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Consumer Perceptions of Genetically Modified Foods: A Mixed-Method Approach

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Consumer Perceptions of Genetically Modified Foods: A Mixed-Method Approach

In July 2016, the United States (U.S.) government passed the National Bioengineered Food Disclosure Law (NBFDL) to standardize labeling of foods with genetically modified (GM) ingredients. The Food and Drug Administration (FDA) approved the first GM *animal*-based food product late in 2015. These developments come more over two decades after the introduction of genetic technology. The FDA regulates GM food products within the U.S. and defines "genetic engineering" (GE) as "certain methods that scientists use to introduce new traits or characteristics to an organism. For example, plants may be genetically modified to produce characteristics to enhance growth or nutrition profile of food crops" (FDA 2012, p. 1). Fragmented and anecdotal information neither confirmed nor disaffirmed benefits and risks of GM foods in the U.S. There is growing confusion about the impact of genetic modification on food products; benefits of GM versus non-GM foods; specific GM food types (i.e., plant-based or animal-based); and the extent of dissemination of GM food items.

Extant research shows consumers are largely unaware of which specific foods are GM (see Radas, Teisl, and Roe 2008). Worldwide, consumers display limited understanding and misconceptions concerning genetic modification (Wunderlich and Gatto 2015). In 2007, the Grocery Manufacturers Association estimated 60–70% of formulated food products contained ingredients from GM crops. Dr. Jeffrey Barach, former VP of Science Policy of the Grocery Manufacturers Association, stated: "Today, that number may be more like 70–80%" (from personal communication with Dr. Jeffrey Barach, November 3, 2010).

The U.S. market now includes the first GM *animal*-based product, from AquaBounty Technologies: AquAdvantage salmon, which the company labels safe to consume and FDA

approved as fit for human consumption. This new GM food category reinforces the need to extend prior GM-related research regarding consumers' attitudes and purchase intentions.

Discontent over the nation's first GM animal food product, and heavy lobbying by consumer advocacy and environmental groups for governmental regulation of GM labeling, suggests consumer acceptance and adoption of AquAdvantage may be slow and volatile. Despite growing controversy across both consumer and producer markets, consumer research exploring implications of GM foods is sparse. Myths and erroneous anecdotes are widespread, evoking and inciting negative beliefs. Regulatory entities seem unclear in setting disclosing policies and standards for production and distribution of GM foods for human consumption. Different states and municipalities have adopted or attempted protocols inconsistent with federal regulatory bodies. Demonstrating clear, distinct messaging to educate consumers is direly needed. However, this requires an understanding of consumer opinions, attitudes, beliefs, and intentions toward GM foods.

The aim of this research is to extend our understanding of consumer perceptions of GM food and distinguish the differences with respect to food type and, in comparison with other disclosure forms (e.g., organic). Across three studies, we provide insight by exploring: 1) What are consumer beliefs about risks and/or benefits of GM compared with non-GM foods? 2) How likely are consumers to buy labeled versus unlabeled GM foods? 3) What are consumers' purchase intentions for GM food and perceived differences between plant- and animal-based products? We employ a mixed-method approach to examine consumer beliefs and attitudes about GM foods across food categories (plant vs. animal-based). We investigate changes in consumers' opinion and behavioral measures for legislative intervention in the form of labeled GM products across food types.

This research has relevant implications for marketers and policymakers. Without clear understanding of consumer opinions, beliefs, and perceptions, marketers will face challenges in effectively communicating benefits and value of GM foods to consumers. With rampant myths regarding GM foods, consumer skepticism keeps increasing. Education and messaging to counter proliferation of these myths are needed to help consumers make informed decisions. Understanding the consumers' perspective is necessary for policymakers in implementing effective labeling and content disclosure regulatory policies, to ensure consumer protection. This work contributes to consumer marketing as the first to examine the impact of GM-disclosure labeling across food types on purchase intention and willingness to pay. Furthermore, we investigate the underlying mechanism of these relationships.

Understanding GM Food

GM foods entered the U.S. food supply in 1994 with the approval of the Flavr Savr® tomato. Despite the general public's long-term exposure to GM technology, consumers lack understanding of what GM entails. A 2013 survey showed 54% of consumers claim little to no knowledge about GE (Hallman, Cuite, and Morin 2013). An absence of labeling to distinguish GM foods may strongly contribute to this dearth of consumer understanding of the meanings and distinctions. Diversity of terms that describe GM may be part of the problem. Beyond "genetic modification" as a catchall term in the media, GE, GM organisms (GMOs), recombinant DNA (rDNA), and biotechnology, are frequently used interchangeably to describe changing an organism's genes. Despite consumers' lack of knowledge of GE, up to 64% of consumers are against GM foods (Scott, Inbar, and Rozin 2016).

