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The Importance of Source: A Mixed Methods Analysis of Undergraduate Students' Attitudes Toward Genetically Modified Food

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Abstract

Even though science says genetically modified (GM) foods are safe, many consumers remain skeptical of the technology. Additionally, the scientific community has trouble communicating to the public, causing consumers to make uninformed decisions. The Millennial Generation will have more buying power than any other generation before them, and more research needs to be done to examine what factors influence their attitudes toward GM food. Guided by the elaboration likelihood model, the purpose of this study was to investigate the influences on undergraduate students' attitude formation after receiving information about GM food. A convergent mixed methods design was used to collect data. This study found that message source had limited influence on students' attitudes toward GM food, but risk perception, knowledge, and source credibility were significant predictors of their change in attitude. Participants also expressed wanting to learn more about the technology. Recommendations were to increase knowledge of GM food among university students to promote use of the central processing route and to further investigate influences on students' change in attitude.

Keywords: genetically modified food, undergraduates, opinion, credibility, risk perception, ELM

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Introduction

In 1988, researchers first inserted glyphosate (herbicide) tolerant genes into soybean plants through a process called genetic modification (Hinchee et al., 1988). Today, over 70% of soybeans in the world have been genetically modified, and farmers have planted over one billion acres of genetically modified (GM) plants worldwide (Fernandez- Cornejo, 2012). An estimated 70% of processed foods sold in grocery stores contain GM food ingredients (Chrispeels, 2014). The United States Department of Agriculture (USDA) (2014) lists a number of benefits GM food offers, including increased crop quality and nutrition, as well as drought, pest, and weed resistance. The World Health Organization (2015) endorsed GM food as safe for consumption after finding no scientific evidence to support otherwise. Additionally, a meta-analysis of 10 years of literature pertaining to GM safety found no significant health risks associated with consumption of the products (Nicolia, Manza, Veronesi, & Rosellini, 2014). Despite numerous scientific findings,

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consumer concern has caused government regulators to develop separate regulations for GM foods (Chassy, 2007; National Academy of Science, 1987; National Research Council, 1989). Some concerns about GM crops center on the ecological impacts involving the development of herbicide resistant plants or direct harm to humans (Losey & Raynor, 1999; Ma, Drake, & Christou, 2003; Phillips, 2008). Despite extensive regulation and numerous peer-reviewed studies showing no differences in nutritional value, consumers remain skeptical of GM food technology (Chassy, 2007; Lemaux, 2008; Zilberman, Kaplan, Kim, & Waterfield, 2013).

A study in Florida found consumers reported they were uninformed about GM food and unsure about advantages and disadvantages of the products (Anderson, Ruth, & Rumble, 2014). When facing a lack of information, consumers will often turn to the media; however, media coverage remains largely negative about GM food, centering on the possible risks rather than science-supported benefits (Mahgoub, 2016; McCluskey, Swinnen, & Vandermoortele, 2015). Additionally, information reported in the media often includes vague or biased data, causing consumers to make decisions with faulty information (Goodwin, 2013). The media's negative portrayal of GM food has been linked to consumers' negative perception of the products (Marques, Critchley, & Walshe, 2014; Vilella-Villa & Costa-Font, 2008).

Consumers' perception of the companies involved in developing and selling GM seeds affects their suspicion of the technology as well (Caffrey, 2014; Chaussee, 2014; Nichols, 2014). Folta (2012) proposed that the public has trouble separating their views of large agriculture companies from their feelings toward the science sold by those same companies. Skepticism of large agricultural companies, coupled with a lack of information about both science and agriculture, has created a need to develop a better connection with the consumer and communicate more effectively (Telg & Irani, 2012).

Skepticism and distrust are commonalities among the general population, but these traits are also inherent in Millennials (Taylor & Ketter, 2010). The Millennial Generation has been defined as individuals who were born between 1980 and 2002 (Elmore, 2010; Howe & Strauss, 2007; Payment, 2008; Taylor, & Ketter, 2010). Millennials did not grow up in rural areas like many people of the generations before them (Taylor & Ketter, 2010). The Millennial Generation accounts for 23% of the United States' population (American Community Survey, 2014) and are estimated to have 11% more buying power than generations preceding them (Hais & Winograd, 2011). As Millennials become an even larger portion of the consumer population, the need for them to be informed on food and agricultural topics becomes greater (Goodwin, 2013). Current college students were born between 1991 and 1996 and are categorized as Millennials. Opinions toward agricultural products are formed while students are in college and develop into more grounded attitudes as they grow older (Sears, 1986), which makes this audience extremely important to study (Goodwin, 2013). Undergraduate students have likely been exposed to years of information about GM food provided to them by the media, friends, and family. Educators need to understand how to best deliver educational information to students about GM food that will allow them to make educated decisions regarding GM products in the future. The purpose of this study was to explore the influences on undergraduate students' attitude formation after receiving information about GM food.

