The Effect of Infographics on Recall of Information about Genetically Modified Foods

by

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ABSTRACT

Agricultural literacy levels are decreasing during a time of great technological growth in the agriculture industry. Many complex ideas, such as genetically modified foods, are gaining public interest while leading to confusion. The role of agricultural literacy campaigns is to be an educational source for those seeking truthful information about such subjects. Although multiple campaigns exist, society as a whole seems to be struggling with grasping topics like genetic modification. When trying to learn such subjects, a leaner's cognitive resources can be overwhelmed, thus hindering the learning process. The inclusion of visual aids can prevent this from occurring. The purpose of this research was to perform an experiment that tested the use of infographics to communicate the dense topic of genetic modification, in hopes of increasing the amount of information viewers can retain and recall by decreasing the cognitive effort on behalf of viewers.

To explore this, 61 undergraduate students were exposed to one of two randomly assigned stimuli. Both stimuli contained the same information about genetically modified foods, but one was presented in the form of an infographic, while the other was a purely textual narrative. Participants were tested in a variety of ways on their ability to recall information. Thirty-four of these participants took part in a delayed survey a week after stimuli exposure to again test recall and retention of the information they viewed.

No significant difference was found in retention and recall rates when using an infographic versus a narrative to communicate a complex topic, but the participants exposed to the infographic had similar or slightly higher recall scores than those who viewed the narrative. Therefore, this study supports the use of infographics as educational materials that can in fact be used in place of traditional curriculum methods. This study

also contains many implications for future research in the area of visual communications in agricultural literacy.

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CHAPTER I

INTRODUCTION

Background and Setting

In 2017, the Innovation Center for U.S. Dairy surveyed 1,000 people to ask if they knew where chocolate milk came from (Dairy Good, 2017). Almost half of the respondents replied they were not quite sure where chocolate milk came from, while 7% of respondents said they believed chocolate milk came from brown cows. A similar study performed by Asda (a retail grocery company) surveyed children and their basic knowledge of where food comes from (Frawley, 2016). Of the 1,000 children in the study, 41% did not know eggs come from chickens, 20% believed avocados are laid by animals, and 15% thought cucumbers are produced by trees. Oklahoma State University conducts a monthly survey about various topics within the realm of food safety and quality. One of these surveys in 2015 asked participants if they thought it should be mandatory to label food that contained DNA (Lusk, 2015). Eighty percent of the 1,000 people surveyed agreed food containing DNA should be labeled (Food Demand Survey, 2015). Recently, the University of Michigan conducted a nationally-representative Food Literacy and Engagement Poll and concluded one third of Americans were unaware foods with no genetic modification still contain genes (Michigan State University, 2017). These studies illustrate the need for more robust agricultural literacy efforts.

With the increasing amount of new innovations within plant biotechnology, genetically modified organisms (GMOs) have become a polarizing topic the public lacks knowledge of, as illustrated by the University of Michigan poll. GMOs are the result of modification made to the DNA of plants or animals through genetic engineering (United

Stated Department of Agriculture, 2018). In spite of increasing genetically modified crop production over the past two decades, the majority of Americans say they have insufficient knowledge about genetically modified (GM) foods (Funk & Kennedy, 2016). GMOs are fervently contested by many and the public remains divided on the subject, despite increasing scientific discovery on the subject (Kuntz, 2014). Consequently, the deficit of literacy on subjects like GMOs leads to mistrust of the products and those who grow them. The public perceives GMOs as having the potential to put human health at risk (Nunez, Kovaleski, Casamali, & Darnell, 2016). According to Kuntz (2014), multiple reasons exist that lead individuals to reject GMOs including religious beliefs, unnaturalness and threat to the environment, and public exclusion from the scientific discussions about GMOs and their inclusion in the world market. The mistrust the public feels toward GMOs and the controversy surrounding the complex subject make the issue important to educate others about. It is for these reasons GMOs were selected to be the topic of the information participants were learning about in the current study.

Typically, young adults, including those attending college, tend to be the largest segment of the population that feels the most negatively about GMOs. In a Pew Research Center survey (Funk & Kennedy, 2016), young adults in the age group of 18-29 held the strongest opinions that foods containing genetically modified ingredients were worse for health. Within this same study, the percentage of adults who followed news about GMOs was measured. More than half (65%) of respondents replied they did not follow news about GMOs too closely, or at all. So, while the public shows obvious apprehension about GMOs, they are not taking the time to educate themselves about the subject.

In general, the public is deficient in their knowledge about agriculture and natural resources and lacks feelings of personal relevancy toward those industries. This has created a need for effective message construction from agricultural and natural resources groups (Settle, Rumble, McCarty, & Ruth, 2017). While there are many methods and media through which agriculturists can convey information, the incorporation of visual communications is increasing in many aspects of society. However, there is a shortage of research performed in the general area of visual communications (Kenney, 2009). Specifically in agricultural education, Pennington, Calico, Edgar, Edgar, and Johnson (2015) called for an expansion of visual communications use in the discipline and additional research on the impact visual communications has on agricultural education efforts.

Agricultural Literacy

Two percent of Americans live on farms (American Farm Bureau Federation, 2018), while the rest are partially or completely removed from the agriculture industry. These individuals base their opinions on past life experiences, which does not necessarily allow them to form an accurate perception of agriculture (Duncan & Broyles, 2006). “The non-agriculture population has little to no understanding of the complexities involved with sustaining a viable agriculture system” (Doerfert, 2011, p. 8).

The global population continues to grow and is projected to reach 9 billion people by the year 2050 (Godfray et al., 2010). Therefore, an impending need exists for all citizens to be well-informed about the food and fiber industry (Lewis, 2010). According to Frick et al. (1991), the United States lacks individuals who can look at the issues facing agriculture holistically and adeptly propose a course of action to solve these problems in a way that will benefit our society. "If U.S. agriculture is going to continue to meet the needs of the U.S. population and address growing global needs, agriculture needs to be understood and valued by all" (Spielmaker & Leising, 2013, p. 1). To gain this understanding of agricultural concepts, literacy in the subject of agriculture must be improved.

According to Powell, Agnew, and Trexler (2008), agricultural literacy revolves around the ability to "think critically and make value judgments about the impact of agriculture as an economic and environmental activity and the concurrent societal and political pressures that result from those judgments" (p. 86). They also noted an agriculturally literate person should be able to analyze and evaluate "trade-offs" to individuals and society stemming from agricultural initiatives (Powell et al., 2008). Kovar and Ball (2013) concluded people who possess agricultural literacy are able to see past sentimental appeals and make educated assessments of these issues.

It was not until the 1980s that the term agricultural literacy was coined and defined. The first to provide a definition was the National Research Council in 1988 in its report titled *Understanding Agriculture: New Directions for Education*. In this document, the council stated "an agriculturally literate person would understand the food and fiber system, and this would include its history and its current economic, social and environmental significance to all Americans" (National Research Council, 1988, p. 8). Frick, Kahler, and Miller (1991) later defined agricultural literacy as "possessing knowledge and understanding of our food and fiber system" (p. 6). One of the most recent definitions comes from the National Agriculture in the Classroom's (2013) Agricultural Literacy Model, which said an individual possessing agricultural literacy not only understands the value of agriculture, but also communicates about the significance of the industry.

According to Vidgen (2016), the need for agricultural literacy is based on the urgency and importance for societies to have sustainable food manufacturing systems to feed a growing population. Additionally, if a person was literate in the subject of agriculture and natural resource systems, he or she would be able to "engage in social conversation, evaluate the validity of media, identify local, national, and international issues, and pose and evaluate arguments based on scientific evidence" (Meischen & Trexler, 2003, p. 44). With these abilities, individuals would be informed consumers educated about innovations in the products they purchase and voters who can make informed decisions when it comes to policy in agriculture. Despite the presented necessity for all individuals to be literate in the subject of agriculture, the impending need for agricultural literacy is lacking. The deficiency of basic agricultural knowledge is due to a perceived absence of practicality for individuals not directly involved in the agriculture industry (Powell et al., 2008). In addition, past literature blames the lack of agricultural literacy levels on the public's separation from life in a traditional agricultural setting. "With each successive generation removed from agrarian life, the general public's comprehension, outlook, and opinion towards agriculture has seemingly degraded" (Doerfert, 2003, p. 2).

Agricultural literacy campaigns can be traced back as far as the 19th Century before the term was used to describe those efforts (Donehower, Hogg, & Schell, 2012). These campaigns originally began as social clubs through which farm and ranch families could exert influence in the industries gaining popularity at the time (railroad, banks, etc.), while also functioning as organizations where educational information was exchanged between members (Donehower, Hogg, & Schell, 2012).

Currently, there are multiple agricultural literacy initiatives in place in the United States. Many of these campaigns focus on reaching school-aged children by presenting basic agricultural concepts with hands-on activities and experiences (Kovar & Ball, 2013). National Agriculture in the Classroom is a project of the National Institute of Food and Agriculture (NIFA) and the United States Department of Agriculture (USDA) that focuses on increasing agricultural literacy levels in children, grades K-12 (Spielmaker & Leising, 2013). In 2013, the National Agriculture in the Classroom Organization (NAITCO) released National Agricultural Literacy Outcomes that contained five themes with benchmarks and outcomes each grade level is expected to meet. To reach these benchmarks, NAITCO implements curriculum at the state level in accordance to the agricultural needs of each state while also providing support to teachers to incorporate agriculture into their classroom instruction (National Agriculture in the Classroom, 2018).

The National FFA Organization also has an agricultural literacy movement called #SpeakAg. The FFA website states being literate on the subject of agriculture can aid in closing the "communications gap that exists between producers and consumers" (National FFA Organization, 2015, p. 1). Although the title of the initiative is a hashtag, this campaign is not only for social media posts. FFA members are encouraged to have conversations with law makers and consumers, as well as share stories of agriculture on various social media platforms.

The National Center for Agricultural Literacy (NCAL) is a combined effort of the NIFA, the USDA, and the NAITCO. The goal of NCAL is to "change how the world thinks about agricultural systems related to science, technology, engineering, and mathematics (STEM), their quality of life, and our environment" (NCAL, p. 1). In addition to developing agricultural literacy curriculum and outcomes, NCAL also houses a database of important research completed in the field of agricultural literacy.

In response to low levels of agricultural literacy, the campaigns that serve to increase agricultural awareness have executed various methods of teaching through their programs. In the early stages of agricultural literacy initiatives, information was disseminated through "newspapers, speakers' bureaus, meetings, conventions, educational programs, children's clubs, and fairs" (Donehower, Hogg, & Schell, 2012, p. 38). More recently, those efforts have taken shape in the forms of school-implemented curriculum, extra-curricular activities like 4-H and FFA, and specialized programs through non-government organizations (Mars & Ball, 2016).

While there are existing curriculum and initiatives, agricultural literacy levels remain low nationwide. Employing dynamic and innovative ways of presenting information could be a method to increase agricultural literacy. Introducing visuals into curriculum, or even integrating them with more traditional forms of informational presentation is an increasing theme in the education sector. Students in higher education today encounter visuals on a regular basis and are required to create meaning from images and obtain knowledge from them (Hattwig, Bussert, Medaille, & Burgess, 2013). As Pennington et al. (2015) outlined, there is now a push for greater integration of visual communications into curriculum as a method of combating outdated techniques and equipping students with skills pertinent to the challenges they will face in the 21st Century.

Visual Communication

According to Francis, Jacobsen, and Friesen (2014), visuals and illustrations have been used for communicating multifaceted ideas since 1786 when William Playfair developed the line graph and bar chart. As technology has advanced greatly in the many centuries since then, digital media have combined with traditional communication formats to create new forms of visual communications. Donohew, Finn, and Christ (1988) stated visual design elements engage a viewer's attention more than the subject matter. Aisami (2014) found the majority of research conducted on the subject of visuals used in learning have highlighted the impact that visuals have on the information recall, determination, and success of students. Visuals have demonstrated the ability to increase student interest in learning because pictures encourage the cognitive process (Aisami, 2014).

Visual communications are not only beneficial to the field of education, but also can aide professionals of science in their efforts to share research and complex ideas. Estrada and Davis (2015) argued there is a place for the incorporation of design elements and visual communication in the realm of science communication. "If popularizing science is treated in the traditional way of being a linear one-way communication between two defined communities—the scientific community and the general public—it becomes a mere translation or a simplified description of scientific knowledge" (Estrada & Davis, 2015, p. 143). They concluded visual communications should be integrated as whole communication efforts in themselves, rather than acting as subsidiary informational pieces to other forms of communication. The authors also stated target audience identification is vital to effective communication through visuals (Estrada & Davis, 2015). Pinto, Moura, and Durão (2016) said the use of visuals in the communication of science can help scientists visualize ideas while having the ability to share illustrated versions of their cognitive processes. They also stated visuals can precisely present data by “displaying information and data in the most diverse visual configurations, from tables and graphs to diagrams, trees, maps, images, drawings, photographs, screenshots, videos, or computer visualizations” (Pinto et al., 2016, p. 59).

In current agricultural literacy curriculum, the use of visuals is limited. One of the only forms of visual information presentations available from agricultural literacy campaigns are in the form of illustrated children’s books (American Farm Bureau Federation, 2018). Graphics are incorporated in some campaigns, but again, these are for elementary age audiences (National Agriculture in the Classroom, 2013). Curriculum for older audiences are lesson plans typed out with an emphasis on verbal lecture and hand-on demonstrations. Visual aids in the form of PowerPoints are present, but their content is mainly textual information with few visuals accompanying the information.

