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Using Audience Segmentation to Determine Millennial Perceptions toward GM Foods

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Abstract

Millennial consumers are an essential population segment who are currently the third highest spenders in grocery aisles. Millennials are often lumped into one homogenous group; however, they are instead a diverse group comprised of unique characteristics. As producers are increasingly adopting genetically modified (GM) crops, it is essential to understand how consumers perceive the technology. Using the Situational Theory of Publics, an online survey was used to capture character traits of millennials and their perceptions toward GM foods. Using non-probability quota sampling (*N*=386), millennials were asked to answer demographic questions as well as questions related to their level of support for GM food; their level of involvement in the issue; and their level of knowledge about GM food. Results show that the majority of respondents (77.2%) were not supportive of GM food, and the largest non-supportive category of respondents (25.6%) had high issue involvement but low knowledge about GM food. Of the respondents supportive of GM food, 91% had low issue involvement. By providing insight into millennial characteristics in regards to demographics and where they align in the situational theory of publics, this research can help further risk communication research and improve the understanding of how communication practitioners can strategically communicate with the diverse perceptions and levels of involvement millennials have with GM food.

Keywords

Situational Theory of Publics, Genetically modified food, Millennials, Supportive publics, Non-supportive publics

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Introduction

The World Health Organization defines genetically modified (GM) foods as "foods derived from organisms whose genetic material (DNA) has been modified in a way that does not occur naturally, e.g. through the introduction of a gene from a different organism" (World Health Organization, 2020, Overview section, para. 1). GM crops first emerged in the early 1970s and have been a topic of debate since the 1990s (Oz et al., 2018). GM ingredients are currently common in human food products, and GM seeds have been widely accepted by farmers for decades. The scientific consensus about GM foods is that no credible studies exist showing a correlation between consumption of GM foods and harm to human or animal health (Chassy, 2002; Conner et al., 2003; Delaney, 2015; Flachowsky et al., 2005; Shelton et al., 2002; Funk & Kennedy, 2016). In fact, a study conducted by Pew Research found that a majority of scientists (88%) agreed on the safety of GM foods on human health. However, perceptions of risk regarding GM foods can elicit strong positions among consumers about whether or not to consume food produced using the technology, causing changes in consumer purchasing decisions and in turn, affecting governmental policies without scientific backing (Klerck & Sweeney, 2007). While a majority of scientists find GM food safe, only one-third of the public (37%) surveyed by Pew Research perceived GM foods to be safe (Funk & Kennedy, 2016). Individuals' perception of risk can depend, at least in part, on their individual characteristics, including demographics like gender, ethnicity, age, political ideals, income, and education (Vaughn & Nordenstam, 1991). In addition, consumers' existing level of knowledge, involvement, and support surrounding GM food can influence their perception of risk and their purchasing habits.

A key consumer in today's market are millennials. Millennials, defined as individuals born between 1981 and 1999, account for $65 billion spent each year and influence upward of $1 trillion in total consumer spending (Nielsen, 2017; Barroso et al., 2020) and are more consumption-oriented than other generations (Sullivan & Heitmeyer, 2008). Individuals in this generation each spend more than $4,000 annually on food, and it is anticipated that within the next decade they will become the top influencers for food purchases (Acosta, 2018; Talty, 2016). Due to the spending power and size of the generation, millennials' perceptions of GM food "could have significant ramifications on policy discourse, regulatory climate, and industry responses" (Oz et al., 2018, p. 5). Connecting millennials with accurate information about GM science is critical.

For communication practitioners to be able to effectively communicate with diverse millennial groups about GM science, it is important to identify different millennial publics and determine how they perceive the technology. Strategic communication allows all types of organizations - corporations, non-profits, government, etc. - to engage in purposeful communication with different segments of their audience (Thorson, 2018). Millennials living in the United States have been narrowly defined as a homogenous group by marketers, even though the generation has been shown to be diverse and comprised of distinctive consumer segments that likely require unique forms of marketing planning and communications (Geraci, 2004).

Previous research has examined the level of knowledge that Americans have about GM foods (e.g. Hallman et al., 2016), along with differences in millennials' and non-millennials' perceptions of GM foods (e.g. Oz et al., 2018). However, there is a lack of research involving how diverse segments of millennials in the United States are making decisions about GM food. Through a national survey of millennials, this study segmented respondents based on their level of support for GM food, level of knowledge about GM food, and their level of involvement in

the issues surrounding GM food. Respondents in this study were also segmented by demographic data to make inferences about how and if millennial demographic characteristics influence perceptions towards GM foods.

Review of Literature

Genetically Modified Crops

GM crops and seed varieties have been largely adopted among farmers, which has caused GM science to become the fastest adopted crop technology with more than 18 million farmers using the technology internationally (Fernandez-Cornejo & Caswell, 2006; Jan, 2015; Lucht, 2015). In the United States, the adoption rate of GM varieties of cotton, corn, and soybeans among farmers has exceeded 90% (Lucht, 2015). Typically, the goals of plant breeding with agricultural and horticultural crops have aimed at improving yields, nutritional qualities, and other traits of commercial value (Moose & Mumm, 2008).

GM science has the potential to produce more food with fewer resources, making it possible to feed the global population that is expected to increase from 6.9 billion in 2010 to 9.6 billion in 2050 (Kochhar, 2014; Sands, 2018; Stamm et al., 2011). Increased efficiency and production of the food supply is needed to adequately sustain the expected population (Hofstrand, 2014). GM crop use also benefits farmers through increases in crop yield, decreases in pesticide and herbicide expenses, increased profits, and improvement of the shelf life of fruits and vegetables (Klümper & Qaim, 2014; Zhang et al., 2016). Farmers also cite non-monetary benefits, such as ease of use, saving of time, and more planning flexibility (Brookes & Barfoot, 2014; Carpenter, 2013; Fernandez-Cornejo et al., 2014; Matin, 2009; Qaim, 2009).

