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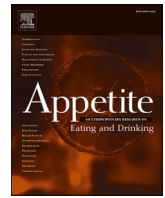
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Meat and morality: The moral foundation of purity, but not harm, predicts attitudes toward cultured meat

Matti Wilks^{a,*}, Charlie R. Crimston^b, Matthew J. Hornsey^c

^a Department of Psychology, University of Edinburgh, United Kingdom

^b School of Medicine and Psychology, Australian National University, Australia

^c School of Business, University of Queensland, Australia

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ABSTRACT

Cultured meat (also referred to as cultivated, cell-based, or cell-cultured meat) is a novel food technology that is presented as a method of meat production without reliance on large-scale industrial farming. The pro-cultured meat narrative rests, in part, on a moral foundation: cultured meat is purported to alleviate the environmental and animal welfare harms associated with farmed meat. Despite this narrative, no research has examined which moral values underpin attitudes towards cultured meat. To examine this, we surveyed 1861 participants from the United States and Germany about their moral foundations and their attitudes towards cultured meat. In line with predictions, people who more strongly endorse moral values about purity (i.e., had higher scores on the purity subscale of the moral foundations scale) held more negative attitudes towards cultured meat. However, this relationship was much more consistent among participants from the United States than participants from Germany. Against predictions, attitudes towards cultured meat were not reliably associated with the extent to which people focus on harm as a moral foundation. The latter finding was particularly surprising in light of harm-reduction narratives around cultured meat. These findings demonstrate the need for a more nuanced discussion about, and understanding of, consumer concerns around cultured meat and the values that underpin them.

1. Introduction

Cultured meat (also known as cultivated, cell-based, or cell-cultured meat) is a novel food technology that is presented as a method of meat production not reliant on large-scale industrial farming. In recent years, there has been an upswing of interest in this technology from investors and the media (e.g., Painter et al., 2020). At the close of 2022 there were more than 156 publicly announced companies producing cultured meat worldwide (Good Food Institute, 2023). Governments are also beginning to consider regulatory challenges, including a recently released report by the World Health Organization and US Food and Agricultural Organization (FAO & WHO, 2023). In 2020, Singapore became the first country to give approval for the sale of cultured meat, followed by the United States in 2023 (Good Food Institute, 2023).

Alongside this growing interest, a body of research examines consumer perceptions of this novel food technology (Bryant & Barnett, 2020; Hocquette, 2023; Pakseresht et al., 2022; Tomiyama et al., 2020). Some of this research focuses on acceptance, revealing reasonably high levels of willingness to try cultured meat (see Bryant & Barnett, 2020,

Table 2). However, rates of acceptance of cultured meat are generally lower than for other alternate proteins (e.g., legumes, plant-based meat) (Onwezen et al., 2021). Moreover, rates of acceptance vary as a function of demographics. Research consistently finds higher rates of acceptance among people who are politically left or liberal, younger, male, from urban areas, and with higher levels of education (Bryant & Barnett, 2020; Heijnk et al., 2023; Rombach et al., 2022; Wang & Scrimgeour, 2022; Wilks & Phillips, 2017). While most early research was conducted with participants from the United States and Europe (e.g., Bryant & Sanctorem, 2021; Dupont et al., 2022), recent cross-cultural studies (e.g., Asioli et al., 2022; Franceković et al., 2021; Rombach et al., 2022) have also revealed country-level differences. For example, Bryant and colleagues (2019) identified slightly more positive attitudes from participants in China and India than the United States, however (Li, Van Loo, van Trijp, Chen, & Bai, 2023) revealed generally negative attitudes towards cultured meat in a Chinese sample. Similarly, Siegrist and Hartmann (2020b) found differences across ten countries and noted particularly low rates of acceptance in France. Recent research has also reconfirmed generally negative attitudes in France, albeit varying across

* Corresponding author. 7 George Square, Edinburgh, EH8 9JZ, UK.

E-mail address: matti.wilks@ed.ac.uk (M. Wilks).

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different consumer segments (Hocquette et al., 2022). Even more recent work has also begun to explore attitudes towards cultured meat across Africa (Kombolo Ngah et al., 2023). Finally, some work has examined how individual differences predict attitudes towards cultured meat. Across several studies, research finds that negative perceptions of cultured meat are associated with high levels of meat attachment, food neophobia, disgust sensitivity, and distrust in science (Bryant, Anderson, et al., 2019; Siegrist & Hartmann, 2020a; Wilks et al., 2019, 2021) (but see Hamlin et al., 2022 who identify a weak relationship between food neophobia and attitudes towards cultured meat).