Theoretical Framework

The elaboration likelihood model (ELM) guided this study. The ELM is commonly used to understand and explain attitude change after an individual is exposed to persuasive communication. The ELM uses two different information-processing routes to display how attitudes can shift (Petty & Capaccio, 1986). Individuals who process information through the central processing route carefully consider the message presented, relate the communication to past experiences, and possess the motivation to process the information (Petty, Brinol, & Priester, 2009).

If a change in cognitive structure occurs as a result of the processing, there will either be a positive or negative shift in attitude. Typically, attitudes formed via the central processing route are resistant to counter persuasion and predictive of behavior (Petty, Haugtvedt, & Smith, 1995). When the information is not relevant, there are distractions, or a person does not have the adequate knowledge to process the information, he or she will use the peripheral route to process the information. Attitude changes resulting from the peripheral route are often short-lived, easily changed, and reliant on peripheral cues (Petty et al., 2009). Peripheral cues include message sources (Petty et al., 2009) and can "affect attitude in the absence of argument processing" (Petty & Capaccio, 1986, p. 134). Researchers have linked perceptions of message sources to people's likeliness of elaboration resulting in an attitude change (Priester & Petty, 1995). Sources that are considered credible typically have at least one of the following qualities: expertise, trustworthiness, or goodwill (Perloff, 2008).

Researchers have applied the ELM to a number of different studies pertaining to agriculture (Meyers, 2008; Goodwin, 2013; Frewer, Howard, Hedderley & Shepherd, 1997). Meyers (2008) looked at how persuasive communication influenced the media's coverage of agricultural biotechnology. The study found prior attitudes had the greatest effect on attitudes associated with agricultural biotechnology (Meyers, 2008). Because pre-existing attitudes tended to be negative, consumers' likelihood for elaboration was low when presented with media coverage of agricultural biotechnology (Meyers, 2008). Goodwin (2013) used the ELM to explore the impact of personal relevance and transparency on college students' trust and perception of the livestock industry. Overall conclusions presented that in the absence of transparent communication, consumers were not as likely to exhibit a great deal of elaboration. Even though neither Meyers (2008) nor Goodwin (2013) identified the elaboration pathway used, both studies supported previous research that indicated consumers used the peripheral pathway when making food-related decisions when no intervention was used (Frewer et al., 1997).

Frewer et al. (1997) also used the ELM to examine both the impact of prior attitudes and source credibility on consumer opinions of GM food. Previous opinions did have an effect, and respondents with negative prior attitudes expressed greater distrust for GM food (Frewer et al., 1997). The study's hypothesized *distrusted* source (a government agency) was viewed as more credible than the trusted source (a consumer organization; Frewer et al., 1997). In addition, prior attitude influenced the perception of source credibility, and source credibility influenced final attitudes toward GM food (Frewer et al., 1997). A similar study by Irani, Sinclair, and Malley (2001) found the Food and Drug Administration (FDA) was the most trusted source by consumers to communicate information about GM food when compared to the USDA and industry sources.

Additionally, research shows consumers often use the peripheral processing route when forming attitudes about agriculture because they do not possess the motivation to process agricultural messages (Frewer et al., 1997). Because the peripheral route relies on cues, such as message source, greater research should be conducted exploring the impact of different sources on changes in attitude about GM food. Understanding information processing can help agricultural educators develop appropriate educational materials for students.

