



Effective strategies for overcoming the naturalistic heuristic

Experimental evidence on consumer acceptance of “clean” meat

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Abstract

The naturalistic heuristic of “what is natural is good” poses a serious barrier to consumer adoption of genetically modified foods, childhood vaccinations, and related technologies. In this study, we examine three messaging strategies — direct debunking, embracing unnaturalness, and descriptive norms — for overcoming consumer resistance in the context of a new food technology: “clean meat” (also known as “cultured” or “in vitro” meat). We compare the effects of these three pro-clean meat appeals against the undermining effects of being exposed to anti-clean meat reactions from other potential consumers. We find persistent negative effects of the anti-clean meat social information over 10 weeks. Of the three pro-clean meat appeals, only the embrace unnaturalness appeal successfully offset the undermining effects of anti-clean meat social information over the 10 week study period, suggesting that advocates wishing to enhance consumer acceptance of new food technologies should focus on how these technologies are similar to products that also seem “unnatural” but which are already widely adopted by consumers.

¹ Corresponding author. De-identified data and code for this project will be made available at: github.com/bnjmacdonald/antinaturalistic-fallacy. All experimental materials, including the text of the treatments and the survey questions, will also be made available here. This research was approved by the Stanford Institutional Review Board (protocol ID: 39306) and the Australian National University (protocol ID: 2016/613). Funding: This research was supported by Animal Charity Evaluators. Animal Charity Evaluators had no involvement in any aspect of study design, implementation, or write up of the results. Declaration of interests: none.

1. Introduction

“Clean meat” — i.e. meat products made from cultured animal tissues (also known as “cultured” or “in vitro” meat) — has the potential to dramatically reduce the environmental footprint and animal suffering associated with conventional meat production, while also yielding health benefits.² However, since clean meat products conflict with the widespread heuristic that “what is natural is good”, these products are at risk of becoming branded as “artificial” and “lab-grown” in the minds of consumers. This “naturalistic heuristic” — where consumers favor products that are congruent with their notion of what is “natural” for humans to consume and what kinds of organisms/chemicals occur in the natural environment — is not unique to clean meat (on the importance of “food naturalness” to consumers, see [Roman et al. 2017](#)). Genetically modified (GM) foods, vaccines, and other technological advances have faced similar barriers to acceptance in the general public ([Lusk et al. 2015](#), [Siegrist 2008](#), [Costa-Font et al. 2008](#), [Saher et al. 2006](#), [Frewer et al. 1996](#), [Miton and Mercier 2015](#), [Yaqub et al. 2014](#), [Nyhan et al. 2014](#), [Siegrist et al. 2009](#), [Siegrist et al. 2007](#), [Runge et al. 2017](#), [O’Keefe et al. 2016](#), [Rollin et al. 2011](#), [Frewer et al. 2011](#), [Siegrist 2008](#)). Making matters worse, the expected benefits of clean meat are temporally distant (e.g. avoiding catastrophic climate change) and spatially removed (e.g. reducing animal suffering in factory farms, preventing deforestation), making it difficult for consumers to incorporate these benefits into their decisionmaking calculus ([Wade-Benzoni and Tost 2009](#), [Markowitz and Shariff 2012](#)).

In this study, we establish three empirical results based on a three wave survey experiment conducted over 11 weeks. First, we show that consumer wariness of clean meat is driven far more by concerns about whether clean meat products are natural and healthy than how clean meat products taste or how much they cost. Second, we examine whether a *debunking unnaturalness* appeal, *embracing unnaturalness* appeal, or *descriptive social norm* appeal is more effective at increasing consumer

² For recent news coverage of clean meat products, see for instance, [Garfield \(June 27, 2017\)](#), [Addady \(February 02, 2016\)](#), [Stone \(May 27, 2016\)](#), [Ferdman \(May 20, 2015\)](#).

acceptance of clean meat products. We show that the *embrace unnatural* appeal led to a sustained increase in consumer willingness-to-pay and interest in clean meat over the study period, while the *debunking unnatural* and *descriptive social norm* appeals produced only short-term improvements. The positive effects of the *embrace unnatural* appeal were strongest among consumers who were *least* interested in clean meat products at baseline, suggesting that this messaging strategy can be an effective tool for influencing skeptical consumers. Third, we show that being exposed to negative reactions about clean meat from complete strangers significantly undermines acceptance of clean meat, with these effects persisting for the entire study period.

This study makes two main contributions. First, we provide disconcerting evidence about the asymmetric effectiveness of pro- vs. anti-adoption appeals towards new technologies, such that extremely small amounts of anti-adoption information led to sustained reductions in consumer acceptance of clean meat, while two of the three pro-adoption appeals had no discernible effects after 10 weeks. While existing research has already cast a pessimistic light on the potential for improving public acceptance of vaccines and other technologies through debunking and informational appeals (Nyhan and Reifler 2015, Nyhan et al. 2014, Lewandowsky et al. 2012), our results extend this literature by: (a) showing that the ineffectiveness of direct debunking strategies extends to novel technologies (such as clean meat) for which consumer attitudes have not yet crystallized; and (b) demonstrating asymmetric information effects, such that consumer attitudes are particularly susceptible to small amounts of anti-acceptance information.

Second, we provide evidence that an *embracing unnaturalness* messaging strategy can be effective at improving public acceptance of new food technologies. This messaging strategy leverages consumers' mental models and “cultural intuitions” (Miton and Mercier 2015, Ecker et al. 2011, Johnson and Seifert 1999) about what is healthy/safe to consume, effectively equating clean meat products with other products consumers are already accustomed to.

2. Material and methods

2.1 Data collection and experimental conditions

This study was organized as a randomized 2x4 full factorial design consisting of three survey waves over an 11 week period using respondents from Amazon Mechanical Turk (MTurk). The experimental conditions and survey waves are described below. This study was pre-registered with the American Economic Association (AEA) Randomized Controlled Trial registry, and a pre-analysis plan was posted at the Open Science Framework (OSF).

Wave 1 (Baseline survey). First, participants were asked to complete a 10 minute survey containing questions on demographics, current levels of meat consumption, attitudes, and potential moderators. All participants were provided with information about what makes clean meat different than conventional meat production and what some of the purported environmental, health, and ethical benefits of consuming clean meat products are.

Wave 2 (Treatment exposure and immediate reactions). Approximately one week after completing the baseline survey, we recontacted all participants via email and asked them to complete a second online survey. At this stage, participants were randomly assigned to either receive anti-acceptance social information or not, and then were randomly assigned to read one of four half-page appeals. Participants assigned to receive anti-acceptance social information were shown a web page listing five short quotes from previous survey respondents expressing negative sentiment about clean meat (e.g. “This seems very unnatural. I don't feel comfortable about this.”, “Artificial meat sounds disgusting”).

All participants were then randomly assigned to read one of four articles: a *placebo* message, *debunking unnatural* appeal, *embrace unnatural* appeal, or a *descriptive norm* appeal. Each message was approximately 150 words in length and contained three images. Immediately after reading the article, all participants completed a 5-7 minute survey eliciting their reactions to the article, alongside their attitudes and willingness to pay for clean meat products.

