The Effectiveness of anti-naturalistic fallacy strategies on acceptance of "clean" meat

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1. INTRODUCTION

Motivation. "Clean meat" – i.e. meat products made from cultured animal tissues – has the potential to significantly reduce animal suffering and environmental damage while improving human health. Although clean meat products have been the source of a great deal of excitement in the media over the past few years,[1] these products are likely to face substantial public resistance since they conflict with prevailing cultural intuitions and cognitions. Since clean meat products are viewed by many potential consumers as "artificial" or "lab-grown" meat, these products conflict with the widespread heuristic that "what is natural is good". Moreover, the expected benefits of clean meat are either temporally distant (e.g. long-term health benefits, avoiding catastrohpic climate change) or spatially removed (e.g. animal suffering in factory farms), making it difficult for consumers to incorporate these benefits in their decisionmaking calculus.[2]

[1] See, e.g. https://www.washingtonpost.com/news/wonk/wp/2015/05/20/meet-the-future-of-meat-a-10-lab-grown-hamburger-that-tastes-as-good-as-the-real-thing/; http://fortune.com/2016/02/02/lab-grown-memphis-meats/; http://gizmodo.com/the-future-will-be-full-of-lab-grown-meat-1720874704.

[2] For a review of recent research on individual decisions with temporally or spatially distant consequences, see Wade-Benzoni and Tost (2009); Markowitz and Shariff (2012).

The "naturalistic heuristic" – where consumer attitudes are biased towards products that are more congruent with their notion of what is "natural" for humans to consume and what kinds of organisms/chemicals/processes occur in the natural environment – is not unique to clean meat. Genetically modified (GM) foods, vaccines, nuclear power, and stem cell research face similar barriers to acceptance in the general public. In short, although a naturalistic heuristic may in general help consumers choose healthier food products with less added sugars, fats, and preservatives, at the same time this heuristic poses a significant barrier to public acceptance of technologies that could have far-reaching benefits for scientific advancement, public health, environmental sustainability, and animal welfare.

There is a rapidly growing body of research on public perceptions of vaccines, GM foods, and nuclear power (see, e.g., Yaqub et al., 2014). which has recently expanded to the study of public attitudes towards clean meat products (e.g. Wilks and Phillips, 2017). Yet, few studies on vaccines, GM foods, or nuclear power have examined the effectiveness of competing messaging strategies at overcoming these naturalistic concerns and increasing consumer acceptance.[3] In particular, we are not aware of any experimental research that compares the efficacy of different messaging strategies for increasing consumer acceptance of clean meat products. Given that clean meat products are expected to become widely available to consumers in the next couple of years, this lack of research on effective strategies for overcoming consumers' naturalistic heuristic raises important concerns about the likely acceptance and uptake of clean meat products.

Research design. In this study, we set out to answer three main questions: (1) To what extent is consumer acceptance of clean meat products driven by concerns about health, safety, and "naturalness" – each of which is indicative of the naturalistic heuristic – rather than more conventional consumer concerns about cost and taste? (2) As a novel consumer product, how susceptible is consumer acceptance of clean meat products to *negative social information*, consisting of negative reactions towards clean meat products from peers? And (3) how effective is "direct debunking" of the naturalistic heuristic at increasing consumer acceptance of clean meat products compared to a simple "social norm" pro-clean meat message and a placebo message?

To address these questions, we conduct a three-wave 2x4 full factorial survey experiment that examines how messaging strategies and *negative social information* affect individual acceptance of clean meat products and susceptibility to the naturalistic fallacy. First, we randomly assign participants to receive negative social information or not, consisting of a sample of five negative reactions towards clean meat from previous survey respondents (e.g. "Artificial meat sounds disgusting"). Second, we randomly assign participants to read either a *placebo* article or one of three pro-clean meat articles: a *natural does not mean good* appeal, *most foods are unnatural* appeal, or *social norm* appeal.

The first two appeals are variations of a "direct debunking" strategy, similar to the "misper-

[3] For exception, see Nyhan and Reifler (2015); Nyhan et al. (2014).

ception correction" messaging strategy commonly used to combat anti-vaccination beliefs.[4] Both the *natural does not mean good* and *most foods are unnatural* appeals invokes the naturalistic heuristic in order to argue against its application in the case of clean meat products, although the two appeals differ in emphasis. Specifically, the *natural does not mean good* appeal focuses narrowly on debunking the naturalistic fallacy, pointing out that some seemingly "natural" compounds are clearly bad (e.g. arsenic) while other seemingly "unnatural" products clearly have positive benefits (e.g. antibiotics). In contrast, the *most foods are unnatural* appeal emphasizes how clean meat products are similar to many other seemingly "unnatural" foods that have already been widely accepted by most consumers, thereby encouraging readers to add clean meat products to the set of products they deem as acceptable. This messaging strategy is meant to leverage consumers' "cultural intuitions" (Miton and Mercier, 2015) about what is acceptable by equating clean meat products with other products they have already accepted. Finally, the *social norm* appeal does not make any persuasive arguments invoking the naturalistic falalcy, instead conveying a *descriptive* norm that many consumers are excited about clean meat and would like to try it once it becomes available in their area.

Results. We produce four main sets of results. First, before turning to the experimental results, we show that consumers' wariness about clean meat is driven far more by concerns about whether clean meat is natural, safe, and healthy – which are symptoms of the naturalistic fallacy – than how clean meat products taste or how much they cost. Second, we show that even small amounts of negative social information about clean meat can make consumers significantly more wary about clean meat products, making the task of marketing clean meat products even more difficult. Third, on a more optimistic note, we show that pro-clean meat appeals which debunk the naturalistic fallacy can counteract nearly all of the negative effects of negative social information. In particular, these appeals produce substantial improvements in consumer attitudes towards clean meat and effectively reduce concerns that clean meat is "unnatural". Nevertheless, we find little evidence that the direct debunking appeals are any more effective than a simple social norm message. Fourth, we show that the positive effects of these appeals are *not* restricted to individuals who were already highly supportive of clean meat products or who already consumed very few servings of conventional meat products per week.