Other work has focused on identifying barriers to acceptance of cultured meat, drawing on both qualitative and quantitative approaches (e.g., Bekker et al., 2017; Bryant, Anderson, et al., 2019; Marcu et al., 2015; Siegrist & Hartmann, 2020b; Verbeke et al., 2015; Wilks & Phillips, 2017). A number of barriers have been identified, including concerns about safety, health, taste, and nutrition, as well as the loss of farming jobs and traditions (Bryant & Barnett, 2020; Pakseresht et al., 2022; Tomiyama et al., 2020). Perceptions of cultured meat as disgusting and unnatural have also emerged as psychological barriers (Bryant & Barnett, 2020; Pakseresht et al., 2022; Rosenfeld & Tomiyama, 2023; Siegrist et al., 2018; Siegrist & Hartmann, 2020b; Siegrist & Sütterlin, 2017; Tomiyama et al., 2020; Wilks et al., 2019, 2021). Indeed, several studies have identified that consumers perceive cultured meat to be unnatural (e.g., Liu et al., 2023), and that concerns about naturalness are strongly linked to negative perceptions of cultured meat (Siegrist et al., 2018; Siegrist & Sütterlin, 2017; Verbeke et al., 2015, 2021). For example, Siegrist and Sütterlin (2017) found that health risks from cultured meat are less acceptable than the same risks from farmed meat, and that this was mediated by ratings of perceived naturalness.

One area that has received very little attention is the role of moral values in shaping attitudes towards cultured meat. This is surprising, given that there is extensive research demonstrating links between moral values and attitudes toward farmed meat (e.g., Feinberg et al., 2019; Leach et al., 2021; McGuire et al., 2023; Piazza et al., 2023; Rosenfeld, 2018; Rozin et al., 1997; Ruby & Heine, 2011). Given this, we consider investigating the role of moral values as a clear next step in understanding attitudes toward cultured meat.

1.1. Moral Foundations Theory

Moral Foundations Theory (Haidt & Graham, 2007) aims to explain and describe variance in our perceptions of what we consider moral and immoral. The theory describes five dimensions of moral value: harm/care, fairness/reciprocity, loyalty/ingroup, authority/respect, and purity/sanctity (though other work proposes a sixth dimension—liberty/oppresion; Haidt, 2012). Haidt and Graham (2007) propose that the extent to which we value each of these foundations shapes the moral judgements we make about the world. These foundations can be divided into binding and individualizing foundations. The binding foundations—loyalty, authority, and purity—are named as such because they focus on groups and traditional social norms. For example, loyalty reflects faithfulness to one's ingroup, while authority reflects deference to or respect for authority. The individualizing foundations—harm, fairness, and liberty—focus on individual rights and wellbeing. For example, fairness reflects concerns for equality and justice. Extensive research has demonstrated that those on the political left tend to predominantly situate their morality around individualizing foundations, while those on the political right tend to more strongly endorse binding foundations (Graham et al., 2009, 2011, 2013; Haidt & Graham, 2007). However, this pattern of result is less consistent outside of Western cultures (Dogruyol et al., 2019; Iurino & Saucier, 2020).

Moral foundations are associated with real-world behaviors and attitudes. For example, participants who endorse the harm foundation tend to be more morally expansive (that is, grant moral concern to a broad range of entities) while those who endorse the foundations of

loyalty, authority, and purity tend to be less expansive (Crimston et al., 2016). Relatedly, research has linked moral foundations to charitable giving. Nilsson et al. (2020) found that the endorsement of harm and fairness foundations was associated with a greater willingness to comply with a request to donate to charity, and higher self-reported charitable donations. Moreover, the authors found that endorsement of loyalty, authority, and purity foundations predicted donation to charities that benefited ingroups, while endorsement of harm and fairness foundations predicted donations to charities that benefited outgroups. Finally, studies from multiple countries have shown links between a range of pro-environmental attitudes and behaviors and the endorsement of harm and care foundations (Dickinson et al., 2016; Jansson & Dorrepaal, 2015; Milfont et al., 2013; Silfver et al., 2023). Notably, however, Silfver et al. (2023) also links certain pro-environmental behaviour (e.g., eating local and natural foods) to endorsement of the loyalty, authority, and purity foundations.

1.2. Moral foundations and attitudes towards cultured meat

To date, researchers have had limited success in improving negative attitudes toward cultured meat (but see Kantor & Kantor, 2021). Both Bryant and Dillard (2019) and Siegrist and Sütterlin (2017) found that describing cultured meat with technical or scientific language led to more negative perceptions than when it is described non-technically. Bryant, Anderson, et al. (2019) examined four messages to overcome the belief that cultured meat is unnatural. Only one approach showed promise: arguing for the unnaturalness of farmed meat—but this was only for some outcome measures (e.g., higher willingness to pay for cultured fish, but not beef) and these limits were acknowledged by the authors. Similarly, Macdonald and Vivalt (2017) found that a message encouraging participants to “embrace unnaturalness” led to more positive perceptions and higher willingness to pay for cultured meat over an 11-week period. By contrast “debunking unnatural” and “descriptive norm” messages initially led to more positive attitudes, but at follow-up performed no better than controls. Importantly, the authors also noted that exposure to negative reactions about cultured meat led to persistently negative attitudes across the entire study.