The *placebo* message urged participants to walk more, making no mention of clean meat products or meat consumption. The *debunking unnatural* appeal was similar to the “misperception correction” messaging strategy commonly used to combat anti-vaccination beliefs (e.g. [World Health Organization 2017](#), [New York State Department of Health 2012](#)). This appeal invoked the naturalistic heuristic in order to argue against its application in the case of clean meat products, pointing out that some seemingly “natural” compounds are clearly bad (e.g. arsenic) while other seemingly “unnatural” products have positive benefits (e.g. antibiotics). Despite the widespread use of this messaging strategy, there is little evidence that such corrections are effective at countering negative attitudes ([Nyhan and Reifler 2015](#), [Nyhan et al. 2014](#), cf. [Chan et al. 2017](#), [Dixon et al. 2015](#)).

The *embrace unnatural* emphasized how clean meat products are similar to many other seemingly “unnatural” foods that have already been widely accepted by consumers (e.g. cultured dairy products; selectively bred fruits/vegetables that barely resemble “naturally” occurring ancestors), thereby encouraging readers to add clean meat products to this set of “unnatural but safe” products. By invoking consumers' existing patterns of consumption, this appeal induced a choice among participants who were wary of clean meat products: either maintain this skepticism and find a way to rationalize what makes clean meat products different than the unnatural products they already consume, or append clean meat products to this set of “unnatural but safe” products. Rather than encouraging readers to abolish the naturalistic heuristic without providing an alternative mental model (as in the *debunking unnatural* appeal), the *embrace unnatural* appeal provided a low dissonance path to accepting clean meat products while also leaving consumers' prevailing mental models and cultural intuitions intact for evaluating new food products.³

³ On the importance of mental models in misinformation correction, see [Lewandowsky et al. 2012](#). On the role of culturally shared intuitions — such as the naturalistic heuristic — in attitudes towards vaccines and related technologies, see [Miton and Mercier 2015](#).

Finally, the *descriptive norm* appeal conveyed a descriptive social norm that many consumers are excited about clean meat and would like to try it once it becomes available in their area. Descriptive information about others' attitudes and behaviors should be especially important when considering new products and technologies that appear risky, since a large base of early adopters provides an important signal to other consumers that the products are healthy and safe.⁴

Wave 3 (Endline survey). Approximately 10 weeks after completing the treatment exposure survey, the same participants were recontacted via email and asked to complete a 7-10 minute followup survey in order to measure attitudes and willingness to pay for clean meat products.

Survey attrition. We recruited 3200 participants in the baseline survey (400 per cell for the 4x2 experiment), of which there were 3157 valid survey responses. 2623 respondents completed the treatment survey wave (83.1%), while 1515 respondents completed the endline survey wave (48.0%). [Figure 8](#) in the [Supplementary Materials \(SM\)](#) displays the balance across experimental arms among respondents who completed all three survey waves, showing that this attrition did not lead to any substantial imbalances between experimental arms on pre-treatment outcomes or other variables of interest.

2.2 Outcome measures

All variables described in this section were measured in the baseline, treatment, and endline survey waves, unless otherwise stated. In all reported results, we standardize dependent variables to have $mean=0$ and $variance=1$, with the exception of dichotomous variables (which we leave unstandardized). We measure respondents' behavioral intentions and attitudes towards clean meat as follows:

Willingness to pay for clean meat. We infer participants' willingness to pay for clean meat using a

⁴ The effectiveness of social norm appeals have been documented in a variety of domains. See, for instance, [Steg and Vlek 2009](#), [Gerber et al. 2008](#), [Goldstein et al. 2008](#).

discrete choice experiment. Respondents were presented with sets of descriptions of three different products, each consisting of a set of 2 attributes: (a) Product: clean meatballs, vegetarian meatballs, conventional meatballs; (b) Price per pound: \$5, \$10, \$15, or \$20. A full factorial design accounting for all interactions consists of 12 different combinations (3 products x 4 prices). We asked respondents to answer one of two alternative blocks of 6 questions (randomly assigned).

Interest in clean meat. We collected several attitudinal measures on attitudes towards clean meat: “how interested are you in purchasing the clean meat product you just read about?” (*interest purchase*, 1-5 scale from “not interested at all” to “extremely interested”), “Would you eat this product?” (*would eat*, 1-5 scale from “definitely not” to “definitely yes”), and “How do you feel about clean meat products?” (*feel*, 1-7 scale from “extremely negative” to “extremely positive”).

Concerns about clean meat. We provided participants with a list of five potential concerns about clean meat products — unhealthy, unnatural, unsafe, taste, and price — and asked them to select all that apply. Participants were also permitted to select “I have no concerns” or to enter another concern not listed.

Perceived benefits of clean meat. We provided participants with a list of six potential benefits of clean meat products — healthier, safer, more environmentally sustainable, may reduce farm animal suffering, tastier, and cheaper — and asked them to select all that apply. Participants were also permitted to select “I foresee no benefits” or to enter another benefit not listed.

3. Results

3.1 Naturalistic reasoning undermines clean meat acceptance

The three pro-clean meat treatment appeals we evaluate in this study are motivated by the premise that consumer concerns about clean meat are driven far more by concerns about safety, health consequences, and/or unnaturalness rather than price and taste. Yet, while existing research showing that consumers are concerned about the naturalness and health consequences of clean meat products (See, for instance, [Wilks and Phillips 2017](#)), these studies have not directly linked these concerns to individuals' willingness to purchase clean meat products. [Figure 1](#) substantiates this premise, tracing how changes in

self-reported interest in clean meat products between waves 1 and 3 correlate with changes in concerns about the unnaturalness, safety, health effects, taste, and cost of these products over the same time period.

Consumers who become concerned about clean meat's naturalness, health effects, and/or safety between waves 1 and 3 became substantially less interested in clean meat products over the same time period. Specifically, becoming concerned about the naturalness of clean meat is associated with a 0.3 standard deviation decrease in *would eat* ($p < 0.001$) and a 0.1 standard deviation decrease in *interest purchase* ($p < 0.01$). In contrast, changes in concerns about taste are only weakly related to interest in clean meat products, and individuals who reported becoming more concerned about cost between waves 1 and 3 became *more* interested in clean meat products.⁵

Figure 1. Link between concerns about clean meat and interest in clean meat

⁵ This counterintuitive finding may be an artifact of the survey question design, such that respondents with strong negative reactions towards clean meat would have been drawn towards the response options for “unnatural”, “unsafe”, and “unhealthy” (crowding out attention to “price” and “taste”).