The scientific consensus is that the consumption of GM foods has not proven to be harmful to human or animal health (Chassy 2002; Conner et al., 2003; Delaney, 2015; Flachowsky et al., 2005). However, consumers perceive a risk to either themselves or the environment (Santaniello et al., 2001). Despite the extensive debate about GM food, many U.S. consumers have little to no knowledge about the topic (e.g. Hallman et al., 2004; Hallman et al., 2013).

Consumer Knowledge and Perceptions about GM Food (all ages)

In a 2016 study, 55% of surveyed Americans reported “that they know very little or nothing at all” about GM foods, and only 26% of respondents believed they had ever eaten a GM food product (Hallman et al., 2016). Even with little knowledge about the science, most respondents in the same study were willing to express an opinion about GM food. For example, 44% of consumers in the same study said they disapprove of GM animal-sourced food products (Hallman et al., 2016). Results of a GM food messaging study by Ruth and Rumble (2019) found that Florida residents’ views most align with statements that GM foods “have not been adequately investigated” and that GM foods “might be riskier to consume than traditional food” (p. 10). In an article summarizing GM knowledge worldwide, Wunderlich and Gatto (2015) reported findings of low consumer knowledge about GM products (Aleksejeva, 2014; Turker et al., 2013, Jurkiewicz et al., 2014) and GM knowledge varies by country (McGarry et al., 2012).

Influences of Individual Characteristics on Consumer Preferences

Previous studies have examined the effects demographic characteristics have on consumer preferences. Specifically, previous research has found that consumers prefer products that are congruent with their gendered identities (Gal & Wilkie 2010; Neale et al., 2016; Ulrich & Tissier-Desbordes, 2018; Worth et al., 1992), cultural characteristics (Hillman, 1979; Rozin, 1988), and education (Mielby et al., 2013; Cavaliera & Ventura, 2018). For example, researchers found that individuals' education levels influence general dispositions towards innovation in the foods. Specifically, it was found that individuals who had higher scientific-technical backgrounds, than social-humanistic literacy backgrounds, held more positive behavioral intentions towards applying technology to food (Cavaliera & Ventura, 2018).

Researchers have found when examining consumer views and behavior specifically in regard to GM foods, that the perceived risk of consuming GM products is a driving factor (Aleksejava, 2012). Thus, this has led researchers to believe that attitudes and behavior towards GM foods are significantly influenced by demographics such as social and economic characteristics (Aleksejeva, 2012; Amin et al., 2014). Additional studies have examined consumers' level of trust related to GM (Verdurme & Viaene, 2001; Siegrist, et al., 2012; Lang, 2013; Gaskell et al., 2004; Rodriguez-Entrena et al., 2013) as summarized in Oz et al. (2018), including trust related to political values. Political ideology is highlighted in risk literature, specifically within the risk and information processing (RISP) model as an individual characteristic that is likely to influence risk perceptions and communication behaviors. Political ideology is believed to play an important role as political psychology researchers believe it is interconnected to values that play an important role in guiding individuals' personal and social lives (Yang et al., 2018). However, according to Yang et al. (2018), its effects are seldom examined. This need to examine characteristics such as political ideology and other demographic characteristics is echoed in a Ruth and Rumble (2019) study of Florida residents' level of acceptance about GM food messages. The authors conclude this study by recommending future research include GM audience segmentation related to gender, education, income, age, and political affiliation.

Despite previous research efforts, the relationship between examining demographic characteristics holistically (e.g., looking at gender identity, age, education, salary, and political ideology), consumers' attitudes and behavior specifically towards GM foods is still an understudied area (Ye et al., 2017; Ekebas-Turedi et al., 2020). Moreso, examining the effects of specific demographic traits within the millennial generation have on GM foods is examined even less.

Millennial Consumer Preferences and Perceptions of GM Food

Previous research shows that millennials are concerned with where their food comes from and how it is marketed to them (Parment, 2013; Smith & Brower, 2012). As such, millennials also demand the ability to seek knowledge through different methods about their food choices and consumer products (Regine, 2011). Due to this expectation, millennials are perceived as being more knowledgeable than other generations in regards to the environment, are less brand-loyal, and are also more concerned about the environmental and the ethical attributes of products (Reisenwitz & Iyer, 2009; Harris et al., 2011; Zsóka et al., 2013; Cavaliers & Ventura, 2018; Bollani et al., 2019).

Research examining GM foods' perceptions has found that attitudes tend to be unfavorable when examining millennials living in the U.S (Linnhoff et al., 2017). This negative

view is amplified when looking at gender. Specifically, the study found that females tend to be more skeptical of GM foods compared to males. This study also examined six factors affecting millennials' attitudes toward GM food. These six attributions of perceived importance in swaying attitudes, in order of ranking, include perceptions of GM foods being healthy, safe, beneficial to the environment, ethical, and authentic (Linnhoff et al., 2017). However, the researchers found that only the attributions of GM foods being authentic, safe, healthy, and ethical had statistically significant correlations with millennials intentions to purchase GM foods.