Purpose & Objectives

The purpose of this study was to explore the influences on undergraduate students' attitude formation after receiving information about GM food. This research aligns with priority one of the national research agenda; informing the public of agricultural and natural resources (Doerfert, 2013). The objectives guiding this study were as follows:

1. Describe undergraduates' prior knowledge, prior attitudes, and prior risk perception regarding GM food.

2. Compare undergraduate students' change in attitude as a result of receiving information delivered by Company 1, Company 2, FDA, or USDA.
3. Determine how message source, source credibility, prior knowledge, and prior risk perception of GM food predict undergraduate students' change in attitude toward GM food.
4. Explore undergraduates' perceptions of GM food.
5. Determine the amount of elaboration used by undergraduate students when presented with information about GM food.

Methodology

Research Design and Methods

In order to gain a deeper understanding of how people view and process information, this study was designed implementing the principles of mixed methods research (Creswell & Plano Clark, 2011; Plowright, 2011). Mixed methods research allows the investigator to gain a deep understanding of individuals' perspectives as well as examine a large number of people's response to different variables, providing a more complete understanding of a research problem (Creswell & Plano Clark, 2011). Mixed method designs have been used in recent years to answer Agricultural Education research questions (Epler, Drape, Broyles, & Rudd, 2013; Walker, 2010; Witt, Doerfert, Ulmer, Burris, & Lan, 2013).

Researchers can select from a variety of designs to conduct mixed methods research (Creswell & Plano Clark, 2011). The parallel convergent design is a type of mixed methods study that allows researcher to gather different, but corresponding, data on the same topic (Creswell & Plano Clark, 2011). The parallel convergent design was used for this study to allow for a more complete understanding of how undergraduate students use the elaboration framework to perceive the messages presented. Two methods were used to collect data: a quantitative questionnaire and structured qualitative interviews. As per the parallel convergent design, both quantitative and qualitative data were weighted equally, and integration occurred at the data analysis step (Creswell & Plano Clark, 2011). The population for this study was undergraduate students in five classes in the College of Agricultural and Life Sciences (CALS) at the University of Florida (UF).

Quantitative Component

The quantitative phase of this study used a questionnaire administered as a pretest- posttest experimental design in order to answer research objectives one through three. As part of the experimental design, one intervention was used with four different variations of the treatment. The intervention was the source attributed to a message describing GM food, which also represented a peripheral cue in the ELM (Petty et al., 2009). Four different groups were used; each variation presented the same message about GM food. The message was adapted from GMO answers (2014) and stated:

> Before genetically modified foods reach the market, crops from genetically modified seeds are studied extensively to make sure they are safe for people, animals and the environment. Today's genetically modified products are the most researched and tested agricultural products in history. (para.16)

Two government agencies, USDA and the FDA, and two agricultural biotechnology companies were selected to represent positive and negative sources respectively. Because government agencies have been identified as more credible by consumers (Frewer et al., 1997), and the USDA is directly associated with agriculture, the FDA was chosen as the control for the experiment. For the purpose of this paper, the companies have been given the pseudonyms,

Company 1 and Company 2. Company 1 was a major agricultural biotechnology company that had experienced major news coverage in recent years. Company 2 was a similar company that had not received the same amount of media attention. Respondents were shown the real names of the companies during the study and told the message did not reflect the views of the organization or business after completing the survey.

The questionnaire adapted questions from previous studies to measure knowledge, prior attitudes, and prior risk perception of GM food, as well as source credibility (Frewer, Howard, Hedderley, & Shepherd, 1996; Frewer et al., 1997; Hallman & Metcalfe, 1994; Osgood, Suci, & Tannenbaum, 1971; Roe & Teisl, 2007; Rumble & Leal, 2013). Attitudes and risk perception of GM food were measured in the pre and post-test. A threat associated with this design is *statistical regression*, where respondents who score high or low on the pretest will score closer to the mean on the posttest (Ary, Jacobs, & Sorensen, 2010). Knowledge and risk perception were measured in this study to represent distraction (risk perception) and knowledge in the ELM to determine if respondents had the ability to process the information (Petty et al., 2009). Because literature indicated people use the peripheral process when presented with communication about agriculture (Frewer et al., 1997), source credibility was measured to determine if the peripheral process was operating. The validity of the instrument was established through use of a panel of experts and a pilot test (Ary et al., 2010). Additionally, internal reliability was measured for each construct. A scale is considered reliable when the Cronbach's alpha is greater than .70 (Field, 2013).