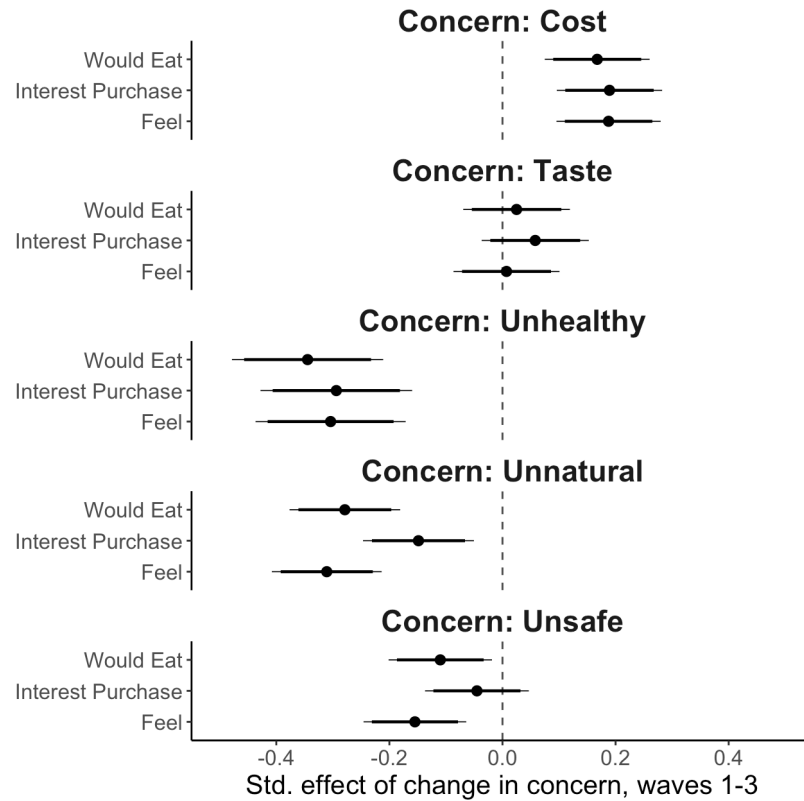


Figure 1. Link between concerns about clean meat and interest in clean meat. Displays estimated standardized effects of a change in concerns about clean meat between waves 1 and 3 on corresponding change in interest in clean meat. Estimates are produced from a simple linear regression of each measure of interest in clean meat on dichotomous indicators representing each concern, as well as controls for baseline demographics and self-reported meat consumption. Dependent variables include: *would eat* (“Would you eat this product?”, 1-5 scale), *interest purchase* (“how interested are you in purchasing the clean meat product you just read about?”, 1-5 scale), and *feel* (“How do you feel about clean meat products?”, 1-7 scale). Dependent variables are standardized to have mean equal to zero and variance equal to one. Horizontal bars represent 90% and 95% confidence intervals.

3.2 Effects of pro-clean meat appeals

How effective are pro-clean meat appeals — either based on direct debunking, embracing unnaturalness, or conveying descriptive social norms — at generating sustained improvements in consumer acceptance of clean meat products? We show that while all three appeals led to encouraging short-term improvements in consumer acceptance of clean meat products, these effects only persisted over the full 10 week post-treatment period for the *embrace unnatural* appeal. [Figure 2](#) displays the

effects of the *debunking unnatural*, *embrace unnatural*, and *descriptive norm* appeals on respondents' marginal willingness-to-pay for clean meat products. We estimate marginal willingness-to-pay from the discrete choice experiment (see [Section 2.2](#)) using conditional logistic regression, in which the dependent variable is a dichotomous variable y_{ijk} , representing whether or not respondent i selected alternative k in choice task j . The model specification is:

$$g(y_{ijk}) = \beta_1 \text{clean} + \beta_2 \text{veg} + \beta_3 \text{cost} + \alpha_{ij} \quad (1)$$

in which $g(\cdot)$ is the inverse logit link, *clean* is a dichotomous indicator representing whether the alternative is clean meatballs, *veg* is a dichotomous indicator representing whether the alternative is vegetarian meatballs, *cost* is the cost of the alternative (\$5, \$10, \$15, or \$20), and α_{ij} represents a fixed intercept for each respondent-choice strata. We estimate the β 's using maximum likelihood, and then construct marginal willingness-to-pay estimates for clean meat as the ratio β_1 / β_3 and marginal willingness-to-pay estimates for vegetarian meatballs as the ratio β_2 / β_3 .⁶

Results for respondents' marginal willingness-to-pay for clean meatballs relative to conventional meatballs, as well as vegetarian meatballs versus conventional meatballs, are displayed in [Figure 2](#) for both wave 2 (measured immediately after treatment exposure) and wave 3 (10 weeks following treatment exposure). The first column displays marginal willingness-to-pay among respondents assigned to the three treatment appeals and the placebo appeal, while the second column displays marginal willingness-to-pay among respondents exposed versus not exposed to the anti-acceptance social information treatment. Each point estimate in [Figure 2](#) represents respondents' estimated marginal willingness-to-pay for clean (or vegetarian) meatballs relative to conventional meatballs, where negative willingness-to-pay estimates indicate that the clean meatballs would need to be \$ x cheaper in order for respondents to select clean meatballs over conventional meatballs. Values closer to zero (i.e. to the right in [Figure 2](#)) represent a higher marginal willingness-to-pay.

⁶ We estimate standard errors using the Delta method.

The *embrace unnatural* significantly increased respondents' willingness-to-pay for clean meat products relative to placebo, which persisted over the entire 10 week followup period. This difference is substantively large: whereas participants who read the placebo article would, on average, need cultured meatballs to be \$5.2 cheaper than conventional meatballs in order to prefer the former (95% CI: 6.1, 4.2), respondents who read the *embrace unnatural* appeal needed only \$3.4 on average (95% CI: 4.2, 2.6). Given that the *embrace unnatural* appeal led to no detectable increase in willingness-to-pay for vegetarian meatballs (relative to readers of the placebo appeal), this finding is unlikely to be a product of social desirability alone.

In contrast, the *debunk unnatural* appeal had no significant effects on willingness-to-pay for clean meatballs, whether measured immediately after treatment exposure or 10 weeks later. And while the *social norms* appeal led to the largest *initial* gains in willingness-to-pay (as measured in wave 2), these effects had largely dissipated by the followup survey 10 weeks later.

Figure 2. Treatment effects (willingness-to-pay)

