The Hedonic Experience of Eating

by Eric C. Anderson

B.A. Hampshire College
M.A. Northeastern University

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Dissertation directed by

Lisa Feldman Barrett
Distinguished Professor of Psychology
Dedication

I have received enormous amounts of help and support in completing my PhD, and I’d like to thank everyone who helped me along the way. Everyone cannot be thanked individually in print due to limited pages, and my limited ability to remember. But thank you.

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Abstract of Dissertation

People believe they experience the world objectively, but previous research has demonstrated that beliefs influence visual perception. In this dissertation, I expand upon this work to test whether beliefs influence the hedonic experience of eating, and whether the hedonic experience of eating is reflected in physiological changes in the body.

In the first chapter, I test whether beliefs about how animals were raised influences the experience of eating meat. Participants read descriptions of how animals were raised, tasted meat samples, and then reported their experience. One sample was paired with a description of animals raised on a factory farm, and the other was paired with a description of animals raised on a humane farm. Importantly, the meat samples in both conditions were the same product. Consistent with our hypothesis, participants perceived the samples differently. Meat paired with factory farm descriptions was perceived as looking, smelling, and tasting less pleasant compared to samples raised on humane farms. Moreover, participants consumed less of the sample paired with the factory farm description, demonstrating that implicit liking and actual behavior were influenced. These findings demonstrate that experience is not determined solely by physical properties of stimuli--experience is also shaped by what we believe.

In the second chapter, I test whether the hedonic experience of food is reflected in physiological changes in the body. To test this, I used peripheral psychophysiological measures in two groups that have very different hedonic responses to meat: vegetarians and omnivores. The aim was to explore the affective responses of these
groups using self-reported affect, peripheral autonomic psychophysiology, and facial muscle movement. I found that vegetarians and omnivores evaluated meat differently (meat was less pleasant for vegetarians), but they evaluated other stimuli similarly. However, psychophysiologically, vegetarians and omnivores had strikingly similar responses to all stimuli—including meat. The one physiological group difference that did emerge was a generally elevated electrodermal response in vegetarians to all pictures. One possibility is that vegetarians conceptualize changes in their bodily states (the increased electrodermal response) in ways that matched their belief system (i.e., that eating meat is cruel, wasteful, impure, or unhealthy). In general, both of these projects are consistent with the idea that the brain constructs the experience of eating.
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Introduction

Every day, people must decide what’s for dinner--and this choice matters. In our evolutionary past, humans had to find enough to eat and avoid poisonous foods. In the 21st century, eating choices still matter: they play an important role in heart disease (Dauchet, Amouyel, Hercberg, & Dallongeville, 2006), obesity (Swinburn, Caterson, Seidell, & James, 2004), diabetes (Malik, Popkin, & Bray, 2010), and stroke (He, Nowson, & MacGregor, 2006). In addition to having important health implications, food and eating plays a central role in what it means to be human (Rozin 1996): from early development (e.g., nursing and weaning) to social interactions (e.g., family meals), cultural traditions (e.g., ethnic cuisine), and religious beliefs (e.g., dietary prohibitions). People also spend a significant amount of their income on food: as much as 50% in developing countries (United States Department of Agriculture Economic Research Service, 2013). Given the central importance of eating in human life, it is surprising that modern academic psychologists pay so little attention to it (Rozin, 1996).

In addition to providing nutrients, food can also be pleasurable (Lowe & Butryn, 2007). One reason we eat ice cream on a hot day is because we enjoy the experience of cold, creamy sweetness (though see Wansink, 2014 for a review of other factors). However, eating for pleasure can lead to negative consequences. For instance, obese participants like both sweet and fat more than non-obese participants (Bartoshuk, Duffy, Hayes, Moskowitz, & Snyder, 2006) which may lead to increased eating and the negative consequences that come with obesity. While part of the hedonic experience of eating is determined by the physical properties of food, psychological factors, such as beliefs, also influence the experience of eating. Beliefs are particularly important to
understand because they are plastic: they can be shaped by culture, education, and advertising. In this dissertation, I explore the hedonic experience of eating meat. Meat is particularly important because eating meat costs the United States an estimated 28.6 to 61.4 billion dollars per year in healthcare costs (as of 1992; Barnard, Nicholson, & Howard, 1995), and eating too much red meat increases mortality (Pan et al., 2012). This dissertation explores the hedonic experience of meat eating in two chapters.

In the first chapter, I test whether affective beliefs about how animals were raised influence the experience of eating meat. In three studies, participants read descriptions of how animals were raised, tasted meat samples, and then reported their experience. One sample was paired with a description of animals raised on a factory farm, and the other was paired with a description of animals raised on a humane farm. Importantly, the samples in both conditions were the exact same product. Interestingly, participants perceived samples paired with factory farm descriptions as looking, smelling, and tasting less pleasant compared to samples paired with humane farm descriptions. These findings demonstrate that the experience of eating is not determined solely by the food you put in your mouth--it is also shaped by what you believe about that food.

The three studies in the first chapter rely primarily on the self-reported experience of consuming the meat, and there are weaknesses of self-reports. For instance, people might be biased to report they liked the humane meat more, when their experience of both products was really the same. The studies in the first chapter attempted to address this concern by measuring the amount of meat consumed. We found that participants consumed less meat when they believed it was raised on a factory farm--suggesting they enjoyed it less. This is a more stringent test of the
hypothesis that affective beliefs influence the experience of eating meat because it is not susceptible to self-reporting bias. It seems unlikely that participants would carefully control the amount of the samples they consumed to conform to perceived researchers goals or values.

In the second chapter, I expanded upon this research to consider bodily responses to meat. The body is particularly important for food perception, because the body prepares for anticipated incoming substances by releasing hormones and digestive enzymes that aid in metabolism and energy regulation (cephalic phase response; Power & Schulkin, 2008). The body also plays a prominent role in major theories of affect and emotion (Barrett, 2015; Clore & Ortony, 2013; Damasio, 1994; Ekman, Levenson, & Friesen, 1983; James, 1884; Lang & Bradley, 2013). One of the functions of affect and emotions is to prepare the organism to act—which requires mobilizing bodily resources. For instance, changes in cardiac activity can prepare the body to move (‘fight or flight’). Peripheral psychophysiological measures have been used by psychologists to measure bodily responses to evocative stimuli (Bradley & Lang, 2007), but to my knowledge, peripheral psychophysiology has never been used to study bodily responses to meat.

Ideally, peripheral psychophysiology could be used to test whether beliefs about how animals are raised influences how the body responds to meat. As an intermediate step, I studied two groups that have very different affective responses to meat: vegetarians and omnivores. These two groups offer an interesting comparison for testing whether peripheral psychophysiological measures would provide a useful window into understanding hedonic experience. Many vegetarians report that they
experience meat negatively (Amato & Partridge, 1989; Barnes-Holmes, Murtagh, Barnes-Holmes, & Stewart, 2010; De Houwer & De Bruycker, 2007; Rozin, Markwith, & Stoess, 1997; Stockburger, Renner, Weike, Hamm, & Schupp, 2009). If these two groups have the same physiological responses to meat, it seems unlikely that subtle belief manipulations would be enough to influence psychophysiological responses. Vegetarians are also interesting to study in their own right and are garnering increased attention by researchers (Ruby, 2012). People who convert to vegetarianism are a group of people that radically changes their diet to reflect their values. Since dietary change is notoriously difficult to maintain, vegetarians might offer insights into how to create enduring dietary behavior change.

In the second chapter, the primary aim was to explore affective responses of vegetarians and omnivores using self-reported affect, peripheral autonomic psychophysiological measures, and facial muscle activation. In particular, I tested three alternative hypotheses. The most specific hypothesis posits that vegetarians experience meat as negative but respond to all other stimuli just like omnivores. The most general hypothesis suggests vegetarians have more global differences in affective processing: such as experiencing all food as hedonically less pleasant or experiencing negative stimuli as more negative. An intermediate hypothesis suggests that animal suffering is also particularly negative for vegetarians. That is, vegetarians responses are not specific to only meat foods, but they are also not general to all foods or stimuli. To test these hypotheses, I presented vegetarians and omnivores with pictures of animals, meat, and other foods. Participants reported their affective reactions and feelings while we measured psychophysiological changes.
The self-report findings support the specificity hypothesis: vegetarians and omnivores evaluated meat differently (meat was less pleasant for vegetarians), but they evaluated other foods similarly and reported similar levels of perceived animal suffering. However, the psychophysiological data tell a different story. Vegetarians and omnivores responded strikingly similarly to all of the stimuli—including meat and animals. Both groups had similar cardiac and facial muscle movement. The one physiological group difference that did emerge was a generally elevated electrodermal response for vegetarians to all pictures (electrodermal activity is thought to be an index of the sympathetic nervous system that prepares the body for 'fight or flight'). One possibility is that vegetarians conceptualize changes in their bodily states (the increased electrodermal response) in ways that matched their belief system (i.e., that eating meat is cruel, wasteful, impure, or unhealthy). This interpretation is consistent with a constructionist approach that argues people use conceptual knowledge to understand and categorize internal bodily sensations (Barrett, 2015). For instance, sensations from your stomach could be interpreted as a sign you are hungry, or that you are getting sick, or they could be used as a 'gut feeling' about a person being evaluated for parole (Danziger, Levav, & Avnaim-Pess, 2011). How the bodily feelings are interpreted depends on the person and context, so drawing strong psychological inferences from physiological measures can be risky in the absence of knowing something about the individual and the context (for review see Quigley & Barrett, 2014).

Taken together, these two studies offer some clarity and raise new questions about the psychology of meat eating. The first study demonstrated that beliefs about animals’ welfare influence the self-reported experience of eating meat. Factory farmed
meat is experienced as less pleasant compared to humanely raised meat. In the second chapter, I characterized the affective responses to meat for vegetarians and omnivores. Self-reported affective responses suggest that vegetarians experience other stimuli just like omnivores. However I found vegetarians exhibit increased electrodermal responses to all stimuli. One possibility is that vegetarians conceptualize electrodermal activity in a manner that is consistent with their belief system. In general, both of these projects are consistent with the idea that people construct their experience of food.
References


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Chapter 1:

Suffering leaves a bad taste: Affective beliefs influence the experience of eating meat
Title:
Suffering leaves a bad taste: Affective beliefs influence the experience of eating meat

Eric C. Anderson¹; Lisa Feldman Barrett¹,²
¹Northeastern University; ²Massachusetts General Hospital / Harvard Medical School

Corresponding Author:
Eric C. Anderson
Department of Psychology
Northeastern University
Boston, MA 02115
Phone: 617-373-4789
Fax: 617-373-8714
Email: ericmranderson@gmail.com

Abstract
People believe they experience the world objectively, but previous research has demonstrated that beliefs can influence visual perception. There is also limited research suggesting that beliefs can influence the experience of eating. In three studies, we test whether beliefs about how animals were raised influence the experience of eating meat. Participants read descriptions of how animals were raised, tasted meat samples, and then reported their experience. One sample was paired with a description of animals raised on a factory farm and the other was paired with a description of animals raised on a humane farm. Importantly, the meat samples in both conditions were the same product. Consistent with our hypothesis, participants perceived the samples differently. Meat paired with factory farm descriptions as perceived as looking, smelling, and tasting less pleasant compared to samples raised on humane farms. Moreover, participants consumed less of the sample paired with the factory farm description, demonstrating that implicit liking and actual behavior were influenced. These findings demonstrate that experience is not determined solely by physical properties of stimuli—experience is also shaped by what you believe.