Based on previous research findings that show millennials have different perceptions towards consumer products and food choices than previous generations, along with research that demonstrates the impact demographics have on consumer behavior, the current research study set out to examine millennial demographic characteristics that may influence perceptions specifically towards GM foods. By examining the relationship between demographic characteristics of millennials and their perceptions towards GM foods, research studies can reveal richer information for communicators to aid in making reliable decisions when trying to reach this population. Communication practitioners can then use audience segments from research studies to create audience profiles, such as personas, for more effective education and communication outreach (Berry, 2018; Vaughan, 2020).

Theoretical Framework

The conceptual model used in this study is the Situational Theory of Publics (STP). Grunig (1983) found that identifying differences in types of publics could aid in developing more effective and targeted communication efforts. The theory proposes that publics arise based on issues that affect them and can assist communication professionals with determining when, why, and how people seek information; their responsiveness to issues; and how communication impacts cognitions, attitudes, and behavior (Overton, 2018). It has been found that the relationship among the variables in STP may explain how people develop attitudes, cognitions, and behaviors. This can then influence how companies can tailor or personalize messages to appeal to different audiences, such as nonpublics, latent publics, aware publics, and active publics (Overton, 2018). Audience segmentation can be used in communication campaigns where common beliefs, values, and attitudes are shared by smaller groups (Slater, 1996), aiding strategic communication efforts, such as the providing more accessible communication of science-based GM food news (Dibb, 1999; Lee & Ho, 2018). Targeted communication efforts can encourage behavioral change (Kotler et al., 2002), which is why STP (Grunig, 1983) is especially relevant in risk and crisis communication.

Grunig (1983) identified four different types of publics: nonpublics, latent publics, aware publics, and active publics (Table 1). Nonpublics have no exposure to the specific issue or problem, while latent publics are exposed to the issue but do not recognize it as an issue. Aware publics recognize that an issue or problem exists but do not take action, while active publics recognize the issue or problem and take responsive action. An individual's level of issue involvement, problem recognition, and constraint recognition are what determine the specific public in which an individual is categorized (Grunig, 1983).

Table 1
Grunig's Categorization of Publics with Behavior Predictions

	High Involvement	Low Involvement
High Problem Recognition/Low Constraint Recognition	Active Publics *(Aware of issue and take action)*	Active/Aware Publics *(Aware of issue, but may or may not take action)*
High Problem Recognition/High Constraint Recognition	Aware/Active Publics *(Aware of issue, but may or may not take action)*	Latent/Aware Publics *(Exposed to issue, but may or may not recognize it)*
Low Problem Recognition/Low Constraint Recognition	Active Publics *(Aware of issue and take action)*	Latent Publics *(Exposed to issue, but do not recognize it)*
Low Problem Recognition/High Constraint Recognition	Latent Publics *(Exposed to issue, but do not recognize it)*	Nonpublics *(No exposure to issue)*

Issue involvement is how personally connected people are to a problem, while problem recognition requires a person to be aware of a problem or issue that is affecting them. Constraint recognition is an individual's perception of their ability or lack of ability to do something about the problem or issue. Individuals who are high in issue involvement and issue recognition but low in constraint recognition for an issue or problem are categorized as active publics. Conversely, those who perceive high constraint recognition and low problem recognition and issue involvement are considered non-publics (Rawlins, 2006). Different communication strategies should be implemented for different publics (Rawlins, 2006). Communication should be behavior-oriented and include a call to action for active publics. Active publics will likely take action, such as providing endorsements, making donations, or writing letters, and are considered to be advocate stakeholders. Stakeholders who have a lack of knowledge or personal connection with the issue are considered to be dormant stakeholders in the aware publics. Communication strategies for the aware public should focus on increasing personal relevance and/or knowledge.

Finally, apathetic publics are simply not aware that an issue exists and fit into the latent public category. Communication efforts with this segment should focus on increasing the saliency of the issue and inviting members to become more involved in addressing the issue (Rawlins, 2006). Hallahan (2000) expanded on STP by exploring the role of inactive publics in public relations strategies by splitting them out of latent public to create two new groups - inactive and aroused, arguing that they are most often overlooked or forgotten. Specifically, Hallahan (2000) explored how issues involvement and knowledge predict consumers' responses to communication. Active publics have high issue involvement, high knowledge levels, try to influence change, and tend to initiate conversations with organizations about issues (Hallahan, 2000) (Table 2). Communication strategies with active publics should address leaders of the public segment and encourage open dialogue. Aware publics have low involvement, high knowledge, and subsequently are unlikely to communicate about the issue or problem unless they would personally benefit from the communication. Depending on the issue, communication

strategies targeted toward the aware group should encourage or discourage them to act as influencers and actively supply them with more information on the issue or problem (Hallahan, 2000).

Table 2
Hallahan's Categorization of Publics with Behavior Predictions

	Low Involvement	High Involvement
High Knowledge	Aware Publics *(Unlikely to communicate about issue unless personal benefit)*	Active Publics *(Tries to influence change regarding issue)*
Low Knowledge	Inactive Publics *(Unlikely to seek information on issue unless personal benefit)*	Aroused Publics *(Familiar to issue and seeks information)*

The aroused public is characterized by moderate/high issue involvement and low knowledge. This group has some familiarity with the issue or problem and will seek information to reduce their risk perceptions. Hallahan (2000) recommended communication researchers examine the source of this group's arousal, and communication strategies should frame messages related to the public's concern of the issue. People labeled as inactive public were characterized by low knowledge and low issue involvement. Outside of their personal needs or without being prompted, inactive publics are unlikely to seek information on an issue (Hallahan, 2000). Therefore, proactive communication strategies focused on providing information work best for this public. Organizations also can build positive relationships with inactive publics by motivating them to learn more about an issue and to increase their knowledge of the topic. Organizations have to actively investigate ways to facilitate communication opportunities with inactive publics and enhance this public's motivation to process the information (Hallahan, 2000).