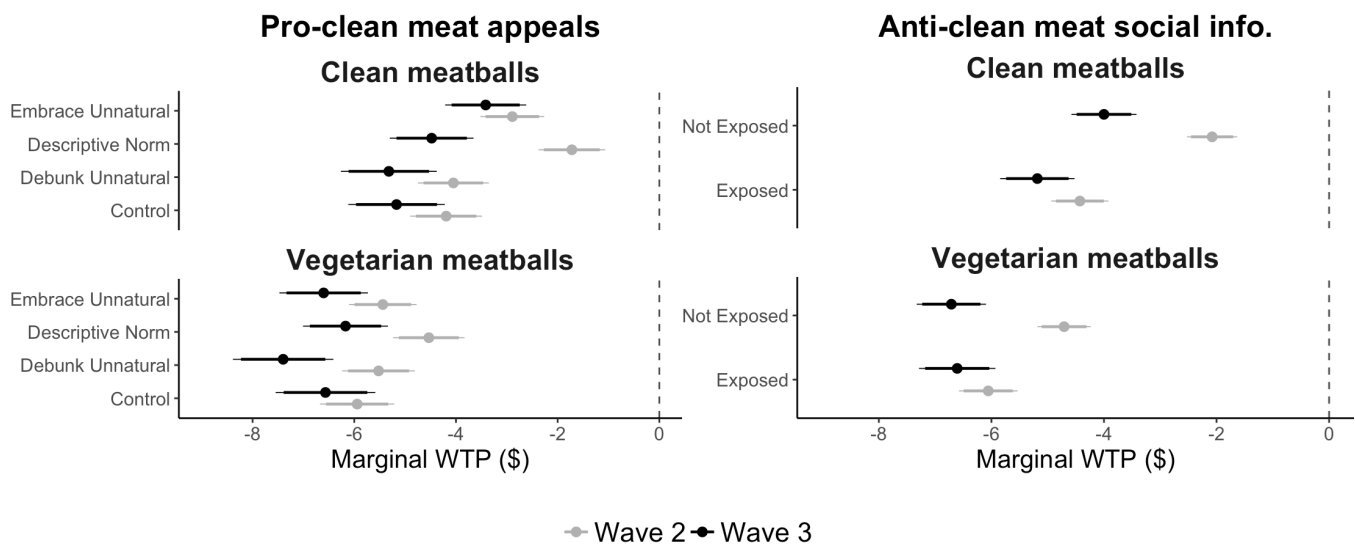


Figure 2. Treatment effects (willingness-to-pay). Displays the marginal willingness-to-pay relative to conventional meatballs for respondents in each experimental cell, with results shown separately for waves 2 and 3. A value of 0 on the x-axis indicates that respondents were indifferent between clean (or vegetarian) meatballs and conventional meatballs. Horizontal bars represent 90% and 95% confidence intervals. Results estimated using conditional logistic regression.

Figure 3 supplements these results with estimated effects of the three treatment appeals on attitudinal measures of interest in clean meat — *would eat*, *interest purchase*, and *feel* — as well as perceived concerns and benefits of clean meat. We estimate the average treatment effects (ATE) of each pro-clean meat appeal on these measures by comparing the *change* in each outcome variable y since wave 1 among respondents who read the treatment appeal versus respondents who read the placebo appeal. Results are shown separately for wave 2 and wave 3 measurements.

As shown in Plots 1-3 of Figure 3, the positive effects of the *debunking unnatural* and *descriptive norms* appeals on consumer attitudes were short-lived. In contrast, respondents exposed to the *embrace unnatural* appeal remained somewhat more likely to report increases in interest in clean meat after 10 weeks relative to the placebo group, whether measured in terms of *feel*, *would eat*, or *interest purchase*. While these effects do not reach conventional levels of statistical significance at the 10 week followup period, they are consistent with the willingness-to-pay results reported above. In the Supplementary Materials, we also explore whether the effectiveness of the three pro-clean meat appeals varies according to whether or not respondents were exposed to anti-acceptance information immediately before reading the pro-clean meat appeal. As in the findings reported here, we find that the *embrace unnatural* is the only appeal to lead to enduring effects regardless of whether we restrict the analyses to respondents that were exposed or not exposed to anti-acceptance information.

Figure 3. Treatment effects on interest, concerns, and perceived benefits.

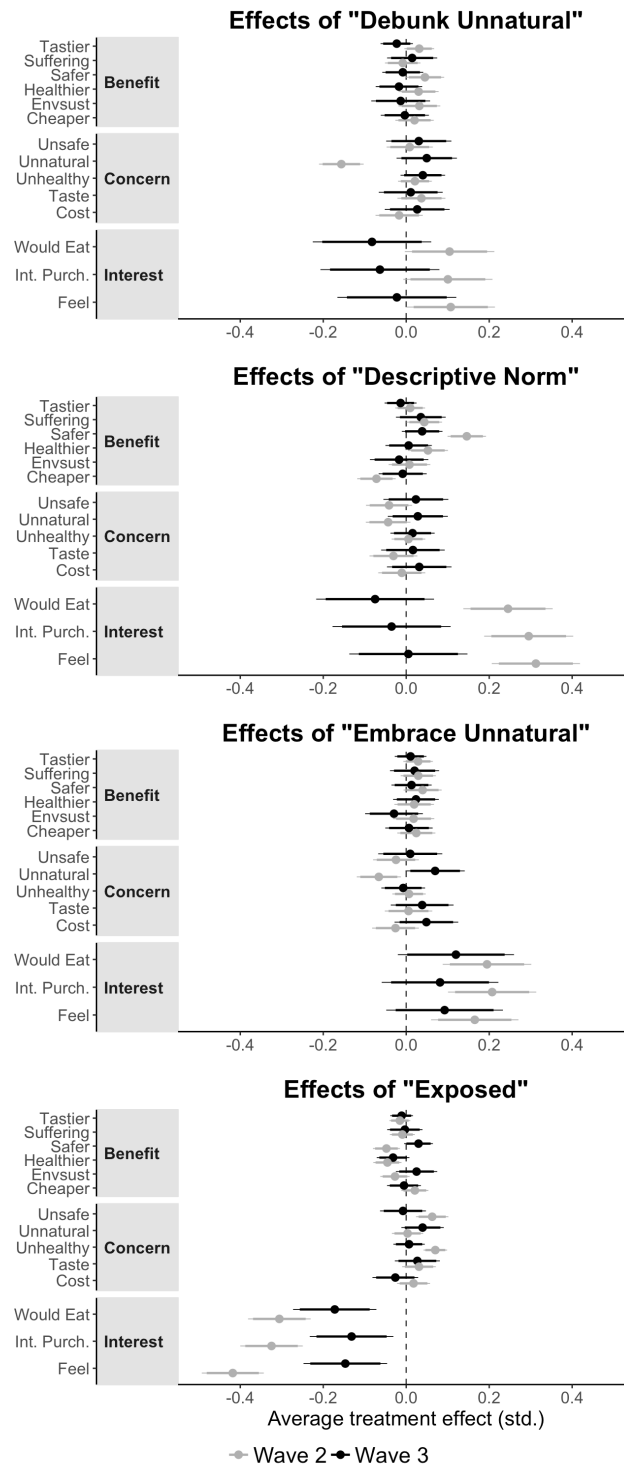


Figure 3. Treatment effects on interest, concerns, and perceived benefits. Displays average treatment effects (ATEs) for each treatment arm relative to control across three groups of outcomes: interest in clean meat, concerns about clean meat, and perceived benefits of clean meat. Panel 1 (top) displays treatment effects of the *debunk unnatural* appeal; Panel 2 displays treatment effects of the *descriptive norm* appeal; Panel 3 displays treatment effects of the *embrace*

unnatural appeal; Panel 4 (bottom) displays treatment effects of exposure to negative social information. The “concerns” and “benefits” variables are dichotomous, representing whether a respondent raised the concern/benefit ($y=1$) or not ($y=0$). Interest variables include: *would eat* (“Would you eat this product?”, 1-5 scale), *interest purchase* (“how interested are you in purchasing the clean meat product you just read about?”, 1-5 scale), and *feel* (“How do you feel about clean meat products?”, 1-7 scale). The three interest variables are standardized to have mean equal to zero and variance equal to one. All dependent variables are measured in terms of the change since wave 1. Treatment effects are shown for wave 2 (immediately after treatment exposure) and wave 3 (10 weeks after exposure) separately. Points represent ATEs, surrounded by represent 90% and 95% confidence intervals.