Why have these interventions been limited in their success? One possibility is that reason-based interventions—that is, explaining the benefits of cultured meat to consumers and expecting that they will update their attitudes in line with evidence—do not adequately address the psychological foundations of cultured meat attitudes. There is considerable body of research demonstrating that our values shape our interpretation of evidence and our willingness to update our beliefs (see Hornsey & Fielding, 2017). However, while there has been extensive exploration of the demographic and personality factors that predict attitudes towards cultured meat (as discussed above; Bryant & Barnett, 2020), there has been virtually no research that aims to understand which values may shape attitudes towards cultured meat.

We can, however, make inferences. Past work has shown strong links between political orientation and attitudes towards cultured meat: those on the political left tend to hold more positive attitudes than those on the political right (Bryant & Barnett, 2020). Similarly, political orientation has been repeatedly linked to our moral foundations, with those on the political right more strongly endorsing the foundations of loyalty, authority, and purity, and those on the political left more strongly endorsing the foundations of harm and care (Haidt & Graham, 2007). This could indicate links between attitudes towards cultured meat endorsement of certain moral foundations.

Previously discussed research also shows strong links between the harm foundation and pro-environmental behaviour, moral expansiveness, and charitable giving (Crimston et al., 2016; Nilsson et al., 2020; Silfver et al., 2023). This reflects the positive public narrative around cultured meat—cultured meat is purported to have the potential to reduce animal suffering and minimize the substantial environmental harms caused by factory farming (Painter et al., 2020). This also aligns

with research into attitudes towards cultured meat, which shows that people identify environmental and animal welfare as the key benefits (Bryant & Barnett, 2020; Pakseresht et al., 2022; Tomiyama et al., 2020). Given the above, it is plausible that endorsement of the harm foundation would predict positive attitudes towards cultured meat.

Furthermore, one of the dominant negative narratives around cultured meat centers around the concept of naturalness—that cultured meat is unnatural and unsafe (Painter et al., 2020). Research has repeatedly identified disgust and naturalness concerns as key barriers to cultured meat acceptance (Siegrist & Hartmann, 2020b). Given this, it is plausible that endorsement of the purity foundation would predict negative attitudes towards cultured meat.

1.3. The current research

This project examines the relationship between endorsement of the five moral foundations and attitudes towards cultured meat. Examining these relationships will deepen our understanding of the psychological factors that underpin attitudes towards cultured meat and may inform communication strategies for those wishing to advocate for public acceptance. Across three studies, we surveyed participants in the United States and Germany ($N = 1861$) about their attitudes towards cultured meat, and also asked them to complete the Moral Foundations Questionnaire (MFQ; Graham et al., 2011) to assess their moral values.

In Study 1a and 1b we surveyed American and German participants respectively. We chose to sample two countries to get a sense of the generalizability of results. We focused on Germany because of the relatively lower rate of political polarization relative to the United States (Boxell et al., 2021). We thought this was pertinent because cultured meat has become a polarizing issue in some parts of the world (e.g., Wilks et al., 2019), and there is some debate about the applicability of moral foundations outside of the United States (Davies et al., 2014; Kim et al., 2012). In Study 1, we had to exclude a large number of participants for failing comprehension and attention checks (313 in Study 1a, and 241 in Study 1b). We thus held concerns about the veracity of our data. Perhaps, for example, we had only retained highly conscientious participants in our sample. Because of this, in Study 2 we opted to replicate Study 1a with another American sample recruited from Prolific ($N = 629$).

We made two predictions. First, we predicted that the moral foundation of harm (i.e., high scores on the harm subscale of the MFQ) would be related to more positive attitudes towards cultured meat. Second, we predicted that the moral foundation of purity (i.e., high scores on the purity subscale of the MFQ) would be related to more negative attitudes towards cultured meat. Because there was no clear theoretical or conceptual reason to link attitudes about cultured meat to the moral foundations of fairness, loyalty, or authority, we did not pre-register predictions about these variables, but included them in the studies for the sake of thoroughness and transparency.

2. Materials and methods

All studies in this manuscript received approval from the Yale University Institutional Review Board. All participants provided informed consent prior to participating. These studies were all preregistered on the Open Science Framework (OSF): Study 1a and 1b, https://osf.io/mwb6g/?view_only=85a34a942d2f4f9eb35c176a6eb2cea7; Study 2 https://osf.io/83cbr/?view_only=7e1ef851c0d840f1a6091b7fe8fefa23. The materials, data, and code for all three studies are also all available on the OSF: https://osf.io/mpydn/?view_only=5e6d957f4cec43fdb8b2cd69d7347494.

2.1. Study 1a

2.1.1. Participants

We collected a nationally representative U.S. sample of 927

participants. We excluded 180 for failing an attention check and another 133 for failing a comprehension check. The attention check was a question embedded in a scale that read “To confirm you are a real person and not a ‘bot’, please select “Strongly agree” for this item”. The comprehension question asked participants to recall information from the cultured meat paragraph (described below), specifying whether cultured meat is made from animal cells or plant cells.