Knowledge of GM food was measured through seven, 5-point Likert scale questions labeled *strongly disagree = 1*, *disagree = 2*, *neither agree nor disagree = 3*, *agree = 4*, and *strongly agree =5* ($\alpha = .82$). The questions asked about respondents' self-reported understanding of general science and technology, food science and technology, and GM food science. The same scale used for knowledge was used to measure risk perception with six questions ($\alpha = .83$). A score of 5 indicated the respondent strongly agreed there was a high risk, and a score of 1 indicated the respondent strongly disagreed that there was a high risk. Risk perception questions asked about threats GM food posed to people and the environment. Prior and final attitude toward GM food was measured using a bi-polar semantic differential scale with six questions ($\alpha = .93$). Negative adjectives were assigned a 1, and positive adjectives were assigned a 5. Attitudes measured if respondents believed GM food to be safe, beneficial, artificial, necessary, healthy, and wholesome. Source credibility was determined using a five question, bipolar semantic differential scale ($\alpha = .90$) measuring goodwill, expertise, and trust (Perloff, 2008). Positive source credibility was assigned a 5, while negative source credibility was assigned a 1. Indexes were created for each construct by calculating the overall average for the scale. Additionally, respondents were asked to answer several demographic questions including age, gender, race, and class rank. The questionnaire was created and administered using Qualtrics, an online survey development tool. Access to the Internet by the target population allowed for an online survey instrument to be used (Dillman, Smyth, & Christian, 2009). Survey data were collected following Dillman et al.'s (2009) tailored design method.

Respondents for the questionnaire were selected using a convenience sample of five courses offered to undergraduate students in CALS at UF. An incentive of extra credit in the class was used to encourage participation. A convenience sample was deemed appropriate due to practical constraints, efficiency, and accessibility to students in CALS (McMillan & Schumacher, 2010). This type of sampling cannot be generalized to the population; however, data can still provide insight into the relationships in the population of CALS students (McMillan & Schumacher, 2010). Lists of students' names and email addresses enrolled in the courses were acquired from the instructors. From these lists, 718 students were contacted by email to take the survey. There was a 58% response rate ($n = 414$) after incomplete responses were removed from

analysis. Table 1 reports the demographics of the respondents. The majority were white (79%), female (71%), and upperclassmen (64%).

Table 1

Demographics of Survey Respondents (n = 414)

Characteristic	*n*	%
Sex		
Female	294	71
Male	120	29
Hispanic Ethnicity	64	16
Race		
American Indian or Alaskan Native	5	1
Black or African American	31	8
Asian or Pacific Islander	53	13
White	328	79
Other	21	5
Class Rank		
Freshman	17	4
Sophomore	131	32
Junior	162	39
Senior	104	25
Age		
18-20	350	85
21-24	56	14
25+	8	2

Data were analyzed using SPSSv22 statistical software package for Windows. Descriptive statistics were used to describe the first objective. Objective two was answered by first calculating the difference in the final attitude from the prior attitude in each group to create a new *change in attitude* variable. Then, an ANOVA was run to determine if there was a difference in the change in attitude between the four source groups. A multiple linear regression model was developed to answer objective three. The predictors for change in attitude were prior knowledge, prior risk perception, source credibility, and the source that respondent was exposed to. Source groups were dummy coded and the FDA was treated as the control in the model because previous studies had determined this was likely a trusted source (Frewer et al., 1997; Irani et al., 2001).

Qualitative Component

The second method for data collection was structured interviews. The interviews were used to answer objectives four and five. A convenience sample of self-selected volunteers was used for the interviews. Participants must have first completed the questionnaire and each participant was offered a small monetary incentive to participate in the interviews. The structured interviews asked 18 questions to investigate participants' perceptions of GM food for objective four. Questions were guided by the ELM (Petty & Capaccio, 1986). Interviews also asked each participant to use thought listing procedures to determine the amount of elaboration they used when presented with information about GM food to answer objective five. This process can be used to understand an individual's cognitive process (Cacioppo, von Hippel, & Ernst, 1997). The method involves asking the participant to write down all thoughts related to a prompt. The prompt was the same informational message the participant saw in the survey, along with the same source. Participants were asked to orally explain their thoughts, what about the message made them feel that way, and to categorize their thoughts as positive, negative, or neutral. (Cacioppo et al., 1997; Heimberg, Nyman, & O'Brien, 1987). While the interviews were intended to take about 30 minutes, they were shorter due to the lack of elaboration by the participants. Each interview lasted between 12 and 30 minutes and was voice recorded for transcription purposes.