Infographics

Matrix and Hodson (2014) defined an infographic as a form of communication created using graphic design techniques that incorporates graphs, charts, icons, ornamental fonts, and diagrams to represent information and data, resulting in a narrative consisting of illustrations. Infographics assist in improved visualization of information. Visualization is defined as “mechanisms by which humans perceive, interpret, use and communicate visual information" (McCormick, DeFanti & Brown 1987, p. 12). The goal of visualization is to convey information more effectively by graphical means (Siricharoen, 2013). An effective visualization can decrease the time it takes to understand data and statistics, find correlations, and attain information (Aguilar, Guerrero, Sanchez, & Peñalvo, 2010). Infographics can be effective presentation formats in research because the combination of graphics and text encourages student understanding of complex information (Abilock & Williams, 2014).

When presenting science-related topics, graphic depictions, such as infographics, have become important means for improving comprehension (Frankel & DePace, 2012). Vanichvasin (2013) examined infographic use in the form of visual communication tools and learning tools with undergraduate students in a knowledge management class. It was found that when used as visual communication tools, infographics could increase interest, understanding, and memory of information, which are characteristics of basic communication for most students, thus making infographics effective communication devices.

Data Visualization

Data visualizations have a different meaning than infographics and are often stand-alone elements found within infographics. Dur (2014) defined data visualizations as illustrations of quantitative information using charts, tables, and graphics. According to Dur (2014), the characteristics of data visualizations and infographics intend to visually represent concentrated and complex information on a certain subject in a way that can be more easily understood. The comprehension of an infographic is not finding a piece of information while looking at said infographic but having the content in a mental representation that can be retrieved when the infographic is not accessible (Albers, 2015). An effective infographic will create the mental depictions needed by a brain to decipher new and/or complex information as the mind goes through the process of storing new data while connecting concepts to any existing information that is possessed by the receiver. When referring to the advantages of combining data visualization and graphic design, Kim and DiSalvo (2010) said "each actively fills its absent traits with the advantages of the other; graphic design strengthens its arguments with objective and real data, while data visualization empathizes visual aesthetics adopting the principles of graphic design" (p. 9).

Need for the Study

"Society at large has moved from a predominantly industrial society that was focused on the production of goods and products for trading, to a knowledge society reliant on information and new knowledge creation for driving economic growth" (Agwa-Ejon & Batchelor, 2016, p. 1). The agriculture industry exemplifies this statement. The decreasing amount of people directly involved in production agriculture along with the increasingly complex nature of agricultural issues presented to policy makers demonstrates a need for an agriculturally literate society so individuals are able to make informed decisions regarding agriculture (Kovar & Ball, 2013). The concept of agricultural literacy is vital to our population because of the lack of agrarian understanding that exists among citizens. It is imperative to understand the public's knowledge of and opinions toward agriculture for the purposes of knowing how they will act in cases of "voting and policy decisions, purchasing or non-purchasing decisions, and education and career choices" (Doerfert, 2003, p. 2).

To overcome low agricultural literacy levels and to attempt to create a well-informed American population, there are multiple agricultural literacy campaigns in the U.S with a majority of those efforts focused on elementary and junior high aged children (Pense, Beebe, Leising, Wakefield, & Steffen, 2006). Based on the conclusions from Pense and Leising (2004), even those agricultural literacy efforts may be too limited in range. The need to research this problem in college-aged adults exists because they are typically not the focus of current agricultural literacy campaigns. In fact, Bellah and Dyer (2007) reported agricultural literacy studies have traditionally concentrated on measurements of student and teacher perceptions, teacher readiness and growth, and recognizing difficulties in curriculum adoption. Similarly, Kovar and Ball (2013) found the same results in an examination of agricultural literacy efforts spanning over two decades. However, they discovered elementary aged children and their teachers are the specific targets of a majority of agricultural literacy initiatives. Vidgen (2016) reported that many times, older audiences, who are the voting population, are often altogether excluded from agricultural literacy efforts.

Doerfert (2003) listed seven recommendations for furthering agricultural literacy research and efforts. These included the creation of an instrument for the collection of agricultural literacy data, agricultural literacy professionals establishing relationships with members of the agriculture industry, and further research on behavioral changes resulting from agricultural literacy endeavors (Doerfert, 2003). Recommendation number six stated "Research is needed to determine if the current models of agricultural literacy are sufficient for individuals to understand more complex agriculture-related issues, policies, and technologies" (p. 10). In this, he specifically mentioned the importance of effectively communicating emerging biotechnologies and the risks and benefits that come along with them. Doerfert's article was written in 2003, and in the years since, many advancements in the field of biotechnology, and with genetically modified organisms (GMOs), specifically have come to fruition, making this recommendation even more urgent than it was at the time of publishing. As he explained, the subject of biotechnology is complex, but important for consumers to understand because of the impact that misinterpretation can have on the agriculture industry, and ultimately, agricultural policy.

While Doerfert (2003) made recommendations for future research in the field of agricultural literacy, the American Farm Bureau Foundation for Agriculture (2012) created attainable benchmarks for multiple age groups that are referred to as the Seven Pillars of Agricultural Literacy. Each pillar is a specific area of agriculture that includes concepts different age groups should be able to understand within each pillar (Figure 1.1). Pillar six is the connection between agriculture and technology, with biotechnology included in this category. The early adult age group should be able to:

> 1. Use knowledge of biotechnology to make informed decisions when purchasing agricultural products, 2. Consider the primary benefits and concerns pertaining to biotechnology in order to make informed voting decisions, 3. Recognize technology in agriculture as a means for solving world hunger challenges. (American Farm Bureau Foundation for Agriculture, 2012, p. 7).

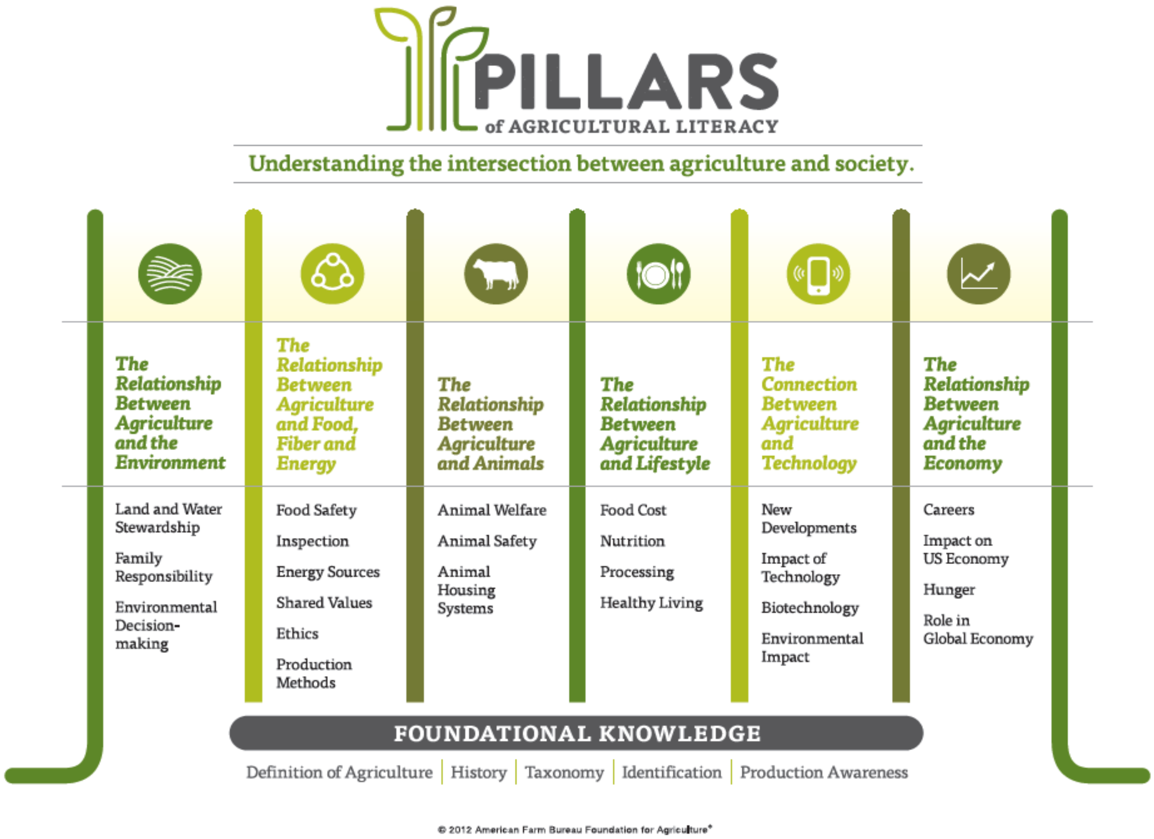


Figure 1.1. The Six Pillars of Agricultural Literacy (American Farm Bureau Foundation for Agriculture, 2012).

Understanding existing literacy levels, how we can most effectively increase those levels, and which methods are the best ways to do this are not only important for the sake of individual knowledge, but also the decisions elected leaders make on behalf of their constituents regarding policy. What once was considered a national issue has now expanded beyond these boundaries with increased agricultural trade in global markets, making agricultural literacy an international issue (Kovar & Ball, 2013). For professionals in agricultural literacy, understanding which forms of information presentation are most effective in fostering retention will be helpful in developing the curriculum of agricultural literacy campaigns. Both the issue of low agricultural literacy levels and dated agricultural literacy campaign techniques create a problem faced by the agriculture industry, and that is how to most effectively increase agricultural literacy levels.

Purpose and Research Questions

Although a worthwhile area to study, research is lacking to confirm the effectiveness of visual communications, including infographics, used in the context of educational materials (Lyra, Isotani, Reis, Marques, and Pedro, 2016). More work is needed to evaluate what influence infographics could have on helping people learn more about agricultural topics and retain that information. The purpose of this study was to determine the effect of infographics on processing information about genetically modified (GM) foods. The research questions guiding this study are as follows:

RQ1: What influence does the message stimuli have on participants' perceptions of GMOs?

RQ2: Do participants **freely recall** more information when exposed to an infographic or textual narrative?

RQ3: Is there a significant difference in participants' **cued information recall** when exposed to an infographic or textual narrative?

RQ4: Is there a significant difference in participants' **information recognition** when exposed to an infographic or textual narrative?

RQ5: Do participants **freely recall** more information a week after initial exposure when exposed to an infographic or textual narrative?

RQ6: Is there a significant difference in participants' delayed **cued information recall** when exposed to an infographic or textual narrative?

RQ7: Is there a significant difference in participants' delayed **information recognition** when exposed to an infographic or textual narrative?

Limitations

The following limitations are acknowledged for this study:

1. The study's participants were a convenience sample of college students at Texas Tech University in Lubbock, Texas. These individuals may not be indicative of college students from across the United States.
2. The majority of participants reported being enrolled in the college of Media and Communications. This means not all colleges at Texas Tech were equally represented in this study; therefore, the study is not generalizable to Texas Tech.
3. The sample size of this study is too small to allow results to be generalizable to an entire population.
4. Participants could have been exposed to information about GMOs in the week between the initial survey and the delayed survey, which could influence their recall of information in the delayed post-test.
5. This study was conducted in an artificial setting; therefore, ecological validity was forgone in order to control the experiment. Consequently, results cannot be generalized to naturally occurring settings.
6. Participants were not required to answer any of the questions on either survey, allowing them to leave questions blank if they so chose.

7. Multiple participants misunderstood the directions for the free recall question, and some answers pertained to the distraction video rather than the stimuli they viewed.
8. Participants were not required to complete the delayed post-test questionnaire because it was sent in an emailed link and not a lab-controlled survey. This caused low post-test response.

Basic Assumptions

The following are assumptions made about this study:

1. Respondents were likely to have perceptions of GMOs based on prior experiences and exposure because of the gaining popularity of GMOs.
2. Participants responded to the instrument honestly and to the best of their ability.
3. All participants could speak and read English.

CHAPTER II

LITERATURE REVIEW

Overview

Chapter I established the need for further investigation into the use of visual communication techniques to communicate topics within agriculture and improve agricultural literacy levels. This chapter provides an overview of research related to agricultural literacy, visual communications, infographics as a tool of communication, and an explanation of how information is processed and stored by way of the Cognitive Load Theory and the Limited Capacity Model of Motivated Mediated Message Processing. Both models provide support for the use of graphical representations when communicating complex issues of science within agriculture and provide explanations for why reducing cognitive strain can improve knowledge retention in literacy efforts. While previous studies used surveys and self-reporting to measure learning, the current study operationalized learning of agricultural concepts as memory and employed several memory measures.

Agricultural Literacy

According to Doerfert (2003), it is important to understand the agricultural knowledge and opinions held by the public (including educators) for a variety of reasons — voting and policy decision, purchasing or non-purchasing decisions, and education and career choices. “A society with an understanding of agriculture and current economic, social, and environmental impacts could lessen current challenges facing agriculture through good decision making” (Kovar & Ball, 2013, p. 168).

A major factor for information comprehension are the perceptions people possess prior to viewing new material. Nisbet, Hart, Myers, and Ellithorpe (2013) explained people are either open or closed minded, and this leads to difficulty in changing perceptions. A closed-minded individual temporarily considers the possibilities of a new concept and tends to base their final decision to accept new information on pre-existing personal opinions. If new information does not line up with these prior beliefs, it gets disregarded. This is also true when individuals do not feel like information is relevant to them, which, as mentioned in Chapter I , is a common way for people to feel about agriculture.

Young adults specifically are fairly new to being involved in policy and the voting process, so it is vital they are well-informed when making decisions that will affect our country as a whole. “In order to meet the challenges of the future, it is imperative that young people and adults become informed, ‘agriculturally literate’ consumers, advocates, and policy makers regarding agricultural issues” (Spielmaker, Pastor, & Stewardson, 2014, p. 1).

Several agricultural literacy studies have been conducted with young adults who are attending college. Specht, McKim, and Rutherford (2014) tested reactions of 93 college students to images from a television news story covering antibiotic use in livestock. They also used a survey to determine the students’ level of agricultural awareness (which they equivalated to agricultural literacy) that reported levels of agreeance to statements about agriculture. The reactions to the images were largely negative. However, those who did not react negatively to the images had self-reported higher levels of agricultural literacy. Students who were more critical of the images self-reported minimal experience in agriculture and demonstrated low agricultural literacy levels. Ultimately, the authors found agricultural literacy to be a successful indicator of respondent feedback, demonstrating that improved literacy reduces the chances of negative reaction toward reports and photos coming from the agriculture industry (Specht et al., 2014).