*Keywords: Affect, Perception, Food, Meat, Morality*
Suffering leaves a bad taste: Affective beliefs influence the experience of eating meat

Every day, we must decide what’s for dinner--and this choice matters. In our evolutionary past, humans had to avoid poisonous foods, making food choices a life and death decision. In the 21st century, eating choices still matter: diet plays a role in heart disease (Dauchet, Amouyel, Hercberg, & Dallongeville, 2006), obesity (Swinburn, Caterson, Seidell, & James, 2004), diabetes (Malik, Popkin, & Bray, 2010), and stroke (He, Nowson, & MacGregor, 2006). One of the factors that influences eating is the experience: we eat ice cream on a hot day because we enjoy the experience of cold, creamy sweetness (though see Wansink, 2014 for review of other factors). For instance, obese participants like both sweet and fat more than the non-obese participants (Bartoshuk, Duffy, Hayes, Moskowitz, & Snyder, 2006), which may lead to increased eating. While part of the experience of eating is due to the physical properties of food, beliefs also influence the experience of eating (de Araujo, Rolls, Velazco, Margot, & Cayeux, 2005; Grabenhorst, Rolls, & Bilderbeck, 2008; Plassmann, O’Doherty, Shiv, & Rangel, 2008; Yeomans, Chambers, Blumenthal, & Blake, 2008). Beliefs are particularly important to understand because they are shaped by culture, education, and advertising. In this paper, we explore whether affective beliefs (beliefs that are positive or negative) can influence the experience of eating. In particular, we test whether affective beliefs about how animals are raised influences the experience of eating meat.

Beliefs Influence Experience

Intuitively, people think their perceptions of the world are caused solely by the world. We experience candy as sweet because sweetness is a property of the candy--candy tastes sweet because it is sweet. However, vision science offers clear evidence
against this kind of realism. The same visual stimuli in the world can yield varying perceptions. For example, in bi-stable illusions, such as the Necker cube (Meng & Tong, 2004) and binocular rivalry (Blake, 2001), perceivers’ conscious experience alternates between two percepts—even though the physical stimulation (photons hitting the retina) stays constant. In the case of binocular rivalry, competition between the percepts play out in the perceiver’s brain (for review see Tong, Meng, & Blake, 2006). Affect (positive and negative feelings) can also influence perception (for discussion see Barrett & Bar, 2009). Negative affective beliefs about a stranger (in the form of gossip) influences how they are visually perceived (Anderson, Siegel, Bliss-Moreau, & Barrett, 2011). As such, perceivers unknowingly contribute to how they see the world. Though much of this research has been pioneered in the modality of vision, the general principle of beliefs influencing perception likely extends to other domains.

Little research has explicitly examined whether affective beliefs influence the perception of food, but there is some research showing beliefs more generally influence the experience of food. For instance, identical scents are experienced as pleasant when labeled ‘cheddar cheese’ but are experienced as unpleasant when labeled ‘body odor’ (de Araujo et al., 2005). People enjoy wine labeled with expensive price tags more than wine with cheap price tags, even though the wines are actually identical (Plassmann et al., 2008). Savory tasting umami (monosodium glutamate present in meat) is experienced as more pleasant when labeled as a ‘rich and delicious taste’ compared to when it is labeled ‘monosodium glutamate’ (Grabenhorst et al., 2008). People enjoy salmon flavored ice cream if they believe it is savory frozen mousse, but they dislike the same substance if they believe it is sweet ice cream (Yeomans et al., 2008). Moreover,
Beliefs about how food is produced can also influence the experience of eating. For instance, organic labels can influence the flavor and pleasantness of food (Lee, Shimizu, Kniffin, & Wansink, 2013). Additionally, coffee labeled “eco-friendly” tastes better to people than identical unlabeled coffee (Sörqvist et al., 2013). These two examples illustrate that food production is often moralized (Pollan, 2006). A key ingredient in morality is thought to be affect (Cameron, Lindquist, & Gray, 2015; Greene, Sommerville, Nystrom, Darley, & Cohen, 2001; Haidt, 2001), so affective beliefs will likely play a role in moralized eating behavior (Rozin, Markwith, & Stoess, 1997). Affective beliefs are particularly important because they are so powerful: people quickly form affective beliefs about who is good and who is bad (Bliss-Moreau, Barrett, & Wright, 2008), and beliefs about contaminated food quickly causes people to dislike it (Rozin, Millman, & Nemeroff, 1986). In this paper, we explore the influence of affective beliefs on the experience of eating meat.

**Meat**

To study whether affective beliefs can influence the experience of eating, we focused on meat. Meat is the ideal candidate because people have strong and diverse affective beliefs about it. For some people, meat is a delicious food, consumed every
day or reserved for special occasions (Fiddes, 1991). For others, eating meat is the cause of suffering for millions of animals (Singer, 1975). While many omnivores agree that raising animals for meat causes suffering, they also enjoy eating meat. This dilemma has been called the Meat Paradox: people enjoy eating meat but dislike harming animals (Bastian, Loughnan, Haslam, & Radke, 2012; Loughnan, Haslam, & Bastian, 2010). Previous research has described at least two responses to this dilemma. First, the desire to reduce the suffering of animals leads some people to avoid eating meat altogether (i.e., vegetarians; Fox & Ward, 2008; for review see Ruby, 2012). Second, there is evidence that omnivores may escape the meat paradox by unconsciously denying that animals suffer (Bastian, Loughnan, Haslam, & Radke, 2012; Loughnan et al., 2010). Finally, for meat eaters who care about animal welfare, there is a third option that has not received empirical attention: reduce the suffering animals experience by improving the conditions in which animals are raised. In fact, businesses and marketers have started to capitalize on omnivores’ concern for animal welfare. Companies realize some consumers are willing to pay more for animal products that are certified as humanely raised (http://www.globalanimalpartnership.org). While some consumers value animal welfare and are willing to pay more for humanely raised products, no research has examined whether beliefs about how animals are raised influences the experience of consuming animal products.

Our goal was to test whether beliefs about how meat was produced would influence the experience of eating it. Here we report three studies that test whether beliefs about how animals were raised influence the experience of eating meat. We were particularly interested in beliefs about animal welfare since people care so much
about animals suffering. To manipulate beliefs in these studies, participants read
descriptions of how the meat animals were raised. Next, participants consumed
samples of meat and reported their experience of eating it. To make sure any observed
differences were not due to physical properties of the meat (Robinson, 2004), the
samples were always identical—the descriptions were the only differences. We
hypothesized that believing animals had suffered would reduce the pleasure of eating
meat.

Study 1

Methods

Participants.

146 Northeastern undergraduate students participated in Study 1. Of these, 29
participants did not follow instructions so were removed from analysis (see below for
details; the pattern of findings does not change with all participants included). The
remaining 117 participants who were analyzed included 72 females (61.5%) and ranged
in age from 17-23 years old ($M = 18.74$). Participants were recruited through
introductory psychology classes and received course credit for participation. All
participants gave written, informed consent before participating.

Materials.

To manipulate participants' beliefs about meat, two labels were prepared that
described two different farms on which cows were raised (Appendix A). The humane
farm label described a farm where animals were raised relatively humanely (i.e. animals
grazed outdoors). The factory farm label described a farm where animals were raised in
relatively inhumane conditions (i.e. animals confined to indoor pens). Each participant was exposed to both labels in randomized order.

After reading one of the descriptions, participants consumed a sample of beef jerky (dried beef). Two separate samples were prepared. Each consisted of two grams of beef jerky cut into ten pieces. Each was placed in the center of a white plate for participants to sample. To control for the physical properties of the sample, the meat was the same organic beef jerky. This was important because the farm environment can influence the physical properties of meat. For instance, grass-fed animals have increased beta-carotene, vitamin E, folic acid, and Omega 3 fatty acid as well as reduced fat (Robinson, 2004). During the experiment, each participant consumed two identical samples, but each sample was paired with a different description to manipulate the participants’ beliefs.

**Procedure.**

After arriving in the lab and consenting, participants completed two trials. In each trial, participants were first instructed to cleanse their palate by sipping a glass of water. Next, participants read one of the descriptions of beef jerky (Appendix A), consumed a sample, and rated the sample (described in more detail below). Then participants completed a second trial with the other description. Therefore each participant completed two trials (tasted two different samples paired with different descriptions; order randomized). In reality, the actual sample was the same beef jerky product on both trials. Participants also completed two filler taste tasks in which they sampled two raisin products using a similar procedure.
After reading the description, participants reported their experience of the sample using 100-point slider scales on a computer. First participants were instructed to look at the sample and rate its appearance (from 0 = ‘very unappealing’ to 100 = ‘very appealing’). Next they smelled the sample and rated its smell (from 0 = ‘very unappealing’ to 100 = ‘very appealing’). Then participants tasted the sample and rated its taste (from 0 = ‘not very good’ to 100 = ‘very good’). They were also asked to report overall how much they enjoyed the sample (from 0 = ‘did not enjoy’ to 100 = ‘enjoyed very much’). Next, participants reported how much they would be willing to pay for a 6 ounce package of the sample (from $0 to $20), and how likely they would be to eat the sample again (from 0 = ‘would never eat it again’ to 100 = ‘would definitely eat it again’). Finally, to quantify an implicit measure of liking, we measured how much of the sample participants had consumed by measuring the weight of the samples before and after the sampling procedure. Participants were free to eat as much of the samples as they wanted so the amount consumed could vary from zero to two grams.

To check whether participants were attending to the descriptions of the samples, participants were immediately asked to recall as much of each description as possible after they completed the sampling procedure. 29 participants did not recall any parts of the description suggesting they did not read them. These participants were removed from analysis, but including them does not change the pattern of findings. Finally, participants were instructed that they could chose to not answer any questions, so some analyses contain fewer observations.

Results
To test whether beliefs influenced the eating experience, we conducted planned paired t-tests (two-tailed) with the description (humane farm vs. factory farm) as the independent (within participant) variable. Supporting our hypothesis, participants reported the factory farm meat sample (compared to the humane farm sample) was less pleasant along all of the consumption dimensions we measured (see Figure 1; see Appendix B, Table 1 for means, standard error (SE), and 95% confidence interval (95% CI)). Factory farm samples (compared to humane farm) looked less appealing, \( t(110) = 5.09, p < 0.001, \eta^2_p = 0.19 \); smelled less appealing, \( t(111) = 2.47, p < 0.016, \eta^2_p = 0.052 \); tasted worse, \( t(113) = 3.10, p < 0.003, \eta^2_p = 0.078 \); and the overall consumption experience was less enjoyable, \( t(114) = 4.17, p < 0.001, \eta^2_p = 0.132 \). Additionally, participants were willing to pay 21.82% less for the factory farmed jerky, \( t(111) = 6.64, p < 0.001, \eta^2_p = 0.284 \), and participants reported being less likely to eat it again, \( t(110) = 5.86, p < 0.001, \eta^2_p = 0.238 \). Finally, participants consumed 8.18% less of the factory farmed sample, \( t(116) = 2.46, p < 0.016, \eta^2_p = 0.050 \) (Figure 2).
Figure 1. Study 1: Hedonic ratings of beef jerky sample. Error bars represent standard errors. All ratings made on 100-point slider scale.

Figure 2. Study 1: Behavioral measures for beef jerky sample. Error bars represent standard errors.

Discussion

The findings from Study 1 support our hypothesis that affective beliefs about how meat animals are raised can influence the experience of eating meat. In general, participants enjoyed beef jerky less when paired with the factory farm description compared to the humane farm description—even though the product was identical. The jerky described as coming from a factory farm looked less appealing, smelled less appealing, and tasted less pleasant. Furthermore, participants were willing to pay less and were less likely to eat jerky from the factory farm. Finally, participants consumed
less jerky when they believed it came from animals raised on the factory farm. These findings support our hypothesis that affective beliefs about meat can influence the experience of eating and can even change important behaviors like future consumption, willingness to pay, and even how much is eaten.

There are some open questions from Study 1. First, in the descriptions of the farms (Appendix A), there are a number of differences between the farms. One product was described as organic while the other was not, which has been shown to influence the perception of food (Lee et al., 2013). Additionally, one farm used antibiotics while the other did not. Therefore, the observed differences between conditions could be due to beliefs about one of these other factors and not due to the perceived suffering of animals.