GM crops are either ingredients in processed foods or fed to animals that are part of the

food supply. The most prevalent GM crops provided 83% of soybean, 29% of maize, and 24% of canola production in 2015 (James 2015; NASEM 2016). The introduction of a GM animal-based food product presents more complexity in consumers' understanding and acceptance of GM foods. Consumers' perceptions of GM crops are likely to differ from those of animal products, because crops are typically *indirectly* consumed (i.e., through processed foods). GM animal-based products may be *directly* consumed. For instance, Puduri et al. (2005) suggest 55% of consumers approve of GM plant-based foods; while only 27% approve of GM animal-based foods. Consumer perceptions of GM fish and seafood may differ as well, because some consumers are likely to eat fish and seafood but not land-based animal products (Gaskell et al. 2004).

Concerns for Health and Environment

Throughout the regulatory review process for approval of AquAdvantage, the media promoted the term "Frankenfish," evoking fear about the safety of such products. Nearly two-thirds of American consumers feel GM foods can be beneficial, yet many are still doubtful and express concerns (Bennett et al. 2005). In contrast, 88% of members of the American Association for the Advancement of Science contend GM foods are safe for consumption (Pew Research Center 2015).

Consumer concerns tend to focus on both environmental and health risks. One suggested threat of GMOs to biodiversity is that GM products overtake the naturally occurring species, resulting in a monoculture (Quist and Chapela 2001). Consumer advocacy, environmental groups and consumers fear a plant or animal monoculture would seriously threaten the global food supply.

Media propagation and exaggeration of health concerns contributes to consumers' misconceptions and confusion, increasing their belief that GM foods pose a threat. Food-related allergies and the safety of unnaturally occurring foods are major concerns for some consumers. Cummins and Ho (2006, p. 5) state: "Many of the genes used to create transgenic food animals are synthetic approximations of the original gene, but deemed, mistakenly, to be 'substantially equivalent' to the natural genes. The synthetic genes contain DNA sequences that have never existed in evolution, and by no stretch of the imagination can they be presumed safe." This and similar press statements indicate people have not been exposed to GM foods *long* enough for researchers and governmental regulatory bodies to definitively recognize potential health effects. A review of existing research on GM versus non-GM foods found no evidence that non-GM crops were any safer (NASEM 2016).

Product Transparency and Labeling

The NBFDL requires standardization for the labeling of products containing GM ingredients (USDA 2016). Gostin (2016) examined the question: "What could be wrong with transparency and disclosure?" stating that scientific consensus exists that GM foods are safe for human consumption and have significant nutritional benefits, as in "golden rice," genetically enriched with vitamin A. Darian and Tucci (2011) found high nutritional value is the most important health benefit influencing consumer food purchase intentions. GM and non-GM foods are considered to have the same nutritional profile. The U.S. has no consistent or mandatory labeling requirements, except for products with *different* nutritional properties resulting from modification (see Byrne 2010). The NBFDL offers companies the options of a product label disclosure statement, a symbol (to be developed), or on-package electronic direction to a website

with content explaining genetic modification and meanings relative to engineered foods (USDA 2017).

Recognizing the need for clarity and transparency, at least 30 states attempted to introduce GMO-labeling legislation (Gostin 2016), but federal standards override these laws. These outcomes of legislative attempts align with findings from surveys conducted by entities in favor of non-labeling, which indicate *low* consumer concerns about GM foods and little desire for labeling. This perception is contrary to findings of extant consumer research, which suggests consumers are *highly* concerned about GM foods and prefer labeling (Radas, Teisl, and Roe 2008). The Center for Food Safety and other labeling advocacy groups maintain it is a consumers' right to not only demand labeling but know specifically which foods are modified and how fundamentally different the food is (Harmon and Pollack 2012; Goskin 2016). This discrepancy between governmental non-labeling policies and consumers' desire for labeling highlights the necessity for further research.

Labeling has a strong influence in reducing consumer ambivalence (Luomala et al. 2015). Several studies show consumers are willing to pay more to avoid foods labeled GM (Costanigro and Lusk 2014; Liaukonyte et al. 2013). Most food manufacturers tend to favor non-labeling. In January 2016, Campbell Soup Company announced it would disclose the presence of GM ingredients in its products (Strom 2016). Campbell is an advocate for federal legislation to standardize labeling rules for U.S. food manufacturers (Strom 2016; Yu 2016). Such transparency inspired other producers to bolster labels of their *organic* products to communicate naturalness to consumers. Through three studies, we sought insight into consumer opinions about and behavioral intentions toward GM foods.