Note to reader: we are awaiting results from the endline survey (survey wave 3), so all findings presented in this draft are based on results from the survey waves 1 and 2.

Contributions. The purpose of this study is to shed light on the ways in which individuals respond to the naturalisic fallacy and whether information treatments can help to counter it. More broadly, this research deepens our understanding of the ways in which individuals form opinions towards new technologies that may conflict with cultural intuitions. Given that online information and social media are an important source of misinformation that drives negative attitudes towards many technologies and products (e.g. GM foods, vaccines, nuclear

[4] See, for instance: www.who.int/vaccine_safety/initiative/detection/immunization_misconceptions; www.health.ny.gov/prevention/immunization/vaccine_safety/misperceptions.

power), these findings offer promise that simple online articles can effectively counteract negative attitudes.

2. EXPERIMENTAL DESIGN

Research questions. In this study, we set out to answer three main questions:

1. To what extent is consumer acceptance of clean meat products driven by concerns about health, safety, and "naturalness" – each of which is indicative of the naturalistic fallacy – rather than more conventional consumer concerns about cost and taste?
2. As a novel consumer product, how susceptible is consumer acceptance of clean meat products to "negative social information"?
3. How effective is "direct debunking" of the naturalistic heuristic at increasing consumer acceptance of clean meat products compared to a simple "social norm" pro-clean meat message and a placebo message?

Data collection. Data was collected in three online survey waves:

1. *Baseline survey.* Participants were asked about demographics, current levels of meat consumption, attitudes, and potential moderators. All participants were also given basic information about clean meat and some purported environmental/health/ethical benefits of consuming clean meat products.
2. *Treatment exposure.* One week after completing the baseline survey, the same participants were recontacted and asked to complete a second survey. Participants were randomly assigned to one of eight experimental cells (see below). Then participants assigned to the four "social information" cells were shown a page containing five short quotes from previous survey respondents that contain negative sentiment about clean meat (e.g. "This seems very unnatural. I don't feel comfortable about this."). All participants were then shown a placebo news article or one of three pro-clean meat appeals corresponding to their experimental cell. Immediately afterwards, all participants completed a short survey containing a discrete choice block (see below) and several open-ended questions regarding their reactions to the news article. Participants were also asked for their attitudes towards clean meat, willingness-to-pay, and interest in further information about clean meat products and vegetarian products.
3. *Endline survey.* Approximately one month after completing the treatment exposure survey, the same participants were recontacted and asked to complete a third and final survey. Participants were asked to complete a short survey containing a discrete choice block, attitudes towards clean meat, willingness-to-pay, and interest in further information about clean meat products and vegetarian products.

Experimental conditions. This study is organized as a randomized 2x4 full factorial design, examining how social information and messaging appeals affect individual acceptance of

clean meat products and susceptibility to the naturalistic fallacy. First, we randomly assign participants to receive *negative social information* or not, consisting of a sample of five negative reactions from previous survey respondents towards clean meat (e.g. "Artificial meat sounds disgusting").

Second, we randomly assign participants to read one of four articles: a *placebo* message, *natural does not mean good* appeal (appeal #1), *most foods are unnatural* appeal (appeal #2), or *social norm* appeal (appeal #3). All messages are approximately 150-200 words in length, with three images that help to convey the main message. The *placebo* message urges participants to walk more, and makes no mention of clean meat products or meat consumption.

Appeals 1 and 2 are variations of a "direct debunking" strategy, similar to the "misperception correction" messaging strategy commonly used to combat anti-vaccination beliefs. While this messaging strategy is in widespread use, there is very little evidence that such correction-oriented appeals are effective at countering negative attitudes/beliefs (Nyhan and Reifler, 2015; Nyhan et al., 2014). While both the *natural does not mean good* and *most foods are unnatural* appeals invoke the naturalistic heuristic in order to argue against its application in the case of clean meat products, the two appeals differ in emphasis. The *natural does not mean good* appeal (appeal #1) provides several examples of objects/phenomena that are clearly good but unnatural (e.g. antibiotics) and objects/phenomena that are clearly bad but natural (e.g. appendicitis). In contrast, the *most foods are unnatural* appeal (appeal #2) describes how nearly all foods we eat today have been artificially engineered through selective breeding and other practices such that they no longer resemble their naturally occuring ancestors. This appeal is designed to more directly align clean meat products with consumers' intuitions about whether clean meat is likely to be beneficial to their health, thereby making it easier to accept the "counter-intuitive" conclusion that clean meat is a desirable product despite the naturalistic heuristic.[5] Specifically, by emphasizing how clean meat is similar to many other kinds of foods that have been widely accepted by most consumers, readers are encouraged to add clean meat products to the set of products that are deemed acceptable rather. Hence, if we were to find that the *most foods are unnatural* appeal is more effective than the *natural does not mean good*, this would suggest that appealing to consumers' cultural intutions is an important component of new product acceptance.

Finally, the *social norm* appeal (appeal #3) conveys a *descriptive* norm that many consumers are excited about clean meat and would like to try it once it becomes available in their area. This appeal makes no attempt to debunk the naturalistic heuristic or to emphasize the benefits of clean meat. Instead, it merely signals to readers that many other consumers seem to be excited about clean meat products, rather than concerned about potential health and safety implications.