Additionally, there is a possibility that the observed differences are due to the design of Study 1. Because participants were asked to evaluate two samples back to back that were physically the same product, perhaps participants’ experience of the two products was actually identical, but because the samples were paired with different descriptions, participants felt some pressure to report a difference. This explanation seems possible for explicit judgments (such as reported willingness to pay), but it seems less likely that participants would carefully regulate the amount of the samples they consumed. Still, this possibility could be tested with a between participant design.

Study 1 does not address another important issue. Typically when people make decisions about what to eat, they are not confronted with a description of how meat was produced. Sometimes sellers might advertise positive attributes about how meat was raised (such as Halal, Kosher, or certified humane), but no sellers advertise meat as
produced on factory farms (possibly for good reason). Study 1 provides no information about how participants would respond if no information about the meat was given. Does the humane description increase the pleasantness of eating? Or does the factory farm description reduce the pleasantness of eating? To perform a conceptual replication, and to address the important open questions raised above, we completed a second study.

**Study 2**

Study 2 was designed to address the unanswered questions from Study 1. First, new descriptions of farms were created so that the only differences were related to animal welfare (see Appendix A; organic and antibiotic language was removed). Second, Study 2 utilized a between participant design, so each participant sampled only one product. This eliminated the possibility that the effect observed in Study 1 was artificially induced by participants repeatedly sampling very similar products. Third, we added a control condition in which the description did not mention how meat animals were raised (instead it described where the product was typically sold). This condition was important because it allowed us to assess participants' experiences when beliefs were not manipulated. We also created an additional description of a factory farm that was framed in a relatively positive way (henceforth ‘factory farm+’). This condition was added to test whether the effect observed in Study 1 was driven by how positively the farms were described or by the affective implications of a moralized issue (i.e., how the animals were raised). The factory farm+ description highlighted one of the advantages of factory farming: the method is efficient which allows meat to be affordably produced. Finally, Study 2 was conducted as a field study on the campus of Northeastern University. This allowed us to efficiently collect data from a more diverse group of
participants (Henrich, Heine, & Norenzayan, 2010) and allowed us to see if the effect was robust enough to hold in an uncontrolled context outside the laboratory.

**Methods**

**Participants.**

Study 2 took place outdoors on the campus of Northeastern University, Boston, MA. Pedestrians (including students, staff, faculty, visitors, and community members) were asked if they would like to participate in a taste study. 259 people participated in the study. Nine were removed for not following instructions and two declined to sample the meat after reading the factory farm description. Therefore the analysis reported here includes 248 people. To keep the study brief, no demographic data was collected, but Northeastern University is a diverse campus, including 10% Asian, 3% Black/African-American, 7% Hispanic/Latino, 49% White, and 18% of students are international (National Center for Education Statistics, 2013).

**Materials.**

Researchers prepared samples of roast beef by placing 2.5 grams of meat in small paper cups with a toothpick. As in the first study, the sample was always the same product, but it was paired with different descriptions to manipulate beliefs. A small table was set up in an area with high foot traffic. Researchers wore red aprons and name tags while collecting data.

A single page of paper was prepared that contained a description of the roast beef (Appendix A) and a scale for participants to indicate how much they liked the roast beef. To manipulate affective beliefs about the meat, we created four different descriptions: a) control, b) humane farm, c) factory farm d) factory farm described in a
relatively positive way (factory farm+). Participants reported how much they liked the sample using a general Labeled Magnitude Scale anchored by “strongest imaginable dislike” to “strongest imaginable like” (Kalva, Sims, Puentes, Snyder, & Bartoshuk, 2014). The scale was 100 millimeter long, and participants were instructed to make a mark anywhere along the scale that corresponding to how much they liked the product.

Procedure.

Researchers invited pedestrians to sample roast beef as part of a brief study. Those who were interested were informed about the study including their rights to refuse to participate and gave verbal consent to continue. No identifying information was collected. Participants were handed a clipboard with a single page that included the description and response scale. Participants were instructed to read the description at the top of the page, then sample the roast beef, and finally, rate how much they liked the meat by marking the visual analogue scale. Because the manipulation in this study was between participants, each participant read only one description and tasted only one sample.

Results

To test whether beliefs influenced the experience of eating meat, we conducted a one-way ANOVA, with description as the independent variable and liking as the dependent variable. Supporting our hypothesis, we found that the descriptions influenced liking, $F(3, 244) = 3.25, p < 0.023, \eta^2_p = 0.038$ (Figure 3; see Appendix B, Table 1 for means, SE, and 95% CI). Follow-up planned independent sample t-tests (two-tailed) revealed that meat paired with the factory farm description was less liked compared to the humane farm, $t(119) = 2.52, p < 0.014$, and control description, $t(119)$
= 2.33, \( p < 0.022 \). The humane farm and control condition were approximately equally liked, \( t(124) = 0.37, p = .712 \). Additionally, the factory farm and the positively framed factory farm were approximately equally liked, \( t(120) = 0.85, p = 0.398 \). The difference between the humane farm and positively framed factory farm reached trend level significance, \( t(125) = 1.90, p < 0.061 \).

![Bar chart showing liking ratings of roast beef sample](image)

**Figure 3. Study 2: Liking ratings of roast beef sample.** Error bars represent standard errors. All ratings made on 100 millimeter general Labeled Magnitude Scale.

**Discussion**

Study 2 again demonstrated that beliefs about how meat animals were raised influences how much people enjoy eating meat. Specifically, knowing that beef was raised in “small cages” (both factory farm conditions) led to lower ratings of liking compared to the humane farm and control descriptions. Interestingly, beef paired with the control description (describing where meat is sold) and humane farm description had similar ratings. This suggests the effect in Study 1 was due to lower enjoyment of
factory farmed beef rather than increased enjoyment for humanely raised beef. This could be due to the fact that our participants believe that in general, farm animals are raised humanely. If this is the case, the humane and control condition might have simply confirmed people’s beliefs, while the factory farm changed their beliefs. Another possibility is that simply drawing participants’ attention to the fact that meat comes from animals reduces the pleasantness of eating meat, and any boost in hedonic experience from the humane description cannot overcome this. The fact that humanely raised products are not more liked than control products presents a possible challenge for producers who want to market humanely raised products. Improving animal welfare is costly, so if consumers enjoy it no more than meat without information about how animals are raised, it might be hard to make up that difference. The meat paired with the positively framed factory farm was not more liked than the meat paired with the factory farm. This suggests that the effect is not simply driven by one of the farms being portrayed in a positive way. Instead this finding suggests that the experience of eating meat is driven by the affective nature of the moralized behavior, not simply the affective tone of a description.

Studies 1 and 2 demonstrated that general hedonic experience is shaped by beliefs. While the findings from the first two studies are interesting, they raise an even more compelling possibility: can beliefs influence very basic perceptual properties of flavor, such as saltiness or sweetness? That is, do the perceptual experiences change—or just more global affective experiences (like overall pleasantness)? There is some evidence that beliefs can influence perceptual properties of flavor. For example, savory salmon flavored ice cream is experienced as more salty when people are expecting
sweet, fruity ice cream, compared to when they are expecting savory mousse (Yeomans et al., 2008). This finding is suggestive that the effects in Studies 1 and 2 may be driven by shifts in the perceptual properties perceived in the meat.

**Study 3**

To test whether beliefs about how animals are raised can influence perceptual properties of flavor (i.e. saltiness, sweetness, etc.), we conducted another study in which participants reported on a variety of taste properties. Because we were studying subtle changes in the perception of flavor, Study 3 was conducted in a laboratory where we could control the environment and keep distractions to a minimum. We returned to a design very similar to Study 1 and used a within participant design.

**Methods**

**Participants.**

117 Northeastern Undergraduate students participated in Study 3. Three participants were removed because they did not follow instructions (the pattern of findings do not change with all participants included). Therefore, data were analyzed for 114 participants (55.3 % female) from 19 to 24 years old ($M = 19.12$). Participants were recruited through introductory psychology classes and received credit for participation. All participants gave written, informed consent before participating.

**Materials.**

Study 3 used similar materials and design to Study 1 with the following modifications. First, we created new meat descriptions (Appendix A). While Study 2 used a very minimal approach to manipulating beliefs, in Study 3 we attempted to create more evocative descriptions. To do this, in addition to the text descriptions, we
added a picture of animals. For the humane farm description we included a picture of animals outside. For the factory farm, we included a picture of animals in cages (see Appendix A). We reasoned that adding visual information would increase participants’ ability to simulate animals’ experiences on farms, which would result in a more potent effect.

Second, Study 3 used a control condition that had no description of the meat. This mirrors many real world situations in which people are not presented with any description of the meat they have the option of consuming. In Study 3, the control condition always came first. This was done because once participants read a label, they may apply it to any subsequent unlabeled samples. For instance, if participants first sampled meat paired with a factory farm label, and then received a sample with no label, participants would likely apply the previous description.

In Study 3, we used samples of deli ham that were prepared by cutting thickly sliced ham into five pieces weighing a total of approximately five grams. Three separate samples were prepared for each participant, and each was placed into a paper sample cup and was lightly heated in a microwave oven for 5 seconds. Samples were kept warm by placing them in an insulated box to retain heat until consumed in the experiment.

**Procedure.**

The procedure in Study 3 was similar to Study 1. Participants tasted three samples. Participants always tasted the ham paired with no description as the first sample. Next, participants sampled ham paired with either the factory farm description
or the humane farm description (order randomized between participants) and then sampled ham paired with the remaining description.

Each trial started with participants cleansing their palate by drinking a small amount of water. Next participants read the farm description (Appendix A), consumed the sample, and reported their experience of the sample. First, participants rated how pleasant the overall consumption experience was on a 100-point slider scale (from 0 = ‘very unpleasant’ to 100 = ‘very pleasant’). Next participants rated different taste properties of the sample: savory, salty, sweet, bitter, sour, fresh, and greasy (from 0 = ‘not very much’ to 100 = ‘very much’). Next participants rated how pleasant the sample tasted, appeared, and smelled (from 0 = ‘very unpleasant’ to 100 = ‘very pleasant’). Next, participants reported how much they would be willing to pay for 16 ounces of the sample (from $0 to $20) and how likely they would be to eat the sample again (from 0 = ‘would never eat this again’ to 100 = ‘would definitely eat this again’). As in Study 1, we measured how much of the sample was consumed by measuring the weight of the samples before and after participants completed the taste test. Participants were free to eat as much of the samples as they wanted so the amount consumed could vary from 0 to 5 grams.

To check whether participants were attending to the farm descriptions, participants were asked to recall the descriptions after they completed the sampling procedure. Only three participants did not recall any parts of the description suggesting they did not read the descriptions. These participants were removed from analysis, but including them does not change the pattern of findings.

**Results**
To test whether beliefs influence the experience of eating meat, we conducted a series of one-way repeated measures ANOVAs (one for each dependent variable), with description as the independent variable (humane farm, factory farm, or control) and ratings as the dependent variable. Greenhouse–Geisser corrected tests are presented if the sphericity assumption was not met (Appendix B, Table 1 reports which tests are corrected). Supporting our hypothesis, we found the descriptions influenced overall pleasantness, $F(2,212) = 20.83, p < 0.001, \eta^2_p = 0.164$. Additionally, descriptions influenced the pleasantness of taste, appearance, smell, how likely participants were to eat the meat again, and how much they would be willing to pay for a 16 ounce package of the sample (all $Fs > 3.51$, all $ps < .05$; see Appendix B, Table 1 for complete statistics). Additionally, descriptions influenced how much of the sample participants consumed at a trend level of significance, $F(2,224) = 2.99, p = 0.052, , \eta^2_p = 0.026$. Descriptions also influenced some of the basic ratings of flavor. Specifically, the descriptions influenced ratings of how savory, salty, fresh, and greasy the samples were (all $Fs > 3.94$, all $ps < 0.022$; see Appendix B, Table 1 for complete statistics). The descriptions did not significantly influence ratings of how sweet, bitter, or sour the samples were (all $Fs < 2.02$, all $ps > 0.134$).