Data were analyzed using *a priori* coding to look at participants' responses pertaining to their perceptions of GM foods (Ryan & Bernard, 2003). Prior knowledge, attitudes, and risk perception were identified from the ELM and previous research as themes that should be investigated. The themes were analyzed using the computer software MAXQDA to develop codes. Objective five described the amount of elaboration used through thought listing procedures, measuring the amount and types of thoughts elicited by the message. Elaboration was also identified by determining if participants used prior experiences to evaluate the message or identified a probable behavioral change as described in the ELM (Petty et al., 2009). There were several measures taken to ensure trustworthiness of the study (Lincoln & Guba, 1986). Credibility was established through data triangulation and member checking with interview participants. Confirmability was ensured through use of an audit trail detailing methodological decisions and processes. In order to aide in transferability, thick and rich descriptions were provided throughout.

Twenty-four students volunteered for the interviews, participants were selected based on sex and assigned source from the questionnaire to best represent the sample from the survey. Some volunteers did not participate due to scheduling conflicts, and the researchers stopped recruiting interviewees after saturation was reached in the interviews (Creswell, 2013). Twelve students participated and were assigned pseudonyms to protect their identities during analysis. Eight (67%) of the participants were female and four (33%) were male. Only one participant was of Hispanic descent (8%), three (25%) were Asian or Pacific Islander, and nine (75%) were white. Most of the participants were juniors or seniors (n = 9, 75%), and three were sophomores (25%). The majority of the students were between the ages 18 and 20 (n = 7, 58%), three were between 21 and 24 (25%), and two (17%) were over the age of 25. One of these participants was in his 40s, but was still an undergraduate student.

Data from both the qualitative and the quantitative components were analyzed at the conclusion of the study. The rationale for this approach was the quantitative data and subsequent analysis provides a general understanding, while the qualitative data explores the research question more in depth (Creswell & Clark, 2011). Data were combined to give a more in-depth understanding of undergraduates' interpretation of information presented about GM food.

Results

Objective 1. Describe Undergraduates' Prior knowledge, Prior Attitudes, and Prior Risk Perception Regarding GM food.

Real limits were created to better interpret the descriptive results for Objective 1 (Sheskin, 2004) and can be seen in Table 2. The index for the prior knowledge construct was created, and the average was 3.97 (*SD* = 0.59). The majority of the respondents reported they *agreed* that they were knowledgeable about GM food. The prior attitude toward GM food index was 2.67 (*SD* = 1.00). The respondents did not have polarized positive or negative attitude and were categorized as *neutral*. Additionally, respondents indicated they *neither agreed nor disagreed* (*M* = 3.07, *SD* =0.61) about the risks associated with GM food.

Table 2

Undergraduates' Prior Knowledge, Risk Perception, Prior Attitude, and Prior Risk Perception of GM Food

	M	*SD*
Prior Knowledge[a]	3.97	0.59
Prior Attitude[b]	2.67	1.00
Prior Risk Perception[a]	3.07	0.61

[a] indicates real limits of 1.00 – 1.49 = *strongly disagree*, 1.50 – 2.49 = *disagree*, 2.50 – 3.49 = *neither agree nor disagree*, 3.50 – 4.49 = *agree*, 4.50 – 5.00 = *strongly agree.*

[b] indicates real limits of 1.00 – 1.49 = *negative*, 1.50 – 2.49 = *slightly negative*, 2.50 – 3.49 = *neutral*, 3.50 – 4.49 = *slightly positive*, 4.50 – 5.00 = *positive*.

Objective 2. Compare Undergraduate Students' Change in Attitude as a Result of Receiving Information Delivered by Company 1, Company 2, FDA, or USDA

The average change in attitude was calculated for each treatment group by subtracting the mean of the prior attitude from the mean of the final attitude measurement. No major changes in attitude were observed. Average change in mean was 0.50 for Company 2, 0.60 for Company 1, 0.60 for the FDA, and 0.60 for the USDA. A one-way ANOVA test showed that there were no significant differences in change in attitude between the treatments (F (3,410) = 0.29, p = 0.83).