These exclusions left a final sample of 614 participants. Of these participants, the average age was 47.3 years with 46.7% identifying as male, 52.6% identifying as female, 0.2% identifying as other, and 0.5% preferring not to say. The majority of the sample ate both red and white meat (77.5%). Other participants reported eating white meat only (5.2%), seafood only (2.4%), or that they were vegetarian (4.9%) or vegan (1%). The remainder of the sample selected “other” for their diet (4.7%) or opted not to answer (4.2%). Almost half the sample (49.9%) had a bachelor’s degree or higher. The sample was politically moderate with a mean score of 5.38 on a 9-point scale where a higher number represents a more conservative political identity. The majority of the sample identified as Caucasian (77.2%), with the remainder of the sample identifying as Asian (5.9%), Black (5.4%), Latino/Hispanic (5.2%), other (3.9%), more than one ethnicity (1.1%) or preferred not to answer (3.9%).

2.1.2. Procedure

We recruited participants via the online recruitment agency Dynata, and paid them for their time. The survey was hosted on Qualtrics. After consenting, participants completed the survey (measures provided below).

2.1.3. Measures

2.1.3.1. Demographics. We first asked participants to report their age, gender, education level, political orientation, diet, and ethnicity.

2.1.3.2. Moral foundations. The MFQ30 (Haidt & Graham, 2007) measures an individual’s tendency to endorse a set of five moral foundations: harm, fairness, purity, loyalty, and authority. Depending on the item, participants were asked to report how much they agree with statements or how relevant a factor is when judging right or wrong on a scale of 1 (not at all relevant/strongly disagree) to 5 (extremely relevant/strongly agree). An example item on the purity subscale is “People should not do things that are disgusting, even if no one is harmed”. An example item on the harm subscale is “It can never be right to kill a human being”. A full version of the scale is available at <https://moralfoundations.org/>.

2.1.3.3. Cultured meat. Participants responded to the question “how familiar are you with cultured meat?” on a scale of 1 (not at all familiar; I have never heard the term) to 5 (I am very familiar; I regularly read news articles and keep updated with developments). They then read a brief paragraph that aimed to provide basic information about cultured meat in a reasonably neutral way. The paragraph stated “Cultured meat is meat made from animal 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. It is different to plant-based meat (like the impossible burger), which is made from plants.”. We then measured willingness to eat cultured meat, perceived goodness of cultured meat, perceived unnaturalness of cultured meat, and absolute opposition to cultured meat, using items adapted from prior research (e.g., Wilks et al., 2021). Willingness to eat was measured by asking participants how likely they would “try cultured meat”, “eat cultured meat regularly”, and “buy it at the supermarket (if it was the same price as farmed meat)”. Participants responded on a scale of 1 (definitely not) to 5 (definitely yes) and the items were collapsed to provide a single, reliable measure ($\alpha = .93$). Perceived goodness was measured with three items: “cultured meat is a good thing”, “I have positive feelings towards cultured meat”, and “cultured meat will have benefits for

society" (1 = strongly disagree, 5 = strongly agree; $\alpha = .92$). A single item asked participants how much they agree with the statement "Cultured meat is unnatural". We measured absolute opposition with a single item that asked participants how much they agreed with the statement "Cultured meat would be wrong no matter how small the risk and how great the benefit" (Scott et al., 2016). Participants responded to each of these on a scale of 1 (strongly disagree) to 5 (strongly agree).

2.2. Study 1b

2.2.1. Participants

In Study 1b, we collected a nationally representative German sample of 859 participants. We excluded 149 for failing the comprehension check and another 92 for failing the attention check, leaving a final sample of 618 participants. Of these participants, the average age was 48.0 years with 50.5% identifying as male, 49.5% identifying as female. The majority of the sample ate both red and white meat (81.2%). Other participants reported eating white meat only (5.8%), seafood only (3.7%), or that they were vegetarian (4.0%) or vegan (1.8%). The remainder of the sample selected "other" for their diet (3.2%) or opted not to answer (0.2%). The sample was highly educated with 79.0% having at least a bachelor's degree or higher. The sample was politically moderate, averaging 4.88/9 where a higher number represents more conservative views. We did not ask about ethnicity in this study as we received advice that this is a sensitive question in German research guidelines.

2.2.2. Procedure and measures

The measures and recruitment were identical to Study 1a, except that we recruited a German sample. Native German speakers forward and back translated the survey.