To explore which descriptions influenced which dependent variables, we visually inspected the means (Figures 4-6) and computed least significance difference tests (LSD; Appendix B, Table 1 reports LSD post hoc results, means, SEs, and 95% confidence intervals). Generally, findings in Study 3 mirror what was found in the previous studies. In Study 3, samples paired with factory farm descriptions looked, smelled, and tasted less pleasant compared to samples paired the humane description.
Participants were also willing to pay 30.55% less for the factory farmed sample and were less likely to eat it again. Participants also consumed 6.19% less of the factory farm sample.

Additionally, as in Study 2, the control condition was generally similar to the humane farm condition (Figures 4-6). The exception is that for pleasantness of appearance and amount eaten, the control condition was more similar to the factory farm description. For willingness to pay, each of the conditions was significantly different. Participants were willing to pay the most for meat paired with the humane description, followed by the control description, and least for the factory farm description.

Descriptions influenced the basic flavor ratings differently depending on the attribute being rated (Figure 6). Post-hoc tests show that meat paired with the humane sample was experienced as less salty and greasy than the other two samples. Meat paired with the factory farmed sample was experienced as less fresh than the other two samples. The meat paired with the control description was experienced as more savory than the meat paired with the factory farm description, and meat paired with the humane description was intermediately savory.
Figure 4. Study 3: Hedonic ratings of ham sample. Error bars represent standard errors. All ratings made on 100-slider scales.

Figure 5. Study 3: Behavioral measures for ham sample. Error bars represent standard errors.
Study 3 again found that beliefs about animal welfare influenced the hedonic experience of eating meat. As in the Study 1, meat paired with the factory farm description was rated as overall less pleasant, and the smell, taste and appearance were less pleasant (compared to the humane farm condition). Participants were also willing to pay less, and were less likely to eat factory farmed meat compared to humanely farmed meat. Additionally, there was a trend level finding that participants ate less of the factory farmed meat. As in Study 2, the control description and humane farm description resulted in very similar ratings (both were more pleasant than the factory farm condition).

Study 3 suggests that beliefs might also influence the raw perceptual properties of flavor. The humane sample was experienced as less salty and greasy than the other two samples. Meat paired the factory farmed sample was experienced as less fresh
than the other two samples. The meat paired with the factory farm description was experienced as less savory than the meat paired with the control description (meat paired with the humane description was intermediately savory). It is unclear why flavor is influenced in this pattern. Flavors that have negative connotations (e.g. greasy and salty) seem to increase for factory farmed meat, while those with positive connotations (e.g. fresh) decrease. One possibility is that the pattern reflects a valenced flavor halo effect such that 'negative' foods (i.e. factory farmed meat) are experienced as having 'negative' taste characteristics (i.e. more greasy, less fresh). Another possibility is that people have different expectations about how factory farmed and humanely raised meat will taste, and these expectations drive perception (Cardello, 2007; Piqueras-Fiszman & Spence, 2015; see general discussion below).

One weakness of Study 3 is that all participants tasted the control meat first (i.e., the meat with no description). Therefore the ratings for this sample should be treated with some caution as there could be an order effect. This choice was made so participants would not use beliefs from the previous condition to inform judgments in the control condition. Despite this limitation, the control condition findings mirror the findings from Study 2 where there was no potential for an order effect, lending greater confidence in the robustness of the effect for this condition.

**General Discussion**

Eating decisions are driven, in part, by pleasure. Because hedonic experience is related to consumption, and plays a role in desire (Papies & Barsalou, 2014), understanding how the mind constructs the hedonic experience of eating is critically important. Meat, in particular, is important because eating too much can increase the
prevalence of metabolic related disease, including cancer, heart disease, and obesity (Barnard, Nicholson, & Howard, 1995). Eating too much red meat, in particular, increases mortality rates (Pan et al., 2012). While incoming sensory signals from the physical substance play a role in constructing the eating experience, beliefs also play a role. We hypothesized that beliefs about how farm animals are raised would shape the hedonic experience of eating meat. Specifically we hypothesized that beliefs that animals were raised on factory farms would reduce the pleasantness of eating meat.

Supporting our hypothesis, three studies found that beliefs about how animals were raised can influence the experience of consuming meat. In general, believing meat came from a humane farm did not boost the hedonic experience compared to meat paired with a control description (Study 2) or no description (Study 3). Rather, believing animals were raised on a factory farm led to a less pleasant consumption experience (Studies 1 - 3). Specific sensory modalities were consistently influenced: factory farmed meat looked, smelled, and tasted less pleasant (Studies 1 & 3). People were willing pay less for factory farmed compared to humanely raised meat (21.82% less in Study 1; 30.55% less in Study 3). People also reported being less likely to eat the factory farmed meat again (Studies 1 & 3). Additionally, people ate less meat when they believed it came from a factory farm compared to humane farm (8.18% less in Study 1, trend of 6.19% less in Study 3). Finally, the perceived flavor of the meat was also influenced by beliefs (Study 3). Factory farmed meat tasted more salty, less fresh, and more greasy compared to humanely raised meat. Broadly, these findings demonstrate that negative beliefs (in this case that meat was raised on factory farms) can reduce the pleasure of eating.
While negative beliefs reduced enjoyment, positive beliefs did not increase enjoyment. Believing meat came from a humane farm did not boost the overall hedonic experience compared to meat paired with a control description (Study 2) or no description (Study 3). This mirrors other studies that find an effect of negative but not positive beliefs (Anderson et al., 2011). In the present study, there are at least three reasons why this might be the case. First, negative beliefs might be special: the cost of missing something negative could result in poisoning, while missing something positive only results in missing something delicious. Second, people might have idealized pastoral beliefs of how animals are typically raised (i.e. contented cows lounging in lush green pastures). If these are people’s typical beliefs, the humane and control conditions in our studies might have lead to generally the same beliefs in participants (i.e. that animals were raised in humane conditions). A third alternative explanation is that the humane description may have provided a lift in hedonic experience, but simply reminding consumers that their meat came from living animals might have worked against this increase. That is, when giving information about how farm animals are raised, there is simply no getting around the fact that meat is animal flesh and this interferes with people’s ability to enjoy meat. This could prove to be a challenge for producers who advertise and sell humanely raised meat: the present findings suggest that reporting humane treatment is no better than saying nothing. Raising animals humanely is more expensive (and thus the product is more expensive), so producers will need to find another way to attract consumers. This concern is slight offset by the finding that people being willing to pay substantially more for humanely raised meat.
Our three studies demonstrate the phenomenon that belief impacts the experience of eating meat; future work will be required to unpack the mechanism driving these effects. One mechanism by which affective beliefs may influence experience is through affective realism (Anderson, Siegel, White, & Barrett, 2012). According to affective realism, affect is a fundamental property of conscious experience (Barrett & Bliss-Moreau, 2009; Wundt, 1897/1998). People experience the world as intrinsically affective: paintings are beautiful or ugly; food is delicious or disgusting. In reality though, experienced affective feelings are generated in the organism. Rotten food is disgusting because people feel disgust when they see and smell it. Affective realism builds on the affect as information perspective (Schwarz & Clore, 1983) which suggests that people reference their affective feelings when making judgments. According to the affect as information perspective, the factory farm description of animals suffering might have produced a negative affective response in participants. Then when participants rated the meat, they consulted their affective state to make ratings. One key difference between affective realism and affect as information is how fundamental affect is in constructing an experience. For instance, according to the affect as information perspective, people can discount affect as a credible source of information (Schwarz & Clore, 1983), and remove the biasing effects of affective misattribution. However according to a strong affective realism perspective, people will often not be able to discount their feelings because those feelings are a fundamental component of the experience. For example, when evaluating a delicious meal, the task is impossible if you discount your feelings. Future studies should test whether discounting feelings eliminates the effect observed the three studies reported here.
Affective realism is consistent with effects that have been previously described as the halo effect (people or objects with one positive attribute are thought to be globally more positive). For instance, instructors perceived to be warm are also perceived to be more attractive (Nisbett & Wilson, 1977). Recent food research showing people prefer 'eco labeled' coffee has been described as a 'green halo effect' (Sörqvist et al., 2015). Foods labeled 'organic' are thought to be healthier in general and are rated as lower in calories (Lee et al., 2013). The affective realism hypothesis builds on the halo effect to include a specific mechanism: the halo is affect. Because feeling that someone is positive is a fundamental part of perceiving people, that feeling of positivity becomes incorporated into diverse perceptions of people (including judgments of competence and warmth; Anderson et al., 2012). Thus, affective representations (here, in the form of beliefs) are an essential component in the ever changing flow of conscious experience (Barrett & Bliss-Moreau, 2009; Wundt, 1897/1998).

According to affective realism, affective beliefs (descriptions of how animals are raised) are examples of conceptual knowledge that are neurally represented in a distributed, multi-modal fashion that include affective and sensory representations (for a discussion of grounded cognition, see Barsalou, 2008; as an example of grounded conceptual knowledge about emotion, see Wilson-Mendenhall, Barrett, Simmons, & Barsalou, 2011). Therefore, knowledge that meat came from animals who potentially suffered would be represented, in part, in regions of the brain that are associated with cognitive perspective taking (mentalizing) and embodied simulation of animals’ pain (mirroring; for review see Zaki & Ochsner, 2012). From an affective realism view, these embodied representations (triggered by descriptions) would then set the neural context
for incoming sensory information. Thus, in the present studies, the descriptions of factory farmed meat have potency because they evoke an embodied representation of animal suffering. Incoming sensory signals are then integrated with those existing representations, constructing the full, unified conscious eating experience.

If affective realism is the mechanism driving the present effects, it suggests the intriguing possibility is that beliefs can even shape the bodily context for incoming nutrients. Beliefs about calorie content have been shown to shape physiological satiety. When people believe they are consuming a high calorie 'indulgent' milkshake, they have increased physiological satiation (measured by ghrelin) compared to when the same people believe they are consuming a 'sensible' milkshake--even though the milkshakes were identical (Crum, Corbin, Brownell, & Salovey, 2011). If beliefs have the power to robustly shape basic metabolic systems as food is ingested, the full health implications could be tremendous.

The affective realism view that beliefs work by creating a neural context is consistent with the literature on expectations. Many studies have found expectations (as a kind of belief) influence food perception (for review see Cardello, 2007; Piqueras-Fiszman & Spence, 2015). Expectations can help people quickly and efficiently detect odors for congruent odor-color pairings (Demattè, Sanabria, & Spence, 2006). Generally, if the incoming gustatory sensory information mostly matches expectations (which is often set based on visual cues), the sensations tend to conform to the expectations. However, if the incoming sensations do not match expectations, foods are typically experienced negatively (as in the case of salmon flavored ice cream; Yeomans et al., 2008).
The idea that expectations play a critical role in perception is consistent with emerging research from neuroscience on predictive coding (for review, see Clark, 2013). This work suggests that the brain is constantly making predictions about incoming sensory information. When eating, the brain would also be making predictions about incoming gustatory and olfactory signals from chemical substances entering the mouth. According to predictive coding, when there is a large mismatch between the expectation and the actual substance, a strong prediction error would be generated that helps the brain make more accurate predictions in the future. An unexplored possibility is that this prediction error is responsible for the unpleasant experience when a food’s actual taste violates the prediction. Evolutionarily, this could have helped organisms avoid food that did not taste as expected, such as: misidentified substances, over or under ripened plants, or spoiled foods.

Weaknesses

Our studies primarily rely on self-reported experience, which can be influenced by demand characteristics. Perhaps in Studies 1 and 3, participants experienced all of the products in the same way, but felt pressure to change their explicit ratings to be more desirable. There are four ways we attempted to address this possibility. First, experimenters were always blind to the condition while participants tasted and rated the product (except the control condition in Study 3). This was done so the experimenters could not influence responses by unknowingly changing their behavior. Second, participants were always instructed that there was no correct response and that their responses would not be linked to their names. Third, in Studies 1 and 3 responses were made on a computer so the researcher was unaware of participants’ responses to
reduce pressure participants may have felt. Finally, and most important, we measured liking implicitly by measuring the amount of meat consumed (Study 1 & 3). We found that participants consumed less meat when they believed it was raised on a factory farm—suggesting they enjoyed it less. It seems unlikely that participants would carefully control the amount of the samples they consumed for social desirability. However future research could use additional implicit or physiological measures to rule out the possibility that the effects observed are not driven by demand characteristics.