Were the positive effects of the *embrace unnatural* appeal concentrated among individuals who were already sympathetic towards clean meat products? In the Supplementary Materials, we estimate treatment effects separately for individuals who reported “low”, “neutral”, and “high” levels of interest in clean meat in the baseline survey. We find that the positive effects of *embrace unnatural* are concentrated among the respondents who were *least* interested in clean meat products at baseline. This result is encouraging, suggesting that the *embrace unnatural* appeal is best suited for combating the pernicious effects of anti-acceptance social information, given that anti-acceptance social information had the largest effects on the least interested consumers. In addition, this result adds support to the idea that the *embrace unnatural* appeal works by offering a low dissonance solution to accepting clean meat products, since we would expect the least interested consumers to experience the most dissonance from being encouraged to consume clean meat products.

3.3 Effects of negative social information

How contagious are the anti-clean meat attitudes of wary consumers? As described in [Section 2.1](#), respondents were randomly assigned to be exposed or not exposed to anti-acceptance social information at the beginning of the treatment wave, consisting of five short quotes from anonymous individuals expressing negative sentiment towards clean meat (e.g. “Our guts are not meant to digest unnatural

things”). We examine the effects of anti-clean meat social information on willingness-to-pay, interest, concerns, and perceived benefits using the same methods described in [Section 3.2](#) above. The results are displayed alongside the appeal effects in [Figure 2](#) (right column) and [Figure 3](#) (bottom plot).

Overall, there is strong evidence that negative social information undermined respondents' marginal willingness-to-pay for clean meat and interest in clean meat, with these effects persisting over the 10 week post-treatment study period. Respondents exposed to negative social information in wave 3 would have needed clean meatballs to be \$5.2 less expensive than conventional meatballs in order to prefer the former (95% CI: 5.8, 4.5), while unexposed respondents only needed clean meatballs to be \$4.0 less expensive on average (95% CI: 4.6, 3.4). Negative social information also led to a significant reduction in respondents' interest in clean meat after 10 weeks, whether measured in terms of *feel*, *interest purchase*, or *would eat*. These effects may be particularly large given that most consumers had little prior information about clean meat (see). In the Supplementary Materials, we also show that anti-acceptance social information has little persistent effect on individuals who were already very interested in clean meat at baseline. Instead, anti-acceptance social information undermines interest in clean meat among respondents with low to moderate levels of existing interest in clean meat products, amplifying the challenge of converting skeptics into regular consumers of clean meat products.

4. Conclusions

Cultivating and sustaining consumer acceptance of new technologies has become a pressing problem in a variety of domains, as demonstrated most clearly with GM foods and vaccines. Unfortunately, consumer attitudes towards these technologies have proven difficult to influence through direct debunking or misinformation correction. We extend this discouraging finding to the context of a new food technology — i.e. clean meat — for which consumer attitudes have not yet crystallized. On a more optimistic note, we provide evidence that an alternative *embrace unnatural* messaging strategy can

lead to enduring gains in consumer acceptance. At the same time, however, we show that the positive effects of this *embrace unnatural* appeal do not fully counteract the enduring negative effects of small amounts of anti-acceptance information from complete strangers.

New food technologies such as clean meat have tremendous potential to provide far-reaching environmental, health, and animal welfare benefits. Yet, the realization of these benefits depends on consumers' willingness to alter their food choices. Since clean meat products are still unfamiliar to most consumers, advocates for these products have the opportunity to craft an initial public narrative. Given the susceptibility of consumer attitudes to negative information, a poorly chosen narrative may become easy prey for opponents and wary consumers. Our results suggest that an effective narrative may be to emphasize commonalities with existing “unnatural” products that have already achieved widespread consumer acceptance. However, future research should replicate this result in the context of other technological advances and more carefully examine alternative messaging strategies. Future work should also examine how consumer attitudes towards new food technologies evolve through repeated exposure, when consumers adopt new food technologies into their regular shopping habits (see [Juhl et al. 2017](#)), and how consumer attitudes vary in accordance with transparency in production processes and consumers' access to information about whether a product contains ingredients produced using the technology.

Supplementary materials

Appendix A: Supplementary figures

Figure 4. Experimental balance on pre-treatment variables.

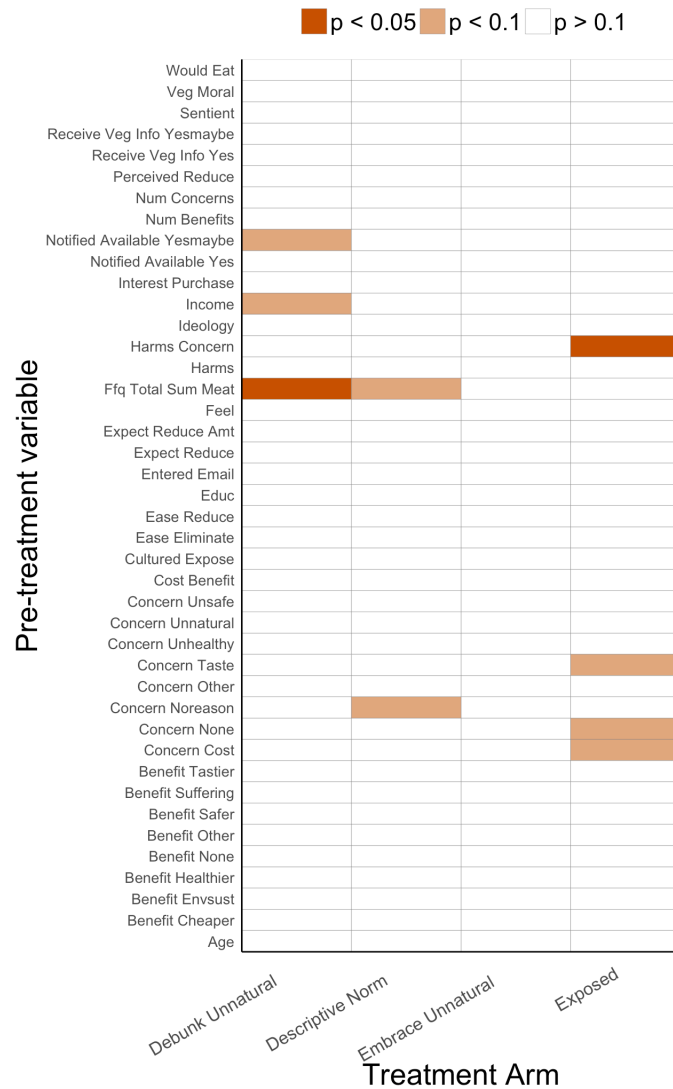


Figure 4. Experimental balance on pre-treatment variables. Displays pre-treatment balance on variables measured in wave 1 among respondents who completed all three survey waves (n=1515). Each cell represents the p-value for a t-test in the difference in means between the control group and the experimental arm (x-axis) on a particular variable measured at baseline (y-axis). As shown, the experimental arms are well balanced with the control group on nearly all pre-treatment covariates. While there is some imbalance in self-reported servings of meat at baseline in the *debunk unnatural* and *descriptive norm* arms, correcting for this difference does not change the results reported above in any substantive way.