Dale, Robinson, and Edwards (2016) also surveyed college students to determine their agricultural literacy levels. Over 500 incoming freshmen at Oklahoma State University were given a survey that covered topics ranging from food and fiber systems to technology and environment issues. The researchers found the overall score of participants did not represent a passing score, establishing that students did not having a passing knowledge of agriculture. The lack of agricultural literacy in the incoming freshmen was attributed to K-12 agricultural literacy initiatives that are not being successfully implemented or promoting information retention in students (Dale et al., 2016).

Anderson, Velez, and Thompson (2014) tested K-12 teachers’ conceptions and knowledge of the agriculture industry before and after they attended an agricultural literacy program. Before taking part in any courses for the program, the teachers were interviewed by the researchers. A majority of the teachers associated the agriculture industry with plant and animal production. The participants were also asked to define agriculture in their own words and take an entrance questionnaire. To track any changes in conceptions, the participants were asked to keep a journal every day during the program and answer prompts given from the researchers. After they partook in the literacy program, the researchers found through the journals that the participants had gained greater understanding of the agriculture industry and developed a basic understanding rather than modest awareness.

As described in Chapter I, it is important to understand the agricultural literacy levels members of society possess, especially those not directly involved in agriculture. The next step in attempting to increase agricultural literacy levels is to understand which method(s) of information presentation are most effective in agricultural literacy campaigns in order to achieve receptiveness and comprehension from our target audience. Exploring visual communications to achieve public responsiveness is a worthwhile venture that starts with visual literacy and understanding how to most efficiently learn from visual representations that are conveying data and information.

Visual Literacy

Wileman (1993) defined visual literacy as “the ability to read, interpret, and understand information presented in pictorial or graphic images” (p. 114). With rapid advancements in technology, as well as the growing use of visuals across a spectrum of industries and disciplines, definitions of visual literacy have shifted in order to incorporate a broader spectrum of what the term encompasses (Association of College and Research Libraries, 2011). It was not until recently that visual literacy was studied as its own discipline, rather than being attached to other fields, as communications professionals recognized the need for multiple literacies to complement changes in communication methods. According to the Association of College and Research Libraries (2011), an individual who is visually literate is “both a critical consumer of visual media and a competent contributor to a body of shared knowledge and culture” (p. 1).

Hattwig, Burgess, Bussert, and Medaille (2013) stated visual literacy is now a mandatory characteristic of higher education because of the “visually rich, and screen-based world” (p. 61) in which college students live. Not only is a large majority of instruction completed online or accompanied by some form of technology, but social media use has also greatly increased in the last decade and influences opinions and learning. Aisami (2015) also confirmed that being visually literate is now an essential skill in education.

Within the discipline of agriculture, many complex topics and concepts could be effectively explained using visuals. Visuals have the ability to reduce time spent learning, enhance intellectual capacity, and improve recall and memory (Kouyoumdjian, 2012). Many agricultural topics are tied to science, like GMOs. By using visual communications to educate about topics in science, agricultural topics will in turn benefit by also having the ability to be explained visually and have the most scientifically complex areas simplified.

In science education, visual literacy is a skill receiving more consideration as communicators in these disciplines are realizing visuals can indeed relay dense scientific topics. Visual communications have been used in the communicating of scientific information and data for some time, but the majority of these communication methods were limited to graphs and other visual depictions of data in order to connect lay audiences (Estrada and Davis, & 2015). Not only has the use of visual communications in science amplified, but the variety of visuals being used has increased (McTigue & Flowers, 2011). Being visually literate in science is not only a helpful skill because of the growing popularity of visual communications use in the field, but also because visual communications can effectively convey information in ways that text cannot. "The inclusion of visual literacy in the teaching of science communication can be argued for on the basis that visuals, unlike words, have the capacity to communicate complex and complete concepts instantaneously to a larger number of recipients" (Estrada & Davis, 2015, p. 145). For communicators in science to create effective visual communications that can alter comprehension, attitudes, and the actions of the public, messages have to be "constructed on a knowledge of visual perception, human cognition and behavior, and with consideration for the personal preferences, cognitive abilities and value systems of the audience" (Frascara, Meurer, Toorn, & Winkler, 1997, p. 3-4). According to Dur (2014), information presented in a visual manner not only increases understanding, but also simplifies complex information. In addition to the perception and decipherability aspects, the human mind can cognitively distinguish visual information transfer faster and in a more efficient and perpetual manner as opposed to written or oral information transfer (Dur, 2014).

Medina (2009) found text and oral presentations are less efficient than pictures for retention of select types of information. If information is presented verbally, people remember about 10% when tested 72 hours after exposure; that figure goes up to 65% when a picture is added (Medina, 2009). Additionally, Parkinson (2012) found visuals are processed 60,000 times faster than stand-alone text. Smiciklas (2012) contributed this to the fact that text has to be broken down and each letter deciphered to understand what is being conveyed, while images are processed nearly immediately because there is no need for the brain to create a mental representation. Not only does data support the use of visuals and their positive aspects, but viewers prefer visuals because already existing illustrations do not require the creation of a new schema (Yildrim, 2016). To employ visual representations in educational materials, information can be conveyed in the form of an infographic that possesses data visualizations.

Infographics

Infographics are “visual displays in which graphics (illustrations, symbols, maps, diagrams, etc.) together with verbal language communicate information” (Meirelles, 2013, p. 11). Davis and Quinn (2014) claimed infographics can support the comprehension of reading and writing, while reinforcing critical thinking skills. A variety of studies have been performed to assess the effectiveness of infographics in an educational setting where information is being taught. For example, Vanichvasin (2013) conducted a study with undergraduate college students that qualitatively and quantitatively tested infographics as tools of communication and education. Participants were given questionnaires to assess the attractiveness, understanding, and retention of the infographic when used as a means of visual communication. Students were asked to rate their satisfaction of using the infographic to present content and be used in activities where learning was expected to take place. The findings of the study indicated infographics used in the context of visual communication tools could increase understanding and retention of information, as the majority of students were able to recall details after viewing the infographic. As a learning tool, students were extremely satisfied with the ability of infographics to present and explain content and be used in learning activities (Vanichvasin, 2013).

Similarly, Ozdamla, Kocakoyuna, Sahina, and Akdaga (2016) incorporated infographics into an anatomy course with 140 undergraduate students enrolled and also looked at infographics as a tool of education. Student reception of infographics being used as educational materials was largely positive. Almost 60% of respondents said "infographics have more advantages than other visuals" (Ozdamla, et al., 2016, p. 376), and 86% of respondents said infographics helped them understand concepts better. Overall, 75% of the population felt positively about infographics in general (Ozdamla et al., 2016). The authors acknowledged infographics can be used to teach complex subjects, just as they were used in this study to teach students about anatomy. They also suggested infographics are a more efficient presentation method than traditional methods like PowerPoint, as they enable ideas to stick with their audiences for longer periods of time (Ozdamla et al., 2016).

Yildirim (2016) also studied infographic use in the classroom but did so over a 20-week program with undergraduate students enrolled in classes in a computer education and instructional technology department. In this program, students learned about the different functions of infographics in an educational setting and had to design their own. The researchers developed an infographic reader survey to collect participant perceptions of infographics. The study reported viewers found infographics educational and preferred them to traditional methods of informational presentation (Yildirim, 2016). Infographics aid in the learning process and are considered more instructive than unaccompanied text (Yildirim, 2016). The authors provided over 20 conclusions and recommendations for infographic use in education, including "infographics can be used to teach basic information about a subject, present new information or confirm the information currently available" (Yildirim, 2016, p. 108).

Rather than measuring student opinions of infographic use, Lyra, Isotani, Reis, Marques, and Pedro (2016) tested knowledge gained from educational infographics with undergraduate students. Participants were given a pre-test to determine what existing knowledge they had on the subject presented in the infographics. Then they were given one of two types of stimuli to view, either infographics or text and graphics material that consisted of the same information as the infographics. The participants then received the same questions from the pre-test with altered vocabulary. Finally, participants received a delayed survey that consisted of the same questions from the first two tests a week later to gauge information retention. Ultimately, the researchers found students who viewed the infographics scored higher on average than students who viewed the alternative form of information. It was also found students who viewed the infographics retained the information they acquired longer than the students who viewed the combination of graphics and text. This indicated "infographics can better support robust learning" (Lyra et al., 2016, p. 1) than simply using graphics with text applied.

Contrary to the aforementioned studies, Comello et al. (2016) tested engagement and comprehension of information using infographics against text-only information displays with 1,162 participants through the online survey tool Mechanical Turk. Rather than the participant pool consisting of college attending adults, this survey recruited adults ages 18-65. The stimuli were presented as either an infographic or textual narrative related to various health behaviors, but the module that focused on tobacco use was the only behavior where an infographic was tested solely against a text-only format. In this module, the infographic outperformed the text-only information format in comprehension scores and it decreased the cognitive load of participants. Cognitive load was self-reported by participants by using a scale of agreeance.

Cognitive load was an important aspect of this study. The next section will describe the theoretical framework used in this study that explains cognitive load, as well as the processes viewers experience while intaking information.

Theoretical Framework

The Limited Capacity Model of Motivated Mediated Message Processing (LC4MP) served as the primary theoretical framework for this study. The Cognitive Load Theory is a framework that came before the LC4MP and is explained here in reference to cognitive resources needed to retain information or learn something new. The LC4MP takes this concept further by dividing the retention process into three subprocesses, as well as explaining information processing and the multiple actions that take place while viewers are comprehending information.

Cognitive Load Theory

Cognitive Load Theory (CLT), introduced by Sweller in 1988, stated cognitive resources in working memory are limited and finite, and the resources can be overloaded if a task requires use of too many of those resources (Jong, 2010). When the mental capacity is overloaded, learning is hindered. “CLT is applicable to all activities in life that involve executing tasks, but has been mostly studied in the setting of education” (Young, Marrienboer, Durning, and Cate, 2014, p. 376).

According to Cognitive Load Theory, the use of graphics in conjunction with text lessens the cognitive load, which is the mental exertion a learner applies on knowledge gain; therefore, the learners can focus more on the content rather than trying to interpret the presentation format (Sweller, 1988). CLT provides a groundwork for designing instructional materials to best develop understanding and foster learning (Cook, 2006). According to Clark and Lyons (2011), most people comprehend information more efficiently while viewing graphics than stand-alone text. and cognitive overload can be prevented by supplanting text with visuals. Wilson (2015) demonstrated this by using two different illustrations of an animal heart. The first was an actual picture of a heart accompanied by a few numbers to identify different parts. Below this picture were lengthy descriptions defining each part of the heart the numbers referenced. The author claimed that by using a method like this, cognitive load is increased in learners and such dense information should be broken down into more manageable material. The second illustration was a graphic depiction of two animal hearts. Rather than an accompanying key and overwhelming amount of text, the illustrations were color coded with arrows connecting the name and specific part of the heart. The use of color makes the anatomy of the heart clear to learners, along with oral explanation from the instructor that is received by learners auditorily rather than visually.

Martin et al. (2018) tested the incorporation of infographics in medical curriculum with 72 emergency medicine physicians. Participants were asked to self-evaluate the mental effort they exerted when viewing infographics and text-only abstracts on a 9-point scale. In the study, mental effort was equated to cognitive load. Participants who viewed infographics reported significantly lower mental exertion than those who viewed the text abstracts. The results of this study suggested infographics are effective in fields where complex topics are being learned, and the professionals in these fields find infographics easier to comprehend and less mentally straining (Martin et al., 2018).

Barnes (2016) also had respondents self-report cognitive load while viewing infographics. Forty-seven undergraduate students partook in a study that consisted of an introductory questionnaire, a graphicacy [sic] test to evaluate participant's abilities to interpret visualized data, viewing of six infographics, a comprehension exam about each infographic, and a perception scale related to the aesthetic factors of the infographics (Barnes, 2016). Participants responded to a 9-point cognitive load scale immediately after viewing each of the six infographics to measure the load induced on each of the participants' cognitive resources. The overall efficiency of the infographics to facilitate information was examined using formulae that "were applied to grand-mean standardized performance, CL, and time data to calculate the average learning efficiency and performance efficiency for each infographic" (Barnes, 2016, p. 179). Learning efficiency (LE) was the factor that described how effective the design of the infographics was in information processing, and performance efficiency (PE) was the factor that described the accuracy and strength of the information processing and comprehension (Barnes, 2016). The authors said PE should be more weighted because it is the element that implies if an infographic indeed facilitated information efficiently. Every infographic displayed a positive correlation between its LE and PE, illustrating the cognitive load experienced with each infographic was low.

The Cognitive Load Theory is helpful in bringing awareness to mental resource overload. The need to understand how learners process information they are being presented with and what it looks like when they cognitively decide to either accept or reject a message is the next step in identifying effective communication techniques. While the Cognitive Load Theory provides a basis for simplifying messages in order to increase information retention, the Limited Capacity Model of Motivated Mediated Message Processing breaks down the steps a viewer of a message takes when consuming information.

Limited Capacity Model of Motivated Mediated Message Processing (LC4MP)

The Limited Capacity Model of Motivated Mediated Message Processing (LC4MP), developed by Lang (2000), is a theoretical description of how messages are encoded, processed, stored, and recalled. According to Lang (2000), the LC4MP is a blend of multiple information-processing models and was originally developed to examine how mediated messages are processed. The original author applied the theory to the message processing of television, but the theory can be applied to any form of mediated messaging where information processing occurs (Lang, 2006). The theory posits humans are assumed to be “limited capacity processors” (Lang, 2009, p. 194). Stated within the LC4MP is the concept that “cognitive resources are required to process information, and humans have only a finite and limited supply of cognitive resources available for use at any given time” (Lang, 2009, p. 194).