**Conclusion**

Just as social affective beliefs (gossip) influence the visual experience of faces (Anderson et al., 2011), affective beliefs about animal welfare influence the experience of eating meat. These effects have powerful implications for food choices and health outcomes. This effect likely extends beyond beliefs about suffering to any strong affective belief (such as other moral violations; e.g. purity or hierarchy norms; see (Graham et al., 2011)). Additionally, these effects almost certainly extend beyond meat to other food, and even other experiences. For instance, believing that a comedian was accused of a sex crime might change the experience of hearing their jokes. Broadly, this work suggests top-down influences (such as affective beliefs) play an important role in shaping experience. Experience is not determined solely by physical properties of the external world--experience is also shaped by what we believe.
References


http://doi.org/10.1016/j.foodqual.2008.02.009

### Table 1. Descriptions of meat samples.

<table>
<thead>
<tr>
<th>Study 1 (jerky)</th>
<th>Control</th>
<th>Humane Farm</th>
<th>Factory Farm</th>
<th>Factory Farm+</th>
</tr>
</thead>
<tbody>
<tr>
<td>This humanely raised beef jerky was raised on a family farm. The animals grazed in outdoor pastures and consumed organic feeds. They were not raised with antibiotics or artificial growth hormones. Care was taken to ensure the welfare of the animals. This product meets all USDA organic certification standards.</td>
<td>This beef was raised at Hillman’s, a farm that values animal welfare. To more humanely raise animals, their cows roam in grassy outdoor pastures. Hillman’s is recognized with awards for their exceptional treatment of farm animals.</td>
<td>This beef was raised at Hillman’s, a facility that values production. To more easily produce meat, their cows are kept in small indoor cages. Hillman’s products pass all federal requirements and are sold around the country.</td>
<td>This beef was raised at Hillman’s, a facility that values efficiency. To more affordably provide meat, their cows are kept in small indoor cages. Hillman’s products pass all federal requirements and are affordably priced for everyone.</td>
<td></td>
</tr>
<tr>
<td>Study 2 (roast beef)</td>
<td>This beef comes from Hillman’s, a store that sells sliced deli meat. This product can be used in a variety of meals including sandwiches. Hillman’s products pass all federal requirements and are sold around the country.</td>
<td>This ham was raised on a farm that focused on animal welfare. The animals were allowed to roam in grassy outdoor pastures where they could graze and exercise. The animals were not isolated so were able to engage in social behaviors with other pigs.</td>
<td>This ham was produced at a factory farm that focused on production. The animals were confined to concrete indoor pens where they were unable to lie down or go outside. The animals were isolated so could not engage in social behaviors with other pigs.</td>
<td></td>
</tr>
</tbody>
</table>
Table 1. Study 1 - 3 means, standard errors, 95% confidence intervals, and test statistics.
Chapter 2:

Vegetarians’ and Omnivores’ Affective and Psychophysiological Responses to Meat
Title:

Vegetarians' and Omnivores' Affective and Psychophysiological Responses to Meat

Eric C. Anderson¹, Lisa Feldman Barrett¹,², Karen S. Quigley¹,³

¹Northeastern University; ²Massachusetts General Hospital / Harvard Medical School
³Edith Nurse Rogers Memorial (Bedford) VA Hospital;

Corresponding Author:

Eric C. Anderson

Department of Psychology
Northeastern University
Boston, MA 02115
Phone: 617-373-4789
Fax: 617-373-8714
Email: ericmranderson@gmail.com
Abstract

Many vegetarians report that meat is unpleasant, but little else is known about people’s affective responses to meat. Here we explore affective responses to meat in vegetarians and omnivores using self-report and psychophysiological measures. We test the hypothesis that vegetarians have global differences in affective processing (e.g. increased disgust sensitivity). We found that vegetarians and omnivores evaluated meat differently (meat was less pleasant for vegetarians), but they evaluated other foods similarly. However, psychophysically, vegetarians and omnivores were strikingly similar responses to all stimuli—including meat. The one physiological group difference that did emerge was a generally elevated electrodermal response in vegetarians to all pictures. One possibility is that vegetarians conceptualize changes in their bodily states (the increased electrodermal response) in ways that match their belief system (i.e. that meat is cruel, wasteful, impure, or unhealthy). These findings are consistent with the idea that the brain constructs the experience of eating.

Keywords: Psychophysiology, Affect, Food, Vegetarian, Meat
Vegetarians’ and Omnivores’ Affective and Psychophysiological Responses to Meat

Humans eat for calories and nutrients but also for pleasure (Lowe & Butryn, 2007). Fascinatingly, there is enormous variation in what people eat and how pleasurable people experience the very same food. For omnivores meat is generally considered a delicious food that is often reserved for special occasions (Fiddes, 1991), but vegetarians perceive meat very differently (for review see Ruby, 2012). Vegetarians often report that meat is negative (Rozin, Markwith, & Stoess, 1997), and many people who convert to vegetarianism report that the hedonic value of meat shifts over time: originally meat is pleasant, but it becomes negative (Amato & Partridge, 1989). Though this ‘hedonic shift’ (Rozin et al., 1997) is not well documented or understood, it may help vegetarians maintain their diets since desire for the taste of meat is one of the most common reasons people report for abandoning their vegetarian diet (Barr & Chapman, 2002; Haverstock & Forgays, 2012). Though many have observed that vegetarians report meat as negative (Amato & Partridge, 1989; Barnes-Holmes, Murtagh, Barnes-Holmes, & Stewart, 2010; De Houwer & De Bruycker, 2007; Rozin et al., 1997; Stockburger, Renner, Weike, Hamm, & Schupp, 2009), little else is known about the affective and emotional responses of vegetarians to meat. For instance, perhaps vegetarians experience all foods more negatively--not just meat.

A common reason for meat avoidance is animal suffering (Amato & Partridge, 1989; Fox & Ward, 2008a; Rozin et al., 1997). Many omnivores are even uncomfortable with the suffering of animals raised on factory farms (Pollan, 2006). These omnivores are faced with the Meat Paradox: they enjoy eating meat but dislike that animals suffer (Bastian, Loughnan, Haslam, & Radke, 2012; Loughnan, Haslam, & Bastian, 2010).
Generally research has focused on people’s judgments of how much animals are suffering, and has not tested how perceived suffering influences the perceiver’s affective state. An untested possibility is that vegetarians might feel more negatively about animal suffering which drives them to adopt a vegetarian diet. In support of this possibility, vegetarians perceive that animals experience a greater range of emotions than omnivores (Bilewicz, Imhoff, & Drogosz, 2011). This might be due in part to omnivores engaging in motivated denial of mind. That is, eating meat reduces how much people perceive meat animals are suffering (Loughnan et al., 2010). Interestingly, perceived capacity to suffer does not predict whether omnivores will eat particular animals (Ruby & Heine, 2012), so meat eating decisions are not driven solely by perceived suffering.

The aim of this paper is to explore the affective and emotional responses of vegetarian and omnivores to animals, meat, and other food stimuli. Affect is typically described as having two dimensions: valence (ranging from pleasant to unpleasant) and arousal (ranging from activated to deactivated; (Barrett, 2006; Russell & Barrett, 1999; Russell, 2003). At any given moment, an organism’s affective state can be described in terms of some combination of valence and arousal, and these feelings are thought to be an important component of a unified conscious experience (Barrett & Bliss-Moreau, 2009; Wundt, 1897/1998). Stimuli are said to be affective when they perturb an organism’s affective state. Snakes and spiders are negative because we feel unpleasant when they appear in front of us. Discrete emotions on the other hand, are particular states that people can experience (e.g. disgust, guilt, or happiness). Emotions have affective features: fear and anger are both unpleasant high arousal states, but fear
and anger are not the same feelings and probably have different causes and consequences. Some researchers argue there is a set of biologically-basic, universally experienced emotions that have evolved to serve a long-standing functional purpose (Ekman & Cordaro, 2011; Izard, 2011; Levenson, 2011; Panksepp & Watt, 2011; Tracy & Randles, 2011). Others argue that emotions are constructed by the brain from external sensory information, internal bodily feelings (interoception), and conceptualization based on past experiences (Barrett, 2014, 2015). While there has been considerable debate over the last century about what exactly emotions are (Barrett et al., 2007; Gendron & Barrett, 2009), the body plays a prominent role in the major theories of affect and emotion (Barrett, 2015; Clore & Ortony, 2013; Damasio, 1994; Ekman, Levenson, & Friesen, 1983; James, 1884; Lang & Bradley, 2013). Part of emotions are feelings from the body (though theories differ on the specifics, and each instance of an emotion might have different bodily feelings). For instance, part of the feeling of disgust might be sensing your stomach churn when smelling fish rotting in the sun. Bodily changes are important because one of the functions of affect and emotions is preparing the organism to act—which requires mobilizing bodily resources. For instance, changes in cardiac activity can prepare the body to move (‘fight or flight’). Additionally, the body might be particularly important for food perception, because the body prepares for anticipated incoming substances with physiological responses that aid in metabolism and energy regulation (i.e. cephalic phase responses; Power & Schulkin, 2008). Because the body plays a role in affective responses, the body can be a window into a person’s affective state. That is, one way to learn something about a person’s affective or emotional state is to measure physiological responses that regulate
the body. Peripheral psychophysiology has been used by psychologists to measure bodily responses to evocative stimuli (Bradley & Lang, 2007), but to our knowledge, peripheral psychophysiological measures have never been used to study bodily responses of vegetarian and omnivores.

Using psychophysiological measures to understand affective reactions does not require participants to accurately report their feelings. This advantage allows researchers to continuously collect data even when participants might be unable or unwilling to accurately report what they are feeling. This could be particularly important when studying meat eating. Many vegetarians view their diet as more than a food choice—to them, eating meat is a moral issue (Rozin et al., 1997) and a source of personal identity (Fox & Ward, 2008b). Because of this, vegetarians may feel social pressure to make reports that conform to others who share their vegetarian identity (e.g. they may report meat is disgusting because other vegetarians report meat is disgusting). Omnivores might also be unwilling to truthfully report their feelings. Male omnivores in particular might be reluctant to acknowledge they are uncomfortable with meat or animal suffering, because meat is strongly linked to masculinity in many cultures (Rozin, Hormes, Faith, & Wansink, 2012; for review see Ruby, 2012). Previous studies of vegetarians’ affective responses have relied on self-reports (Rozin et al., 1997). In fact, there have only been a handful of studies on vegetarians that have used research methods that go beyond self-reports at all, and none of these studies have focused on affective and emotional responses. For instance, using implicit association tasks, two groups have found that vegetarian have more positive implicit associations toward vegetables, and less positive associations toward meat, compared to omnivores.
Measuring electrical signals on the scalp using electroencephalogram (EEG), researchers found vegetarians (compared to omnivores) produced enlarged late positive potentials when viewing meat pictures (but not other pictures), suggesting that meat captures vegetarians’ attention (possibly because it is a potent negative stimulus; Stockburger et al., 2009). These studies show vegetarians and omnivores seem to perceive meat differently, even when using methods that do not rely on self-reports. However, no studies that we are aware of directly measure biological systems thought to be critical in affective experience, such as bodily responses.