2.3. Study 2

2.3.1. Participants

We collected a sample of 650 participants via Prolific. Participants were required to be 18 years or older and living in the United States. We excluded 13 participants for failing the comprehension check and 8 for failing the attention check, leaving a final sample of 629 participants. Of these participants, the average age was 36.8 years, with 49.8% of participants identifying as male, 48.1% identifying as female, and 2.1% identifying as other. The majority of the sample ate both red and white meat (83.0%). Other participants reported eating white meat only (4.5%), seafood only (2.4%), or that they were vegetarian (4.3%) or vegan (2.2%). The remainder of the sample selected "other" for their diet (3.7%). Almost half the sample (53.6%) had a bachelor's degree or higher. The sample was relatively left-leaning with a mean score of 3.83/9 where a higher number represents more conservative views. Finally, the majority of the sample identified as Caucasian (73.6%), with the remainder of the sample identifying as Asian (8.4%), Latino/Hispanic (7.2%) or Black (6.7%). Some participants identified as more than one ethnicity (2.7%) or reported "other" (1.4%).

2.3.2. Procedure

The procedure and measures were identical to Study 1a, with two exceptions. First, we recruited participants via Prolific. Second, participants reported their demographics at the end of the survey instead of the beginning. We paid participants an average of US\$11.81 per hour for participation.

3. Results

3.1. Study 1a

We first examined descriptive statistics. Average ratings converged around the mid-point for willingness to eat cultured meat ($M = 2.83$, SD

$= 1.26$), the perception that cultured meat is good ($M = 3.11$, $SD = 1.09$), and absolute opposition to cultured meat ($M = 2.94$, $SD = 1.20$). Participants also generally saw cultured meat as unnatural ($M = 3.54$, $SD = 1.11$). We first examined correlations between the predictors and outcome measures (Table 1).

Consistent with predictions, the moral foundation of purity was correlated with more negative orientations towards cultured meat on three of the four outcome measures: lower belief that cultured meat is good, greater belief that cultured meat is unnatural, and greater absolute opposition to cultured meat. Contrary to predictions, the moral foundation of harm was not significantly correlated with any of the four outcome measures. We also identified strong correlations between the moral foundation subscales. Given this, we tested for collinearity but our tests did not meet criteria ($VIF < 2.95$).

In line with our preregistration, we then conducted a series of linear regressions with the five moral foundations and demographics as predictors of attitudes to cultured meat. We conducted four regressions, one for each of the outcome measures: willingness to eat, perceived goodness, perceived naturalness, and absolute opposition. We report the betas and p -values here (Table 2), but full models can be found in supplementary materials.

Findings for the demographic predictors reflected past work: those on the political left, who were younger, who had higher levels of education, and who identified as male tended to have more positive attitudes towards cultured meat. These predictors were more consistently predictive for measures of general attitudes (willingness to eat, perceived goodness) while only political conservatism was predictive across all measures.

In line with predictions, and consistent with the correlations, the moral foundation of purity was significantly associated with lower belief that cultured meat is good, greater belief that cultured meat is unnatural, and greater absolute opposition to cultured meat. Importantly, these relationships emerged over and above effects of demographics, including political conservatism. Contrary to predictions, the moral foundation of purity was not predictive of willingness to eat cultured meat. Also contrary to predictions, the moral foundation of harm was not predictive of any outcome measures.

We did not make predictions around the other three moral foundations, but for the record, regressions suggested that fairness and loyalty were positively predictive of willingness to eat cultured meat and the belief that cultured meat is good. However, these findings did not emerge in the bivariate correlations, thus they may be the result of statistical suppression rather than indicating a robust relationship.

3.2. Study 1b

When examining descriptive statistics, mean scores again converged around the mid-point for willingness to eat cultured meat ($M = 2.98$, $SD = 1.23$) the perception that cultured meat is good ($M = 3.18$, $SD = 1.14$) and the view that cultured meat is unnatural ($M = 2.84$, $SD = 1.14$). In this German sample, participants reported slightly above the mid-point for absolute opposition to cultured meat ($M = 3.41$, $SD = 1.14$). We first examined correlations between the predictors and outcome measures (Table 3).

Unlike Study 1a, the moral foundation of purity correlated with absolute opposition to cultured meat, but no other outcome measures. In line with Study 1a, the moral foundation of harm was not correlated with any outcome measures. We again found strong correlations between the moral foundation subscales but did not find evidence of collinearity ($VIF < 2.52$).

Following the preregistration, we then conducted a series of linear regression with the five moral foundations and demographics as predictors of attitudes to cultured meat (see Table 4 for a summary; full models can be found in supplementary materials).

We again found demographic predictors consistent with prior work: younger participants and those on the political left tended to have more

Table 1
Correlations between predictors (moral foundations) and outcome measures (attitudes towards cultured meat).

	Willing to Eat	Good	Unnatural	Absolute Opposition	Harm	Purity	Fairness	Loyalty
Good	0.81***							
Unnatural	-0.42***	-0.50***						
Absolute Opposition	-0.35***	-0.45***	0.54***					
Harm	-0.01	0.03	0.07	0.08				
Purity	-0.04	-0.08*	0.28***	0.30***	0.47***			
Fairness	0.11**	0.12**	0.02	0.07	0.73***	0.41***		
Loyalty	0.07	0.03	0.17***	0.24***	0.45***	0.67***	0.38***	
Authority	-0.02	-0.04	0.23***	0.24***	0.49***	0.71***	0.42***	0.75***

Note. * $p < .05$, ** $p < .01$, *** $p < .001$.