Theoretical Framework

Consumers tend to be skeptical of GM in food production and supply (Bredahl 2001), GE technology, and associated risks (Ruth and Rumble 2017). Resistance to the release of AquAdvantage, compared with GM plant products, indicates a threshold was crossed and a behavioral shift occurred. Previous research largely ignored internal factors (e.g., perceptions) that influence consumer behavior in this context. These factors are cornerstones of product development and marketing.

Purchasing GM foods and particularly animal-based products is nonroutine (requiring deliberate consideration). The theory of reasoned action (TRA) serves well in analyzing nonroutine decisions (Paul, Modi, and Patel 2016) to study consumer attitudes and behavioral response. We apply TRA (Fishbein and Ajzen 1975; Ajzen and Fishbein 1980), integrating additional model variables compatible with recent theorizing about GM food consumption. We examine underpinnings of consumer opinions, feelings, and attitudes toward GM plant- and animal-based foods and disclosure of GM animal-based ingredient type on product evaluations.

TRA postulates the strongest predictor of behavior is intention and actions of social relevance are volitional (Ajzen and Fishbein 1980). Intention is a function of attitude and subjective norms. Attitude toward a behavior refers to judgment about performing a behavior. Attitudes are functions of beliefs which are behaviorally based. Subjective norms are functions of beliefs, that specific individuals or groups (i.e., family referents) think one should/should not perform the behavior. Consumers who believe GM foods are safe for human consumption and have positive benefits to society will have favorable attitudes and opinions toward purchasing GM products; those who think GM foods will have adverse effects and pose environmental and ecological risks will hold unfavorable attitudes and opinions. Someone who thinks social referents are favorable toward GM foods will perceive social pressure to purchase.

We adapt Han and Harrison's (2007) theoretical model of purchase intention of GM foods and develop an integrated framework to understand how GM labeling affects consumer opinions, purchase intentions, and willingness to pay (WTP) across food categories. We consider risk perceptions that precede behavioral intention and warrant further attention.

Drawing on attitude theories and multi-attribute models, we examine the role of information provision through disclosure labeling. Research demonstrated that knowledge of risk and benefits influences consumer attitude formation toward GM foods; risk has a negative influence and benefits a positive one (Zhu and Xie 2015). Links between beliefs and attitudes about food consumption, based on manufacturing methods, that exist as a function of perceptions and the provision of information, have also been identified. Han and Harrison's (2007) model (see Figure 1) proposes that availability of information and consumer beliefs affect consumer attitude toward GM foods. We posit that, given the inconsistency of credible information regarding GM foods, it is unlikely consumers' attitudes and beliefs will change without marketplace intervention. Nontechnical, easily comprehensible information presented in familiar format is likely to have a greater effect in modifying attitudes and beliefs. We therefore suggest that information, in the form of labeling, will be critical to shaping opinions and behavioral intentions.

We have three research goals. (1) To understand consumer beliefs and attitudes toward GM foods: the expected health and nutritional benefits and risks of plant- and animal-based GM versus non-GM foods. In study 1, we implement a projective narrative to elicit consumers' attitudes and beliefs. (2) To examine the impact of disclosure through labeling, which can frame consumer perceptions and judgments about the product. With product-specific information, consumer knowledge concerning GM, attributes, and benefits increases and is likely to impact

both purchase intention and WTP for GM foods. Utilizing an experiment, we address this goal in study 2. (3) To determine the effect of food type (plant vs. animal-based) on consumers' purchase intent and perceptions when GM ingredients are disclosed (or absent). This goal is addressed in study 3.

STUDY 1

Using an online projective survey, we explore consumer beliefs about benefits and risks of GM and non-GM foods. Projective studies are a structured way of examining a consumers' unconscious mind, beliefs, feelings, and attitudes, which aligns with our purpose (Webb 1992).

Participants and Design. We recruited participants through emails to undergraduate and MBA students at a southeastern public university. Participants were asked to share the email, creating a snowball convenience sample size. The email stated that volunteers were needed for a study about food marketing and consumer behavior, ensured anonymity, and provided a link to the web-based survey. Sample size of 27 was obtained, consisting of 72% male, average age 28 years, and 64% students.

Procedure. The survey used a variety of question formats. To examine consumers' knowledge of genetic modification, we asked "What does the term 'genetically modified' mean to you?" We solicited word associations with "genetically modified salmon," "genetically modified vegetables," and "nongenetically modified foods." We asked participants, "What do you think about GM foods?" and "What do you think of the claim that GM foods have the same nutritional composition as non-GM foods?" We concluded with three fictitious pictorial narratives; the first presented a man grocery shopping and viewing a display of "Tomatoes" beside a display of "GM-Free Tomatoes"; the second showed a woman reading a food label, with

the thought cloud "Is this genetically modified?"; the third presented a menu with a GM salmon special. For each image, participants described the scenarios with prompts such as, "What is he/she thinking?"; "Why is he/she having these thoughts?"; and, "What will happen next?" Demographic questions followed.