The goal of the present study was to test between two alternative hypotheses about vegetarians' affective responses. The specificity hypothesis suggests that affective differences between vegetarians and omnivores is very specific to meat stimuli. That is, vegetarians experience meat as negative, but other foods and stimuli are experienced as equally positive and negative when compared to omnivores. The alternative, generality hypothesis, is that vegetarians have general differences in affective processing (Fessler, Arguello, Mekdara, & Macias, 2003). For instance, Fessler et al. noted the possibility that meat may be more disgusting to vegetarians because they are more sensitive to disgusting stimuli in general (i.e. higher trait disgust; Haidt, McCauley, & Rozin, 1994). Using a large online sample of people who ate differing amounts of meat, Fessler et al (2003) found no support for this hypothesis using survey measures. Increased disgust sensitivity was not related to decreased meat eating. However, Fessler et al. did not directly compare vegetarian to omnivores. Rather, they treated meat eating as a continuous variable, so participants reported the
amount of meat they typically consume and if they avoided particular meat. Additionally, Fessler et al. only measured self-reported disgust and not any other affective responses. An intermediate position (between the specificity and generality hypotheses) is that vegetarians might have different affective responses to animals, because animals are closely associated with meat, and are the reason many vegetarians avoid meat.

To test the specificity of vegetarians' affective responses, we presented vegetarians and omnivores with pictures of animals, meat, and other foods. Participants reported how appetizing the foods were and how much they believed the animals pictured suffered. Participants also reported their affective and emotional feelings, and we measured physiological changes. We recorded two commonly used measures of autonomic nervous system activity and two measures of facial muscle movement. First, we measured electrodermal activity which is thought to be an index of sympathetic nervous system activity (engaged in the ‘fight or flight’ response). Electrodermal activity is often related to increases in arousal (Bradley, Codispoti, Cuthbert, & Lang, 2001; Lang, Greenwald, Bradley, & Hamm, 1993), and researchers typically find elevated electrodermal activity in response to high arousal pictures (e.g. snakes and erotica; Bradley et al., 2001; Codispoti, Bradley, & Lang, 2001). Secondly, we measured cardiac activity as measured by heart period (the duration between heart beats; inversely related to heart rate). Heart period has been shown to increase following negative pictures (heart rate deceleration; (Bradley et al., 2001; Codispoti et al., 2001; Lang et al., 1993). In general, while some researchers argue there are distinct physiological patterns that correspond to discrete emotions (Ekman et al., 1983), generally meta-analyses have not found consistent and specific responses for discrete emotions
(Cacioppo, Berntson, Larsen, Poehlmann, & Ito, 2000; Siegel et al., under review; for detailed discussion see Quigley & Barrett, 2014). There is better evidence that psychophysiological measures are related to valence and arousal (Cacioppo et al., 2000; Siegel et al., in prep), but there is still enormous variation depending on the experimental context. For instance, heart rate decreases in response to negative pictures, but increases while imagining negative events (for discussion see Bradley & Lang, 2007). This variation makes sense because the appropriate bodily response will vary considerably depending on the context. Thus, physiological responses are likely to be more consistent within a particular experimental paradigm (such as picture viewing), rather than across different paradigms.

Since the time of Darwin (1872), scientists have studied the link between facial expressions and affective and emotional states. For instance, activation of the corrugator supercilii facial muscle is consistently associated with negative affect (Bradley et al., 2001; Lang et al., 1993; for review see Cacioppo et al., 2000). In the present study, we measured corrugator muscle activity using facial electromyography. We also measured levator labii activity, which some researchers have associated with disgust (Vrana, 1993): both to food (Hoefling et al., 2009) and other disgusting contexts more broadly (Chapman, Kim, Susskind, & Anderson, 2009; though see Cameron, Lindquist, & Gray, 2015 for discussion). Using levator activity as an index of disgust is consistent with the 'basic' emotion view that each emotion has a unique facial muscle configuration, so emotional states can be read from the face (Ekman, 1992). Again, other researchers have argued that facial expressions do not map onto emotions in a one-to-one way (for discussion see Barrett, 2015). Rather, facial expressions are made
for a variety of purposes (Russell, Bachorowski, & Fernandez-Dols, 2003), and context plays a strong role in interpreting them (Aviezer et al., 2008). Our view is that peripheral physiological and facial muscle activation are more strongly related to affective states than discrete emotional states (Cacioppo et al., 2000; Siegel et al., under review; Siegel et al., in prep). Therefore, in this paper we use peripheral physiological and facial muscle activation to give information about how participants' bodies are responding and to make qualified inferences about participants' affective states.

To summarize, the primary aim of this paper is to explore affective responses of vegetarians and omnivores using self-reported affect, autonomic psychophysiological measures, and facial muscle movement. In particular, we test between three alternative hypotheses. The most specific hypothesis posits that vegetarians experience meat as negative but respond to all other stimuli just like omnivores. The most general hypothesis suggests vegetarian have more global differences in affective processing such as experiencing all food as hedonically less pleasant or experiencing negative stimuli as more negative. An intermediate hypothesis suggests animals suffering is also particularly negative for vegetarians.

An auxiliary goal was to replicate previous work showing that omnivores engage in motivated denial of mind (Bastian et al., 2012; Loughnan et al., 2010). As noted earlier, many people like eating meat, but dislike causing suffering to animals. This conflict (the Meat Paradox) results in omnivores implicitly denying animals experience suffering (Bastian et al., 2012; Loughnan et al., 2010). Therefore, we hypothesized that if omnivores are first exposed meat meals, they would subsequently report that animals suffer less (compared to those exposed to vegetable meals). This would happen
because viewing and rating the appetizingness of meat meals should make salient to people that they typically enjoy eating meat. Then, when faced with an animal that potentially experiences suffering, participants would be faced with the meat paradox, which they can reduce through motivated denial of mind. We also test the opposite situation: whether seeing animals first would reduce the pleasantness of subsequently viewed meat. People who first think about psychological attributes of an animal are more disgusted by eating them (Ruby & Heine, 2012), so we hypothesize that if people first consider the mental state of animals, they would subsequently find meat less appetizing.

Methods

Participants

Eighty-six participants were enrolled from Northeastern University and the greater Boston community through recruitment flyers. One participant was excluded for erratic behavior, so the analysis reported here includes 85 participants who completed the experiment. This final sample includes 40 vegetarians (75% female; $M$ age = 21.43) and 45 omnivores (67% female; $M$ age = 20.32; see Table 1 for demographic data). There is not complete agreement on the definition of vegetarian (see Ruby, 2012 for discussion): some vegetarians avoid all animal products (vegans), some eat fish (pescetarian), and others eat meat when convenient or in social situations where avoiding meat might cause social conflict. For the purpose of this study, vegetarians were self-identified (some ate fish, but all avoided red meat and chicken). Six vegetarians also identified as vegan (consumed no animal products). Due to equipment malfunctions, some physiological data was not available for some participants, so the
number of observations varies for some comparisons. Participants were required to be
native English speakers. Volunteers were ineligible if they had skin allergies, overly
sensitive skin, chronic medical conditions, mental illness, asthma, or a history of
cardiovascular illness or stroke. They were also ineligible if they had taken medications
to treat ADHD, insomnia, anxiety, high blood pressure, rheumatoid arthritis,
epilepsy/seizures, cold/flu, or fever/allergies (i.e., those medications with autonomic
actions) within the 72 hours before the study session. Eligible participants were asked to
refrain from consuming caffeine, tobacco, diet pills, sleeping pills, and alcohol for 12
hours prior to the experiment. To ensure food stimuli would be maximally evocative, all
participants were asked to refrain from eating for four hours before the study. Subjects
received $5 per ½ hour of participation. The study took approximately 3 hours to
complete.

Questionnaires

Participants completed a set of questionnaires that asked about demographic
and health information. Participants reported their age, gender, height, weight, and
dominant hand on the demographic questionnaire. The health questionnaire included
questions about history of cardiovascular illness, asthma and skin allergies, about
chronic medical problems, family medical history, and any current medications.
Participants also reported their current level of stress, number of hours they slept the
previous night, how many hours per week they typically spend exercising, and their
average daily consumption of alcohol, tobacco, sleeping pills and diet pills. Finally,
participants reported their consumption of such products in the last 12 hours to ensure
compliance with eligibility criteria. In addition, participants completed a set of individual
difference questionnaires at the end of the experimental session with two of these measures analyzed here: the Individual Difference in Anthropomorphism Questionnaire (IDAQ; Waytz, Cacioppo, & Epley, 2010), and the Disgust Scale-Revised (DS-R; Olatunji et al., 2007). There were no group difference in levels of anthropomorphism (IDAQ; Waytz, Cacioppo & Epley, 2010), $t(72)=0.647$, $p = 0.31$, (see Table 1) or trait disgust (DS-R; Olatunji et al., 2007), $t(72)=0.054$, $p=0.957$ (Table 1). Additional questionnaires that were completed were not analyzed for this study.

<table>
<thead>
<tr>
<th></th>
<th>Vegetarian</th>
<th>Omnivore</th>
<th>$p$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>40</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>% female</td>
<td>75%</td>
<td>67%</td>
<td>0.27</td>
</tr>
<tr>
<td>Age (years)</td>
<td>21.43</td>
<td>20.32</td>
<td>0.14</td>
</tr>
<tr>
<td>BMI</td>
<td>22.98</td>
<td>23.01</td>
<td>0.98</td>
</tr>
<tr>
<td>IDAQsum</td>
<td>53.76</td>
<td>48.06</td>
<td>0.31</td>
</tr>
<tr>
<td>DS-R Total</td>
<td>14.74</td>
<td>14.79</td>
<td>0.96</td>
</tr>
<tr>
<td>Core</td>
<td>8.20</td>
<td>8.38</td>
<td>0.74</td>
</tr>
<tr>
<td>Animal Reminder</td>
<td>5.04</td>
<td>4.63</td>
<td>0.36</td>
</tr>
<tr>
<td>Contamination</td>
<td>1.50</td>
<td>1.79</td>
<td>0.31</td>
</tr>
</tbody>
</table>

**Table 1. Participant demographic information.** A Fisher’s exact test was used to test if the proportion of female participants differed between the two groups. All other variables
were tested with independent sample t-tests. BMI = Body Mass Index. IDAQsum = Individual Differences in Anthropomorphism scale (higher numbers represent more anthropomorphism; Waytz, Cacioppo & Epley, 2010). DS-R = Disgust Scale-Revised (higher numbers represent higher trait disgust; Olatunji et al., 2007). The total score represents the sum of all three subscales below. The Core subscale represents the degree to which participants report they would be disgusted by a threat of sickness (e.g. #5: ‘If I see someone vomit, it makes me sick to my stomach’). The Animal Reminder subscale represents the degree to which participants report they would be disgusted by situations that serve as reminders that humans have animal origins (e.g. #8: ‘It would bother me tremendously to touch a dead body’). The Contamination subscale represents the degree to which participants report they would be disgusted by situations with possible transmission of a contagion (e.g. #11: ‘I probably would not go to my favorite restaurant if I found out that the cook had a cold’).

**Picture task**

During the primary experimental task, participants viewed and rated pictures of different foods and affective pictures while autonomic physiological measures and facial muscle activity was recorded (described below). To assess affective responses to meat, participants were presented with pictures of cooked meat (meat meals). Pictures of vegetarian meals (vegetable meals) were also presented as a non-meat food stimulus. To test whether vegetarians are particularly sensitive to negative foods, we included pictures of rotten foods. To test whether vegetarians are less sensitive to positive foods, we included pictures of sweet foods. Finally, to test vegetarians' affective reactions to
animals raised for meat, we included pictures of animals on farms (Table 2; see Online Appendix A for stimuli). Five pictures came from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 2008) and the rest were collected online.