Table 2
 β and p values for the role of demographics and moral foundations in predicting attitudes towards cultured meat.

	Willing to Eat		Good		Unnatural		Absolute opposition	
	β	p	β	p	β	p	β	p
Age	-0.22	< .001	-0.21	< .001	-0.02	0.707	-0.14	0.001
Gender	-0.12	0.004	-0.09	0.025	0.04	0.405	0.02	0.660
Diet	-0.06	0.155	-0.001	0.962	-0.002	0.948	0.03	0.536
Education	0.15	< .001	0.18	< .001	-0.05	0.248	-0.04	0.287
Conservatism	-0.10	0.016	-0.10	0.020	0.11	0.018	0.11	0.016
Harm	-0.08	0.186	0.01	0.839	-0.02	0.702	-0.05	0.412
Purity	-0.10	0.105	-0.16	0.007	0.26	< .001	0.24	< .001
Fairness	0.18	0.003	0.15	0.010	-0.11	0.079	-0.01	0.889
Loyalty	0.17	0.008	0.15	0.022	-0.05	0.430	0.03	0.639
Authority	-0.04	0.548	-0.03	0.619	0.11	0.106	0.05	0.497

Note: Gender is coded as 0 = male, 1 = female. Higher numbers on Diet represent more meat consumption.

positive responses overall, while higher education and lower meat consumption specifically predicted willingness to eat cultured meat.

Overall, we found fewer relationships between moral foundations and attitudes towards cultured meat in the German sample than in the U. S. sample. Purity predicted absolute opposition to cultured meat but did not significantly predict the other three outcome variables. In line with Study 1a, harm was again not predictive of any measures of attitudes towards cultured meat. Outside of our predictions, we also found that

the moral foundation of fairness predicted the belief that cultured meat is good, a finding which was also reflected in the correlations. Finally, we found that the moral foundation of authority negatively predicted the belief that cultured meat is unnatural, though this finding did not emerge in the bivariate correlations, casting doubt on the robustness of the pattern.

Table 3
Correlations between predictors (moral foundations) and outcome measures (attitudes towards cultured meat).

	Willing to Eat	Good	Unnatural	Absolute Opposition	Harm	Purity	Fairness	Loyalty
Good	0.83***							
Unnatural	-0.43***	-0.46***						
Absolute Opposition	-0.60***	-0.64***	0.47***					
Harm	-0.02	0.04	0.06	0.06				
Purity	-0.01	0.00	0.04	0.13**	0.36***			
Fairness	0.05	0.11**	0.02	-0.01	0.73***	0.35***		
Loyalty	0.04	0.05	-0.00	0.09*	0.35***	0.60***	0.38***	
Authority	0.07	0.05	-0.04	0.10*	0.28***	0.61***	0.28***	0.62***

Note. * $p < .05$, ** $p < .01$, *** $p < .001$.

Table 4
 β and p values for the role of demographics and moral foundations in predicting attitudes towards cultured meat.

	Willing to Eat		Good		Unnatural		Absolute opposition	
	β	p	β	p	β	p	β	p
Age	-0.27	< .001	-0.17	< .001	0.11	0.010	0.08	0.067
Gender	-0.06	0.139	-0.03	0.548	0.01	0.768	0.05	0.214
Diet	-0.12	0.004	0.01	0.883	-0.03	0.528	0.003	0.942
Education	0.08	0.044	0.05	0.207	-0.04	0.327	-0.06	0.164
Conservatism	-0.09	0.039	-0.12	0.005	0.15	< .001	0.07	0.137
Harm	-0.01	0.846	-0.02	0.747	0.06	0.348	0.06	0.361
Purity	-0.09	0.088	-0.10	0.068	0.10	0.079	0.13	0.023
Fairness	0.08	0.175	0.12	0.044	-0.01	0.934	-0.11	0.081
Loyalty	0.05	0.370	0.07	0.233	-0.04	0.469	0.08	0.067
Authority	0.11	0.057	0.08	0.162	-0.13	0.020	0.05	0.214

Note: Gender is coded as 0 = male, 1 = female. Higher numbers on Diet represent more meat consumption.

3.3. Study 2

When examining descriptive statistics, mean scores again converged around the mid-point for willingness to eat cultured meat ($M = 3.16, SD = 1.24$) and the view that cultured meat is unnatural ($M = 3.26, SD = 1.24$). Participants were slightly above the mid-point for the view that cultured meat is good ($M = 3.54, SD = 1.09$) and below for absolute opposition ($M = 2.04, SD = 1.14$). We also examined correlations between predictors and outcome measures (Table 5).

In line with Study 1a, purity correlated with all four measures of attitudes towards cultured meat—namely, lower willingness to eat cultured meat and lower belief that cultured meat is good, greater belief that cultured meat is unnatural, and greater absolute opposition. Unlike Studies 1a and 1b, the moral foundation of harm positively correlated with the belief that cultured meat is good, but harm was not reliably associated with the other three outcome variables.

