2.

In support of our preregistered hypotheses, people who were higher in conspiratorial ideation and disgust sensitivity had less positive attitudes to cultured meat. People higher in these traits were also more likely to view cultured meat as unnatural (full regression models are provided in supplementary material).

In line with our third aim, we conducted a series of correlations exploring the relationship between various beliefs about cultured meat and the view that it is unnatural (Table 3) (See supplementary material for percentage of sample that selected each response option). Bonferroni corrections were applied to account for multiple comparisons ($p = .01$). All items correlated strongly with both negative attitudes and the view that cultured meat is unnatural ($p < .001$). However, we note that two items that are conceptually related to naturalness of the process (genetic modification, processed/made with chemicals) were the *least* strongly related to negative attitudes and to the overall view that it is unnatural. In contrast, the strongest correlation with ratings of unnaturalness was with a belief that related to safety issues.

In line with our fourth aim, we examined ratings of naturalness for each component of the process of creating cultured meat (see Table 4). Interestingly, the process that was rated the least natural was *grinding these muscle fibres to create ground meat, such as chicken nuggets or a hamburger patty* (See supplementary material for percentage of sample that selected each response option). To explore this, we conducted a series of paired sample t-tests with Bonferroni corrections ($p = .004$). These revealed that every mean was significantly different from every other mean ($ps < .001$) except for the comparison of *growing the cells with a plant-based serum* and *layering these muscle fibers together* ($p = .085$). Notably, the lowest-rated item is the only one in the list that is also part

Table 2
Demographic and personality predictors of positive attitudes to cultured meat and the view that it is unnatural.

Predictor	Betas	
	Positive attitudes to cultured meat	Cultured meat is unnatural
Familiarity	.12***	-.06
Age	-.06	.03
Sex	-.12***	.11**
Education	.01	-.03
Income	-.04	-.00
Political orientation	.22***	-.21***
Diet	-.09**	.06
Disgust sensitivity	-.27***	.20***
Conspiratorial ideation	-.18***	.12***

Note: *** $p < .001$, ** $p < .01$, * $p < .05$. Sex was coded such that 0 = male, 1 = female. Political orientation was scored such that high scores correspond to a more liberal orientation. Diet was scored such that high scores correspond to a diet that involves less meat.

of the process of creating farmed meat—grinding meat together to make food. Furthermore, the perceived unnaturalness of this stage in the process was strongly associated with global attitudes towards cultured meat, including the perception that cultured meat is unnatural.

4. Discussion

The view that cultured meat is unnatural is one of the most pervasive barriers to consumer acceptance. Despite this, we have limited understanding of the psychological motivations that are associated with this view. In the current project, we explored a range of beliefs and attitudes about cultured meat, with a view to identifying the psychological process through which people come to the conclusion that cultured meat is unnatural.

First, we replicated the established finding that support for cultured meat was negatively associated with the perception that it is unnatural ($r = -0.72$). When specific cultured meat practices were described, the association between support and naturalness ratings were more modest, but still highly significant.

Second, we found that those high in conspiratorial ideation (associated with mistrust and fear e.g. DiGrazia, 2017) and those high in disgust sensitivity were more likely to view cultured meat as unnatural. This replicates past work (Wilks et al., 2019) showing that these traits predict absolute opposition to cultured meat (i.e. the view that something is wrong regardless of the consequences; Scott et al., 2016). This pattern of results suggests that affective responses may underpin opposition to cultured meat, including the perception that it is unnatural.

Third, we measured a range of beliefs about cultured meat, and correlated them with evaluations of how natural cultured meat is perceived to be. If we arrive at the view that cultured meat is unnatural through a process of analytic reasoning, we would expect the strongest correlations among the beliefs that are specifically related to naturalness. Here we find the opposite: While all beliefs were significantly correlated with naturalness ratings, the two *lowest* correlations were with beliefs that captured specific naturalness concerns—that cultured meat is genetically modified and that it is made with chemicals. By contrast, the strongest correlations were with beliefs related to health and safety concerns. This suggests that the view that cultured meat is unnatural may be driven by an affective process more so than an analytic process.