Negative, positive, and neutral IAPS pictures were also presented but will not be discussed here. Pictures of the same type were presented in blocks of 12 pictures (see Table 2 for block order). Each picture was shown for 6 seconds (as in Lang et al., 1993) with a jittered ITI (ITI durations were randomly drawn from a normal distribution, $M = 6$ s, $SD = 2$ s). After each picture was shown, participants made a single judgment using a continuous slider scale. For food pictures, participants were asked: ‘how appetizing is this?’ (from 0 = ‘not appetizing’ to 1 = ‘very appetizing’). For pictures of animals on farms, participants were asked: ‘how much is this animal suffering?’ (from 0 = ‘not at all’ to 1 = ‘very much’). During the entire task, participants were instructed to remain as still as possible, but they were given the opportunity to move if needed after each trial. After completing each block of 12 pictures, participants were asked to report how they felt during the previous block of pictures. First they reported felt valence and arousal using 9 figure self-assessment manikin scale which visually depict a manikin displaying valence and arousal (Bradley & Lang, 1994; valence scores varied from -1 = negative to 1 = positive; arousal varied from 0 = deactivated to 1 = activated). Participants also reported the degree to which they felt: disgusted, guilty, angry, sad, happy, and hungry (from 0 = ‘not at all’ to 1 = ‘extremely’). All ratings were made in the order listed here using a 100-point continuous slider scale. Due to a software error, ratings of hunger were not recorded for the first 23 participants. After the first three blocks, participants completed a 2-3 minute ‘vanilla’ baseline task (Jennings, Kamarck, Stewart, Eddy, &
Johnson, 1992). The goal of this baseline section was to have a simple cognitive task for participants so they would not ruminate on prior blocks and return to their basal physiological state more quickly. For this task, participants were presented with a series of 12 colored squares (duration varied, randomly drawn from a normal distribution, $M = 12$ s, $SD = 2$ s) and were asked to count the number or red squares that appeared over the entire period.

<table>
<thead>
<tr>
<th>Picture type</th>
<th>Ratings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meat meals$^1$</td>
<td>How appetizing is this?</td>
</tr>
<tr>
<td>Animals on farms</td>
<td>How much is this animal suffering?</td>
</tr>
<tr>
<td>Vegetable meals$^1$</td>
<td>How appetizing is this?</td>
</tr>
<tr>
<td>Vanilla baseline</td>
<td></td>
</tr>
<tr>
<td>Sweet foods$^2$</td>
<td>How appetizing is this?</td>
</tr>
<tr>
<td>Rotten foods$^2$</td>
<td>How appetizing is this?</td>
</tr>
<tr>
<td>Vanilla baseline</td>
<td></td>
</tr>
<tr>
<td>Positive IAPS$^3$</td>
<td>How pleasant is this?</td>
</tr>
<tr>
<td>Neutral IAPS</td>
<td>How pleasant is this?</td>
</tr>
<tr>
<td>Negative IAPS$^3$</td>
<td>How pleasant is this?</td>
</tr>
</tbody>
</table>
Table 2. Picture blocks and ratings. Blocks are listed in order of presentation. Blocks in grey were not analyzed in this report. Blocks with the same superscript were randomly ordered with each other. Each block contained 12 pictures shown in random order for 6 seconds each. After each picture, participants were asked to make a judgment about that picture. After each block, participants reported how they felt during that block.

Procedure

After providing written informed consent, participants’ eligibility was confirmed by the experimenters. Next, physiological sensors were applied for recording electrodermal activity (EDA), the electrocardiogram (ECG), and facial electromyography (EMG) over two muscle regions (described below). Next, participants filled out the health and demographic questionnaires. Participants then received instructions for the picture task, which they completed as described above. After the picture task, the sensors were removed. Finally, participants completed the individual difference questionnaires before being debriefed and compensated for their participation.

Physiological Measurement.

We recorded four physiological measures of interest: electrodermal activity, the electrocardiogram, and facial muscle activity over the corrugator supercilii and levator labii muscle regions on the face. All physiological measures were sampled at 1000 Hz using BioLab v. 3.0.13 (Mindware Technologies LTD; Gahanna, OH), and were acquired on a BioNex 8-Slot Chassis (Model 50-3711-08).

Electrodermal activity was recorded from the thenar and hypothenar eminences of the palm on participant’s non-dominant hand using disposable, pre-gelled (0.5%
chloride salt) Ag/AgCl (11mm inner diameter) electrodes from Biopac (Goleta, CA). In cases where the paste was insufficient, additional isotonic electrode paste (Biopac isotonic electrode gel; Goleta, CA), was added to these electrodes. Electrocardiogram activity was recorded by fitting participants with pre-gelled ConMed (Westborough, MA) Cleartrace Ag/AgCl sensors using a modified lead II configuration. Facial muscle activity was recorded by placing reusable Ag/AgCl electrodes (Mindware Technologies LTD; Gahanna, OH) over the corrugator supercilii and levator labii muscle regions on the left side of the participant’s face (as recommended by Fridlund & Cacioppo, 1986). For one participant, sensors were placed on the right side of the face due to a facial piercing that prevented proper site preparation or placement on the left side of the face. For all participants, a reference electrode was placed behind the ear on the mastoid process (on the same side as the other electrodes). Electrodes were filled with a conductive electrolyte gel (Signa Gel from BioMedical Instruments; Warren, MI), which had a 5% saline base. Before placement, each site was cleaned with alcohol and exfoliated using a semi-abrasive lotion (Lemon prep; Mindware Technologies LTD). To ensure proper signal conductivity, skin was prepared until conductance was below 5 Kohms ($M=3.08$, $SD=2.41$) when possible. Preparation was terminated if participants reported discomfort, so some conductances were greater than 5 Kohms.

**Physiological processing**

For analyses, the continuous physiological signals for each trial were extracted around the stimulus onset time to create 7-second trial responses (from 1 second pre-stimulus onset to 6 seconds post-stimulus onset). These data were then binned into 0.5-second intervals for each trial. Because raw EMG signals vary around zero, we
calculated the absolute value of facial muscle activity before calculating 0.5 second bins. The 1-second pre-stimulus interval served as the baseline, and was subtracted from the post-stimulus 0.5 second bins to create post-stimulus change scores (Codispoti et al., 2001). This allowed for the visualization of responses over time during picture viewing. In studies using similar paradigms (e.g., Bradley, Moulder, & Lang, 2005; Codispoti et al., 2001), there are commonly two prominent response phases in the heart period response (the inverse of heart rate) during picture viewing: an early and late phase. For statistical analysis for all variables, we computed means for these two phases: 0-3 seconds (early phase) and 3-6 seconds (late phase) post-stimulus onset. Electrodermal activity was assessed as skin conductance level. To analyze cardiac data, we calculated heart period using Mindware HRV software (Gahanna, OH). Each trial was visually inspected by trained research assistants, and automatic R-spike detection was verified using MindWare analysis software (HRV version 3.0.22). In-house MATLAB (MathWorks, Natick, MA) scripts were used to process electrodermal activity and EMG (corrugator and levator) data as described above. For statistical analysis, Greenhouse-Geisser corrections were used where appropriate.

Results

Picture ratings

First, to test whether the order in which participants saw pictures of meat meals and animals on farms influenced ratings, we compared participants who were randomly assigned to view animals first to those who viewed meat meals first. We used a repeated measures ANOVA with order (meat meals first or vegetable meals first) and diet (vegetarian or omnivore) as between participant factors, picture type (meat meals,
vegetable meals, rotten foods, sweet foods, animals on farms) as the repeated measure, and participants' ratings were the dependent variable. There was no main effect of order, $F(1, 80) = 0.022, p = 0.883$, and order did not interact with any of the other factors, so both orders were collapsed for all other analyses.

To test whether vegetarians and omnivores rated pictures differently, we ran the same repeated measures ANOVA without the order factor. Ratings were influenced by diet and type of picture, as demonstrated by a main effect of diet, $F(1, 82) = 42.23, p < 0.001, \eta^2_p = 0.340$, and picture type, $F(3.47, 284.10) = 444.74, p < 0.001, \eta^2_p = 0.844$. This was qualified by a significant interaction between diet and picture type, $F(3.47, 284.10) = 67.86, p < 0.001, \eta^2_p = 0.453$. To understand the interaction, we directly compared how the different pictures were rated by vegetarians and omnivores with a series of planned independent sample t-tests. As predicted, vegetarians reported meat meals were significantly less appetizing, $t(82) = -13.40, p < 0.001, \eta^2_p = 0.686$ (Figure 1; see Table 3 for means, standard errors of the mean (SEMs), and 95% confidence intervals (CIs)). However there was no difference in how the two groups rated the other foods (vegetable meals, $t(82) = 1.42, p = 0.159$, rotten foods, $t(82) = 0.59, p = 0.558$, or sweet foods, $t(82) = -1.57, p = 0.121$). Both groups reported that animals were experiencing substantial amounts of suffering, but there was no difference between the groups, $t(82) = 0.86, p = 0.395$. 


Affect and emotion ratings

To compare the affect and emotions vegetarians and omnivores reported while looking at different pictures, we ran a series of MANOVAs with diet as the between participant factor, and participants’ different affective and emotional ratings (valence, arousal, disgusted, guilty, angry, sad, and happy) as the dependent variables. Ratings of hunger were analyzed separately since the first 23 participants were missing hunger ratings. Thus, including hunger in the omnibus MANOVA would eliminate the 23 cases that were missing hunger but contained the other descriptors. We ran one MANOVA for each block of pictures (meat meals, vegetable meals, rotten foods, sweet foods, and animals on farms). In general, there was no effect of diet for vegetable meals, rotten foods, or sweet foods (all $p > 0.154$), meaning that vegetarians and omnivores reported similar affective and emotional states when viewing vegetable meals, rotten foods, and sweet foods (see Figure 2 & Table 3). However when viewing meat meals,
diet did influence how participants reported feeling, $F(7,76) = 9.75, p < 0.001$, $\eta^2_p = 0.473$. Additionally, when viewing animals on farms, diet also influenced how participants reported feeling, $F(7,76) = 2.35, p = 0.031$, $\eta^2_p = 0.178$. To understand these effects, we ran follow-up independent sample t-tests directly comparing vegetarians to omnivores on each variable. When viewing meat meals, vegetarians reported feeling more disgusted and sad, and less pleasant, happy, and hungry compared to omnivores (all $p$s < 0.016; Figure 2, see Table 3 for complete results). When viewing animals on farms, vegetarians felt more disgusted, less pleasant, and less hungry (all $p$s < 0.051), but these differences were quite small compared to the differences observed for meat meals (see Table 3 for effect sizes). Interestingly, both groups felt similar levels of arousal, guilt, anger, sadness, and happiness when viewing animals on farms (see Figure 2, Table 3).
Figure 2. Affect and emotion ratings. For depiction in this figure only, the original valence ratings on a -1 to +1 scale were transformed to be on a 0-1 scale to match the other ratings.
Psychophysical responses

To compare vegetarians’ and omnivores’ physiological responses to the pictures, we first visualized the findings in 0.5-second bins (as in Bradley et al., 2005; Codispoti et al., 2001; Figure 3). To test our hypotheses, we conducted a series of repeated measures ANOVAs (one for each physiological measure) using the 0-3 and 3-6 second bins. For each ANOVA, diet (vegetarian vs. omnivore) was the between participant variable, picture type (meat meals, vegetable meals, rotten foods, sweet foods, and animals on farms) and response bin (early or 0-3 s vs. late or 3-6 s) were the repeated measures, and change scores for each physiological measure served as the dependent variable in each analysis.

For skin conductance level, there was an interaction between response bin and diet, $F(1,235.57) = 4.26, p = 0.043, \eta^2_p = 0.055$. To better understand the interaction, we next completed two ANOVAs, one for each response bin. For the early bin (0-3 s), there was no effect of picture type or diet (all $p$s $> 0.23$). For the later bin (3-6 s), there was an effect of picture type, $F(2.84,207.18) = 3.70, p = 0.014$, and there was a trend toward an effect of diet, $F(1,73) = 3.88, p = 0.053, \eta^2_p = 0.050$, but no interaction, $p > 0.45$. As can be seen in Figure 3, vegetarians had greater skin conductance level responses than omnivores across all picture types (except rotten foods). To follow up on this finding, we tested whether vegetarians and omnivores had different basal skin conductance levels during a three minute resting baseline period before the picture task started. Mean skin conductance levels were not significantly different between vegetarians and omnivores during the three minute resting baseline period, $t(77) = 0.011, p = 0.991$. 