Subject recruitment and sample size. We recruited participants through Amazon Mechan-

[5]For a discussion of how "culturally shared intuitions" – such as the naturalistic heuristic – may affect beliefs towards vaccines and similar technologies, see Miton and Mercier (2015).

ical Turk (MTurk). Each participant was paid US$0.50 for completing the baseline survey, US$0.50 for completing the treatment survey, and US$1.00 for completing the endline survey (for a total of US$2.00 for participation in the entire study). Following the baseline survey, we recontacted participants via email. We recruited 400 subjects per experimental cell, for a total of 3200 subjects.

Primary outcome measures. All variables described in this section were measured in the baseline, treatment, and endline survey waves, unless otherwise stated.

- *Interest in clean meat.* We collect several attitudinal measures on attitudes towards clean meat, such as "how interested are you in purchasing the clean meat product you just read about?" (1-7 scale) and "Would you like to be notified when clean meat products are available in your area?" (yes/maybe/no and provision of e-mail address in a follow-up question asked to those answering "yes" or "maybe").
- *Concerns about clean meat.* We asked participants to select the two most important concerns they have about clean meat products. We also provided participants with an open-ended text box to state their most important concerns about clean meat products.
- *Perceived benefits of clean meat.* We asked participants to select the benefits they think clean meat products will have. We also provided participants with an open-ended text box to state what they perceive will be the most important benefits of clean meat products.
- *Willingness to pay for clean meat.* We infer participants willingness to pay for clean meat from a discrete choice experiment at the end of the treatment survey. Respondents were presented with sets of descriptions of two or three different products, each consisting of a set of 2 attributes: (a) Product: clean meatballs, vegetarian meatballs, conventional meatballs; (b) Price per lb: $5, $10, $15, or $20. A full factorial design accounting for all interactions among those exposed to information about clean meat consists of 12 different combinations (3 products $\times$ 4 prices). We asked respondents to answer one of two alternative blocks of 6 questions (randomly assigned).

Secondary outcome measures. All variables described in this section were measured in the baseline, treatment, and endline survey waves, unless otherwise stated.

- *Attitudes towards factory farming.* We collected four attitudinal measures on meat consumption and factory farming. Participants were asked to rate whether and how much factory farming contributes to animal suffering and whether this is an issue they care about; whether and how much factory farming contributes to environmental degradation, and whether this is an issue they care about; and whether they think it is morally preferable to avoid eating factory farmed meat. Participants were also asked whether they would be interested in receiving tips on how to reduce their meat consumption.
- *Perceptions of social norms.* On a seven point scale, participants were asked whether they agree or disagree with the statement that more and more people in the US are reducing their meat consumption (1=strongly disagree, 7=strongly agree).

- *Perceptions of vegetarians.* Participants were asked to give their feelings towards vegetarians (1=extremely positive, 7=extremely negative).
- *Perceptions of intelligence and sentience.* Participants were asked to rate seven species of animals on a 1-7 scale in terms of perceived intelligence (1=very unintelligent, 7=very intelligent). Similarly, participants were asked to rate how capable these seven species of animals were of experiencing pain and suffering on a 1-7 scale (1=completely incapable, 7=highly capable). We use "humans" as a comparison group in the analyses.
- *Ease of reducing meat consumption.* On a seven point scale ranging from very difficult (1) to very easy (7), participants were asked to rate how easy it would be to completely eliminate conventional meat products from their diet over the next year and how easy it would be to reduce their consumption of conventional meat products by 25% over the next year.

3. RESULTS

Overall, how interested are consumers in clean meat products? Based on the results of our survey, there is a sizable minority of consumers who are interested in trying clean meat products. At the end of the treatment survey wave, 36.4% of respondents in the control group ($n = 308$) entered their email address in order to be notified when clean meat products become available in their area. In addition, 51.3% of respondents answered "probably yes" or "definitely yes" to whether they would eat a clean meat product, while 28.6% of respondents said that they were "very interested" or "extremely interested" in purchasing clean meat products. See Figure 6 in the Appendix for further information on these descriptives.

In the analyses that follow, we examine consumer attitudes towards clean meat products in four stages. First, we show that consumers' wariness about clean meat is driven far more by concerns about whether clean meat is natural, safe, and healthy than how it tastes and how much it costs. Second, we show that even small amounts of negative social information about clean meat can make consumers significantly more wary about clean meat products, making the task of marketing clean meat products even more difficult. Third, on a more optimistic note, we show that pro-clean meat appeals which debunk the naturalistic fallacy can counteract nearly all of the negative effects of negative social information. In particular, these appeals produce substantial improvements in consumer attitudes towards clean meat and effectively reduce concerns that clean meat is "unnatural". Nevertheless, we find little evidence that the direct debunking appeals are any more effective than a simple social norm message. Fourth, we show that the positive effects of these appeals are *not* restricted to individuals who were already highly supportive of clean meat products or who already consumed very few servings of conventional meat products per week.

3.1. Naturalistic reasoning undermines interest in clean meat

How important are consumer concerns emanating from the naturalistic fallacy – such as perceptions that clean meat is "unnatural", "unsafe", or "unhealthy" – in undermining willingness to eat clean meat products relative to more conventional consumer concerns, such as price and taste? Here, we show that the former concerns are the main barriers to consumer interest in purchasing and eating clean meat products, while price and taste are only weakly related to consumer interest. Figure 1 illustrates this fact, showing that respondents in the placebo group ($n = 308$) who expressed these concerns were dramatically less interested in clean meat products than respondents who reported more concerns about price and taste. For instance, among respondents who did *not* raise the "unnatural" concern about clean meat in the baseline survey wave, 44.7% provided an email address at the end of the treatment wave to be notified when clean meat becomes available in their area. In contrast, only 28.9% of respondents who listed "unnatural" as a concern provided an email address.[6] By comparison, 41.2% of respondents who did *not* raise "taste" as a concern entered an email address in contrast to 32.4% among respondents raising the "taste" concern. Hence, while concerns about the extent to which clean meat is natural, safe, and healthy were raised *less* often than concerns about price and taste, the former concerns are much more strongly associated with individual interest in clean meat products.