Objective 3. Determine how Message Source, Source Credibility, Prior Knowledge, and Prior Risk Perception of GM Food Predict Undergraduate Students' Change in Attitude toward GM Food

A multiple linear regression model was created to examine if the message source, source credibility, prior knowledge, and prior risk perceptions toward GM food predicted the change in attitude toward GM food (Table 3). The model was significant (F (6,407) = 76.85, $p < .01$) and could account for 52% of variance in change in attitude ($R^2 = .52$). Prior risk perception ($p < .01$), prior knowledge ($p < .01$), and source credibility ($p < .01$) were identified as significant predictors of the change in attitude toward GM food after receiving persuasive communication. These results indicate that for every one-unit increase in risk perception, change in attitude would increase by 1.02 (b = 1.02), and for each one-unit increase in prior knowledge or risk perception, there was a .27 (b = -0.27) or .14 (b = -0.14) decrease in attitude change respectively. None of the sources were significant predictors of attitude change.

Table 3

Predictors of Change in Attitude toward GM Food

Predictor	*b*	*t*	*p*	*F*	R^2
(Constant)	2.96	1.39	.02	76.85	.52
Company 1	.04	.40	.69		
Company 2	-.24	-.25	.81		
USDA	-.25	-.26	.80		
Prior Risk Perception	1.02	14.43	.00*		
Prior Knowledge	-.27	-4.38	.00*		
Source Credibility	-.14	-2.88	.00*		

* indicates significance at $p < 0.01$

Objective 4. Explore Undergraduates' Perceptions of GM food

Perceptions of GM food were explored during the qualitative interview portion of this study. Participants expressed limited knowledge of GM food, neutral attitudes, and an overall skepticism toward the technology.

Knowledge. During the interviews, participants expressed that they were not exactly sure what GM food was. Felicia said, "I don't know much about [GM food], but I think it's when basically food is scientifically grown." Even though the participants admitted they did not fully understand the technology, they did associate GM food with gene manipulation. Some participants, like Bella, were more knowledgeable, "To my understanding, GM food is a food in which a certain gene characteristic trait has been modified, inserted, or removed to change the original genetic composition of it." Overall, participants admitted they did not understand GM food though. For example, Annie said:

> I really do not know anything about [GM food]. What I think it is, is you modify the DNA or the genes [of the food] to make it either easier to grow or resistant to certain diseases and that is what my guess would be.

Attitudes. A number of participants indicated that they had neutral attitudes toward GM food as a result of their limited knowledge. Tiffany said, "I would put [my attitude as] neutral toward [GM food]." Some participants, like Alicia, reported slightly more negative attitudes, "I would say I view [GM food] as bad, but not bad enough to stop me [from purchasing], because in the media, they are sometimes portrayed as really bad." Overall, most of the participants had neutral attitudes though. Leah explained:

> I cannot really argue that [GM food] is good, and I cannot argue that it is bad if I am not that well informed about it. For me to take a side, I would say that I would extensively have to research about it.

Risk perception. During the course of the interview, participants explained their skepticism toward GM food. Leslie said, "I mean it is true that generally [GM foods] are very tested. I do think, however, that there are always consequences that you cannot always predict." Felicia explained she had similar concerns, "So we don't know the long term effects [of GM food] yet." Tiffany was also skeptical toward the safety of GM food:

> I think [GM food] is just all very new and needs to be approached with caution. I think if we stay cautious and nothing seems to come up that is bad then, you know, we will see what happens after that.

Even though a number of participants expressed concerns regarding GM food, many did not see any major issues with the food. Lilly said, "I think [GM food] is safe, I have not heard too much about people having problems with eating GM foods." Others reported benefits they believed GM food offered such as "mass production and feeding large populations," as explained by Felicia. Bella also said, "I [have read that GM food] would enable people to be able to produce higher quantities of crops, and to potentially be able to help the growing population." While the participants did acknowledge the potential advantages of growing GM food, many still felt uncertain about the long-term effects of the products.