For heart period, there was no main effect of diet, and diet did not interact with any other factors (all $ps > 0.14$), so we did not conduct extensive follow-up tests. Previous work has shown the heart period is influenced by valence of the picture (heart rate deceleration in response to negative pictures; Bradley et al., 2001; Codispoti et al., 2001; Lang et al., 1993). We found different picture types did influence heart period for the late bin (3-6 s), $F(4,304) = 9.52, p < 0.001, \eta^2_p=0.111$. Consistent with the findings showing prolonged heart period in response to negative pictures, there was a greater prolongation of heart period (i.e., greater HR deceleration) for rotten compared to sweet foods, $t(77) = 3.80, p < 0.001, \eta^2_p=0.158$. There was also a greater prolongation of the heart period when viewing pictures of animals on farms compared to when viewing vegetable meals, $t(77) = 4.34, p < 0.001, \eta^2_p=0.197$ (see Figure 3).

For facial EMG activity over the corrugator supercilii muscle region, there was no main effect of diet, and diet did not interact with any other factors (all $ps > 0.58$), so again extensive follow-up tests were not completed. Previous work has shown corrugator activity increases to negative pictures (Bradley et al., 2001; Lang et al., 1993; for review see Cacioppo et al., 2000). We found an effect of picture type on corrugator activity, $F(2.81,204.74) = 6.64, p < 0.001, \eta^2_p=0.083$, in the late bin. Consistent with the previous research showing increased corrugator activity to negative pictures, we found greater corrugator activity when viewing animals on farms compared to vegetable meals, $t(74) = 3.66, p < 0.002, \eta^2_p=0.153$.

For facial EMG activity over the levator muscle region, there was no main effect of diet, and diet did not interact with any other factors (all $ps > 0.16$), so extensive
follow-up tests were not completed. Visually, there were no clear patterns in levator labii muscle activity (see Figure 3).
Discussion

In general, Americans eat a lot of meat, and this has an impact on health. In the United States, eating meat leads to an estimated $28.6 to 61.4 billion per year in healthcare costs (as of 1992; Barnard, Nicholson, & Howard, 1995). Eating too much red meat, in particular, increases mortality rates (Pan et al., 2012). Despite this, the vast majority of people continue to eat meat— in large part because it is hedonically pleasant. Vegetarians are an interesting group that has decided to avoid eating meat for a variety of reasons (for review see Ruby, 2012). Previous research has reported that vegetarians have different affective reactions to meat (Rozin et al., 1997), which may support maintaining their diets since desire for the taste of meat is one of the most common reasons for returning to meat eating (Barr & Chapman, 2002; Haverstock & Forgays, 2012). Very little research has unpacked the affective reactions of vegetarians and omnivores to meat. The aim of this study was to explore vegetarians' affective responses to meat. We sought to test between the specificity hypothesis (that vegetarians affective responses differ only to meat) and the generality hypothesis (that vegetarians affective responses differ generally to wide range of stimuli). The intermediate hypothesis suggests that vegetarians might also have affective differences in response to animals suffering.

The ratings of food pictures are consistent with the specificity hypothesis, namely that vegetarians differ only in their affective responses to meat, but do not have a more general affective differences. Not surprisingly, we found that meat was rated as less
appetizing by vegetarians (compared to omnivores). However, vegetarians and omnivores evaluated other foods similarly (vegetable meals, rotten foods, and sweet foods), suggesting vegetarians did not experience all foods as hedonically less pleasant. We also found similar levels of disgust sensitivity in vegetarian and omnivores as measured by the Disgust Scale-Revised (DS-R; Olatunji et al., 2007), a result consistent with Fessler et al. (2003).

We found that vegetarians and omnivores reported similar levels of perceived animal suffering for animals on farms, also consistent with the specificity hypothesis. We also found similar levels of anthropomorphism among vegetarians and omnivores using the IDAQ (Waytz, Cacioppo & Epley, 2010). This is evidence that these two groups are similar in their tendency to perceive minds in non-human animals when asked directly. These findings stand in contrast to previous studies which found evidence that omnivores perceive animals as experiencing fewer emotions (Bilewicz et al., 2011) and deny animals’ experience of suffering as a way to reduce cognitive dissonance (Bastian, Loughnan, Haslam, & Radke, 2012; Loughnan, Haslam, & Bastian, 2010). These inconstancies could be due to differences in experimental protocol. Future research should test under which conditions vegetarians and omnivores perceive animal minds differently.

Vegetarian and omnivores reported similar affective and emotional states while viewing most foods (vegetable meals, rotten foods, sweet foods). Again the two groups were most different when viewing meat, consistent with the specificity hypothesis.. Vegetarians reported feeling more disgusted and sad, and less pleasant, happy, and hungry when viewing meat (compared to omnivores). There was also some evidence
supporting the intermediate hypothesis: when viewing animals on farms, vegetarians reported feeling more disgusted, less pleasant, and less hungry (compared to omnivores), though these differences were quite small compared to the differences observed for meat meals. One untested possibility is that omnivores regulate their emotional responses when confronted with animal suffering, as happens when people are confronted with mass suffering (Cameron & Payne, 2011). Another possibility is that vegetarians might up-regulate their negative emotions as a way of maintaining commitment to their diet and beliefs. In sum, the picture ratings and affect and emotion self-report data support the specificity hypothesis: vegetarians have very similar affective reactions to omnivores, except when viewing meat.

However, the physiological responses do not support the specificity hypothesis. First, the physiological patterns of vegetarians and omnivores were strikingly similar across all of the picture types—including meat meals and animals. Specifically, both groups had similar cardiac responses (i.e., heart period) and facial muscle activation (both corrugator and levator) across all picture conditions. It is particularly interesting that vegetarians and omnivores had similar physiological responses to meat since their self-reports differed dramatically. Importantly, the one physiological group difference that did emerge was a generally elevated skin conductance level for vegetarians in response to meat meals, vegetable meals, sweet foods, and animals on farms. The only type of stimuli where this pattern was not visible is when the groups viewed rotten foods. This last finding is additional evidence that vegetarians do not have increased disgust sensitivity. Because our measures were calculated as change scores from one second before the stimuli were presented, the increased skin conductance level
represents a difference in reactivity, not simply an elevated tonic skin conductance level. This is supported by the finding that resting absolute skin conductance levels before the task started did not differ between groups.

Although there was an overall lack of group differences in physiological responses to viewing meat pictures, we did find several expected patterns of physiological responses to the different types of pictures. For instance, both groups had robust electrodermal responses when viewing pictures of animals on farms. This suggests that looking at animals and considering whether they experience suffering is highly evocative for both vegetarians and omnivores. Heart period and corrugator activity also increased when viewing animals on farms. This is consistent with self-reported negative affect and emotions from both groups when viewing pictures of animals on farms. In general, the strongest reactions we observed were in response to the pictures of animals on farms. We also observed increased heart period (greater HR deceleration) for rotten compared to sweet foods—consistent with other research showing increased heart period while viewing negative pictures (Bradley et al., 2001; Codispoti et al., 2001; Lang et al., 1993). While some researchers have used levator labii as an index of disgust (Chapman et al., 2009; Hoefling et al., 2009; Vrana, 1993), others point out the lack of specificity (for discussion see Barrett, 2015). Here we found levator showed no consistent pattern. Our findings are consistent with the idea that levator labii activation does not specifically index disgust responses. One possibility is that facial muscles were only minimally engaged in our task because of the non-social nature of the experimental context (Fridlund, 1991). Facial expressions are thought to
be communicative, so different findings might be observed if participants were viewing food pictures in a social context (for example, dining with friends or family).

Our auxiliary goal was to test whether omnivores would engage in motivated denial of mind (Bastian et al., 2012; Loughnan et al., 2010). To test this, we tested whether seeing pictures of meat meals before animals on farms would reduce how much suffering omnivores perceived. We found no evidence of this: the order in which meat meals and animals on farms were presented did not influence how much suffering omnivores reported. This failure to find evidence of motivated denial of mind could be due to differences in experimental design. Previous studies that found motivated denial of mind required participants to actively choose to eat meat (Bastian et al., 2012; Loughnan et al., 2010) which possibly resulted in stronger dissonance (conflict between choosing to eat meat and causing suffering to animals) and motivation to escape it. In our study, participants passively viewed pictures so did not have to reconcile a choice they made to eat meat with the reality that animals suffer during meat production. Additionally, we hypothesized that omnivores who first considered the mental state of animals would subsequently find meat less appetizing (Ruby & Heine, 2012). Again, we also found no evidence of this—the order did not influence how appetizing meat meals were rated. Future research should test under which conditions considering animals’ mental states influences the pleasantness of meat.

In summary, across the self-report data, vegetarians and omnivores generally made similar reports—except when viewing meat—consistent with the specificity hypothesis. However, this was not reflected in the psychophysical data. Across all four measures there were no psychophysical group differences to meat. Rather,
there was only a general elevation in vegetarians skin conductance response--
consistent with the *generality hypothesis*.

One possible explanation for these findings is that vegetarians conceptualize
changes in their bodily states (i.e. sympathetic nervous system activity that increased
skin conductance) in a manner consistent with their belief system (i.e., that meat is
cruel, wasteful, impure, or unhealthy). Even though vegetarians have similar elevated
responses to other stimuli (vegetable meals, sweets, and animals on farms), those
responses were not incorporated into their ratings in the same way for these other
stimuli. This is consistent with a constructionist approach that argues people use
conceptual knowledge to understand and categorize internal bodily sensations (Barrett,
2015). For instance, sensations from your stomach could be interpreted as a sign you
are hungry, or that you are getting sick, or they could be used as a 'gut feeling' about a
person being evaluated for parole (Danziger, Levav, & Avnaim-Pesso, 2011). How the
feeling is interpreted depends on the person and context so drawing strong
psychological inferences from physiology is risky (for review see Quigley & Barrett,
2014).

Future research could explore other physiological responses to meat to help
understand the differences between vegetarians and omnivores. For instance, cephalic
phase responses prepare the body for incoming food by secreting digestive enzymes
that aid in metabolism (Power & Schulkin, 2008). As famously noted by Pavlov (1902),
the body is essentially making predictions (Clark, 2013) about incoming nutrients and
preparing accordingly. Predictions (in the form of beliefs) have metabolic
consequences: when people believe they are consuming a high calorie 'indulgent'
milkshake, they have increased physiological satiation (measured by ghrelin) compared to consuming a 'sensible' milkshake--even though the milkshakes were identical (Crum, Corbin, Brownell, & Salovey, 2011). Predictions made while chewing also influences gastric motor activity (Stern, Jokerst, Levine, & Koch, 2001). This suggests that predictions can change how the body processes incoming substances. An open question is how vegetarians' bodies would prepare to metabolize meat. Would a vegetarian's brain predict that meat is not a food item? Or would their brain and body betray their dietary commitments by martialing digestive resources?

Additionally, future research might look at different motivations and cultural contexts for avoiding meat (for review see Ruby, 2012). There is wide variability, and our study included people who were born vegetarian and people who converted, though these two groups might be very different. Also, people who converted to vegetarianism for animal welfare reasons might respond very differently from people who grew up avoiding meat as a cultural tradition. Our sample size is not sufficient to address these questions, but heterogeneity among vegetarians' responses might be hiding differences.

In sum, we found no evidence of broad or general affective differences between vegetarians and omnivores in self-reports. However vegetarians had elevated skin conductance level in response to all of the pictures (except rotten foods). One possibility is that vegetarians conceptualize their bodily responses to be consistent with their diet and belief system. Conceptualizing bodily responses in this way may lead to the negative self-reported affect, and may protect them from giving in to the temptation of meat.
References


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### Supplemental Tables

**Table 3. Affect and emotion ratings.** All ratings were made using a slider scale. Scores could vary from 0 to 1, except for valence, which could vary from -1 to 1.
<table>
<thead>
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<th>95% CI</th>
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<td>0.008</td>
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Heart period

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Corrugator

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Levator

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*Table 4. Physiological response means, standard errors, and 95% confidence intervals.*