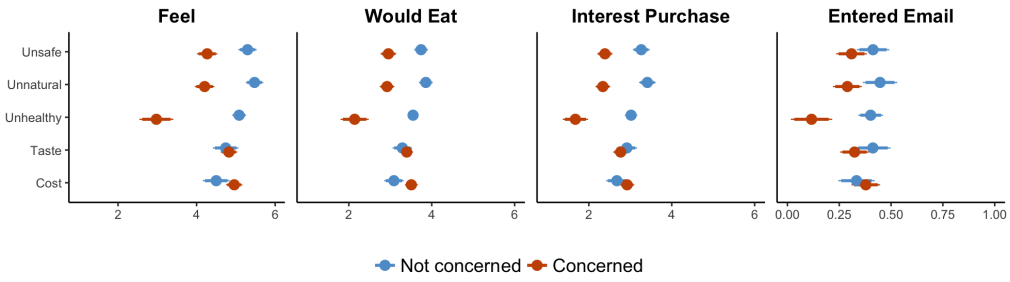

Figure 1: Interest in clean meat by concern raised. Average interest in clean meat (measured in treatment wave) among respondents raising each of five possible concerns about clean meat (measured at baseline), showing that "unnatural", "unhealthy", and "safe" concerns are associated with large reductions in interest in clean meat on average. Means are displayed separately for individuals expressing the concern and individuals not expressing the concern. Means are computed from the subset of respondents who were not exposed to any treatment condition ($n = 308$). Horizontal bars represent 90% and 95% confidence intervals.

However, given the novelty of clean meat products, these concerns about whether clean meat is natural and safe might merely be the result of an initial "shock factor", such that consumers' concerns will shift more towards price and taste as they become more comfortable over time with the normalcy of clean meat products. Our results offer some support for this perspective, although the results are mixed. While the percentage of respondents raising "unsafe" as a concern dropped from 49.5% to 40.1% between the baseline and treatment waves (diff: 9.4%; $p < 0.01$), the percentage of respondents raising "unnatural" as a concern

[6] This strong association between the "unnatural" concern and interest in clean meat persists even after controlling for other concerns and demographics in a simple linear probability model framework.

did not change at all. Conversely, the proportion of respondents citing "cost" as a concern increased significantly from 62.9% of respondents to 68.7% (diff: 5.8%; $p < 0.05$), yet the proportion of respondents raising "taste" as a concern remained nearly constant at approximately 56%. Hence, while we find some evidence that consumer concerns about clean meat shift away from safety and towards price through repeated exposure (without any further information about the benefits/costs of clean meat), concerns about how "natural" clean meat is appear more sticky.

3.2. Effects of Negative social information

How susceptible are consumer attitudes to exposure to the anti-clean meat attitudes of other consumers? As we've shown above, a sizable minority of consumers have a positive orientation towards clean meat products, yat the same time many consumers are wary about the safety, naturalness, and health benefits of these products. Given the novelty of clean meat products in the minds of consumers, small amounts of negative information about clean meat products could drastically shift consumer opinion against these products.

Here, we examine the extent to which a small amount of negative social information – in the form of short quotes from previous survey respondents expressing negative sentiment towards clean meat (e.g. "Our guts are not meant to digest unnatural things") – undermines consumer interest in clean meat products. Figure 2 displays the effects of the negative social information on attitudes towards clean meat, comparing all respondents who were exposed to the negative quotes against unexposed respondents. The results are discouraging, showing that small amounts of social information from complete strangers significantly decreases respondents' interest in clean meat products. In particular, this information led to a decrease of 3.4% percentage points ($p < 0.05$) in the proportion of individuals who entered their email address to be notified when clean meat products are available in their area. In addition, negative social information led to a significant increase in the proportion of respondents concerned about whether clean meat is healthy and safe (2, panel 1). Exposed individuals were 7.5% percentage points ($p < 0.01$) more likely to raise "unhealthy" as a concern about clean meat than individuals not exposed to negative social information, as well as 5.0% percentage points more likely to raise "unsafe" as a concern.