Results and Discussion

We conducted iterative analysis to determine emergent themes in the data (Strauss and Corbin 1988), and highlighted possible themes, noting commonalities and differences. We used axial coding to group segments of data related to common themes. We examined themes and related data to recognize underlying meanings, beliefs and categorizations that participants attributed to GM foods.

In response to, "What does the term genetically modified mean to you?" consumers demonstrated a mistaken belief that genetic modification involves adding, or injecting, synthetics into existing food products, thereby altering their normal functioning. Examples of misunderstandings include:

Food that has been injected with some type of drug.

Steroid and other nonnormal substance given to the animal or food.

The chemical, or synthetic, factor was further evident in the word associations analysis. We found negative responses: "farmed," "steroids," and "pesticides." Word associations with "nongenetically modified foods" revealed positive associations such as "tasty," "natural," and "healthy." Overarching emergent themes (Table 1) included health and nutritional beliefs of GM foods; concern for health and environmental risks; and negativity toward GM animal products; each discussed below.

[INSERT TABLE 1 HERE]

Certain participants indicated negative beliefs about health and nutritional attributes of GM foods, stating:

> *I would be worried that they would be found to be unhealthy for you several years from now.*
>
> *I do not like the concept of GMOs in developed countries as we would not know the exact effects on humans or on nature before at least ten years.*

Some participants made associations, such as "not nutritious," "horrible," and "mutants," potentially indicative of future avoidance intentions. Nevertheless, other consumers did recognize potential benefits, denoting prospective segments where GM foods may be positively received. One participant demonstrated positive beliefs about benefits GM foods can offer globally:

> *… this could be the breakthrough needed to be able to ultimately feed the world and help eradicate hunger. Plants (and fish and animals) can be adapted to grow in environments where they previously could not…. we may be able to modify foods to help cure some diseases and eliminate others by enhancing the naturally occurring benefits.*

Interestingly more of the negative perceptions and associations with GM were found for salmon than vegetables. Particularly, as demonstrated below, in the word association task some participants who assigned neutral or positive attributes to GM vegetables, ascribed negative associations to GM salmon; "common" versus "gross," "giant" versus "mutant," "fine" versus "unnatural," and "acceptable" versus "horrible."

Participants also expressed doubt about claims that GM and non-GM foods have the same nutritional composition.

> *I believe it [has] the same nutrition, but it also comes with negative ingredients.*
>
> *I would think that is true, but that some alteration would also have harmful unhealthy aspects that would outweigh other supposed benefits.*

Results suggest animal-based products are associated with negative opinions when disclosed as GM. Confronted with a menu with GM salmon, more participants had their "character" leave the restaurant or choose another meal than stay and eat the GM salmon. Analysis revealed consumers were uncomfortable with the GM disclosure:

> *I do not want to eat at that place. I want to eat at a place where it is more expensive, but where the product quality is better, too. Then, we will start to think that if the menu did not [state] that the salmon was GM, though it was, we would have [entered] and ordered that dish…we cannot be sure that the product will be GMOs free. Hum . . . we are confused now.*

This raises questions about the true desirability of mandatory labeling. All consumers may not desire full disclosure, as indicated by consumer advocacy groups favoring labeling legislation. Lastly, health, and the environment, were the most commonly identified risks of eating GM foods. Specific health concerns included "long-term impact on natural functioning of the body," "cancer," and "allergic reactions." Few respondents said there were no risks.

Related literature (Bennett et al. 2005; Siipi, 2015) supports consumer concern that GM makes food unnatural and could lead to unknown consequences for both health and the environment. The implication for marketers and policymakers is that these issues must be addressed, and labeling may be one method. We uncovered some underlying beliefs, but questions remain: What impact might label disclosure have on consumer willingness to buy GM foods? Is there a difference in opinion toward, and preference for, GM foods based on food *type*?

STUDY 2

Consumers' experience with GE included several scientific announcements that influenced their perception of the practice, efficacy and effect on nature. The controversy regarding GM animal-based foods ensued without much information to counter the myths and negative perceptions and present a well-balanced understanding for consumers. With introduction of AquAdvantage, consumers' opinions are likely to remain connected to past stereotypes, influencing receptivity. With low receptivity, consumers are unlikely to fully grasp or assess potential inherent value or benefits of GM foods. Valente and Chaves (2017) determined that with respect to value, consumers are less willing to accept a discount to purchase or a GM ingredient in exchange for lower prices.