The three subprocesses (processes occurring within a larger process) of the LC4MP are encoding, storage, and retrieval (Lang, 2000), as shown in Figure 2.1.

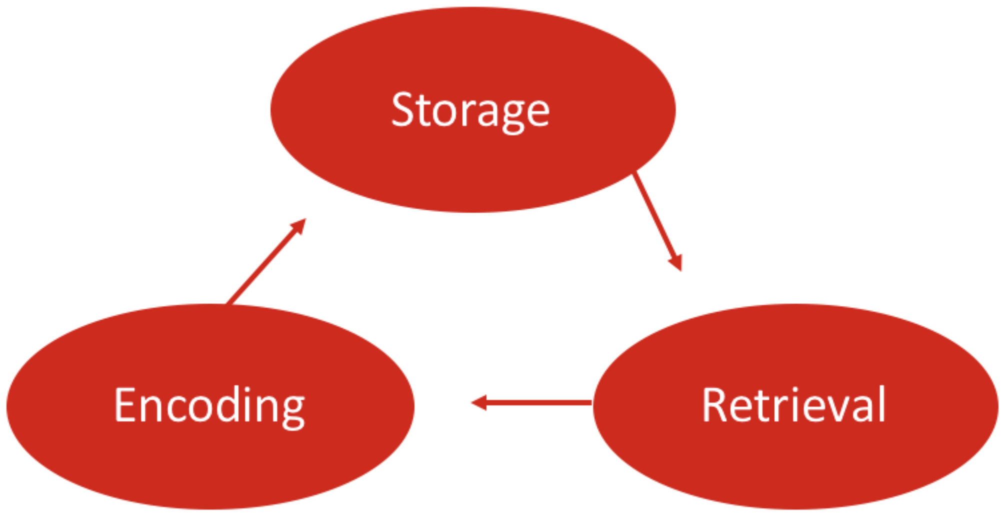


Figure 2.1. The three subprocesses of the LC4MP.

During the first subprocess of the LC4MP, encoding of information occurs at the initial exposure to the information (Lang, 2000). Then, the receiver experiences the controlled and/or automatic selection process. The controlled resource allocation process is the act of the receiver intentionally and consciously making an effort to place information into memory, while the automatic selection process is subconscious and occurs if information is relevant to the receiver or an unexpected occurrence comes from novel information (Lang, 2000). This automatic resource allocation is called the orienting response (Lang, 2009). Felder and Silverman (1988) stated the processing step of information intake may involve "simple memorization, inductive or deductive reasoning, reflection or action, self-examination, or interaction with others" (p. 674). After one of these processes (or possibly a combination of) has occurred, the outcome is the material is either learned or not learned (Felder & Silverman, 1988), or in this case, encoded into short term memory or stored in working memory through the second subprocess. "The encoding subprocess is the gateway to cognition, essentially moving information from the sensory store to what often has been referred to as short-term memory" (Potter, 2009, p. 586). All incoming information will either be recognized as important enough to keep or discarded. If kept, the brain creates a representation that an individual can easily retrieve later if needed (Lang, 2000). Once a message has been encoded by the receiver, some of the message's information will then be transferred from the working memory to long-term memory in the process of storage.

In the second subprocess of the LC4MP, the mental representation of a message that has been constructed in the encoding process will be linked with previously encoded information to then create an association of information that subsequently leads to new information possessed by the receiver (Lang, 2000). As the receiver contemplates the new information further, more associations between incoming and previously stored information form (Lang, 2000). The more associations that are made, the more wholly the information is stored.

In the final subprocess of retrieval, receivers search through information stored in long-term memory, and bring it to the working memory in order to start the continual LC4MP process over and make associations between existing information and incoming information (Lang, 2000). Although the LC4MP process is constantly occurring, it does not always follow a uniform method. Information may or may not be stored in full, or at all, and all three of the subprocesses can occur quickly or in a more thorough manner (Lang, 2000). In the end, "memory of a message is a composite of the outcome of all three subprocesses" (Lang, 2000, p. 50).

To test information retention on a subject of literacy, Meppelink, Weert, Haven, and Smit (2015) conducted a study with 231 participants aged 55 years or older who were classified as either having low or high health literacy. Participants viewed one of four randomly assigned messages that contained complex information about colorectal cancer. Two of the stimuli were audio conditions that consisted of narrations the participants listened to with accompanying animations. The animations remained the same for both conditions, but the audio narration differed. One of these stimuli was classified as more difficult than the other. The other two stimuli were non-detailed illustrations accompanied by supporting text. Here, the text varied, but the illustrations remained the same for both conditions. Again, one of these stimuli was classified as more difficult than the other. Recall of information was measured using an information recall questionnaire that consisted of 14 open-ended questions. The researchers concluded the individuals classified as having low health literacy benefitted from information presented in a multimodal format where less information was presented textually, and there were more visual elements. Those with low health literacy had high rates of recall and positive attitude toward illustrations used to communicate the complex topic of colorectal cancer. The groups that did receive stimuli treatments where text was presented in a way the authors classified as “non-difficult” recalled information better than the groups who had the more difficult text treatment, and the attitudes toward the non-difficult text treatment were not negative. This demonstrates that complex topics do not require complex explanations in order for information recall to occur, and that images, as well as animations, can effectively communicate a message without overwhelming the viewer.

Simplification of information fosters the three subprocesses of the LC4MP and in turn does not overload cognitive resources.

Performing another study on increasing literacy, Salazar (2009) tested the effects of text and graphics in science literature with the goal of increasing science literacy. Each of the 136 college student participants that consisted of various academic classifications took a prior knowledge test and then viewed four articles. They were then asked to complete a post-reading survey about the information they read. Four science articles were chosen from online sources, and the researchers created two versions of each article, so they varied in complexity. In addition, two more versions were created that either included the original article's graphics or did not include graphics at all. This means there were 16 articles a participant could view before the random assignment of the four they viewed. The researchers found that graphics used in addition to text that was lower in complexity caused participants, especially those who scored low on the prior knowledge questionnaire, to score higher on recognition and recall questions. The best option for communicating complex topics is to use low complexity messaging, but the researchers stated that if literature about complex science topics is unable to be put into simplistic terms, a visual depiction of the topic needs to be utilized. This will prevent viewers' cognitive resources from overload, giving them an alternate piece of information to process, rather than attempting to decipher stand-alone text that contains dense material.

Buettner (2015) looked at this same concept but with website complexity. Participants ages 23-35 were asked to view three different websites and perform tasks within each site. As this was occurring, participants' pupil size throughout the process was being measured by an eye-tracking system. The bigger their pupils grew in diameter was an indication of the cognitive load they were experiencing while performing tasks. The average pupil size of all participants was taken for each of the treatments. Both the left and right eye pupil measurements were recorded. The first treatment, which was the simplest in layout and type of elements, had the lowest average pupil sizes. This result supports simplistic website layouts are better to use when considering the design of a website because viewers will have a lesser chance to be cognitively overloaded while viewing the website. These results can apply to other types of mediums in terms of deciding how complex the information being communicated needs to be. More simplistic forms of information presentation will not only keep viewers engaged with the information they are viewing, but it will also allow them to intake more information because they will not be cognitively overloaded.

These studies all used the LC4MP to make a case for using one communication medium over another in order to create information retention. However, there is no current literature on the use of infographics in conjunction with the LC4MP to create increased information retention. Due to this gap in research, the current study tested the use of infographics to communicate an agricultural topic in hopes of reducing the amount of cognitive resources devoted to information processing and increase information retention.

CHAPTER III

METHODOLOGY

Overview

This study sought to test the effect infographics have on recall of information about genetically modified organisms. Based on the LC4MP, implementing visual aids while teaching complex topics can reduce cognitive strain on a learner, and foster the encoding, storage, and retrieval subprocesses. This chapter explains the procedures guiding the research process and steps taken in this experiment. It will focus on the guiding research questions, the research design used to conduct this study, and descriptions of the study sample, instrumentation, stimulus treatments, data collection procedure, and data analysis.

Purpose and Research Questions

The purpose of this study was to determine the effect of infographics on processing information about genetically modified (GM) foods. The research questions guiding this study are as follows:

RQ1: What influence does the message stimuli have on participants' perceptions of GMOs?

RQ2: Do participants **freely recall** more information when exposed to an infographic or textual narrative?

RQ3: Is there a significant difference in participants' **cued information recall** when exposed to an infographic or textual narrative?

RQ4: Is there a significant difference in participants' **information recognition** when exposed to an infographic or textual narrative?

RQ5: Do participants **freely recall** more information a week after initial exposure when exposed to an infographic or textual narrative?

RQ6: Is there a significant difference in participants' delayed **cued information recall** when exposed to an infographic or textual narrative?

RQ7: Is there a significant difference in participants' delayed **information recognition** when exposed to an infographic or textual narrative?

Research Design

This study employed a pretest-posttest experimental design (Wimmer & Dominick, 2003). "Quantitative research is an approach for testing objective theories by examining the relationships among variables" (Creswell, 2014, p. 4). To test the relationships among the variables of this study, an experiment was performed. According to Ary, Jacobs, Sorenson, and Razavieh (2010), the three characteristics of an experiment are the manipulation of an independent variable, control of extraneous variables that could affect the dependent variable, and the measurement of the effect the independent variable has on the dependent variable. This study met all these requirements.

To control the relevant variables, the Law of the Single Independent Variable was followed. This law states that "if two situations are equal in every aspect except for a variable that is added to or deleted from one of the situations, any difference appearing between the two situations can be attributed to that variable" (Ary et al., 2010, p. 267). The manipulated independent variable was the format of stimuli participants received.

There were two different stimuli for this study which were randomly assigned to participants. Creswell (2014) stated a true experiment randomly assigns treatments to participants, just as this study did. The dependent variables measured were three memory measures (free recall, cued recall, and recognition) and post-perceptions of GMOs. Creswell (2014) stated "experimental research seeks to determine if a specific treatment influences an outcome" (p. 13). It is for this reason an experimental design was the best choice for this study so the influence of each stimuli on the recall of information could be determined.

Population and Sample

The population for the study was undergraduate students at Texas Tech University. A convenience sample was taken from the population, which resulted in 65 participants. These participants were students who voluntarily chose to participate through the College of Media and Communication's SONA system. The SONA system is a research management tool that allows researchers to recruit participants and assign credit. An announcement describing the study was sent out to members of the SONA system, and can be found in Appendix A. The SONA system recruits students enrolled in courses offered through the College of Media and Communications as well as students enrolled in agricultural communications courses. The students can be enrolled in various departments at Texas Tech. Students were awarded course extra credit for their participation. Names of participants were recorded by the SONA system to award the extra credit but were not linked to the survey responses. Students in the SONA pool were sent an email that included the study recruitment announcement. All participants in the pool were 18 years or older. This study was in compliance with the College of Media and Communication Research Subject Participant Pool Policies and Procedures.

Instrumentation

The instrument for this study was a questionnaire constructed in Qualtrics (Appendix B). The questionnaire contained 63 questions, but each participant only answered 47 of those, as they did not see questions for the type of stimuli they did not view. Participants were randomly assigned one of two stimuli. The stimuli and randomization were built into the survey. The survey measured participant demographics, prior knowledge of GMOs, perceptions of GMOs, free recall, cued recall, and recognition of information. Participants were not given a time limit to complete the questionnaire, but infographic viewers took 21.97 minutes on average to complete the questionnaire, while narrative viewers took 20.45 minutes on average.

Demographics

The demographics measured were gender, age, ethnicity, academic classification, academic college of enrollment at Texas Tech, and cumulative GPA.

Existing Knowledge of GMOs

To test for any prior knowledge participants possessed about GMOs, five questions were written based on the facts presented in the infographic used in the study. These were asked before participants were exposed to the stimuli. A panel of Texas Tech faculty members reviewed the questions and determined them suitable items to test from the infographic.

Perceptions of GMOs

Participant perceptions of GMOs were measured in order to answer research question 3. Participants rated their agreement to 10 questions on a 7-point Likert type scale ranging from 1 = *strongly disagree* to 7 = *strongly agree*. The statements included inquiries about GM food production and the ethics of the process. The GMO perception scale was adopted from Linnhoff, Volovich, Martin, and Smith (2017). The authors did not report reliability; therefore, a post hoc reliability analysis was performed. The original 10-item scale has an alpha reliability of .49. Three items were removed making the final version a 7-item scale that had an alpha reliability of .92, shown in Table 3.1.

Table 3.1
GMO Perception Scale (N = 61)

Item
~~I believe GM foods are fundamentally against nature~~
GM food is pretending to be natural food
~~GM food is authentic food*~~
GM food production is out of touch with nature
GM foods are artificial foods
GM food production tampers with nature
GMO-Free food production means making products the way they should be
~~GM food production is a good idea*~~
GM food production is an unwise decision
I am strongly against the production of GM food

Note: *Item is reverse coded. Strikethrough indicates item was removed in final instrument. Instruments measured on a 7-point Likert scale where 1 = *Strongly Disagree* and 7 = *Strongly Agree*

Stimuli

Participants were randomly assigned to receive one of two stimuli. The first stimulus was an infographic about GMOs (Figure 3.1, p. 49). The second stimulus was a text narrative that contained the same information as the infographic but had none of the graphic design elements (Figure 3.2, p. 50). A panel of experts made up of Texas Tech graduate level faculty reviewed multiple infographics to identify one that was most appropriate to use for this study. The infographic selected to be a stimulus in this study was chosen because it contained a balanced amount of visuals and text and encompassed enough testable information for the sake of this study. The infographic was also chosen because it contained basic information about GMOs that did not require further explanation by the researchers. The facts presented in the infographic were relevant to American consumers.