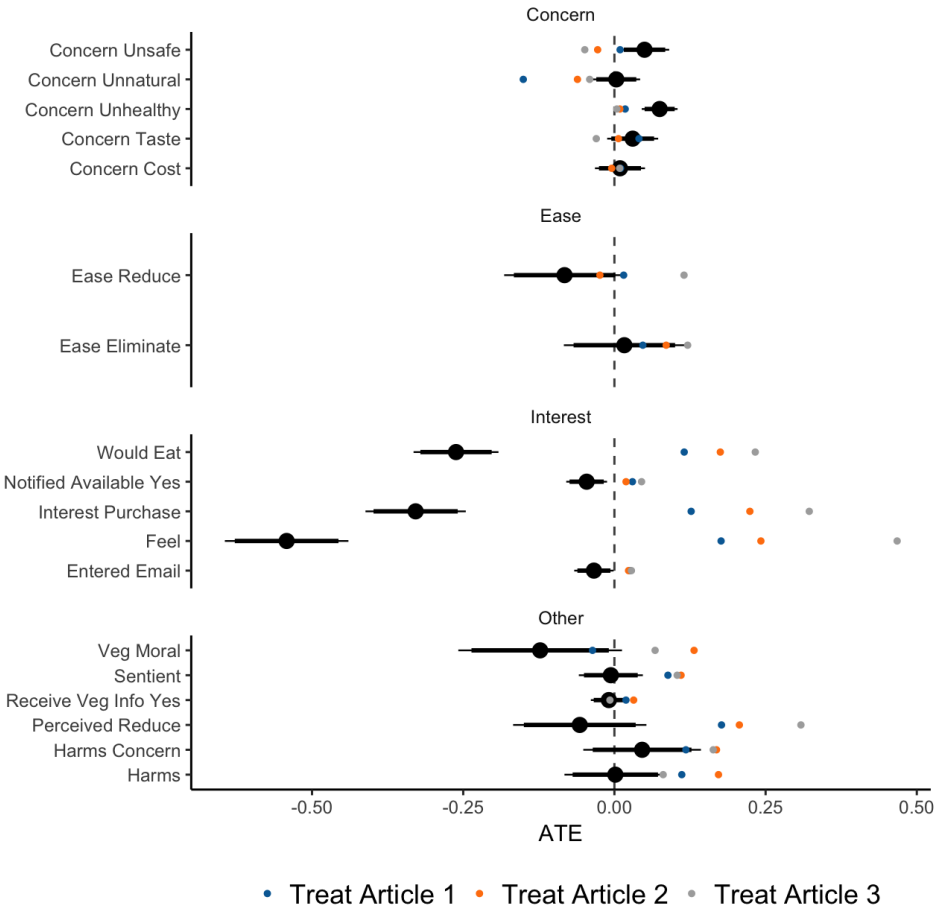

Figure 2: Social information effects. Each black dot represent the estimated treatment effect of negative social information on a single outcome measure. Outcome measures are computed as the change between baseline and treatment waves. Horizontal bars represent 90% and 95% confidence intervals. For comparison, the small colored dots represent estimated treatment effects of the three treatment appeals. Treat article #1: *natural does not mean good* appeal; Treat article #2: *most foods are unnatural* appeal; Treat article #3: *social norm* appeal.

3.3. Appeal effects

Can simple appeals aimed at debunking the naturalistic fallacy and conveying descriptive social norms effectively overcome the pernicious effects of negative social infomation shown above? Here, we show that each of the three pro-clean meat appeals examined in this study can largely – but not completely – wash out these negative effects. Figure 3 displays the effects of the *natural does not mean good* appeal (Appeal #1), *most foods are unnatural* appeal (Appeal #2), and *social norm* appeal (Appeal #3) relative to placebo on interest in clean meat, while Figure 4 displays the effects on concerns about clean meat. In both figures, outcome variables are measured in terms of the change between baseline and endline surveys. We discuss the main results below.

Interest in clean meat. As shown in Figure 3, all three appeals led to improvements in consumer attitudes towards clean meat products. While the *social norms* appeal had larger effects than the other two appeals on consumer feeling towards clean meat (*feeling*) and interest in purchasing clean meat (*interest purchase*), the three appeals are broadly similar in their effectiveness. Yet, the effects on willingness to be notified when clean meat products become available (*notified available* and *entered email*) are significantly weaker.

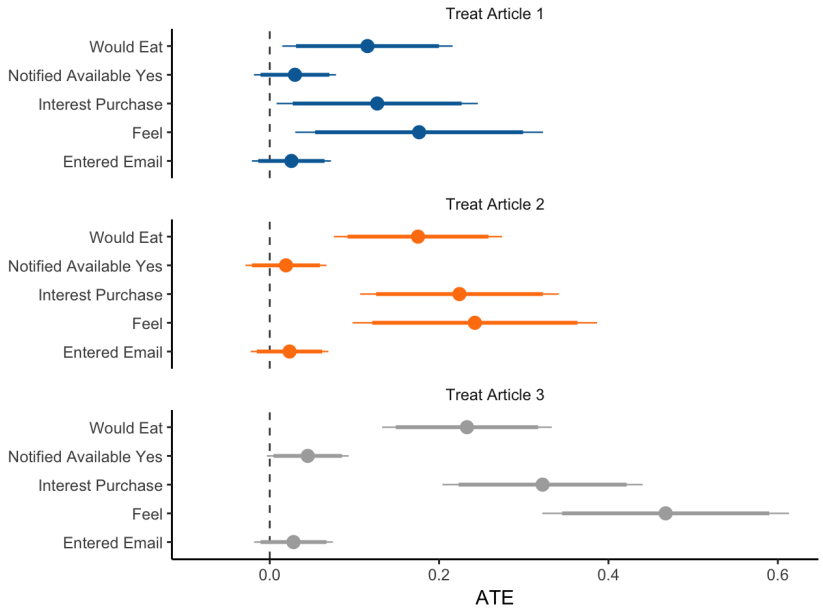

Figure 3: Appeal effects on interest in clean meat. Each dot represents the estimated treatment effect of a pro-clean meat appeal (relative to the placebo appeal) on a given outcome measure. Outcome measures are computed as the change between baseline and treatment waves. Horizontal bars represent 90% and 95% confidence intervals. Treat article #1: *natural does not mean good* appeal; Treat article #2: *most foods are unnatural* appeal; Treat article #3: *social norm* appeal.

Concerns about clean meat. Figure 4 illustrates that the *natural does not mean good* and *most foods are unnatural* appeals effectively reduced consumer concerns about whether clean meat is "unnatural", as we should expect. For instance, the proportion of respondents

in the *natural does not mean good* arm raising "unnatural" as a concern decreased by roughly 15 percentage points more between the baseline and treatment waves than the comparable change among respondents reading the placebo article. The *scial norms* appeal also led to a non-trivial reduction in the number of respondents raising the "unnatural" concern, yet this effect does not reach conventional levels of statistical significance.

The *most foods are unnatural* and *social norms* may have also led to sizable reductions in concerns about the safety of clean meat, which should be expected given that the former emphasizes that clean meat is not very different from many other safe food products and the latter normalizes clean meat products by emphasizing widespread consumer excitement about their availability. However, these effects do not reach conventional levels of statistical significance.