Study 1 results reveal some consumers acknowledge the benefits of GM foods but doubt nutritional composition is identical to non-GM food products. Consumers would also likely avoid GM fish when given the choice. Relative to consumption, technological-modification disclosures are likely to have a direct inverse relationship on consumers' opinions and behavioral responses (Huffman et al. 2003). GM disclosure may generally have a negative effect on opinions and purchase intentions and is likely to intensify these effects for *animal*-based food products. We predict:

> **H_1**: A GM label disclosure will reduce consumers' (a) opinions, (b) purchase intentions, and (c) WTP.

> **H_2**: Product type will moderate the effects of a GM label for consumers' perceptions and purchase intentions. Specifically, the influence of the GM label will be stronger (weaker) for animal-based (plant) foods for (a) opinions, (b) purchase intentions, and (c) WTP.

Based on the TRA, we hypothesize:

H_3: Consumers' product opinion mediates the effect of GM labeling on behavior.

Specifically, GM labeling causes unfavorable opinions and negatively influences (a) purchase intentions and (b) WTP.

Method

Participants and Design. To examine the changes in consumers' opinions, purchase intentions, and WTP that result from a GM-disclosure label, we conducted a 2 (**GM-disclosure**: present vs. absent) X 2 (**food type**: plant-based vs. animal-based) between-subjects experiment. We recruited 235 participants through Amazon's Mechanical Turk (mTurk). Thirty-one participants were removed from the sample for failing at least one embedded attention check measure, leaving 204 in the final analysis. The sample was 43.4% male, average age 36 years, median income $40,000–$49,000, and 90% with a four-year college degree. The cell sizes were 57–59.

Measures and Procedure. Participants were randomly assigned to one of four conditions and shown an image of a plant-based (broccoli) or an animal-based food (salmon), with the GM-disclosure label either present or absent. For consistency, images were of frozen food products with the same brand, colors, and overall design. All branding was removed from the packaging using Photoshop, to avoid bias that may occur due to familiarity or preference. A pretest was conducted to ensure participants perceived the packaging as equally attractive across food types.

Pretest. Sixty-seven participants from mTurk (40% male, avg. age 38 years) were randomly assigned to view either the plant- or animal-based product and respond to a three-item measure of attractiveness: "The product you reviewed is 'Appealing,' 'Attractive,' and 'Desirable'" (1 = strongly disagree, 7 = strongly agree; Amos, Clinton, and Spears 2010). Demographic questions followed. The three items were averaged to form an attractiveness index (α = .98). An independent samples t-test ascertained no significant difference in participants'

attractiveness perceptions of the plant- and animal-based products ($M_{plant\text{-}based}$ = 4.42 vs. $M_{animal\text{-}based}$ = 5.05; $p > .10$).

To maintain the images as realistically as possible, we used the GM-disclosure statement implemented by Campbell in 2016 ("partially produced with genetic engineering"), which was placed on the packaging under the food-descriptive name, using Photoshop. Participants' intention to buy the specific product they viewed was assessed, utilizing the following four-item scale: "How likely are you to try this product?" "How likely are you to buy this product if you happened to see it in a store?" "How likely are you to actively seek out this product in a store in order to purchase it?" and "How likely are you to patronize this product?" (1 = not at all likely, 7 = very likely; Baker and Churchill 1977). Participants answered, "What is your overall opinion toward the product?" Next, we offered a reference of the product's average price (identical for both products) and asked about participants' WTP. The study concluded with demographic and attention check questions.

We utilized an instructional manipulation check (Oppenheimer, Meyvis, and Davidenko 2009) and a self-reported question to measure the effectiveness of each manipulation independent of our measures. These embedded questions occurred after responses to our dependent measures were recorded. To check our manipulation of the GM label, we asked participants to recall whether they saw it. We conducted a two-way contingency table analysis to ascertain the significance of those participants who correctly identified their experimental condition: 62% of those who saw the GM label and 82% of those who did not answered correctly ($\chi^2 = 48.3$, $p < .001$, Cramer's V = .46). The high significance and medium effect size confirm the manipulation effectiveness. All participants correctly identified seeing either the animal- or plant-based product in the respective conditions.

Results and Discussion

Opinion. To assess participants' overall opinion toward the product, a 2 (GM disclosure) X 2 (food type) ANOVA was performed and showed participants' opinion of the product was significantly greater without a GM disclosure ($M_{present}$ = 3.47 vs. M_{absent} = 3.92; F (1, 200) = 13.56, $p < .001$, $\eta^2 = .063$). The food type and interaction effects were both nonsignificant ($p > .05$).

Purchase Intention and WTP. We examined the effect of GM-disclosure label across food type on participants' purchase intention for the specific product viewed. The four-item scale was averaged to form a product purchase intention index ($\alpha = .94$). A 2 (GM-disclosure) X 2 (food type) ANOVA revealed a significant main effect of the label: the label reduced participants' purchase intention ($M_{present}$ = 3.18 vs. M_{absent} = 3.76; F (1, 200) = 5.80, $p = .017$, $\eta^2 = .028$). Food type had a significant main effect: purchase intentions were greater for the plant-based (M = 3.72) than the animal-based product (M = 3.22; F (1, 200) = 4.25, $p = .041$, $\eta^2 = .021$). The interaction effect was nonsignificant ($p > .05$).