Although we did not find evidence of collinearity in Study 1a or 1b, we were mindful that the moral foundation subscales were highly correlated—a pattern that we anticipated and found in Study 2 (Table 5). As such, we made a preregistered decision to include only the harm and purity subscales in the regression models, as these were our variables of interest. We conducted a series of linear regressions with demographic variables, and the harm and purity subscales as predictors. We again conducted one linear regression for each outcome measure: willingness to eat, perceived goodness, perceived unnaturalness, and absolute opposition. We report the betas and p-values in Table 6, but full models can be found in supplementary materials. For transparency, we also report the results of the model including all subscales in the supplementary material. Any changes to key findings are noted.

We again found that younger participants, males, and those on the political left tended to have more positive responses overall. Purity was a significant predictor of all four measures of attitudes towards cultured meat, predicting lower willingness to eat cultured meat, lower belief that cultured meat is good, greater belief that cultured meat is unnatural, and greater absolute opposition to cultured meat. Unlike Study 1a, we also found that the moral foundation of harm was a significant positive predictor of the belief that cultured meat is good (but no other reliable associations were found with regard to harm). We note this finding did not persist in a full regression model with all moral foundation subscales (see supplementary materials). Overall, the results from Study 2 closely mirror those from the other U.S. sample in Study 1a.

4. Discussion

Across three studies we surveyed 1861 participants from the United States and Germany exploring the links between attitudes towards cultured meat and moral values, using the Moral Foundations Questionnaire (Haidt & Graham, 2007). We predicted that high scores on the purity subscale of the MFQ would be associated with negative attitudes towards cultured meat, while high scores on the harm subscale would be associated with positive attitudes. We found support for the first hypothesis: the moral foundation of purity uniquely predicted, and was correlated with, negative attitudes toward cultured meat in all

studies—though this pattern was much stronger in participants from the United States than those from Germany. We did not find any evidence for the second hypothesis: with the exception of perceived goodness in Study 2, the moral foundation of harm was not predictive of, or correlated with, attitudes towards cultured meat.

4.1. Theoretical contributions

In past research, people often cite unnaturalness as a reason to reject cultured meat (Bryant & Barnett, 2020; Siegrist et al., 2018; Siegrist & Hartmann, 2020; Siegrist & Sütterlin, 2017). Here we provide the first evidence directly linking this to the moral foundation of purity—showing that people who score high on the purity subscale of the MFQ are more likely to consider cultured meat unnatural, and also reject it more generally.

This finding has potential implications for the growing body of literature highlighting the role of emotion in the rejection of cultured meat. Research has previously linked judgements about purity to the emotion of disgust (e.g., Horberg et al., 2009). Other work has found that those higher in disgust are more likely to oppose cultured meat—and in particular to reject it on the grounds of absolute (moral) opposition (see Scott et al., 2016) or concerns about naturalness (Wilks et al., 2019, 2021). Perhaps, then, the links between these emotions and the rejection of cultured meat are driven by values surrounding purity. Understanding the mechanisms that facilitate the complex interplay between disgust, purity, and the moralization of cultured meat is an important area of future research.

Contrary to predictions, the moral foundation of harm was not generally predictive of attitudes (positive or negative) towards cultured meat. There was one exception to this; in Study 2, the moral foundation of harm correlated with, and was predictive of, perceiving cultured meat as good. However, this pattern did not persist when all five moral foundations were included in a regression model (detailed in supplementary material), thus we do not consider it a robust effect. These results are particularly surprising given that the pro-cultured meat narrative in media and industry is around harm reduction (Painter et al., 2020). It is possible that harm-based values would be a stronger predictor if the harm-relevant components of farmed meat were made salient in the experimental context (e.g., harm to animals and the environment). However, it may simply be that the narratives dominating media and industry do not capture the values underlying positive attitudes.

The demographic predictors identified here largely align with past research. We find that political orientation was a strong and consistent predictor of attitudes, with those on the political left showing more positive attitudes than those on the right (Bryant & Barnett, 2020) in both the United States and Germany. In line with prior research (Bryant & Barnett, 2020; Bryant, Anderson, et al., 2019, 2020; Shaw & Mac Con Iomaire, 2019; Slade, 2018; Wilks et al., 2019) younger people and those with higher education also generally preferred cultured meat, while men and those who ate more meat also showed more positive attitudes for some (but not all) measures. These results persisted across three studies, with participants from both the United States and Germany.

Table 5
Correlations between predictors (moral foundations) and outcome measures (attitudes towards cultured meat).