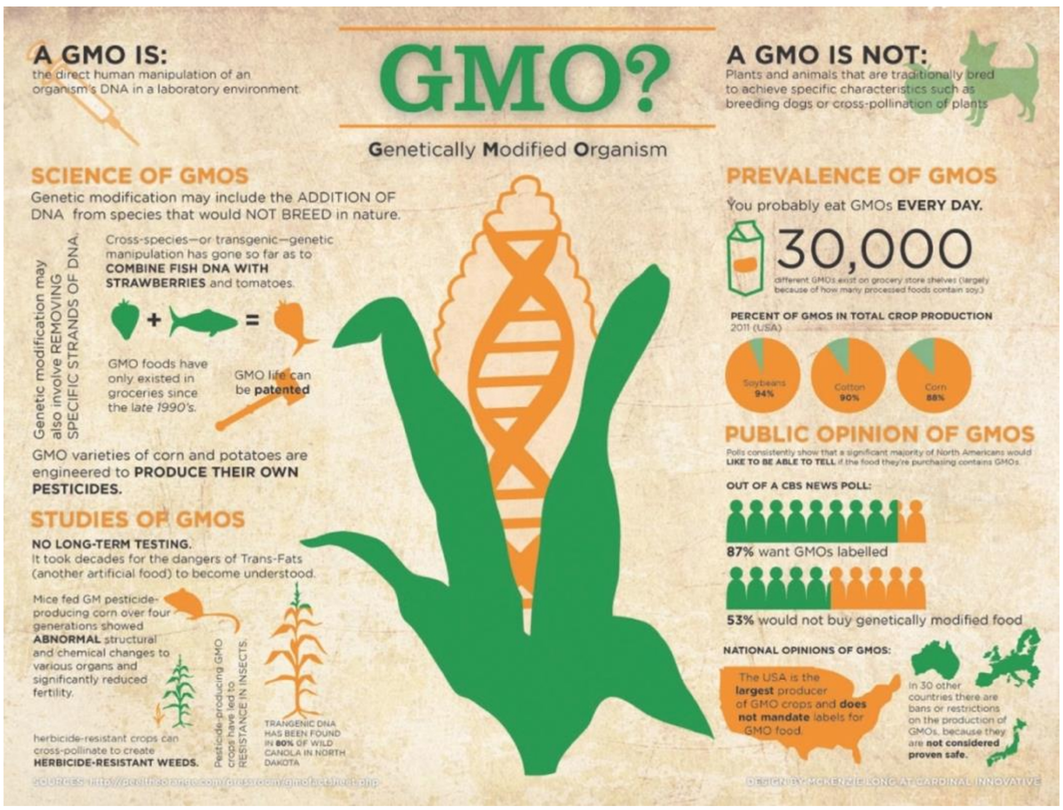


Figure 3.1. GMO Infographic used as a stimulus in this study.

Please read the following narrative:

Science of GMOs
A Genetically Modified Organism (GMO) is a human manipulation of an organism's DNA. Genetic modification may include the addition of DNA from species that would not breed in nature. The process may also involve removing specific strands of DNA. A cross-species – or transgenic – genetic manipulation has gone so far as to combine fish DNA with strawberries and tomatoes. Some GMO varieties of corn and potatoes are engineered to produce their own pesticides. GMO life can be patented. A GMO is not a plant or animal that has been traditionally bred to achieve specific characteristics such as breeding dogs or cross-pollination of plants.

Prevalence of GMOs
GMO have only existed in food since the late 1990's, but now you probably eat GMOs every day. More than 30,000 different GMOs exist on grocery store shelves (largely because of how many processed foods contain soy). In 2011, the GMOs compromised 94% of total crop production in soybeans, 90% in cotton, and 88% in corn.

Studies of GMOs
It took decades for the dangers of trans-fats (another artificial food) to become understood. Mice fed GM pesticide-producing corn over four generations showed abnormal structural and chemical changes to various organs and significantly reduced fertility. Pesticide-producing GMO crops have led to resistance in insects, and herbicide-resistant crops can cross-pollinate to create herbicide-resistant weeds. Transgenic DNA has been found in 80% of wild canola in North Dakota.

Public Opinion of GMOs
Polls constantly show that a significant majority of North Americans would like to be able to tell if the food they are purchasing contains GMOs. Out of a CBS news poll, 87% want GMOs labeled, and 53% would not buy genetically modified food. The USA is the largest producer of GMO crops and does not mandate labels for food containing GMOs. In 30 other countries, there are bans or restrictions on the production of GMOs because they are not considered proven safe.

Figure 3.2. Narrative about GMOs used as a stimulus in this study.

Distraction Video

Participants watched a 3-minute video immediately after stimuli exposure. There were no questions within the instrument about the video. The video served as a means of clearing working memory, so participants were not immediately answering the free recall question, which would demonstrate memory. Rather, the participants were required to access any information they had stored about the stimuli they viewed in answering the recall questions. The distraction video was only used in the first questionnaire and not the delayed post-test questionnaire.

Recall and Retention

The goal of infographic use in education is to positively affect the learning process. To test the effects infographics have on an individual's ability to recall information, free and cued recall questions are employed. In free recall, participants are asked to recall any information they can remember from the material they viewed. They are not prompted with any cues that trigger the cognitive memory searching process (Aue, Criss, & Novak, 2016). In cued recall, participants are given cues that serve as aides in remembering information by giving a context clue within the question. Endres, Carpenter, Martin, and Renkl (2017) noted past literature that examined information retrieval "typically use a fairly straightforward test such as free recall, cued recall, or multiple-choice, and find that retrieval is beneficial for learning" (p. 13). If an individual is able to retain and later recall information, learning has taken place and information has been encoded and stored in memory.

In order to examine if infographics create high rates of information retention and recall, viewers must be tested using questions that ask for free recall of information as well as cued recall. A delayed post-test questionnaire is suggested to be employed to affirm retention of information, also considered knowledge gain (Lyra et al., 2016).

Free Recall

After viewing the distraction video, participants were given a blank text box and asked to freely recall any information they could remember from the infographic or narrative they viewed. The order in which participants provide answers was not controlled (Hunt, Smith, & Toth, 2016) and participants usually remember the initial items they see on the list or material they are being asked to recall (Kuhn, Lohnas, & Kahana, 2017). An example of a free recall question can be seen in Figure 3.3.

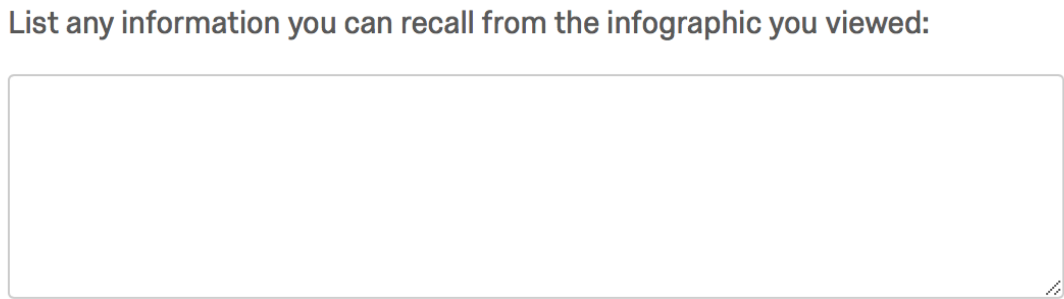


Figure 3.3. Example of a free recall question.

Cued Recall

To test cued recall of information, participants were given five questions that asked facts from the infographic/narrative. Participants are given a cue and must retrieve the correct memory based on that cue (Aue, Criss, & Novak, 2016). “The task is particularly useful for understanding memory because memory is cue driven and cued recall provides a straightforward way to manipulate the cue” (Aue et al., 2016, p. 104). Participants were given a blank text box and prompted to give one correct answer to each question. An example of a cued recall question can be seen in Figure 3.4.

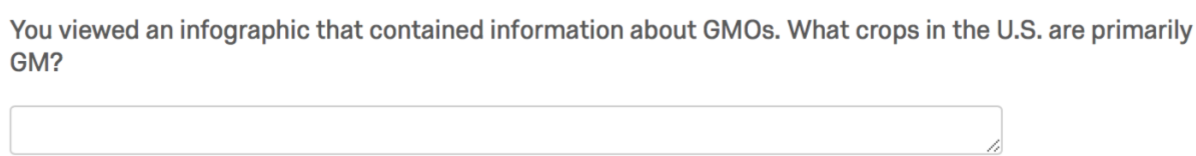
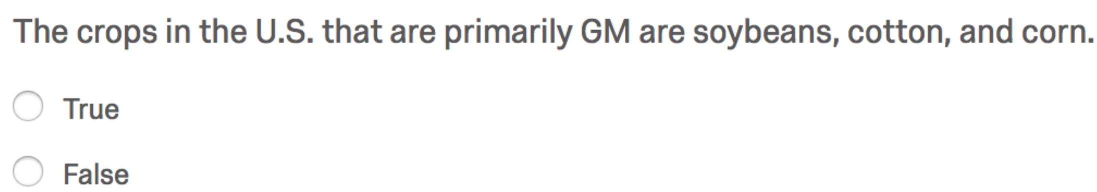


Figure 3.4. Example of a cued recall question.

Information Recognition

“Recognition refers to people’s ability to determine what they have previously experienced” (Malmberg, Criss, Gangwani, & Shiffrin, 2012, p. 115). In the questions measuring information recognition, participants were given 10 true or false questions. Five of these questions were the same five knowledge questions participants answered at the beginning of the questionnaire. The other five questions were false and did not actually appear on infographic/narrative. Malmberg, Criss, Gangwani, and Shiffrin (2012) stated past studies have found the more items participants are tested on, the less accurate their answers are. Therefore, participants were only tested on five facts from the infographic/narrative. An example of an information recognition question can be seen in Figure 3.5.


The crops in the U.S. that are primarily GM are soybeans, cotton, and corn.

True

False

Figure 3.5. An example of an information recognition question.

Delayed Post-Test Questionnaire

The questionnaire was sent to participants one week after they took the initial questionnaire. The questionnaire participants received was dependent on what stimuli they viewed in the first survey. This questionnaire began with the same free recall, cued recall, and recognition questions participants received in the first survey. The participants were also asked to provide their perceptions of GMOs once more with the same 10 questions that were also in the first questionnaire.

Procedure and Data Collection

Before implementing the experimental phase, the questionnaire with stimuli was pre-tested (Wimmer & Dominick, 2003) with five Texas Tech graduate students in the Department of Agricultural Education and Communications. These students completed the study as if they were actual participants, but the data they provided were not included in the final data analysis. The graduate students made the researcher aware of any issues such as broken links, missing graphics, spelling errors, and punctuation mistakes. They also provided feedback on the length of the questionnaire, general content, and ensured the stimuli were randomly assigned.

Texas Tech University students were recruited to participate in the study using the SONA system. Volunteers were invited to a social laboratory in the College of Media and Communication. They were asked to sit at a computer and were read instructions and given information about the study per the approved IRB oral script (Appendix C).

All participants signed a consent form (Appendix D) before they began the survey, giving the researcher permission to use the email addresses provided to send the delayed questionnaire a week later. The consent form also presented general information about the study, how long participation would take, how participant privacy would be protected, contact information for individuals who could address questions about the study, and procedures to follow if a student no longer wanted to participate. Before the participants took the questionnaire, the researcher read an oral script explaining the purpose of the study, how privacy would be protected, and who to contact for inquiries. An information screen was presented to the participants on the first page of the Qualtrics questionnaire. This informed participants of what they were expected to do during the questionnaire, how to proceed if they no longer wished to participate, and contact information for inquiries about the study. Participants were also informed on how their privacy would be protected. Names were not linked to documentation, all data was stored in a locked office and on a password protected computer, and any potential identifying material was destroyed with the completion of data analysis. Extra credit was the only incentive offered for participation.

Participants proceeded to the questionnaire, which was created in Qualtrics. Qualtrics is a web-based survey platform that allows researchers to create and distribute questionnaires online. The first part of the questionnaire consisted of the following items: gender, year of birth, ethnicity, academic classification, academic college in which they are enrolled at Texas Tech, and cumulative GPA. Five questions testing existing participant knowledge of GMOs were then presented. This section was employed to determine if any statistically significant difference existed in pre-existing knowledge for those randomly assigned to the narrative or infographic stimulus. Using a t-test, no statistically significant difference was found.

In the next section of the questionnaire, participants were asked to rate their level of agreeance to 10 questions that measured perceptions of GMOs and GM crops. Next, participants were instructed to view one of two stimuli. The stimuli were randomized evenly using the survey flow tool in Qualtrics. Participants either viewed an infographic about GMOs or a purely textual narrative that contained the same information from the infographic. After viewing the stimulus and distraction video, participants answered a three-part questionnaire that tested free recall, cued recall, and recognition of information contained in the stimulus they viewed. Participants were again asked to indicate their level of agreeance to the same 10 questions that measured perceptions of GMOs and GM crops. Finally, a delayed questionnaire was sent a week later that contained the same questions participants responded to in the post-test portion of the instrument. Participants were not provided with the infographic or text narrative to view a second time.

The infographic used in this study did contain information from a study that was later retracted. Despite this, the panel of experts decided to choose this specific infographic because it was one of the top results from Internet searches for GMO infographics; therefore, it is likely a source sought out by individuals looking for information about GMOs. Having fraudulent information within the infographic would also identify how memorable that finding was to participants. This brings up an implication for future research to study the recall of accurate versus inaccurate information. If participants recall more false information, this creates a difficult task for agricultural communicators to be the overcomers of misinformation. Upon completion of the questionnaire, participants were debriefed with one of two statements found in Figure 3.6.

The infographic you viewed does not fully represent the views of the agriculture industry. The 2012 study that reported a connection between mice fed GM pesticide-producing corn and the development of abnormalities was later retracted due to misrepresentation of the data. Genetically modified foods have not been proven to cause any negative health effects in the people or animals that consume them. For accurate information about GM foods, you can find infographics and reports at http://isaaa.org. Thank you for taking the time to complete this survey and contribute to research within agriculture.