Similar results were found for WTP: participants were willing to pay significantly more without the label ($M_{present}$ = 3.49 vs. M_{absent} = 4.02; F (1, 200) = 5.44, $p = .021$, $\eta^2 = .026$). Food type significantly influenced WTP; however, this is expected because salmon typically costs more than broccoli ($M_{animal\text{-}based}$ = 4.25 vs. $M_{plant\text{-}based}$ = 3.27; F (1, 200) = 20.20, $p < .001$, $\eta^2 = .092$). The interaction was nonsignificant ($p > .05$). Overall, our results demonstrated an unfavorable effect of the label across our measures that holds for both plant- and animal-based food types. H1 but not H2 is supported.

[INSERT TABLES 2 & 3 HERE]

The Mediating Role of Opinion. H3 predicts consumers' overall opinion toward the product will mediate the effects of GM labeling on purchase intentions and WTP. To assess mediation, we used PROCESS macro Model 4, with 5000 bootstrap samples (Table 3; Hayes 2018). For purchase intention toward the product and WTP, no indirect bootstrap intervals contain a zero, indicating significant mediation. The resulting bootstrap intervals for direct effects of the label on the dependent variables were nonsignificant ($p > .05$), suggesting only indirect mediation.

We find strong support that labeling works through consumers' overall opinion to have favorable effects across behavioral outcomes, confirming H3. Considered with study 1 results, these findings illustrate that consumers have negative associations with GM-labeled versus non-GM products. Consumers are more likely to buy unlabeled GM products. Although the GM and non-GM products look identical, perhaps highlighting the product as GM cues consumers and triggers negative perceptions, causing a decreased likelihood of purchasing and WTP.

STUDY 3

Study 3 aims to build on the findings of study 2, expanding the examination of food types and considering the organic label, often used by manufacturers as a contrast to GM. We propose that acceptance and purchase intention may be conditionally based on food type and meanings consumers ascribe to GM foods (single ingredients and processed foods). Further, the Protective Action Decision Model (PADM; Lindell and Perry 2012), suggests that the effects found could be in response to changing perceptions in food *technology* (e.g., technology in food product is trustworthy) more so than differences in product-specific opinions. Thus, consumers level of trust in food technology may provide an alternative explanation to our findings; this is also

examined.

Method

Participants and Design. We conducted a 3 (**disclosure**: GM, organic, or control) X 5 (**food type**: animal-based meat, animal-based fish, fruit, vegetable, legume) between-subjects experiment. We received responses from 792 participants, through mTurk, in a manner identical to that of the previous study; 42 were removed from the sample for failing at least one embedded attention check measure, leaving 750 in the final analysis. Cell sizes were 48–52. The sample had a median income of $50,000–$59,999, 88.9% with some college education, over 62% with a college degree, 61% female, and average age of 37 (SD = 13).

Measures and Procedure. Participants were randomly assigned to a condition and shown an image of the assigned food category and ingredient disclosure. Chicken (meat) and salmon (fish) represented animal-based products; plant-based products were peaches and carrots; and almonds represented the legume. We presented each product in canned packaging, except almonds (in a bag). Both packaging had pictorial representative images of the food, product name (e.g., Sliced Peaches in Light Syrup), and logo for a fictitious brand (SML Food Inc.) to improve face validity and avoid brand familiarity effects. This factor was also recoded to reflect a food type *category* (e.g., plant-based, animal-based) for additional analytical comparisons.

We manipulated ingredient disclosure through a list of ingredients furnished below the image. The GM condition contained the statement Campbell used ("partially produced with genetic engineering). The control condition listed only ingredients; the organic condition identified ingredients as organic. Following the image and disclosure information, we assessed participants' opinion, purchase intention, and WTP, implementing the same measures as in study

2 ($\alpha \geq .92$). Participants were also given a three-item seven-point measure of trust in food technology to examine the alternative explanation ($\alpha = .95$; Sheinin, Sajeev and Ashley 2011). We included embedded questions to ensure our manipulations were as designed and participants were actively partaking.