Figure 5. Treatment effects (discrete choice, odds ratio).

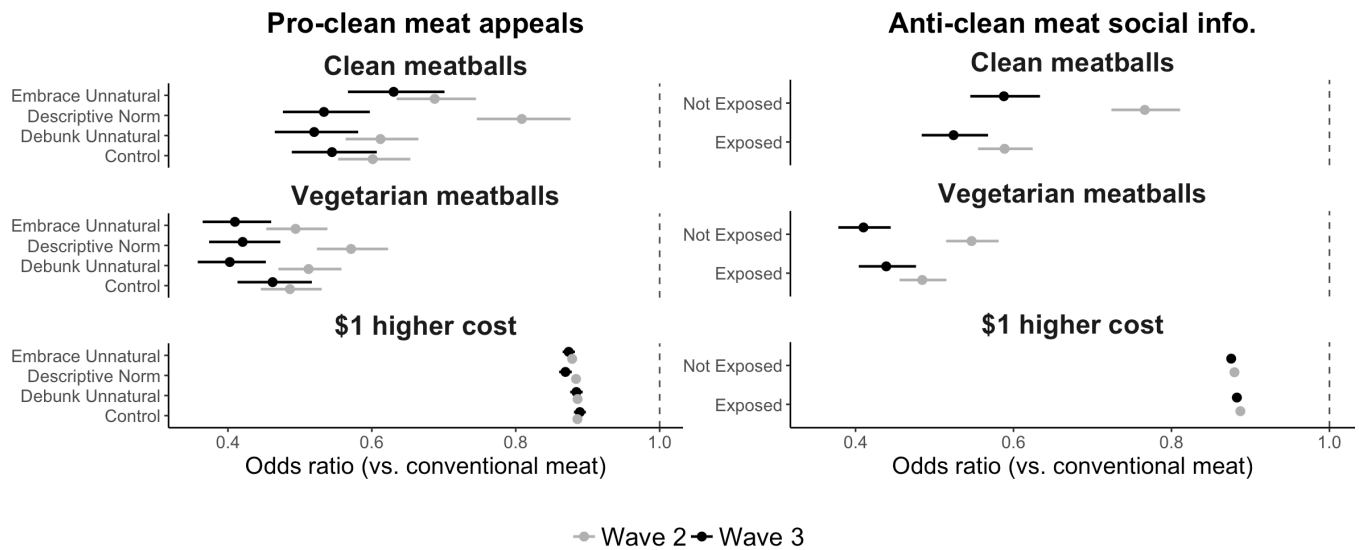


Figure 5. Treatment effects (discrete choice, odds ratio). Displays odds ratios of selecting clean (or vegetarian) meatballs relative to conventional meatballs among respondents in each experimental cell, with results shown separately for waves 2 and 3. A value of 1.0 on the x-axis indicates that respondents were indifferent between clean (or vegetarian) meatballs and conventional meatballs. A value of 0.6 indicates that respondents were only 60% as likely to choose clean (or vegetarian) meatballs relative to conventional meatballs. Horizontal bars represent 90% and 95% confidence intervals. Results estimated using conditional logistic regression.

Figure 6. Heterogeneity in treatment effects by baseline interest in clean meat.

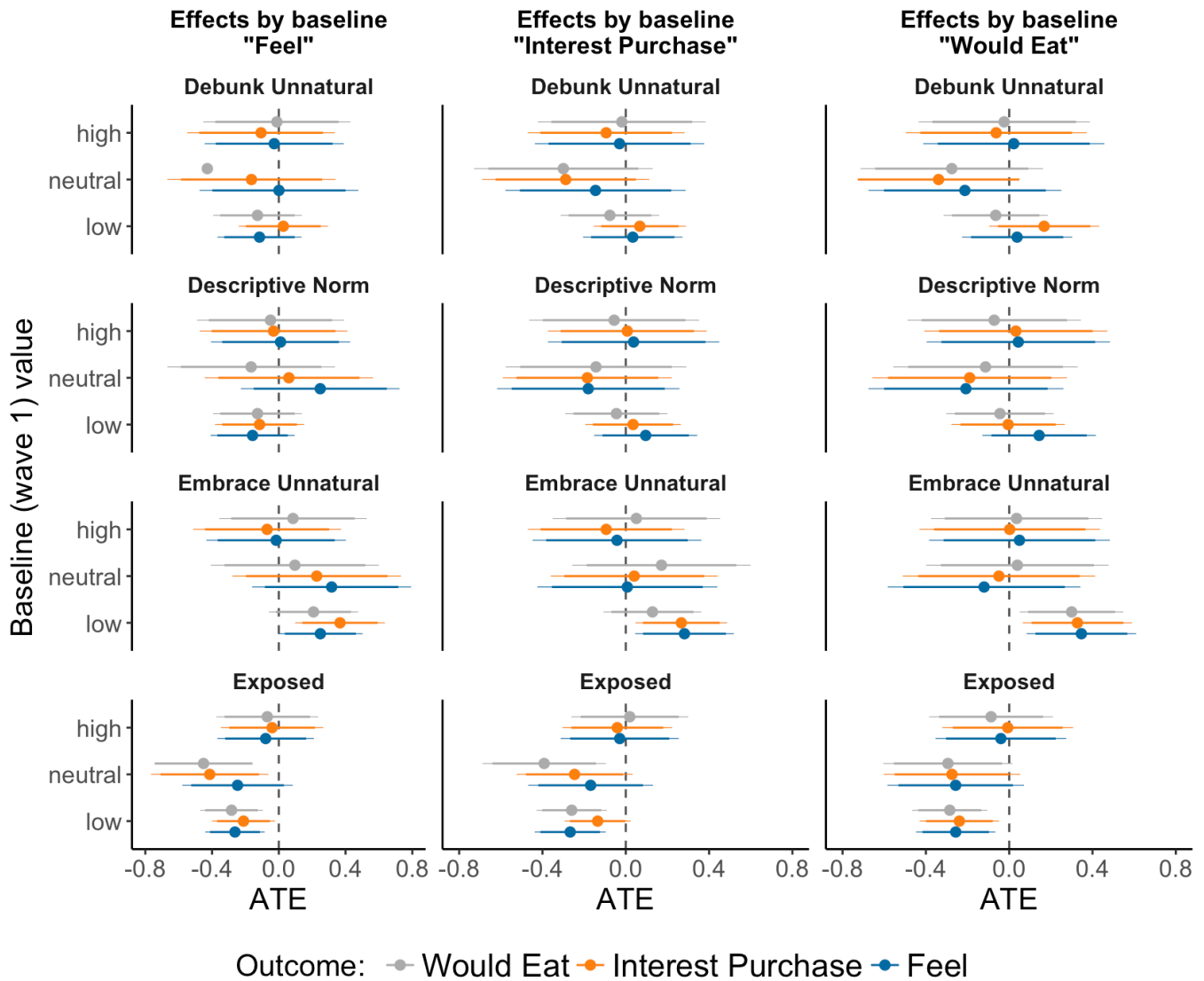


Figure 6. Heterogeneity in treatment effects by baseline interest in clean meat. Displays ATEs of each treatment appeal and negative social information (“exposed”) on interest in clean meat. Results are estimated separately conditional on low vs. neutral vs. high levels of baseline interest in clean meat. Column 1 displays treatment effects of the three treatment appeals (and the effects of negative social information) on three measures of interest in clean meat — *would eat* (“Would you eat this product?”, 1-5 scale), *interest purchase* (“how interested are you in purchasing the clean meat product you just read about?”, 1-5 scale), and *feel* (“How do you feel about clean meat products?”, 1-7 scale) — where results are estimated separately for respondents with low vs. neutral vs. high levels of baseline *feel*. Columns 2 and 3 display the same effects, except that results are broken down by baseline *interest purchase* and baseline *would eat*, respectively. All dependent variables are measured as the change between waves 1 and 3. Points represent ATEs, surrounded by represent 90% and 95% confidence intervals.