The narrative you read does not fully represent the views of the agriculture industry. The 2012 study that reported a connection between mice fed GM pesticide-producing corn and the development of abnormalities was later retracted due to misrepresentation of the data. Genetically modified foods have not been proven to cause any negative health effects in the people or animals that consume them. For accurate information about GM foods, you can find infographics and reports at http://isaaa.org. Thank you for taking the time to complete this survey and contribute to research within agriculture.

Figure 3.6. The disclaimer statements participants read at the completion of the survey.

Data Analysis

The data were collected in Qualtrics then exported to IBM SPSS v. 24. The use of descriptive statistics allowed for an overview of the data, including participant demographic information and the mean and standard deviation values for the perception scale used and the questions within the study instrument. Reliability for the GMO perception scale used was established post hoc using Cronbach's alpha values. Inferential statistics were employed to provide answers to the research questions. This included independent samples t-tests and paired samples t-tests.

The free recall question that appeared immediately after participant exposure to stimuli, as well as a week after exposure, required the collection of qualitative data. Following the technique Agostinho (2005) and Steede, Gorham, and Irlbeck (2016) implemented, key message statements from participant answers to open-ended questions were identified. After identifying these statements, the researcher determined how many of those statements were present in each response in order to provide comparison between the two stimuli. This technique is helpful in creating commonality and uniformity among participant answers that have slight variances, but represent the same ideas. This method allows for the emergence of varied emphases from data that may not have been reported if standardized themes were employed (Bazeley, 2009).

Description of Participants

The descriptive characteristics of the participants are reported in Table 3.2. Sixty-five participants completed the initial questionnaire; 61 of those responses were kept within the study, while four responses were removed due to missing information.

Twenty-one (34.4%) of the participants identified as male, and 40 (65.6%) of the participants identified as female. The average age of participants was 22.07 (*n* = 58, *SD* = 2.47); three participants did not report their age. The largest population of students identified as white (*n* = 34, 55.7%), had academic classification as a junior (*n* = 23, 37.7%), and were enrolled in the College of Media and Communications (*n* = 35, 57.4%). Participants were asked to report their cumulative GPA. The mean cumulative GPA of students was 3.10 (*SD* = .504); two participants chose not to provide their GPA.

Twenty-nine participants viewed the infographic, and 32 viewed the narrative. In total, 38 of the participants responded to the delayed post-test questionnaire. Twenty-five of those responded to the delayed questionnaire about the narrative with three responses being thrown out due to lack of data. Thirteen participants responded to the delayed questionnaire about the infographic, with one response being thrown out due to lack of data. A 41.54% attrition was experienced from the first questionnaire to the delayed questionnaire, with just over half of the original participants providing data through the delayed questionnaire.

Table 3.2

Demographics of Participants (N=61)

Characteristic	*f*	%
Gender		
Male	21	34.4
Female	40	65.6
Ethnicity		
American Indian or Alaskan Native	1	1.6
Asian	2	3.3
Black or African American	7	11.5
Native Hawaiian or Pacific Islander	0	0
White	34	55.7
Other / Not Listed	17	27.9
Prefer Not to Answer	0	0
Academic Classification		
Freshman	4	6.6
Sophomore	14	23.0
Junior	23	37.7
Senior	20	32.8
College of Enrollment		
College of Architecture	0	0
College of Agricultural Sciences and Natural Resources	10	16.4
College of Arts and Sciences	6	9.8
College of Business Administration	5	8.2
College of Education	0	0
College of Engineering	1	1.6
College of Human Sciences	4	6.6
College of Media and Communication	35	57.4
College of Visual and Performing Arts	0	0
School of Law	0	0

CHAPTER IV

RESULTS

Overview

The purpose of this study was to determine the effect of infographics on processing information about genetically modified (GM) foods. To accomplish this, the researcher conducted a quantitative experiment with the use of a survey instrument. This chapter provides the results of the study to answer the research questions below:

RQ1: What influence does the message stimuli have on participants' perceptions of GMOs?

RQ2: Do participants **freely recall** more information when exposed to an infographic or textual narrative?

RQ3: Is there a significant difference in participants' **cued information recall** when exposed to an infographic or textual narrative?

RQ4: Is there a significant difference in participants' **information recognition** when exposed to an infographic or textual narrative?

RQ5: Do participants **freely recall** more information a week after initial exposure when exposed to an infographic or textual narrative?

RQ6: Is there a significant difference in participants' delayed **cued information recall** when exposed to an infographic or textual narrative?

RQ7: Is there a significant difference in participants' delayed **information recognition** when exposed to an infographic or textual narrative?

Analysis of Variables

As described in Chapter III, the instrument was distributed to a convenience sample of 65 student participants via Qualtrics. Four participants were removed due to missing data, so the final sample consisted of 61 participants. Descriptive analyses are included in this chapter to give an overview of the data, followed by the inferential statistics used to analyze the research questions. Research questions 2 and 5 required the collection of qualitative data in the form of written answers from participants; therefore, the data acquired from the free recall and delayed free recall questions within the instrument was not examined in SPSS. The researcher analyzed this data to identify the message statements participants could recall from the stimulus viewed.

GMO Perceptions

To measure pre-existing perceptions toward GMOs, as well as perceptions immediately after viewing stimuli and a week later in the delayed questionnaire, a GMO perception scale was adapted from Linnhoff et al. (2017). Participant perceptions were measured prior to stimuli exposure, immediately after stimuli exposure, and a week after stimuli exposure. Descriptive statistics from these three perception measurements are shown in the next three tables. Table 4.1 illustrates average participant perceptions before they were exposed to stimuli. Participants were asked to indicate their response to each scale item using a 7-point Likert scale with 1 = *strongly disagree* and 7 = *strongly agree.* The grand mean was 3.83 (SD = 0.94) indicating overall neutral attitudes toward GMOs.

Table 4.1
Descriptive Statistics of Pre-Existing Perceptions Toward GMOs (N = 61)

Question	*M*	*SD*
GM food is pretending to be natural food	3.95	1.86
GM food production is out of touch with nature	3.87	1.74
GM foods are artificial foods	3.69	1.87
GM food production tampers with nature	4.41	1.60
GMO-Free food production means making products the way they should be	4.20	1.76
GM food production is an unwise decision	3.38	1.70
I am strongly against the production of GM food	3.16	1.76

Note: Scores based on Likert scale with 1 = *strongly disagree* and 7 = *strongly agree*

Table 4.2 provides average participant perceptions immediately after they were exposed to stimuli. Participants were asked to indicate their response to each scale item using a 7-point Likert scale with 1 = *strongly disagree* and 7 = *strongly agree.* The grand mean was 4.01 (*SD* = 1.46) indicating overall neutral attitudes toward GMOs.

Table 4.2
Descriptive Statistics of Post-Perceptions Toward GMOs (N = 61)

Question	*M*	*SD*
GM food is pretending to be natural food	4.20	1.84
GMO-Free food production means making products the way they should be	4.11	1.92
GM food production is out of touch with nature	3.95	1.76
GM food production is an unwise decision	3.44	1.84
GM foods are artificial foods	4.46	1.97
I am strongly against the production of GM food	3.28	1.81
GM food production tampers with nature	4.64	1.67

Note: Scores based on Likert scale with 1 = *strongly disagree* and 7 = *strongly agree*

Table 4.3 provides average participant perceptions one week after they were exposed to stimuli. Participants were asked to indicate their response to each scale item using a 7-point Likert scale with 1 = *strongly disagree* and 7 = *strongly agree.* The grand mean was 3.93 (*SD* = 0.64) indicating overall neutral attitudes toward GMOs.

Table 4.3
Descriptive Statistics of Delayed Perceptions Toward GMOs (N = 34)

Question	*M*	*SD*
GM food is pretending to be natural food	3.85	1.91
GMO-Free food production means making products the way they should be	4.62	1.95
GM food production is out of touch with nature	3.86	1.89
GM food production is an unwise decision	4.62	1.94
GM foods are artificial foods	3.21	1.87
I am strongly against the production of GM food	3.68	1.89
GM food production tampers with nature	3.18	1.88

Note: Scores based on Likert scale with 1 = *strongly disagree* and 7 = *strongly agree*

Pre-Existing Knowledge

To measure pre-existing knowledge about GMOs, participants were given five true/false questions that included statements about GMOs. There was also an option to select *I don't know*. The percent of correct and incorrect answers for each question are displayed in Table 4.4. The mean score was 59.67 (*SD* = 21.75).

Table 4.4
Descriptive Statistics of GMO Pre-Existing Knowledge (N = 61)

	Correct Answer		Incorrect Answer	
Item	*f*	%	*f*	%
30,000 Genetically Modified Organisms exist on grocery store shelves	31	50.8	30	49.2
The crops in the U.S. that are primarily genetically modified are soybeans, cotton, and corn.	37	60.7	24	39.3
Cross-species – or transgenic – genetic manipulation has gone as far as to combine fish DNA with strawberries and tomatoes	20	32.8	41	67.2
A GMO is a direct manipulation of an organism's DNA	44	72.1	17	27.9
The USA is the largest producer of GM crops	50	82.0	11	18.0

Pre-Existing Perceptions Compared to Delayed Perceptions

Research question 1 asked: What influence does the message stimuli have on participants' perceptions of GMOs? A paired samples t-test was conducted to compare participant perceptions of GMOs before exposure to a stimulus and a week after they were exposed to a stimulus. No significant difference was found in pre-existing perceptions of GMOs of infographic viewers (M = 3.24, SD = 1.21) and delayed perceptions of infographic viewers (M = 3.65, SD = 0.65); $t(11)$ = -1.03, p = 0.33). Despite this, average perceptions increased by 0.41 from pre-perceptions to delayed perceptions, indicating participants felt slightly more negative about GMOs a week after stimuli exposure. Similarly, no significant difference was found in pre-existing perceptions of GMOs of narrative viewers (M = 4.04, SD = 1.80) and delayed perceptions of narrative viewers (M = 4.08, SD = 0.59); $t(21)$ = -0.12, p = 0.91). Similar to the perceptions of infographic viewers, narrative viewers felt slightly more negative about GMOs a week after they were exposed to stimuli, but this increase was less than that of infographic viewers, at 0.04. Table 4.5 displays these results.

Table 4.5
Pre-Existing Perceptions Compared to Delayed Perceptions

Stimulus and perception type	*M*	*SD*	*t*	*p*
Infographic viewers pre-existing perceptions of GMOs	3.24	1.21	-1.03	0.33
Infographic viewers delayed perceptions of GMOs	3.65	0.65		
Narrative viewers pre-existing perceptions of GMOs	4.04	1.80	-0.12	0.91
Narrative viewers delayed perceptions of GMOs	4.08	0.59		

Free Recall

Research into what participants could freely recall about the stimuli was addressed with research questions 2 and 5. Research question 2 asked: Do participants freely recall more information when exposed to an infographic or textual narrative? Research question 5 asked: Do participants freely recall more information a week after initial exposure when exposed to an infographic or textual narrative? One question was used to test free recall in this study, and the same question tested free recall in the delayed post-test questionnaire in order to answer research questions 2 and 5. Participants were asked to list any information they could remember from the stimulus they viewed. The opportunity for multiple text answers required this question to be treated as qualitative data. As explained in Chapter III, message statements were analyzed from the answers participants provided. Tables 4.6 and 4.7 provide the participant statements identified for the free recall question posed after the stimulus exposure and a week later.

In the free recall question presented immediately after stimuli exposure, none of the infographic viewers mentioned the study that fed mice genetically modified food. Multiple narrative viewers recalled this piece of information. This was the only piece of information provided as a common statement that was not found in the analysis of free recall feedback from each stimulus. The only exception were statements made about graphic design elements being recalled, but this was not a possible statement that could be made by those who viewed the narrative. It should also be noted that many participants belonging to both groups were able to recall exact percentages included with the information about the CBS study conducted to gauge acceptance of GMO labeling.

Table 4.6

Presence of Message Statements by Stimulus in Post-Test (N = 61)

	Infographic (n =29)		*Narrative (n = 32)*	
	f	%	*f*	%
30,000 GMOs are on shelves in stores or 30,000 GMOs are consumed daily by everyone	14	48.28	15	46.88
Combination of fish and tomato / strawberry DNA	10	34.48	12	37.50
CBS survey about GMO labeling	8	27.59	8	25.00
The definition of a GMO	7	24.14	7	21.88
The USA produces the most GMOs	6	20.69	9	28.13
Popular GMO crops are corn, soybeans, and cotton	5	17.24	8	25.00
Information about the distraction video	5	17.24	4	12.50
The graphic design of the infographic	4	13.79	N/A	N/A
The USA does not mandate GMO labeling	3	10.34	3	9.38
GMOs are banned by 30 countries	1	3.45	7	21.88
The study done with mice and GMOs	0	0.00	7	21.88

In the delayed free recall, participants were asked to write what they could remember about the stimulus they viewed a week earlier. Six of the narrative viewers said they could not recall any information they viewed a week earlier or simply did not provide an answer at all. Two infographic viewers also provided similar responses. While it was noted in the first free recall question that multiple narrative viewers recounted the information about the study that tested genetically modified foods on mice, only one narrative viewer recalled this fact in the delayed post-test questionnaire. It can be observed there were fewer statements mentioned in the delayed free recall analysis than in the first free recall analysis.

Table 4.7
Presence of Message Statements by Stimulus in Delayed Post-Test (N = 34)

	Infographic (n =12)		*Narrative (n = 22)*	
	f	%	*f*	%
Popular GMO crops are corn, soybeans, and cotton	4	33.33	4	18.18
Combination of fish and tomato / strawberry DNA	3	25.00	6	27.27
The USA produces the most GMOs	3	25.00	1	4.55
I do not remember / did not answer	2	16.67	6	27.27
30,000 GMOs are on shelves in stores or 30,000 GMOs are consumed daily by everyone	1	8.33	5	22.73

Cued Recall

The five questions used to test cued recall were developed by the researcher and reviewed by a panel of experts. Cued recall was measured immediately after stimuli exposure and a week later using open-ended questions that had correct responses possible. The descriptive statistics for each question and the number of participants who answered those questions correctly for both the first set of cued recall questions, as well as the delayed cued recall questions, are shown in the next two tables.