Manipulation Checks. To measure the effectiveness of our disclosure conditions, we asked participants to recall the disclosure condition (e.g., "the food product I saw earlier in this survey was (A) produced with genetic engineering, (B) grown organically, (C) none of the above, or (D) I don't remember"). We conducted a two-way contingency table analyses to ascertain the significance of those participants who correctly identified their experimental condition; 80.6% (GM ingredients), 86.5% (organic ingredients), and 72.8% (control) of participants correctly remembered their experimental condition: $\chi^2 = 662.7$, $p < .001$, Cramer's V = .699. Finally, we requested participants recall the specific food product: 100% (almonds), 96.1% (peaches), 94.4% (carrots), 87.0% (chicken), and 96.7% (salmon) of participants correctly remembered their experimental condition: $\chi^2 = 2408.9$, $p < .001$, Cramer's V = .924. The significant results and large effect sizes confirm the effectiveness of our experimental manipulations.

Results and Discussion

Opinion. A 3 (disclosure) X 5 (food type) ANOVA revealed a significant effect of disclosure (F (8, 742) = 14.3, $p < .00$; $\eta^2 = .04$). Opinion is most favorable with organic labeling, despite food type. However, there is a significant interaction between conditions *(*F (8, 742) = 2.55, $p = .01$; $\eta^2 = .03$; see Figure 2). The degradation of opinion is strongest for peaches (M_{GM} = 2.50; $M_{Organic}$ = 3.06; $M_{Control}$ = 3.00) and salmon (M_{GM} = 2.72; $M_{Organic}$ = 3.21; $M_{Control}$ = 2.84). When either product includes a GM disclosure, perceptions of opinion significantly decline

compared to the same product with an organic or no disclosure ($p \leq .003$ for each contrast). To investigate the differences between food category, products were combined into their respective categories of plant and animal. By food category, the negative effect of GM information is largest ($\eta^2 = .04$) for *plant*-based products ($M_{GM} = 2.64$; $M_{Control} = 3.04$; $M_{Organic} = 3.08$; $F(2, 748) = 15.0$, $p < .001$), contrary to H2. Differences between animal-based products are also significant, but the effect is not as large ($M_{GM} = 2.75$; $M_{Control} = 2.86$; $M_{Organic} = 3.03$; $F(2, 748) = 4.55$, $p = .01$; $\eta^2 = .01$). These results suggest reception of AquAdvantage could *suffer* if other providers use the organic labeling standards being developed by the USDA (USDA 2017).

[INSERT FIGURE 2 HERE]

Purchase Intention and WTP. As expected, product type moderates the effect of disclosure ($F(8, 742) = 2.39$, $p = .015$; $\eta^2 = .03$). Effects mirror the same pattern shown for consumers' opinion, where negative effect of disclosure is largest for peaches ($M_{GM} = 2.24$; $M_{Control} = 2.64$; $M_{Organic} = 2.42$) and salmon ($M_{GM} = 2.36$; $M_{Control} = 2.30$; $M_{Organic} = 2.51$). Comparisons across food categories show the largest differences between disclosure conditions continue for plant-based products (F (2, 748) = 4.79, $p = .009$; $\eta^2 = .013$) but *not* animal-based products ($p = .8$). If differences across food types for price perceptions (i.e., meat is generally more expensive) are controlled, planned contrasts revealed a marginal interaction between food type and disclosure for WTP, which significantly increased with organic disclosure across most foods. For almonds and salmon, difference between conditions was significant ($M_{GM} = \$4.21$; $M_{Control} = \$3.99$; $M_{Organic} = \$3.40$; F (2, 742) = 4.38, $p = .013$; $\eta^2 = .012$ and $M_{GM} = \$3.17$; $M_{Control} = \$3.23$; $M_{Organic} = \$3.79$; F (2, 742) = 3.03, $p < .05$; $\eta^2 = .01$, respectively). Planned contrasts showed WTP was lowest for the GM peach ($2.72) compared to the organic version ($3.19, $p = 0.09$) and the control ($3.28, $p = .05$).

The Mediating Roles of Opinion and Trust. As in study 2, H3 predicted that consumers' perceptions of overall opinion (i.e., an overall perception of the product) mediate the effects of disclosure information on our modeled measures. To test the alternative explanation of trust in food technology, both factors (trust in food technology and opinion) are tested in a parallel mediation model as a result. To test the indirect effect of disclosure on our behavioral outcomes (i.e., our disclosure ➔ opinion and trust ➔ purchase decisions mediation path), we employed the Preacher and Hayes's (2008) bootstrap method (n = 1,000 samples) via Hayes's (2018) PROCESS SPSS macro (Model 4). For purchase intention, results show support for full mediation for each factor. The data are consistent with our expectation that disclosure information negatively influences purchase intention indirectly both through opinion (-.23; 95% CI = -.35 to -.11) and through trust in food technology (-.02; 95% CI = -.04 to -.005). In multiple mediator models, the indirect effects are directly comparable because PROCESS can generate bootstrap CIs for all possible pairwise comparisons between indirect effects. Our results demonstrate that the a_1b_1 effect through opinion is significantly different from the a_2b_2 effect through trust (difference = -.21; 95% CI = -.32 to -.10). Consumers' opinion also fully mediates the negative effects of disclosure on WTP (-.13; 95% CI = -.20 to -.07) but *not* for trust (CI = -.03 to .001), though the contrast between a*b paths is significant (difference = -.12; 95% CI = -.19 to -.06). Since these contrast paths are of the same sign, our results may be interpreted as differences in strength where opinion is the stronger mediator (Hayes 2018). Thus, though parallel mediation does exist, opinion provides a stronger explanation for the effect of the GM disclosure on purchase intention and WTP.