	Willing to Eat	Good	Unnatural	Absolute Opposition	Harm	Purity	Fairness	Loyalty
Good	0.78***							
Unnatural	−0.51***	−0.56***						
Absolute Opposition	−0.61***	−0.76***	0.50***					
Harm	0.05	0.10*	−0.01	−0.01				
Purity	−0.29***	−0.35***	0.31***	0.48***	0.07			
Fairness	0.14***	0.18***	−0.06	−0.12**	0.60***	−0.05		
Loyalty	−0.14***	−0.23***	0.19***	0.34***	0.07	0.61***	−0.04	
Authority	−0.25***	−0.28***	0.27***	0.37***	0.02	0.68***	−0.07	0.72***

Note. * $p < .05$, ** $p < .01$, *** $p < .001$.

Table 6
 β and p values for the role of demographics and moral foundations in predicting attitudes towards cultured meat.

	Willing to Eat		Good		Unnatural		Absolute opposition	
	β	p	β	p	β	p	β	p
Age	-0.13	< .001	-0.17	< .001	0.04	0.302	0.11	0.002
Gender	-0.20	< .001	-0.21	< .001	0.15	< .001	0.15	< .001
Diet	-0.23	< .001	-0.02	< .001	0.05	0.203	0.05	0.140
Education	0.02	0.502	0.06	0.535	-0.05	0.231	-0.09	0.014
Conservatism	-0.21	< .001	-0.17	0.138	0.11	0.026	0.11	0.021
Harm	0.09	0.169	0.11	< .001	-0.04	0.303	-0.04	0.244
Purity	-0.16	< .001	-0.22	0.006	0.25	< .001	0.40	< .001

Note: Gender is coded as 0 = male, 1 = female. Higher numbers on Diet represent more meat consumption.

Finally, it is important to recognize that the overall pattern of results was much stronger for the United States samples than the German sample. In the German sample, purity only predicted and correlated with one measure: absolute opposition to cultured meat. By contrast, it was associated with nearly all outcome measures in both U.S. samples. Interestingly, this difference does not appear to be driven by differences in overall attitudes towards cultured meat, or overall scores on the purity subscale (which were similar across all three samples). It is possible the weaker relationships in the German sample reflect differences in the makeup moral foundations across cultures. Some research suggests that the five factor model identified in the MFQ does not generalize equally well to all countries outside the United States (Turino & Saucier, 2020; Kim et al., 2012). Perhaps the purity subscale captures slightly different values in the German than United States sample, with the former less strongly linked to concerns about cultured meat.

4.2. Limitations

In Study 1a and 1b, we excluded a sizable portion of participants from our sample for failing a content check. We had concerns that this may have affected the representativeness of our data—for example perhaps we excluded participants low in conscientiousness—and part of the motivation for running Study 2 was to examine the data with higher quality participants. We note that the conclusions of Study 2 were very similar to Study 1a, which provides some reassurance that the high levels of attrition in the earlier studies did not have a major impact on the results. Another limitation is that our research surveys participants from just two countries, even though we acknowledge that past research has shown substantial variability in attitudes towards cultured meat across countries. For example, participants from Germany appear to have more positive attitudes than participants from France (Bryant, van Nek, & Rolland, 2020), while participants from China and India have more positive attitudes than those from the United States (Bryant, Szejda, et al., 2020). We lack sufficient cross-cultural data to make generalizable claims about how these relationships may emerge in a broader range of countries, particularly those with non-WEIRD backgrounds (Henrich et al., 2010). In addition, our work is not experimental, so we cannot make causal claims. However, we have taken a first step towards showing associations with these relationships. Finally, we note that there are statistical limitations with the inclusion of correlated predictors (e.g., Draper & Smith, 1998). We took steps to address this, confirming that there was no evidence of problematic levels of multicollinearity, and examining the models with the presence of only focal variables as well as the full moral foundations scales (See Study 2 and supplementary materials). Nonetheless, it is important to be mindful of this when interpreting our results.

4.3. Practical contributions

These findings may be of particular interest to advocates and those working in the alternate protein space. As discussed earlier, interventions aimed at shifting attitudes towards cultured meat have been

largely unsuccessful. These interventions have mostly focused on using information and education to improve attitudes, particularly information related to harm. The dominant narrative in cultured meat advocacy has also historically been about harm reduction (Painter et al., 2020). Perhaps then, these interventions have been limited in their success because they are not necessarily addressing the values that underpin consumer attitudes.

To clarify, we do not think that these results are strong enough to justify a shift away from harm-reduction claims in general. However, we hope that they encourage advocates and activists to more carefully consider the values that may underlie opposition to cultured meat—and take seriously the possibility of purity-based values as a contributor to shaping our attitudes.

Ethical statement

All studies in this manuscript received approval from the Yale University Institutional Review Board. All participants provided informed consent prior to participating.

CRediT authorship contribution statement

Matti Wilks: Writing – review & editing, Writing – original draft, Methodology, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Charlie R. Crimston:** Writing – review & editing, Writing – original draft, Methodology, Conceptualization. **Matthew J. Hornsey:** Writing – review & editing, Writing – original draft, Conceptualization.

Declaration of competing interest

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

Data availability

Anonymized data is made available on the open science framework.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.appet.2024.107297>.

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