Overton (2018) examined the influence of STP within the context of environmental corporate social responsibility (CSR) communication on information seeking and processing. Findings from this study indicated that individuals that fall under public categories that seek information are impacted differently than those who simply process information that may be presented to them. This finding is significant as it provides both researchers and practitioners guidance regarding differences in behavioral intention between the types of publics (Overton, 2018). In addition, it confirmed the applicability of the theoretical framework when applying it to polarizing topics such as environmental issues.

Chen (2019) applied STP to consumer activism within a similar vein of looking at polarizing topics. Within this study, Chen hypothesized that consumers are more likely to act on political stance versus economic reasons, expanding upon previous segmentation practices used with STP. A key finding from this study is that economic capital is an important predictive power in grouping publics, more so than inferred concepts typically examined via STP. Specifically, Chen reported that individuals that fall within the active publics category may be able to do so due to being within the middle-class and having more time to be involved in activities outside of economic well-being (Chen, 2019). Chen claimed this leads the active middle class publics to partake in behaviors such as information-seeking and processing, along with spreading boycott messaging. However, it should be noted that the notion of being an active public does not always correlate with having a higher income. Within this same study, it was

found that individuals who fall under the upper, elite class may be less likely to be vocal about politically fraught issues (i.e., participate in boycotts) due to being better educated. This finding challenges previous STP assumptions regarding constraint and problem recognition, along with involvement.

Recent studies such as those from Overton (2018) and Chen (2019) point to the need to continue to examine how demographic characteristics can influence STP segmentation for polarizing topics (i.e., GM food consumption). As such, the research questions in the current study expand upon the work completed in previous research using STP by applying it specifically to the categorization of millennials into groups based not only on their level of support, issue involvement, and levels of knowledge related to GM foods, but also by demographic characteristics.

Research Objective

The purpose of this study was to identify differing perceptions of GM foods among millennials with respect to audience segmentation and demographic data. Results are intended to help communicators understand and reach varying segments of millennials. Much research has been done to examine consumer attitudes toward GM food and GM technology in general, but little has been done to examine what knowledge millennial consumers have and how they perceive the technology. Risk scholars have recognized the importance of public type categorizations to explain how and why individuals seek and use information or avoid it (e.g., McComas, 1998; Xifra, 2016; Overton, 2018; Chen, 2019). By providing insight into millennial characteristics in regards to where they align in the situational theory of publics, this research can help further risk communication research and improve the understanding of how communication practitioners can reach millennials when discussing GM foods.

RQ1: What proportion of millennial consumers fall into each of the eight public groupings (supportive inactive, aware, aroused, active and non-supportive inactive, aware, aroused, active)?

RQ2: What are the demographics of millennials (gender, age, ethnicity, political ideology, education, income) within the eight examined publics (supportive inactive, aware, aroused, active and non-supportive inactive, aware, aroused, active)?

Methods

To address the study's research questions, an online survey was administered through Qualtrics. Non-probability quota sampling was used to target millennials aged 18-41 living in the United States. A total of 525 participants, who were recruited through a paid Qualtrics panel, received a survey with 47 items that was reviewed by a panel of experts for face and content validity. Cronbach's alpha was used to analyze the dataset for survey reliability and internal consistency of items (Tavakol & Dennick, 2011). Each of the individual scales used to compute the publics categories, including level of support, issue involvement and perceived knowledge, were above the recommended minimum level of .70 for reliability (Tavakol & Dennick, 2011).

In addition, to help ensure participants were fully paying attention to the questions and to prevent straightlining, two attention filter questions were reverse coded. After removing respondents from the sample who either failed the attention checks or did not complete the survey, the final analysis included a response rate of 73.5% with 386 usable responses. Because

this is a non-probabilistic, opt-in sample, it is considered a descriptive study; although results cannot be applied to the entire United States millennial population, results can be used to inform communication and outreach campaigns regarding GM food.

Procedure

Respondents were sorted into one of eight public groups based on their level of support, level of issue involvement, and level of knowledge related to GM foods. The eight public groups follow Hallahan's (2000) typology: non-supportive inactive, non-supportive aware, non-supportive aroused, non-supportive active, supportive inactive, supportive aware, supportive aroused, and supportive active. Level of support was measured with an eight-item, five-point bipolar semantic differential scale. Statements included "Genetically modified food is:" Good/Bad, Positive/Negative, Beneficial/Not Beneficial, Acceptable/Not Acceptable, Necessary/Unnecessary, Important/Unimportant, Essential/Not Essential, and Crucial/Trivial. Positive statements were coded as a "1," and negative statements were coded as a "5". An index was created by summating each item and calculating the average. A dichotomous variable was then created by coding respondents as supportive if their mean on the index was equal to or less than 2.49. Respondents were coded as non-supportive if their index mean was equal to or higher than 2.5.

Issue involvement was measured with a four-item, five-point bipolar semantic differential scale. Statements included: 1) "I am very concerned about genetically modified food," 2) "I am not at all concerned about genetically modified food," 3) "I am bothered by genetically modified food," and 4) "I am not bothered by genetically modified food." Positive statements were coded as "5," and negative statements were coded as "1". An index was created by summating each item and calculating the average. A dichotomous variable for issue involvement was then created. Respondents were coded as high issue involvement if their mean on the index was equal to or higher than the average for the sample ($M = 3.22$, $SD = 1.26$). Respondents were coded as low issue involvement if their index was below the mean.