General Discussion

The purpose of this research is to examine consumers' opinions and behavioral intentions toward GM-labeled foods and differences across food types. We investigate the mechanisms underlying the relationship between GM labels and behavioral intentions. We determine, consistent across food types, that consumers possess more negative opinions toward GM-labeled foods; have lower intentions to purchase them; and are willing to pay less for them. While consumers' opinions and purchase decisions for animal-based products with GM disclosures are less favorable (i.e., negative) *in general*, they are inconsistent between animal products (chicken, salmon). The moderating role of product type, as predicted in H2, occurred for salmon but not for chicken. Unexpectedly, outcomes are also negatively affected for one plant-based product (peaches), but not another (carrots). Interestingly, effects between disclosure conditions are not significant for non-animal or non-plant products (almonds). The main effect of GM label, then, is qualified by an interaction with food type. Yet, effects are driven by animal *and* plant-based products and not uniformly as we expected. These results reveal the nuanced role of food type as product disclosures (e.g., "contains genetically-engineered ingredients") are made. Our results also suggest although both opinions of the product and trust in food innovations mediate the relationship between GM labels and behavioral intentions, opinion toward the product is a significantly stronger mechanism.

Implications

The NBFDL prevents U.S. states from issuing their own labeling requirements. Instead, food manufacturers can (1) label with the USDA symbol and text, showing the presence of GMOs; (2) label using plain language; or (3) label with a QR code that links to ingredient information (i.e., in which GM ingredients would be disclosed). Our results show how one specific format, on-package labels, influence consumer outcomes. In previous studies, other

labeling formats have been explored. For example, retailers were recently required to disclose calorie and nutrition information for single-ingredient meat products (e.g., ground beef). Some retailers used posters to communicate this information to shoppers. Research shows these types of disclosures fail to help consumers understand differences between products (Burton et al. 2015). The reason is, disclosures in the form of product labels worked best. Any other labeling types (posters, QR codes, etc.) require additional layers of effort that consumers are unlikely to exert.

These findings are important for legislators and marketers concerned with the effects of current marketplace counter-labeling (e.g., Non-GMO Verified Project). To implement effective regulatory policies, policymakers must understand the consumer's perspective. Despite no international regulatory consensus, public opinions worldwide reflect a common theme; consumers want to freely choose between GM foods and traditional equivalents. Any labeling policy a federal agency considers, however, must dovetail with public-education campaigns.

Consumers who are keenly involved in ensuring their well-being, have become more vigilant in learning about foods with desired nutritional properties or positive outcomes. We find consumer opinion mediates the relationship between GM label and behavioral intentions. Educating consumers about GM production methods and downstream effects on health and the environment will allow for informed decisions. With more education, demand for labeling may dissipate.

Limitations and Future Research

Technological advances spurring GM foods are persistent. Extensive inclusion of other foods types in the human food supply is inevitable. Our research focuses on specific plant- and animal-based modification, excluding other food types, which future research must address.

Further, while the NBFDL offers several means of disclosure, we focused on one format – a product label disclosure statement. Future studies should explore others.

Consumer perceptions of the effects of consuming traditional nutrient-rich, doctor-recommended products such as milk should be explored, as some consumers tend to distrust regulatory organizations about growth hormones in certain foods. Examining consumer adoption of these products can provide insights that may predict potential future response to GM foods. As these organizations conduct further research, reports may highlight positive benefits of GM foods and offer endorsements that can allay consumer apprehension. GM foods fundamentally offer options for consumers, but many seem determined to resist adoption. Protective action decision-making may add more insights into their resistance and allow us to recognize factors that may change their subjective knowledge to align with factual benefits.

The findings of study 1 confirm education is needed to allay consumer fears. Affective reactions by consumers underscore a marketplace rife with confusion. These outcomes are likely to impede attitude change and should be explored. One suggestion to promote cognitive responses in pre-purchase judgements includes terminology standardization. Consumers remain confused, uncertain regarding claims' validity, and skeptical about the wholesomeness of what is presented as credible for human consumption. Governmental and advocacy entities must present uniformity in messaging, eliminate consumer misperception, demystify the notion of GM, properly educate consumers, and increase transparency for enhancing consumer trust.

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