Objective 5. Determine the Amount of Elaboration used by Undergraduate Students when Presented with Information about GM food

During the thought listing procedures, participants listed anywhere from one to five thoughts. For most of the thought lists, participants presented more negative or neutral thoughts than positive thoughts. The participants who displayed the most elaboration throughout the interviews had the most negative attitudes to begin with. Participants who expressed more negative attitudes in the interviews spoke the longest, but a lot of the knowledge they were using to assess the message did not align with the science of the technology. Leon reported his distrust of the information because:

> Research tells me there is not enough research [about GM food]. Research that has been done so far is kind of wavering in the direction that we need to back off of GM [use in] our livestock and our food because it is affecting human things. It is not just making the cow bigger. Now it is affecting human genetics because it is what we ingest, it is what we process. A lot of those additives become part of us.

The majority of the time, participants regurgitated the message as part of their thoughts, not drawing upon any past experiences. For example, Annie said:

> So I looked at the statement and I saw their initial statement is how they are studied extensively. And that made me feel better because if they are studied a lot you know they have a pretty good understanding for how this could affect people and things like that.

Ken simply wrote down "I agree [with the statement]."

David had a similar thought when reading the message, "So I read it as [saying] 'highly regulated and it's the safest in history', so it makes you think [GM foods] are safe." Some participants did try to use past experiences and knowledge to assess the message, especially when looking at the source. Jim recalled:

> Company 2 is a very old company who has engaged in a lot of petro chemical work and a lot of their history, if you look at it, it's not necessarily good for people or the environment, it's good for them making a lot of money. So I guess I am inherently biased against Company 2.

Many participants took notice of the sources when they first read the message. Ken said, "Well it is the United States, it is the USDA that puts it out. I feel like those are the main people you should trust." Alicia shared similar thoughts for the FDA, "The FDA is supposed to be the one that keeps us safe and food safe. I mean everyone understands that there is interest behind everything, but I would say the FDA is pretty trustworthy." Participants who saw industry sources had different opinions though. Leslie said, "I think I would say I trust Company 2 a little bit, but I

would not say I trust it completely. Everyone has always got an agenda." Leon had a stronger opinion toward Company 1 saying, "Honestly anybody who makes a claim like that deserves to be examined."

Participants unanimously agreed the message had little to no impact on their future behaviors regarding GM food. Felicia said, "[The messages] might cross my mind, but I don't think my buying habits ultimately will change." Annie agreed and explained, "I do not think [the message] will affect my food purchases too much. I might look at the labels more, but I do not think I will go out of my way to not or to buy GM food."

Even though participants did not indicate a behavioral change, many were curious to learn more about GM foods. Annie expressed her feelings, "Yeah I just do not want to say they are awful if I do not know. I feel like I should probably know more about it." Jim agreed that he was interested in learning more as well, "[I want to learn more about my] criticisms so I can have actual facts to support my arguments." Many participants also indicated they did not believe the information about GM food was easily accessible. Lilly explained, "I think I would like to learn more about [GM food]. I do not think I see enough in the news. A lot of our foods are GM, so I would like to learn more information before making purchases."

Discussion

Understanding how undergraduate students form attitudes toward GM food after receiving information is essential for agricultural educators and extension agents to develop educational opportunities for college students. The interview portion of this study found participants appeared to possess limited knowledge of GM food but were able to admit this lack of knowledge. These results conflict with the survey findings, where the majority of respondents agreed that they had knowledge of GM food technology. The survey results may be due to students feeling they had read enough about the technology to understand it. The overall prior knowledge index also included reported understanding of basic science and technology. The undergraduate students in CALS likely had exposure to these topics in recent courses, which would increase their reported knowledge for the measurements and inflate the prior knowledge of GM food construct score. Additionally, because the survey results were self-reported, there was no way to determine if the finding was reflective of actual knowledge. The survey findings also conflicted previous research that indicated general consumers had limited knowledge of the technology (Anderson et al., 2014). During the interviews, many participants expressed wanting to have more information on the topic before forming any concrete attitudes toward GM food. This finding supported previous research (Anderson et al., 2014) and may explain why the majority of the survey respondents were unsure about risks of GM food and had neutral attitudes toward the product.

The survey indicated the source, which served as a peripheral cue, used to present information about GM food had no influence on attitude change exhibited by the respondents. Many participants during the interviews did take notice of the source, but none of the students expressed a change in attitude. Industry sources appeared to evoke skepticism from participants when completing the thought-listing portion of the interview. Government sources were more trusted among the participants, similar to other studies (Frewer et al., 1997; Irani et al., 2001) but did not lead to any further thought toward the information presented. These qualitative findings indicate students may use more elaboration when an industry source presents information rather than a government source because it made the participants consider the message more. However, greater elaboration did not necessarily produce changes in attitude.