Figure 7. Heterogeneity in appeal effects by number of servings of meat consumed per week at baseline.

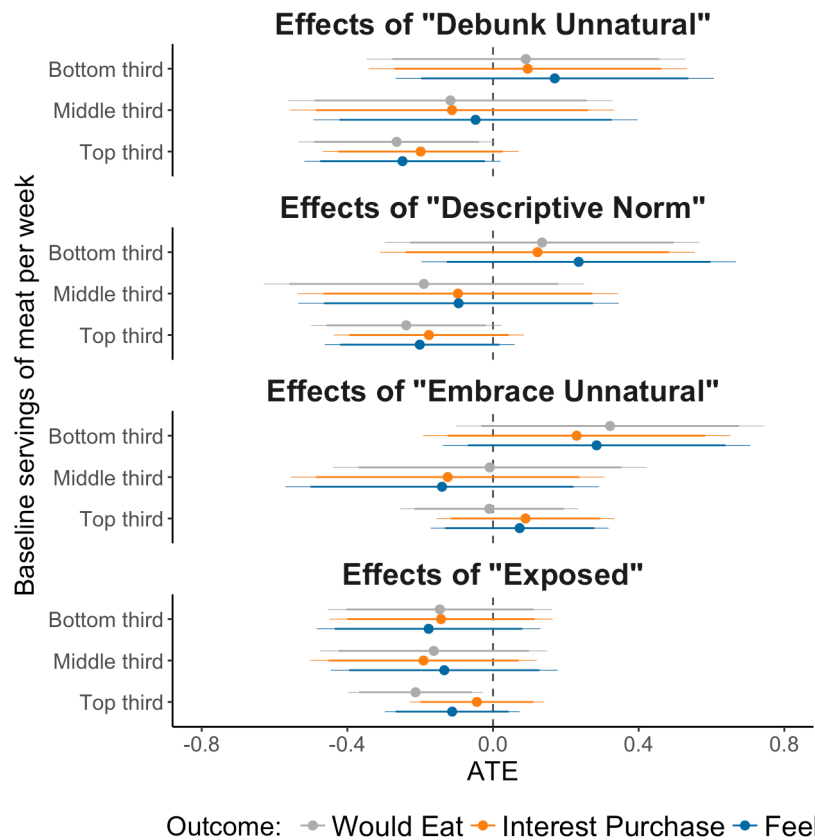


Figure 7. Heterogeneity in appeal effects by number of servings of meat consumed per week at baseline. Displays ATEs of each treatment appeal and negative social information ("exposed") on interest in clean meat. Results are estimated separately conditional on low vs. moderate vs. high levels of baseline self-reported servings of meat consumed per week. Dependent variables are: *would eat* ("Would you eat this product?", 1-5 scale), *interest purchase* ("how interested are you in purchasing the clean meat product you just read about?", 1-5 scale), and *feel* ("How do you feel about clean meat products?", 1-7 scale). All dependent variables are standardized to have mean equal to zero and variance equal to one, and are measured as the change between waves 1 and 3. Panel 1 (top) displays treatment effects of the *debunk unnatural* appeal; Panel 2 displays treatment effects of the *descriptive norm* appeal; Panel 3 displays treatment effects of the *embrace unnatural* appeal; Panel 4 (bottom) displays treatment effects of exposure to negative social information. Points represent ATEs, surrounded by represent 90% and 95% confidence intervals.

Figure 8. Heterogeneity in appeal effects by baseline concern about clean meat

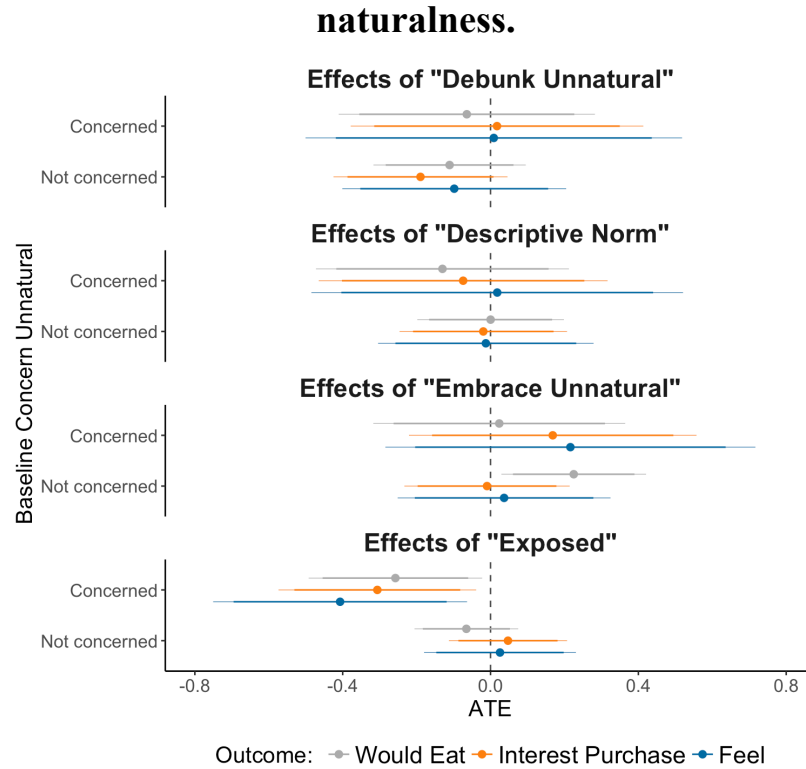


Figure 8. Heterogeneity in appeal effects by baseline concern about clean meat naturalness. Displays ATEs of each treatment appeal and negative social information (“exposed”) on interest in clean meat, conditional on whether respondents were concerned about the naturalness of clean meat at baseline (y-axis). Dependent variables are: *would eat* (“Would you eat this product?”, 1-5 scale), *interest purchase* (“how interested are you in purchasing the clean meat product you just read about?”, 1-5 scale), and *feel* (“How do you feel about clean meat products?”, 1-7 scale). All dependent variables are standardized to have mean equal to zero and variance equal to one, and are measured as the change between waves 1 and 3. Panel 1 (top) displays treatment effects of the *debunk unnatural* appeal, estimated separately for respondents who were concerned versus not concerned about the naturalness of clean meat at baseline; Panel 2 displays treatment effects of the *descriptive norm* appeal; Panel 3 displays treatment effects of the *embrace unnatural* appeal; Panel 4 (bottom) displays treatment effects of exposure to negative social information. Points represent ATEs, surrounded by represent 90% and 95% confidence intervals.