The average cued recall scores for all participants was 68.75 (*SD* = 25.87) immediately after stimuli exposure. The average score for infographic viewers was 65.71

(*SD* = 28.21). This indicates an overall failing score on a grading scale of 100%. The average score for narrative viewers was 68.75 (*SD* = 25.87). Similar to infographic viewers, this indicated a failing score on a grading scale of 100%, although narrative viewers overall cued recall score was higher than that of infographic viewers. These results can be seen in Table 4.8.

Table 4.8
Cued Recall Questions Answered Correctly (N = 61)

Question	*Infographic (n = 29)*		*Narrative (n = 32)*	
	f	%	*f*	%
Which country is the largest producer of GM crops?	28	96.55	32	100.00
A GMO is a direct manipulation of an organisms_____	23	79.31	21	65.63
Because of the large amount of foods that contain soy, how many GMOs exist on grocery store shelves?	18	62.07	27	84.38
Cross-species – or transgenic – genetic manipulation has combined the DNA of what two organisms?	14	48.28	13	40.63
What crops in the U.S. are primarily GMO?	8	27.59	12	37.50

The average delayed cued recall scores for participants was 59.41 (*SD* = 27.63) one week after stimuli exposure. The average score for infographic viewers was 61.67 (*SD* = 31.29). This indicates an overall failing score on a grading scale of 100%. The average score for narrative viewers was 58.18 (*SD* = 26.12). Similar to infographic viewers, this indicated a failing score on a grading scale of 100%, but unlike the first round of cued recall questions, infographic viewers scored higher on delayed cued recall questions. This indicates that infographic viewers remembered information longer than narrative viewers. Both stimuli groups had decreased average scores from post-cued recall to delayed cued recall. These results can be seen in Table 4.9.

Table 4.9
Delayed Cued Recall Questions Answered Correctly (N = 34)

Question	*Infographic (n= 12)*		*Narrative (n= 22)*	
	f	%	*f*	%
A GMO is a direct manipulation of an organisms_____	10	90.91	17	77.27
Which country is the largest producer of GM crops?	9	81.82	21	95.45
Cross-species – or transgenic – genetic manipulation has combined the DNA of what two organisms?	7	63.64	7	31.82
Because of the large amount of foods that contain soy, how many GMOs exist on grocery store shelves?	7	63.64	10	45.45
What crops in the U.S. are primarily GMO?	3	27.27	7	31.82

Research question 3 asked: Is there a significant difference in participants' cued information recall when exposed to an infographic or textual narrative? Research question 6 asked: Is there a significant difference in participants' delayed cued information recall when exposed to an infographic or textual narrative? To answer research questions 3 and 6, a paired samples t-test was conducted to compare cued recall and delayed cued recall scores of both the infographic viewers and the narrative viewers. These results can be found in the next two tables.

No significant difference was found in cued recall question scores for infographic viewers (M = 70.00, SD = 27.63) and narrative viewers (M = 68.18, SD = 27.37); t(58) =

-0.44, p = 0.67. However, infographic viewers scored higher on average than narrative viewers (Table 4.10).

Table 4.10
Cued Recall Scores for Both Stimulus Groups (N = 61)

Stimuli	*M*	*SD*	*t*	*p*
Infographic Viewers (*n* = 29)	70.00	27.63	-0.44	0.67
Narrative Viewers (*n* = 32)	68.18	27.37		

No significant difference was found in delayed cued recall question scores for infographic viewers (M = 61.67, SD = 31.29) and narrative viewers (M = 58.18, SD = 26.12); $t(32)$ = 0.35, p = 0.73. Similar to post-cued recall scores, infographic viewers scored higher on average than narrative viewers. Average scores from post-cued recall to delayed cued recall decreased for both groups. These results can be seen in Table 4.11.

Table 4.11
Delayed Cued Recall Scores for Both Stimulus Groups (N = 34)

Stimuli	*M*	*SD*	*t*	*p*
Infographic Viewers (*n* = 12)	61.67	31.29	0.35	0.73
Narrative Viewers (*n* = 22)	58.18	26.12		

Recognition

The 10 true/false questions used to test information recognition were developed by the researcher and reviewed by a panel of experts. Recognition was measured immediately after stimuli exposure and a week later. The descriptive statistics for each question and the number of participants who answered those questions correctly for both the first set of recognition questions, as well as the delayed recognition questions, are shown in the following two tables.

The average recognition scores for all participants was 91.08 (*SD* = 10.96) immediately after stimuli exposure. The average score for infographic viewers was 89.66 (*SD* = 13.49), which indicates an overall passing score on a grading scale of 100%. The average score for narrative viewers was 92.50 (*SD* = 8.42). Similar to infographic viewers, this indicated a passing score on a grading scale of 100%. Narrative viewers scored higher on average on recognition questions. These results can be seen in Table 4.12.

Table 4.12
Recognition Questions Answered Correctly (N = 61)

Question	*Infographic (n = 29)*		*Narrative (n = 32)*	
	f	*%*	*f*	*%*
A GMO is a direct manipulation of an organisms DNA	29	100.00	28	87.50
The crops in the U.S. that are primarily GM are soybeans, cotton, and corn	28	96.55	32	100.00
The USA is the largest producer of GM crops	28	96.55	32	100.00
30,000 GMOs exist on grocery store shelves	27	93.10	31	96.88
The crops in the U.S. that are primarily GM are grapes, alfalfa, and cantaloupe	27	93.10	30	93.75
Cross-species - or transgenic – genetic manipulation has gone as far as to combine fish DNA with strawberries and tomatoes	25	86.21	30	93.75
Cross-species - or transgenic – genetic manipulation has combined the DNA of a monkey with a cauliflower plant	25	86.21	28	87.50
China is the country that produces the largest amount of GM crops	24	82.76	31	96.88

A GMO is an organism grown without alteration to its DNA	24	82.76	22	68.75
Only 10 kinds of GMOs exist on grocery store shelves	23	79.31	31	96.88

The average delayed recognition scores for all participants was 88.33 (*SD* = 14.48) one week after stimuli exposure. The average score for infographic viewers was 89.17 (*SD* = 13.11) indicating an overall passing score on a grading scale of 100%. The average score for narrative viewers was 87.50 (*SD* = 15. 85), which is also a passing score on a grading scale of 100%. Unlike post-recognition, infographic viewers scored higher on average than narrative viewers in delayed recognition. These results can be seen in Table 4.13.

Table 4.13
Delayed Recognition Questions Answered Correctly (N = 34)

Question	*Infographic (N = 12)*		*Narrative (N = 22)*	
	f	%	*f*%	
The crops in the U.S. that are primarily GM are soybeans, cotton, and corn	12	100.00	21	95.45
Only 10 kinds of GMOs exist on grocery store shelves	12	100.00	18	81.82
A GMO is an organism grown without alteration to its DNA	11	91.67	17	77.27
Cross-species - or transgenic – genetic manipulation has gone as far as to combine fish DNA with strawberries and tomatoes	11	91.67	18	81.82
The crops in the U.S. that are primarily GM are grapes, alfalfa, and cantaloupe	11	91.67	20	90.91
A GMO is a direct manipulation of an organisms DNA	11	91.67	18	81.82
The USA is the largest producer of GM crops	11	91.67	20	90.91

Cross-species - or transgenic – genetic manipulation has combined the DNA of a monkey with a cauliflower plant	10	83.33	17	77.27
30,000 GMOs exist on grocery store shelves	10	83.33	21	95.45
China is the country that produces the largest amount of GM crops	8	66.67	22	100.00

Comparison of Recognition and Delayed Recognition Scores

Determining the participants' information recognition from the stimuli was addressed with research questions 4 and 7. Research question 4 asked: Is there a significant difference in participants' information recognition when exposed to an infographic or textual narrative? Research question 7 asked: Is there a significant difference in participants' delayed information recognition when exposed to an infographic or textual narrative? To answer research questions 4 and 7, a paired samples t-test was conducted to compare recognition and delayed recognition scores of both the infographic viewers and the narrative viewers. These results are presented in the next two tables.

No significant difference was found in recognition question scores for infographic viewers (M = 92.73, SD = 8.27) and narrative viewers (M = 92.50, SD = 11.38); $t(59)$ =-1.00, p = 0.32. Average recognition scores for each group were nearly identical, with infographic viewers having a higher average score by 0.23. These results can be seen in Table 4.14.

Table 4.14
Recognition Question Scores for Both Stimulus Groups (N = 61)

Stimuli	*M*	*SD*	*t*	*p*
Infographic Viewers (N = 29)	92.73	8.27	-1.00	0.32
Narrative Viewers (N = 32)	92.50	11.38		

No significant difference was found in delayed recognition scores for infographic viewers (M = 87.73, SD = 15.41) and narrative viewers (M = 89.17, SD = 13.11); $t(30)$ = 0.31, p = 0.76. Unlike the post-recognition scores, the narrative viewers had higher average delayed recognition scores than infographic viewers. These results can be seen in Table 4.15.

Table 4.15
Delayed Recognition Scores for Both Stimulus Groups (N = 34)

Stimuli	*M*	*SD*	*t*	*p*
Infographic Viewers (N = 12)	87.73	15.41	0.31	0.76
Narrative Viewers (N = 22)	89.17	13.11		

CHAPTER V

CONCLUSIONS, DISCUSSION, AND RECOMMENDATIONS

Overview

The purpose of this study was to determine the effect of infographics on processing information about genetically modified (GM) foods. The results of this study contribute to the argument that visual representations have a place in agricultural communications and should ultimately be incorporated into agricultural literacy efforts in hopes of generating higher information retention frequencies in audiences. This chapter summarizes the results reported in Chapter IV and provides key findings, conclusions, discussion, and recommendations.

Key Findings

Seven research questions were examined in this study, and the key findings for each are provided below.

RQ1: What influence does the message stimuli have on participants' perceptions of GMOs?

The results of the paired samples t-test found no significant difference in participant perceptions toward GMOs before exposure to stimuli and a week after stimulus exposure. However, the mean for those who received the infographic stimuli increased by 0.41 from before viewing the stimuli to when their perceptions were collected a week later, while the mean for those who received the narrative only increased by 0.04.

RQ2: Do participants freely recall more information when exposed to an infographic or textual narrative?

The results of the qualitative analysis of free recall answers indicated no meaningful differences between what the group who viewed the infographic freely recalled compared to the group who viewed the narrative.

RQ3: Is there a significant difference in participants' cued information recall when exposed to an infographic or textual narrative?

The results of the independent samples t-test found no significant difference in cued information scores between the two groups.

RQ4: Is there a significant difference in participants' information recognition when exposed to an infographic or textual narrative?

The results of an independent samples t-test found no significant difference in information recognition scores between the two groups.

RQ5: Do participants freely recall more information a week after initial exposure when exposed to an infographic or textual narrative?

The results of the qualitative analysis found no meaningful differences between what the group who viewed the infographic freely recalled compared to the group who viewed the narrative.

RQ6: Is there a significant difference in participants' delayed cued information recall when exposed to an infographic or textual narrative?

The results of the independent samples t-test found no significant difference in delayed cued information scores between the two groups.

RQ7: Is there a significant difference in participants' delayed information recognition when exposed to an infographic or textual narrative?

The results of the independent samples t-test found no significant difference in delayed information recognition scores between the two groups.

Conclusions and Discussion

The results of this study did not find that one form of information presentation was more effective than the other at altering perceptions about the given topic. This adds to the existing issue of how to change attitudes about agricultural production practices. This is a difficult task because the public has little understanding of agriculture (Settle et al., 2017) and the complexities involved within the industry (Doerfert, 2011). Therefore, it is difficult to influence or altogether change perceptions, and that process will most likely not occur with the viewing of a simple infographic. In response, agricultural literacy campaigns must stay consistent in their efforts to allow audiences to retain information, with the ultimate goal being the gain of general agricultural knowledge (Spielmaker & Leising, 2013), and eventually the encouragement of changes of perceptions toward agriculture. As Dale et al. (2016) and Specht et al. (2014) reported, college age students are especially lacking in knowledge about the agriculture industry and require consistent exposure to agricultural concepts in order to reinforce information, especially those students who report low agricultural literacy levels.

The free recall, cued recall, and information recognition measures used in this study gauged the ability of the two stimuli to create information retention and recall in viewers. There was no statistically significant difference found in free recall, cued recall, and information recognition rates when information was presented in either the form of an infographic or a narrative. These findings are similar to those of Lyra et al. (2016) who also used free recall, cued recall questions, and information recognition questions, as well as a delayed survey method to measure information retention and recall. The difference in the allocation of resources between the two stimuli could help explain the non-significance observed between the groups. While the two groups were presented with the same information, infographic viewers were required to view graphical representations that narrative viewers did not see. The narrative viewers were responsible for creating mental representations for information on their own, whereas the infographic viewers did not have to put as much effort into this cognitive step. So while informational presentation could have played a role in resource allocation, participants were still intaking the same information and experiencing the introduction of novel information that took more effort to process than information that did not have an impact on viewers or was information they already knew.

Also comparable to the findings of Lyra et al. (2016), the current study found infographic viewers demonstrated better long-term recall on average than narrative viewers, although there was no statistically significant difference found between the two groups on any of the variables measured. However, unlike Lyra et al. (2016), the current study measured participant post-test perceptions of GMOs as a dependent variable. As previously mentioned, perceptions were not altered by either stimulus.