In the survey, source credibility, prior risk perception, and prior knowledge were significant predictors of change in attitude, which is consistent with previous research (Frewer et al., 1997; Meyers, 2008). As respondents' knowledge increased, the change in attitude decreased.

Because knowledge was associated with the ability to process information, respondents with more knowledge may have not used peripheral processing but experienced less of an attitude change (Petty et al., 2009). Risk perception was considered a distraction in the ELM under the ability to process information. The greatest change in attitude was associated with higher perceptions of risk, but there was no way to know the direction of the attitude change. Source credibility was used to explain if the peripheral process was operating in the ELM, and the results showed that as source credibility increased, change in attitude decreased, and the decrease was relatively small. The peripheral process was likely not operating in a way to produce changes in attitude, which was supported by the ANOVA and the thought listing analysis.

The qualitative data in this study led us to conclude participants used minimal elaboration when they assessed the message about GM food (Cacioppo et al., 1997), which aligns with previous agricultural research using the ELM (Frewer et al., 1997; Goodwin, 2013; Meyers, 2008). Similar to the survey, neither attitude change nor intent of behavioral change was reported by any of the participants; these characteristics could indicate use of the central processing route if present (Petty et al., 2009). Many of the participants initially noticed the message source and either talked about their immediate distrust or trust associated with it. This attention to the peripheral cues is indicative of the peripheral pathway (Petty et al., 2009). Participants who had higher risk perceptions at the beginning of the interview ended up expressing more negative final attitudes after reading the message. Overall, the participants did not appear to have the knowledge or the motivation necessary to evaluate the message, use the central processing route, and experience a cognitive change in attitude (Petty et al., 2009).

Recommendations

Students reported they had high knowledge concerning GM food, but the qualitative data showed they might not understand as much as they had originally indicated. Students expressed wanting to learn more in order to make educated decisions about GM products, but did not know where to access the information. The agricultural industry needs to make the information more accessible to undergraduate students. Increasing the knowledge of GM food could help students use more elaboration when assessing information about GM food, which would lead to lasting changes in attitude (Petty et al., 2009). Because students reported not knowing where to find the information on GM food, agricultural educators should review the concepts of GM food in appropriate classes. Additionally, educators should include how to evaluate the credibility of information in their curriculum to encourage independent and critical thinking about information presented about GM food and other contentious topics. Teaching students where to find unbiased information will help facilitate their learning about GM food. Agricultural education, communication, extension, and leadership departments should also consider offering an agricultural issues course to students. The class content could be used to inform undergraduate students about GM food and other contentious agricultural topics and help students learn to assess the credibility of information and sources.

Collaborating with universities, extension educators should develop question and answer seminars, bring in guest speakers with an expertise in GM science, and develop educational workshops to teach students what foods are genetically modified and why. The workshops and seminars should be free of jargon and relevant to the needs of the students. Making the information easy to understand and accessible will aid in the students' processing of the information. Working with the FDA or USDA may prove to be successful in adding trust to information presented to students. Agricultural educators should be aware of how collaboration with industry sources could affect the interpretation of information by undergraduate students. Agricultural students may view the industry sources as credible, but students outside of the industry may not trust them and reject the provided information.

Further research is needed to truly understand how students form attitudes toward GM food. The message source appeared to have little to no effect on students' attitude change regarding GM food; however, risk perception was associated with the greatest change in attitude. Additional research should be conducted to determine if greater perceptions of risk would create a more positive or negative final attitude toward GM food after presented with information, as well as explore its interaction with elaboration. Measurements for motivation to learn about GM food and a more representative measurement of knowledge could also strengthen the research. This study should be replicated with Millennial consumers not in college, as well as general consumers, to help develop future non-formal educational opportunities. Agricultural educators could use these findings for different food technologies like irradiated food, in-vitro meat, and other emerging food sciences. Other possible research could include testing different educational methods used to present information, such as structured agricultural experiences, webinars, guest lectures, reflections, etc., on students' elaboration. Researchers could also explore changes in attitude after students complete a course, workshop, or seminar related to agriculture. Repeated exposure to content over a longer period may elicit greater changes in attitude.

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