Finally, the three appeals had no demonstrable effects on consumer concerns about the health benefits, taste, or cost of clean meat products. Overall, the substantial effects of the pro-clean meat appeals on consumer concerns about clean meat's "natural" qualities provides reason for optimism that these appeals can effectively improve consumer attitudes by combating the naturalistic fallacy. However, the weak effects on consumer concerns about clean meat's safety and health benefits raise doubt about the degree to which these appeals can effectively induce other shifts in consumer concerns about clean meat products.

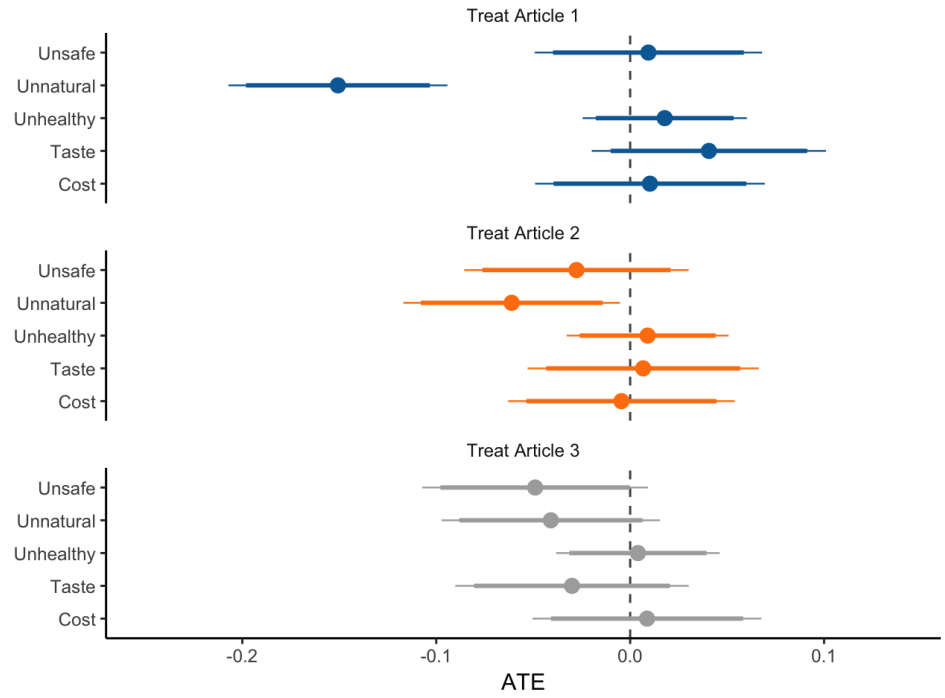

Figure 4: Appeal effects on concerns about clean meat. Each dot represents the estimated treatment effect of a pro-clean meat appeal (relative to the placebo appeal) on a given outcome measure. Outcome measures are computed as the change between baseline and treatment waves. Horizontal bars represent 90% and 95% confidence intervals. Treat article #1: *natural does not mean good* appeal; Treat article #2: *most foods are unnatural* appeal; Treat article #3: *social norm* appeal.

3.4. Did appeals influence the least interested respondents?

Are the effects of the pro-clean meat appeals driven merely by individuals who are already interested in consuming clean meat products? If the appeals have little effect on those that are opposed to or undecided about clean meat, then the results reported above would greatly *overstate* the potential for expanding the clean meat market through short pro-clean meat appeals of the sort examined in this experiment. Fortunately, as we show in Figure 7 (Appendix), the effects of each pro-clean meat appeal on various measures of interest in clean meat are *not* systematically smaller among individuals who reported being less interested in clean meat in the baseline survey.

In addition, Figure 8 (Appendix) displays the effects of the three pro-clean meat appeals broken down by whether respondents agreed or disagreed with the negative social information (if shown). Respondents who *disagreed* with the negative social information – indicating favorable baseline attitudes towards clean meat – were not affected by the pro-clean meat appeals. In contrast, respondents who *agreed* with the negative social information were more likely to increase their acceptance of clean meat products after reading one of the three appeals.

In short, *we find no evidence* to suggest that the positive effects of the pro-clean meat appeals on consumer attitudes are concentrated among individuals who are already supportive of clean meat products.

3.5. Did appeals influence the biggest meat-eaters?

Are the effects of the pro-clean meat appeals driven by individuals who already consume very few servings of meat? For clean meat products to achieve significant environmental, animal welfare, and health improvements, they will need to adopted by typical meat-eaters rather than vegetarians and "reducetarians" who only eat a few servings of meat products each week. In Figure 5, we estimate treatment effects separately for individuals who reported at baseline eating 0-9 servings of meat per week, 9.5-13 servings of meat per week, 13.5-19.5 servings of meat per week, and 20 or more servings of meat per week. Here, we find that the pro-clean meat appeals had roughly similar effects across all four levels of weekly meat consumption. If anything, the effects are smaller among individuals who reported eating *less* meat at baseline. In addition, we do not find any evidence that individuals who eat vegetarian meats – such as tofu and tempeh – responded more positively to the appeals, adding further optimism that the pro-clean meat appeals have the potential to encourage meat-eaters to substitute clean meat products in place of conventional meat products.