Perceived knowledge was assessed by asking respondents five questions: asking if some GM crops have been modified for increased herbicide resistance; if GM food can be sold as organic; if the USDA has deemed GM food as safe to eat; if plants or animals whose cells have been inserted with a gene from an unrelated species is considered GM; and from the list provided, which food crop does not have a GM variety available for human consumption within the United States. A count variable was created for the perceived knowledge construct, and each correct answer counted as one point. The scale ranged from zero (low knowledge) to five (high knowledge). If respondents answered four or five questions correctly, they were coded as having perceived high knowledge. Perceived low knowledge included respondents answering between zero and three questions correctly.

Publics categories were coded depending on respondents' level of support, followed by issue involvement and knowledge. Once divided based on the level of support, those with low issue involvement and low knowledge were coded as Inactive publics; respondents with low issue involvement and high knowledge were coded as aware publics; respondents with high issue involvement and low knowledge were coded as aroused publics; and respondents with high knowledge and high issue involvement were coded as active publics (Hallahan, 2000).

Respondents were asked demographic and sociocultural questions including gender, age, ethnicity, political ideology, education, and income. These characteristics were then broken into the eight different public groupings.

Results

Research Question 1: What proportion of millennial consumers fall into each of the eight public groupings (supportive inactive, aware, aroused, active and non-supportive inactive, aware, aroused, active)?

Based on answers to questions about level of support for GM food, issue involvement related to GM food, and level of knowledge of GM food, the proportion of respondents in each of the eight public groupings is displayed in Table 3. Over three-fourths (77.2%) of respondents were in the non-supportive category, with nearly half non-supportive with high issue involvement. Less than one-fourth (22.8%) of respondents were in the supportive category, and less than 3% of all respondents were supportive with high issue involvement. Lastly, 56.2% of all respondents had low knowledge of GM food regardless of their level of support or level of issue involvement.

Table 3

Breakdown of Respondents into Public Groupings

Group	*n*	%
Non-supportive (*n* = 298)		
Inactive (Low Issue Involvement/Low Knowledge)	62	16.1
Aware (Low Issue Involvement/High Knowledge)	49	12.7
Aroused (High Issue Involvement/Low Knowledge)	99	25.6
Active (High Issue Involvement/High Knowledge)	88	22.8
Supportive (*n* = 88)		
Inactive (Low Issue Involvement/Low Knowledge)	51	13.2
Aware (Low Issue Involvement/High Knowledge)	29	7.5
Aroused (High Issue Involvement/Low Knowledge)	5	1.3
Active (High Issue Involvement/High Knowledge)	3	0.8

Research Question 2: What are the demographics of millennials (gender, age, ethnicity, political ideology, education, income) within the eight examined publics (supportive inactive, aware, aroused, active and non-supportive inactive, aware, aroused, active)?

Gender

Respondents were asked what gender they most readily identified as: male (*n* = 174, 45.1%), female (*n* = 206, 53.4%), and other (*n* = 6, 1.5%) (Table 4). The largest groups of respondents in three of the four non-supportive public groups (inactive, aroused, and active) were female. The largest groups of respondents in three of the four supportive public groups were male. Male and female respondents in the supportive aware category were equal (*n* = 14).

Table 4
Gender Frequencies by Public Grouping

	Inactive *n (%)*	Aware *n (%)*	Aroused *n (%)*	Active *n (%)*
Non-supportive				
Male	28 (45.2)	27 (55.1)	36 (36.4)	30 (34.1)
Female	33 (53.2)	22 (44.9)	63 (63.6)	56 (63.6)
Other	1 (1.6)	-	-	2 (2.3)
Supportive				
Male	32 (62.7)	14 (48.3)	4 (80.0)	3 (100.0)
Female	17 (33.3)	14 (48.3)	1 (20.0)	-
Other	2 (3.9)	1 (3.4)	-	-

Age

No notable differences were identified in the age of respondents in relationship to public groups (Table 5). Because analyzed respondents were ages 18-36, no notable differences in age were expected.

Table 5
Age of Respondents by Public Group

Public Groups	Non-supportive				Supportive			
	n	Min	Max	Mean	*n*	Min	Max	Mean
Inactive	62	18	35	26.9	51	18	35	26.3
Aware	49	19	35	27.8	29	22	35	28.5
Aroused	99	18	36	27.2	5	19	34	24.4
Active	88	18	36	27.4	3	22	34	28.3

Ethnicity

Respondents were asked to identify the ethnicity(s) that best described them (Table 6). The majority of respondents in all eight groups were Caucasian. The most common public grouping for participants who selected Caucasian was non-supportive aroused (n = 63), followed by non-supportive active (n = 57). The most common public grouping for participants who selected African American were non-supportive aroused (n = 15). The two most common public groupings for participants who selected Hispanic/Latino were a tie between non-supportive aroused (n = 21) and non-supportive active (n = 21).