Figure 9. Descriptive statistics: Interest in clean meat products.

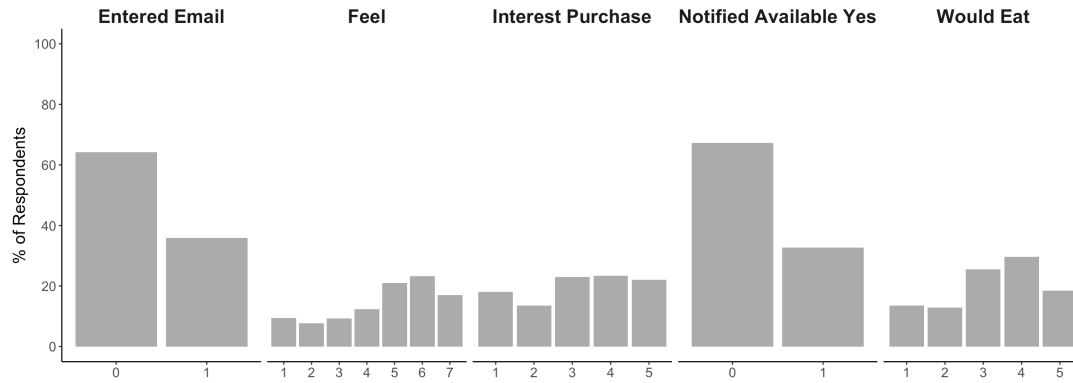


Figure 9. Descriptive statistics: Interest in clean meat products. Displays distributions of measures of interest in clean meat, as measured at baseline. Interest variables include: *entered email* (whether or not respondent entered email after “yes” response to “Would you like to be notified when clean meat products are available in your area?”), *feel* (“How do you feel about clean meat products?”, 1-7 scale), *interest purchase* (“how interested are you in purchasing the clean meat product you just read about?”, 1-5 scale), *notified available (yes)* (“Would you like to be notified when clean meat products are available in your area?”), *would eat* (“Would you eat this product?”, 1-5 scale).

Figure 10. Heterogeneity in appeal effects by exposure to anti-acceptance social information.

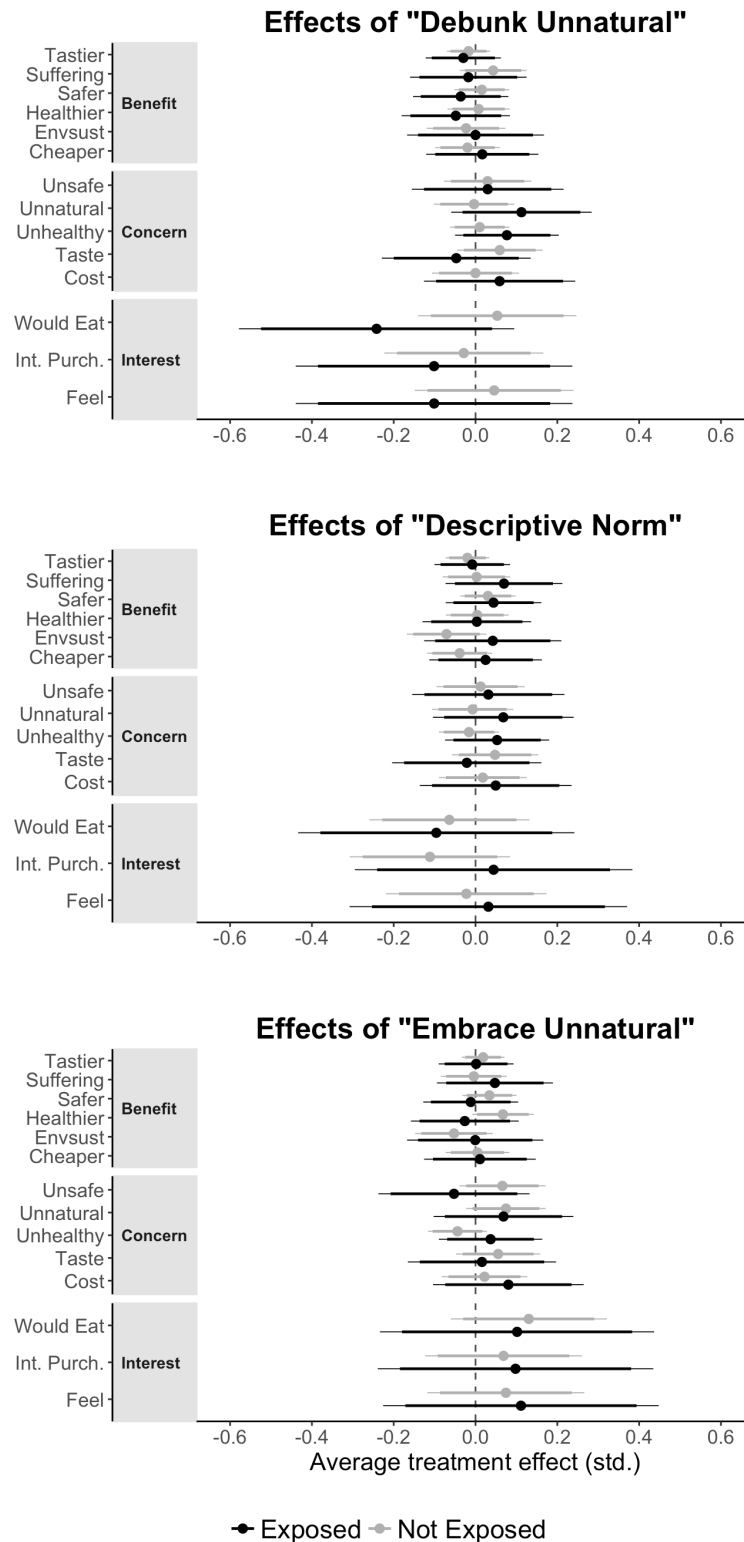


Figure 10. Heterogeneity in appeal effects by exposure to anti-acceptance social information. Displays the effects of each treatment appeal, estimated separately for respondents exposed to anti-acceptance social information versus

respondents that were not exposed. Panel 1 (top) displays treatment effects of the *debunk unnatural* appeal; Panel 2 displays treatment effects of the *descriptive norm* appeal; Panel 3 (bottom) displays treatment effects of the *embrace unnatural* appeal. The “concerns” and “benefits” variables are dichotomous, representing whether a respondent raised the concern/benefit ($y=1$) or not ($y=0$). Interest variables include: *would eat* (“Would you eat this product?”, 1-5 scale), *interest purchase* (“how interested are you in purchasing the clean meat product you just read about?”, 1-5 scale), and *feel* (“How do you feel about clean meat products?”, 1-7 scale). The three interest variables are standardized to have mean equal to zero and variance equal to one. All dependent variables are measured as the change between waves 1 and 3. Points represent ATEs, surrounded by represent 90% and 95% confidence intervals.

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