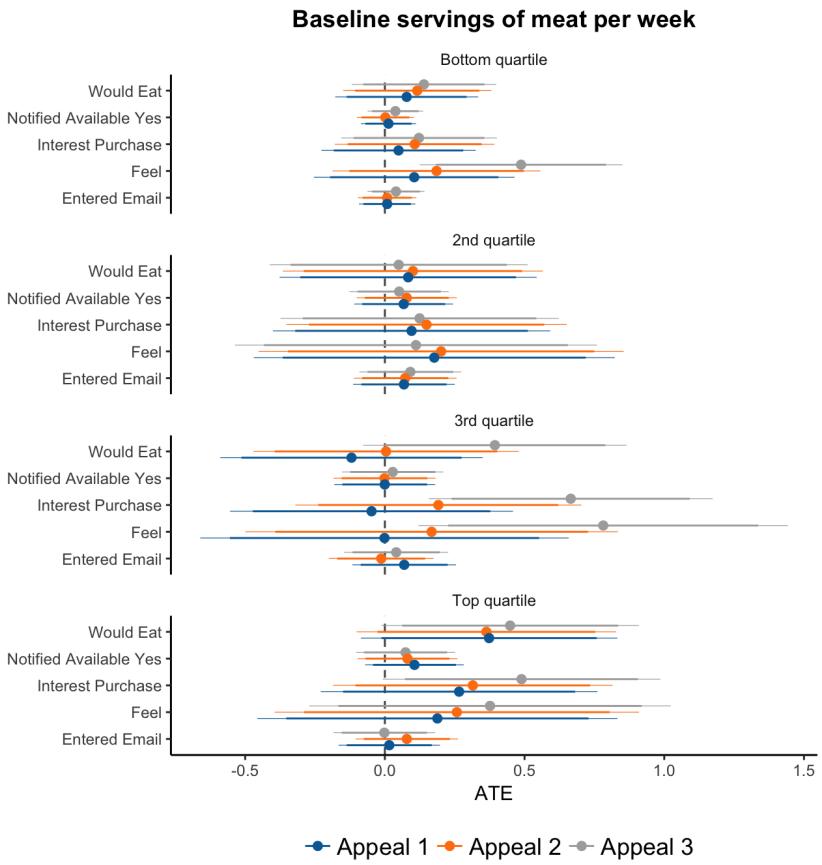

Figure 5: Heterogeneity in appeal effects by number of servings of meat consumed per week at baseline. Horizontal bars represent 90% and 95% confidence intervals. Treat article #1: *natural does not mean good* appeal; Treat article #2: *most foods are unnatural* appeal; Treat article #3: *social norm* appeal.

3.6. Combating negative social information

As shown in Figure 2, the pro-clean meat appeals counteract much of the pernicious effects of negative social information. But are certain appeals more effective at curtailing the effects of negative social information than others? We examine this question in Figure 9 (Appendix), displaying the effects of each appeal on interest in clean meat products, broken down by whether respondents were exposed to negative social information or not. Here, the *most foods are unnatural* and *social norms* appeals are just as effective at improving consumer attitudes towards clean meat whether or not respondents had just been exposed to negative social information. In contrast, the *natural does not mean good* appeal is marginally *more* effective in the face of negative social information, with all coefficients somewhat larger when respondents had just read anti-clean meat quotes. However, these estimates are imprecise and should not be given much inferential weight. Hence, overall we find that all three pro-clean meat appeals are roughly as effective in the face of negative social information, and there is no single appeal that is consistently more effective than the others in this setting.

While it is promising that, for the most part, the treatment appeals continue to have positive effects on consumer acceptance of clean meat products in the face of negative social information, Figure 2 contains a less encouraging result: *none* of the three pro-clean meat appeals entirely counteract the negative effects of social information. On average, respondents who read the *placebo* appeal and who were *not* exposed to negative social information maintained a higher level of acceptance of clean meat products than respondents who were exposed to negative social information in combination with any one of the three pro-clean meat appeals. Hence, in order to overcome the pernicious effects of negative social information, individuals are likely to need repeated exposure to pro-clean meat appeals.

4. CONCLUDING REMARKS

Overall, we show that simple "debunking" appeals aimed at combating the naturalistic heuristic can be effective at improving public acceptance of cultured meat products. At the same time, however, these positive effects can easily be over-shadowed by small amounts of negative social information. More results to come soon.

5. APPENDIX

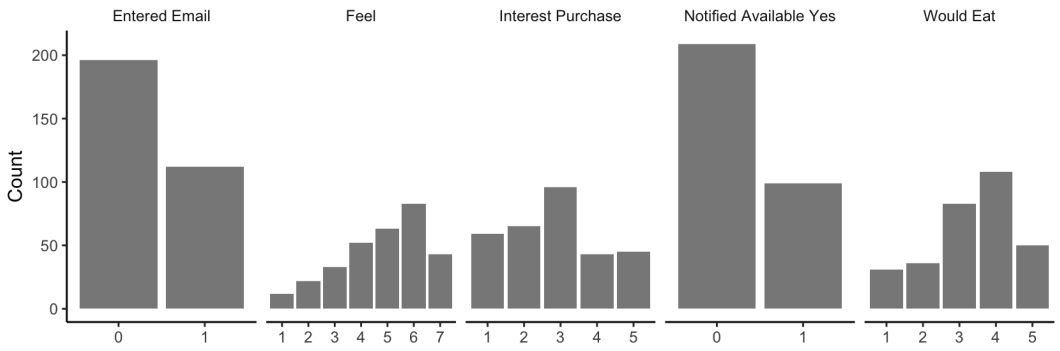

Figure 6: Interest in clean meat products.