Table 6
Respondent Ethnicity by Public Grouping

	Inactive *n (%)*	Aware *n (%)*	Aroused *n (%)*	Active *n (%)*
Non-supportive				
Caucasian	44 (71.0)	36 (73.5)	63 (63.6)	57 (64.8)
Caucasian/Asian	1 (1.6)	-	-	
Caucasian/African American				1 (1.1)
African American	7 (11.3)	6 (12.2)	15 (15.2)	8 (9.1)
Asian	1 (1.6)	-	-	1 (1.1)
Hispanic/Latino	9 (14.5)	7 (14.3)	21 (21.2)	21 (23.9)
Supportive				
Caucasian	35 (68.6)	23 (79.3)	3 (60.0)	3 (100.0)
Caucasian/Asian	1 (2.0)	-	-	
Caucasian/Native American/ Pacific Islander	-	-	1 (20.0)	-
African American	4 (7.8)	-	1 (20.0)	-
Asian		-	-	-
Hispanic/Latino	11 (21.6)	6 (20.7)	-	-

† *Note: Due to no participants identifying with "other," it was omitted from table*

Political Ideology

The political affiliation with the largest number of respondents (*n* = 154, 39.8%) was liberal (Table 7). The largest percentage of respondents who classified themselves as liberal were those in the non-supportive aroused grouping (*n* = 40, 26%). The smallest percentage of respondents who classified themselves as liberal were those in the supportive aroused (*n* = 3, 1.9%) and supportive active (*n* = 1, 0.6%) groupings. The political affiliation with the second largest number of respondents (*n* = 134) was conservative. The largest percentage of respondents who classified themselves as conservative were those in the non-supportive active grouping (*n* = 36, 40.9%).

Table 7
Political Affiliation by Public Grouping

Public Groups	*n*	Liberal *n (%)*	Conservative *n (%)*	Libertarian *n (%)*	Green Party *n (%)*	Other *n (%)*
Non-supportive						
Inactive	62	23 (37.1)	25 (40.3)	4 (6.5)	1 (1.6)	9 (14.5)
Aware	49	22 (44.9)	14 (28.6)	4 (8.1)	-	9 (18.4)
Aroused	99	40 (40.4)	26 (26.3)	2 (2.0)	4 (4.0)	27 (27.3)
Active	88	30 (34.1)	36 (40.9)	6 (6.8)	3 (3.4)	13 (14.8)
Supportive						
Inactive	51	21 (41.2)	18 (35.3)	4 (7.8)	2 (3.9))	6 (11.8)
Aware	29	14 (48.3)	11 (37.9)	3 (10.3)	-	1 (3.4)
Aroused	5	3 (60.0)	2 (40.0)	-	-	-
Active	3	1 (33.3)	2 (66.7)	-	-	-

Education

Respondents were asked to provide their highest level of education (Table 8). The majority of respondents to the survey had at least a high school education or equivalent, with the highest level of respondents (n = 119, 30.8%) reporting they had received some college education, but no degree. Of the respondents with some college education but no degree, non-supportive aroused and non-supportive active were the most frequent publics groupings, both at n = 30 (25%). Respondents with some college also had the highest grouping of non-supportive inactive (n = 24, 20.2%). The least reported education level was for the respondents with less than 12th-grade education (n = 10, 2.6%).

Table 8

Highest Level of Education Achieved by Public Grouping

Public Groups	*n*	Less than 12th grade *n (%)*	High school graduate *n (%)*	Some college, no degree *n (%)*	2-year college degree *n (%)*	4-year college degree *n (%)*	Graduate or Professional Degree *n (%)*
Non-supportive							
Inactive	62	3 (4.8)	13 (21.0)	24 (38.7)	3 (4.8)	15 (24.2)	4 (6.5)
Aware	49	1 (2.0)	11 (22.4)	14 (28.6)	8 (16.3)	14 (28.6)	1 (2.0)
Aroused	99	5 (5.1)	27 (27.3)	30 (30.3)	13 (13.1)	20 (20.2)	4 (4.0)
Active	88	-	20 (22.7)	30 (34.1)	13 (14.8)	22 (25.0)	3 (3.4)
Supportive							
Inactive	51	1 (2.0)	13 (25.5)	12 (23.5)	5 (9.8)	16 (31.4)	4 (7.8)
Aware	29	-	4 (13.8)	7 (24.1)	4 (13.8)	10 (34.5)	4 (13.8)
Aroused	5	-	1 (20.0)	2 (40.0)	1 (20.0)	1 (20.0)	-
Active	3	-	-	-	1 (33.3)	2 (66.7)	-

Income

Respondents were asked to provide their income (Table 9). Income was reported in $25,000 intervals, starting at $25,000 or less and going to $250,000 or more. The largest percentage of respondents were in the income range $25,000 to $49,999 (*n* = 112, 29%). The largest category of responses by level of income is non-supportive aroused (35, 35.4%), and more than half (216, 55.8%) of all respondents in the study are in the non-supportive categories with incomes under $74,999. Of the respondents making $100,000 or more, 69% of them were in non-supportive groupings.

Table 9

Income of Respondents by Public Grouping

	Non-supportive *n (%)*				Supportive *n (%)*			
	Inactive *(n = 62)*	Aware *(n = 49)*	Aroused *(n = 99)*	Active *(n = 88)*	Inactive *(n = 51)*	Aware *(n = 29)*	Aroused *(n = 5)*	Active *(n = 3)*
Less than $25,000	13 (21.0)	6 (12.2)	19 (19.2)	14 (15.9)	9 (17.6)	3 (10.3)	-	-
$25,000 to $49,999	16 (25.8)	15 (30.6)	35 (35.4)	29 (33.0)	9 (17.6)	6 (20.7)	2 (40.0)	-
$50,000 to $74,999	10 (16.1)	11 (22.5)	20 (20.2)	28 (31.8)	9 (17.6)	8 (27.6)	2 (40.0)	-
$75,000 to $99,999	15 (24.2)	6 (12.3)	14 (14.1)	9 (10.2)	12 (23.5)	8 (27.6)	-	3 (100.0)
$100,000 to $124,999	2 (3.2)	5 (10.2)	5 (5.1)	4 (4.5)	7 (13.7)	1 (3.4)	-	-
$125,000 to $149,999	2 (3.2)	2 (4.1)	3 (3.0)	3 (3.4)	3 (5.9)	2 (6.9)	-	-
$150,000 to $174,999	1 (1.6)	1 (2.0)	1 (1.0)	1 (1.1)	1 (2.0)	1 (3.4)	-	-
$175,000 to $199,999	2 (3.2)	-	2 (2.0)	-	1 (2.0)	-	-	-
$200,000 to $224,999	1 (1.6)	1 (2.0)	-	-	-	-	-	-
$250,000 or more	-	2 (4.1)	-	-	-	-	1 (20.0)	-