Fourth, we found that certain components of cultured meat were considered less natural than others. Interestingly, the part of the process that was considered least natural - grinding muscle fibers to create ground meat - is the only item that reflects traditional meat production practices. It is revealing that the part of the process that is considered least natural was not a process conducted in the laboratory, but rather the part of the process in which cultured meat was turned into food. This suggests that it is the thought of *eating* cultured meat - rather than the process of creating it - that elicits the feeling that it is “unnatural”. Again, this would be consistent with a disgust-based pathway to ratings of naturalness rather than an analytic pathway.

We provide evidence suggesting that emotion plays a role in how we arrive at the view that cultured meat is unnatural. However, these data do not rule out the role of analytic thinking in forming the view that cultured meat is unnatural. It is plausible that both analytic and intuitive drivers contribute to this view. Indeed, extensive research has documented that these two systems operate in parallel, often interacting and guiding one another (Alhakami & Slovic, 1994). Perhaps, then, our perception that cultured meat is unnatural stems from a combination of both intuitive and analytic judgements. This is an important area for future research. We also note that the link between naturalness and acceptability may not be salient for everyone. That is, some people may believe that cultured meat is unnatural, yet still see it as acceptable. Understanding the factors associated with this belief could yield valuable insights into the psychological interplay between acceptability and naturalness.

Table 3

Agreement with various beliefs about cultured meat, and the correlation between these beliefs and attitudes toward cultured meat.

Belief	Mean (SD)	Correlation with positive attitudes	Correlation with rating of cultured meat as unnatural
Cultured meat is genetically modified/the same as GM food	3.11 (0.98)	-.29***	.26***
Cultured meat is highly processed/made with chemicals	3.56 (0.94)	-.38***	.43***
Cultured meat is molecularly the same as real meat	2.77 (1.12)	-.61***	.53***
Cultured meat producers care more about profit than health	2.95 (1.04)	-.55***	.45***
Cultured meat will have safety issues that we don't know about yet	3.27 (1.07)	-.66***	.57***

Note: *** $p < .001$.**Table 4**

Naturalness ratings for five components of the process of creating cultured meat, and their correlations with attitudes toward cultured meat.

Item	Mean (SD)	Correlation with positive attitudes	Correlation with rating of cultured meat as unnatural
Extracting cells from an animal through a harmless biopsy ^a	3.21 (1.23)	.26***	-.32***
Growing those cells with a plant-based serum (such as yeast) that allows them to proliferate ^b	2.68 (1.26)	.47***	-.54***
Allowing these cells to develop into muscle fibers ^c	2.83 (1.30)	.53***	-.58***
Layering these muscle fibers together ^b	2.63 (1.27)	.46***	-.57***
Grinding these muscle fibers to create ground meat such as chicken nuggets or a hamburger patty ^d	2.49 (1.27)	.53***	-.58***

Note: *** $p < .001$. Superscripts denote significant differences as determined by t-tests ($p < .001$).

We do not wish to overstate these findings. We have not provided causal evidence that these views are formed intuitively; our research is cross-sectional and correlational. Related to this, we acknowledge that our case is circumstantial. Generally, it is difficult to obtain unambiguous evidence that people reach a conclusion through an intuitive as opposed to an analytic process. Rather, we offer several pieces of indirect evidence that converge to suggest that perceptions of whether cultured meat is unnatural are not formed solely through an analytic process of reasoning.

Our sample also skewed younger than typical samples and we only recruited U.S. participants. It remains unclear whether these findings would generalize to older and non-U.S. populations. Given recent cross-cultural findings (e.g. Bryant et al., 2019), replication and extension are important next steps.

These data are informative for the cultured meat industry. Current

approaches to improving acceptance often presume an analytic mechanism—focusing on information and education strategies (e.g. Anderson & Bryant, 2018, p. 27; Macdonald & Vivaldi, 2017). This may explain the limited success of these strategies. Perhaps, then, strategies that address more affective responses would see more success, either alone or in conjunction with information. However, we caution readers to be mindful of the limitations mentioned above and encourage explicit testing of these approaches before they are adopted into consumer strategies.

These findings also have implications for our notions of naturalness more generally. Naturalness is raised as a concern for many technologies that have the capacity to bring positive change to the world (e.g., Golden Rice). Understanding how and why people form these views can better enable us to address public concerns and increase acceptance of these beneficial new technologies.

Ethics statement

This study received ethical approval from the Yale University Institutional Review Board, approval number: 1302011578.

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Appendix A. Supplementary data

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