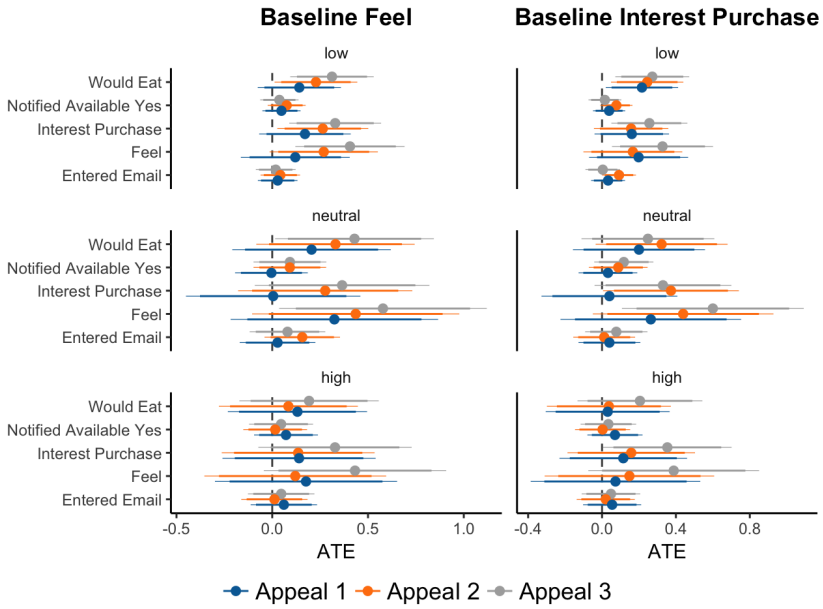

Figure 7: Heterogeneity in appeal effects by baseline interest in clean meat. Horizontal bars represent 90% and 95% confidence intervals. Treat article #1: *natural does not mean good* appeal; Treat article #2: *most foods are unnatural* appeal; Treat article #3: *social norm* appeal.

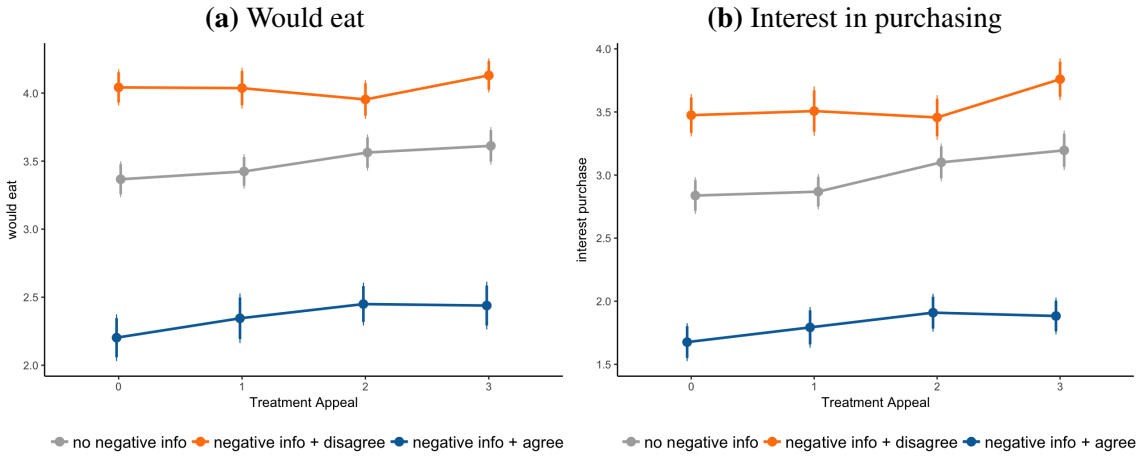

Figure 8: Appeal effects by agreeance with negative social information. These plots display the averages for individuals exposed to each of the treatment appeals (x axis) in terms of whether they would eat clean meat products (subplot (a)) and whether they are interested in purchasing clean meat products (subplot (b)), broken down by whether respondents agreed or disagreed with the negative social information. 90% and 95% confidence intervals are shown.

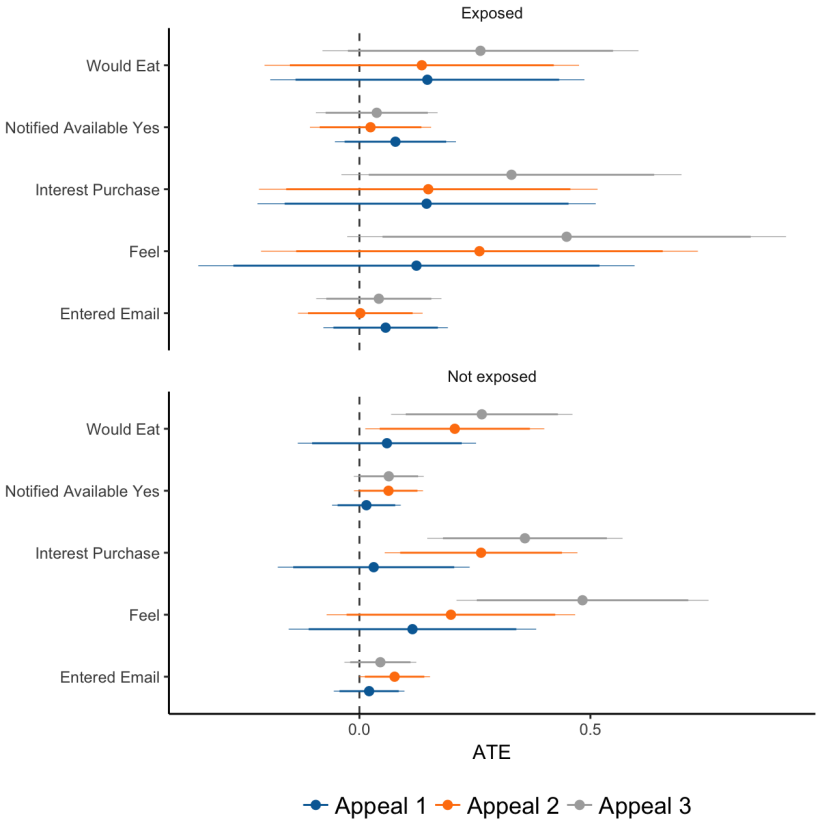

Figure 9: Heterogeneity in appeal effects by whether respondents exposed to negative social information. Horizontal bars represent 90% and 95% confidence intervals. Treat article #1: *natural does not mean good* appeal; Treat article #2: *most foods are unnatural* appeal; Treat article #3: *social norm* appeal.

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