Note: there were no respondents in the $225,000 to $249,999 income category

Discussion

Reaching diverse millennial publics with scientific education and outreach and idnetifying their acceptance or hesitancy towards GM technology is essential considering the size of their population group, purchasing power, and social influence (Jang et al., 2011; Sullivan et al., 2008; Taylor & Cosenza, 2002). The purpose of this study was to identify differing perceptions of GM foods among millennials with respect to audience segmentation and demographic data. Identifying publics can assist in determining when, why, and how people seek information; their potential responsiveness; and the effect it may have on outcomes such as attitude and behaviors. Although this study cannot be generalized to the entire population of millennials, the results of this study can be used to help education and outreach practitioners better strategize communication efforts about GM foods with different millennial public groups.

Publics

Respondents could be sorted into eight different publics, based on their level of support of GM foods, level of issue involvement, and level of knowledge of GM food: non-supportive inactive, non-supportive aware, non-supportive aroused, non-supportive active, supportive inactive, supportive aware, supportive aroused, and supportive active. More than three-fourths (77.2%) of respondents (n = 298) were in the non-supportive categories, and 22.8% (n = 88) were in the supportive categories. More than half (56.1%) of respondents had low knowledge of GM food, which aligns with previous studies of both American and worldwide consumers' level of knowledge (e.g. Hallman et al., 2016; Wunderlich & Gatto, 2015).

Non-supportive Publics

The majority of respondents were in the non-supportive active (high issue involvement and high knowledge of GM foods) and non-supportive aroused (high issue involvement and low knowledge of GM foods) categories. Communication practitioners may have difficulty when communicating with and attempting to sway non-supportive active publics because, while they are more likely to seek out information and less likely to avoid information, their opinions are less likely to change than other publics. Findings from previous studies suggest that when communicating with the non-supportive active public, communication practitioners should focus on addressing opinion leaders of the public segment and encourage open dialogue about concerns or issues regarding GM foods (Hallahan, 2001). To reach the non-supportive aroused public, practitioners should work to identify the source of arousal and frame messages related to their concerns (Hallahan, 2000) because those resistant toward topics have been found to think more emotionally in terms of their food choices.

Supportive Publics

Eighty out of the 88 supportive respondents had low issue involvement (the supportive inactive and supportive aware public groups). Communication practitioners can increase some of these individuals' involvement in the issue by trying to make the issue of GM food important and personally relevant. For the supportive inactive public, communication practitioners should be proactive in communicating with this public and provide motivation for them to increase their

knowledge about GM food (Hallahan, 2000). Communication practitioners should encourage members of the supportive aware public to act as influencers and supply them with additional information (Hallahan, 2000). For example, providing individuals of this public with messages and information about the benefits of GM technology to farmers, consumers, and the environment could be of benefit. However, practitioners should be careful not to overwhelm them with information and unintentionally increase opposition for the technology.

Gender

The majority of respondents in three of the four non-supportive public groups were female. The majority of respondents in three of the four supportive public groups were male. Findings align with previous research that men generally have more positive attitudes towards GM science than women (Moerbeek & Casimir, 2005). This may be because women take on the traditional role of grocery shoppers, have more control over what children in family units eat, and may be more concerned about what their children eat than their male counterparts (Moerbeek & Casimir, 2005). Females may also be more health conscious and more concerned about the perceived risks of GM food. Additionally, women have been found to be more risk-averse than men, and this may also influence their greater aversion to GM food (Baker & Burnham, 2001; Gregory & Thomas, 2001; Maxfield et al., 2010).

Age

Age is a common factor to study related to differences in perceptions. Since the study was limited to millennials, the finding of no significant difference for age within respondents was not surprising. Perhaps significant differences in age among publics may be found if future research looked at different groups or a broader age range, as older individuals have been found to be less risk tolerant than younger generations (Ellis & Tucker, 2009).

Ethnicity

The largest number of respondents self-identified as Caucasian, African American, or Hispanic/Latino, and the majority in each group were non-supportive active or non-supportive aroused. Previous research has found that some science-related topics elicit wide differences of opinion across racial and ethnic groups (Funk & Lee, 2015). However, a meta-analysis looking at 193 different surveys regarding attitude and knowledge towards science technology found that findings interpreted as cultural variation can be accounted for mainly by variation in the relative proportion of individuals with particular attributes rather than “culture” per se (Allum et al., 2008). Comparing public groupings in regard to GM foods symmetrically across different countries, versus only in the United States, may provide communicators with a better idea of cross-cultural differences. Within the United States, Pew Research reports a significant gap in access to information and knowledge about scientific concepts along racial and ethnic lines (2015). This could cause an interrelated issue with how knowledge of scientific issues impacts attitudes towards GM foods.

Political Ideology

Past research indicates that roughly half of millennials do not identify as liberal or conservative but have voted heavily liberal in the 2008 and 2012 U.S. presidential elections. Additionally, millennials are the only generation in which liberals are not significantly outnumbered by conservatives (Pew Research Center, 2014). In general, conservative Republicans have been found to be more supportive of GM food than liberals (Costa-Font et al., 2008). However, the findings of this study do not support that, as higher numbers of non-supportive respondents are in both the conservative and liberal categories. As more millennials become more politically active, this could point to a shift in traditional political groupings when it comes to GM science.

Education

The lack of differences in the level of education findings in this study align with what was found in a meta-analysis looking at how knowledge impacts attitudes towards GM foods (Allum et al., 2008). Allum et al. found that overall levels of education do not correlate with positive attitudes towards GM foods (2008). However, the more an individual knows directly related to science technology, specifically biology and genetics, the more accepting they are towards the matter (Allum et al., 2008; Funk & Lee, 2015; Cavaliere & Ventura, 2018). Future research should examine not only general education levels, but perhaps look directly at the level of science courses taken, or at what point in time and where knowledge towards GM foods was received.

Income

In all eight public groups, the income level of the majority of respondents was $75,000 or less. Some studies have shown that low-income individuals are less hostile to GM food (Baker & Burnham, 2001; Funk & Kennedy, 2016). However, others have found no correlation between income level and support of GM food (Antonopoulou et al., 2009). This study found that generally, lower salaries were more broadly distributed across public groups, regardless of supportiveness or non-supportiveness. Based on findings from this study, communication practitioners should focus on increasing the GM science knowledge of wealthier supportive publics. However, because income can rise with age and experience, this study is limited related to income as it only studied 18-36-year olds. Overall, more research is needed to compare level of income and level of support for GM food.

Practical Implications

This study aligns with previous research findings that many American consumers, global consumers, and millennials have a general lack of knowledge about GM food, and that despite that lack of knowledge, consumers form attitudes towards the technology. A summary article of consumer knowledge of GM food states that consumers "are dissatisfied with their self-rated knowledge, indicating a desire and a need for widespread consumer education" (Wunderlich & Gatto, 2015, p. 849). This perceived knowledge gap aligns with the documented need for an

increase of educational materials regarding biotechnology, such as GM foods, that are well organized and accurate (Wunderlich & Gatto, 2015).

Research such as this current endeavor helps provide a snapshot of where millennial audiences in the U.S. stand on the issue. Knowledge of audience segments can then be used by groups such as food industry leaders, science communicators, and food marketing agencies to determine what strategies should be used when communicating about GM foods. For example, this study found that the largest majority of millennials surveyed (25.6%) fell within the non-supportive aroused publics. Future research could be conducted to determine whether this level of support is generalizable across the millennial generation. If so, communication practitioners can execute strategies that focus on framing messages regarding GM foods that target specific emotional connections. This strategy would be guided by the STP framework as it has been found that non-supportive aroused publics think more emotionally about topics.

Even more, studies segmenting both STP and demographic information can aid communication practitioners in creating persona profiles that guide strategic communication efforts. Persona profiles are commonly used within the industry to help develop snapshots of who is being communicated with, along with what their needs and potential behaviors are (Berry, 2018; Vaughan, 2020). These profiles typically contain external information (e.g., age, gender, employment, income), along with internal information (e.g., motives, attitudes, behavioral intentions).

The current study provides a clearer profile of millennials by STP segmentation of publics through their perceptions of GM foods. Literature within the STP domain has a long history of showing that having an understanding of what publics a consumer falls into allows communication practitioners to target communication efforts more efficiently. This includes developing and improving strategies for communicating about biotechnology, as called for by Wunderlich and Gatto (2015). The results and discussion provided in this manuscript offers suggestions on how practitioners tasked with educating or communicating with the general public should attempt to engage with different millennial publics, depending on their level of interest in GM foods and how they seek out information about GM foods. This is important as previous literature shows that attitudes about GM food products influence consumers' purchase intentions, along with their perception of benefits and risks (Oz et al., 2017).

Limitations and Future Research

The limitations associated with this study are similar to those of all self-report online surveys. This was a non-probabilistic sample, so significant differences were not calculated because results of this study cannot be applied to the entire U.S. population of millennials. Since survey responses were collected through Qualtrics, survey responses were forced, and fatigue may have played a role in response collection. This may have manifested itself in the form of survey respondents randomly answering or straightlining, which led to the 26.5% responses that were pulled from the survey.

As previously discussed, specific education in regards to biology and genetics has been shown to correlate with attitudes towards science technology, such as GM foods (Allum et al., 2008; Pew Research Center, 2016). While knowledge of GM foods was captured and used to segment individuals into public groupings, it is unclear where their knowledge originated. It has been found that general education categories are not always an accurate indication of such knowledge (Allum et al., 2008). Having a more in-depth understanding of where scientific

knowledge originates from could help communicators in understanding how level of knowledge impacts public groupings.

Future research should focus on exploring the possible relationship between the respondents' level of issue involvement with the type of risk respondents associate with GM food (risk to self, other, the environment). Additionally, future research should search for correlation between the level of support and systematic and heuristic processing to see if non-supportive publics are processing information about the technology more analytically or more emotionally. This research could help practitioners better strategize communication efforts with non-supportive publics to increase their understanding and support for the technology. Lastly, it is recommended that future research examine the motivational triggers for inactive publics and the source of arousal for non-supportive aroused publics.

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