The current study’s conclusion that infographics are not superior to textual information is not consistent with what Yildirim (2016) or Comello et al. (2016) found. Both of these studies found infographics outperformed purely textual information when participants were tested on information retention. However, Yildrim (2016) had participants self-report their opinion of how much more effective infographics were than text rather than testing the true information retention of participants with recall and recognition questions. Additionally, Comello et al. (2016) tested multiple health literacy modules, and only one of these modules indicated infographics were more effective than purely textual information. Although these studies did claim infographics are superior to textual information, they did not test the information recall of participants, thus neglecting to explore the educational potential of infographics. However, these studies did ask participants about their feelings toward infographics, and those feelings were reported to be positive. So, although knowledge gain was not measured, participants liked infographics, and that alone could be an indicator of learning from the materials. If an individual is partial to a certain format of information, he or she will likely choose that format to learn from and gain more information from it than from a different format. While a viewer's preference is not scientific and is only known by each individual, feeling positively toward a specific presentation of information could lead to decreased cognitive strain and increased information retention because the viewers are enjoying what they are looking at. Yildrim (2016) also credited the ability of infographics to educate viewers to the way in which infographics are organized, with the important points emphasized.

While this study did not find infographics are more effective at creating information retention and recall, it did affirm infographics are just as effective at communicating information about GMOs as narrative text. This implies these visualizations can be used to reach educational goals when communicating complex topics and infographics can compete with more traditional forms of educational materials. This conclusion is similar to what Ozdamla et al. (2016) found when incorporating infographics in an anatomy course, and Meppelink et al. (2015) also discovered in their study that used infographics to communicate health literacy topics. These findings, including those of the current study, support the CLT and LC4MP by demonstrating cognitive load can be reduced by using visuals and minimizing the amount of information presented to viewers. The subprocesses of encoding, storage, and retrieval can occur without interruption, and even more quickly, as visualizations are provided to viewers, thus eliminating the need for viewers to create a new mental visualization for incoming information.

Infographics serve as an efficient way to present information while enabling information retention. As Hattwig et al. (2013) stated, visual literacy has become a mandatory aspect of education. Therefore, infographics should be employed in all aspects of education when possible to address the need to improve visual literacy. Students will continue to see more infographics, so it is vital they can critique those visual representations and perhaps even leverage this form of communication to demonstrate of knowledge.

Recommendations

This section explores potential future research in the areas covered in this study as well as implications for practice.

Research

An aspect of the LC4MP not tested in this study was the effect of emotions on information processing. Two different systems are involved with this. The first system entails responses to negative stimuli and defending against potential threats. The second system is a natural desire to satisfy behavioral needs and responds to positive stimuli and supports motivated behavior and information gathering (Lang, Sanders-Jackson, Wang, & Rubenking, 2012). Research should be conducted on the rate of information recall from infographics that are framed negatively or positively to determine if one of the frames evokes higher recall rates because of the format of the presented information. This research could be an extension of this study and use GMO infographics that present obviously biased information from both a negative and positive aspect.

An additional aspect based on the LC4MP that was not considered in the current study was secondary task reaction time (STRT). STRT can be helpful in determining the attention allocated to a medium (Bracken, Pettey, & Wu, 2014). By introducing distractions or increasing level of difficulty while participants are viewing media, the amount of resources being allotted in efforts to pay attention or understand the information can be measured, as well as the amount of cognitive strain participants are experiencing. Information like this could be helpful for future research in this area that focuses on cognitive overload, resources allocation, and knowledge gain and knowing how participants allocate cognitive resources.

The LC4MP is a relatively new model introduced less than 20 years ago that has not been applied in many studies. Agricultural communications professionals should use this model in research to understand consumer message processing. This model could have great implications for advertising and marketing, as well as more specific issues like GM food labeling.

Another recommendation for future research in this area is to complete an eye tracking study. Using eye-tracking technology would allow researchers to determine what elements viewers focus on most while viewing infographics and if any elements distracted viewers from retaining information. Results from research conducted in this area could help infographic designers during the process of deciding what information to include on an infographic, along with the visualizations used to represent information. Designers would be able to have a sense of what the balance of an infographic would look like, meaning that if too many visuals distract a viewer from retaining information, those visuals can be replaced with text, and vice versa. This type of research could increase the effectiveness of infographics by concluding what the correct use of visuals and text is that allows viewers to retain the information on the infographic.

A similar study could be conducted on this topic, but the stimuli should be embedded into other materials, like a magazine or informational pamphlet. The effects of infographics on information retention should be tested in this way because the current study did not provide ecological validity since it was conducted in a lab setting. By embedding infographics into a material that has other information within it, the ecological validity of infographics would remain intact, while the effects of infographics on information retention could be examined because there will be other information competing for viewer attention. A study like this would determine if infographics are effective at communicating information in the midst of other materials competing for viewers' attention and cognitive resources.

The design aspects of visual communications should be a subsequent area of research. Factors like color, layout, font choices, and images should all be examined to gauge viewer preference and visual appeal, as well as cognitive preference. As Meeusah and Tangkijviwat (2013) found, hue of color on an infographic can have an impact on level of information comprehension. When the color yellow is used against a white background, information is hard to see, and therefore, learning is hindered. Na and Suk (2014) used a color emotion equation to identify the emotions different colors evoke. This aspect could be combined with the appetitive and aversive aspects of the LC4MP to determine the emotions viewers feel when presented with infographics containing different colors. In regard to layout, Yildrim (2016) found viewers preferred vertical layouts of infographics. This is contributed to the ease of vertical infographics when scrolling, as compared to horizontal infographics, which are the least preferred. The time a viewer takes to read an infographic can increase when a vertical format is used, as readers tend to read faster when information is in a vertical layout (Yidrim, 2016). Multiple layouts should be tested to confirm this notion and to test learning ability and determine if one layout is superior in creating higher rates of knowledge gain. The infographic used in this study should be tested against other infographics about the same topic but have a different layout. This would reveal how much the layout truly affects what is retained from an infographic.

Past literature mentions adults are often neglected from agricultural literacy research (Bellah & Dyer, 2007; Pense et al., 2006). Therefore, an experiment should be performed with adults who are older than college age to gauge the perceptions and agricultural literacy levels of individuals who are no longer involved in standardized educational programs, as previously mentioned. Adults are the individuals in society who are voting and influencing agricultural policy decisions. Spielmaker and Leising (2013) claimed that in order for agriculture to successfully provide for the country's population, "agriculture needs to be understood and valued by all" (p. 1). If understanding is gained by the people who make decisions that influence governmental policy in our society, it could aid the agricultural industry and eliminate some of the challenges the industry faces (Kovar & Ball, 2013).

One limitation of the study was the low response rate for the delayed post-test questionnaire. Participants in this particular study were not motivated to partake in the delayed questionnaire because it was not worth as much extra credit as the first questionnaire, and they were not required to come to the media lab to take the delayed questionnaire. The attrition from the original questionnaire to the delayed questionnaire most likely affected findings and the fact that no statistically significant difference was observed between the two groups. It is recommended an incentive for delayed questionnaires surveys be made equal or higher than the first survey. Future research should attempt to have participants return to the lab where they took the first questionnaire to ensure the delayed questionnaires do indeed get completed rather than lost in emails or simply ignored.

This study should be repeated with more than two conditions with the possibility of adding a control group. The delayed post-test technique should be kept in order to efficiently measure the long-term memory, and ultimately, knowledge gain, of participants. It is also recommended this study be replicated with more participants to obtain generalizable results. Doerfert (2003) found an overwhelming majority of agricultural literacy studies employed non-experimental research designs, so more experimental research in the field of agricultural literacy should be conducted.

Practice

As mentioned, agricultural literacy campaigns can benefit from the use of the LC4MP model to better understand which forms of communications are most effective at teaching agriculture concepts. By understanding how audiences encode, store, and recall information, and recognizing that overly complex information causes these subprocesses to halt, designers of agricultural literacy curriculum can create materials that do not overload cognitive resources while simultaneously supporting the learning of information.

In this study, participants recalled multiple facts from the infographic in the free recall, cued recall, and information recognition questions. They were also able to recall those same facts in the delayed questionnaire. These facts included the 30,000 GMOs on grocery store shelves fact and the crossing of fish DNA with that of strawberries and tomatoes fact. On the infographic, the fact with the number 30,000 had the number written in large font to make it more noticeable. The DNA fact was accompanied by a visualization of a fish crossed with a strawberry. It is likely these facts were memorable because of the large visualizations used to illustrate them, and they contained novel information to viewers. Novel and surprising information can be remembered better than common visualizations like graphs or charts (Borkin, 2013). The LC4MP model can be used to explain why participants remembered facts like these. Because there was not much text to go along with these facts on the infographic, the visuals used as informational representations were easy to comprehend and store in memory and later recall when prompted by the questions within the study instrument. These statements in the narrative did not contain visual representations but did present viewers with novel information that triggered an orienting response (Lang, 2009) and led to allocation of resources to absorb this information because it presented new or unexpected information.

The emotional aspect of the LC4MP can be used to understand how viewers react to positive and negative messages. This could be helpful when deciding what type of information to present to audiences and how to frame that information. For example, if it is known that viewers will remember negative information because it is shocking and uncomfortable to hear, then presenting negative side effects of not growing and purchasing GMO foods may be the tactic to use when communicating about GMOs and attempting to influence perceptions. Additionally, professionals working on behalf of agricultural literacy campaigns should provide more information more frequently, and the curriculum should be more robust and diverse. To enhance curriculum in these ways, dynamic visual communications techniques like infographics should be integrated to present the wide array of topics within agriculture, especially complex topics like genetic modification. Including techniques in this curriculum to reach individuals in all age groups, not just school-aged children, will produce more diverse agricultural literacy campaigns.

While searching for an infographic to use in this study, it was noted there were many infographics being produced by groups who categorize themselves as anti-GMO. Very few infographics found were from agricultural companies and contained factual, unbiased information. Even the infographic used in this study contained information from a study that was later retracted. Agricultural companies should produce infographics to ensure factual information is available to consumers. By using all available communication tools, the agriculture industry can continue to combat misinformation and increase literacy levels.

In addition to the visual elements of infographics being studied, the integration of infographics in adult education should also be considered. Modern curriculum in higher education is often standardized in order to teach many people at once. After students leave formal education settings, there is no standardized curriculum that continues to teach them. Students transitioning to adulthood become responsible for furthering their knowledge and are responsible for the mediums through which they choose to receive information. This makes it imperative for agricultural literacy campaigns to create educational materials adults will find important enough to spend time learning from. Convenience is important to many people, as well as brevity of information. Infographics are an ideal method of communication to inform adult audiences.

Multiple authors have proven infographics have a place in classroom education among various school grades and age groups (Martin et al., 2018; Vanichvasin, 2013; Odzamla et al., 2016). Infographics should be incorporated into classroom instruction, either as supplementary material to existing curriculum or as stand-alone materials that teach concepts unaided. Davidson (2014) had students develop their own infographics focused on environmental subjects the class was studying. After the students performed research, they synthesized their findings into an infographic while proposing solutions to problems. Students were fascinated by the combination of data and graphic design, thus encouraging more exploration into the topics addressed (Davidson, 2014). This phenomenon can be experienced by students in any classroom setting, but the learning process is taken a step further when students are enabled to create their own infographics. This requires students to formulate visuals that personally represent the information they are learning, thus better enabling them to retain information because they had a part in the explanation of data and were able to connect pre-existing knowledge to new information.

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APPENDICES

APPENDIX A: RECRUITMENT MATERIALS

Participants were recruited through the College of Media and Communications SONA system. The following information was available sent in announcements to members of the SONA system, and was available for viewing on the College of Media and Communications SONA website.

Study Name	The Effect of Infographics on Recall of Information about Genetically Modified Foods
Study Type	**Standard (lab) study** This is a standard lab study. To participate, sign up, and go to the specified location at the chosen time.
Credits	0.75 Credits
Duration	30 minutes
Abstract	This is a **Lab** study worth **.75** study credits. It will take **30 minutes** of your time.
Description	This study is called "The Effect of Infographics on Recall of Information about Genetically Modified Foods." The research findings will be used to inform future research about communication and education techniques in the field of agricultural communications. In this study, you will be asked to take a survey via computer. In this survey, you will be asked to answer questions about your knowledge and perception of GMOs, as well as view an infographic or read a paragraph. You will be asked to answer questions about whichever medium you view. If you agree to provide your email address, you will be sent a follow up survey a week later that contains questions about this study. You will receive additional study credit if you take the delayed survey. Participation will take about 30 minutes of your time, including the follow up survey. *If you would like to participate but object to the study procedures or cannot participate at the available times, you may earn alternate study credit while the study is active. Please contact Dr. Glenn Cummins, associate dean for research, at glenn.cummins@ttu.edu.*
Researchers	Courtney Meyers Kassie Waller
Deadlines	Deadlines that occur on a Saturday or Sunday will be moved back to Friday Sign-Up: 24 hour(s) before the appointment Cancellation: 24 hour(s) before the appointment

Figure A.1. SONA recruitment information.

APPENDIX B: THESIS INSTRUMENT

Demographics

What is your gender?

- ○ Male (1)
- ○ Female (2)
- ○ Prefer Not to Answer (3)

What year were you born?

____

What is your ethnicity?

- ○ American Indian or Alaska Native (1)
- ○ Asian (2)
- ○ Black or African American (3)
- ○ Native Hawaiian or Other Pacific Islander (4)
- ○ White (5)
- ○ Other/Not Listed (6)
- ○ Prefer Not to Answer (7)

Appendix B, Continued

What is your classification?

- ○ Freshman (1)
- ○ Sophomore (2)
- ○ Junior (3)
- ○ Senior (4)
- ○ Graduate (5)

Which Texas Tech college are you currently enrolled with as a student?

- ○ College of Architecture (1)
- ○ College of Agricultural Sciences and Natural Resources (2)
- ○ College of Arts and Sciences (3)
- ○ College of Business Administration (4)
- ○ College of Education (5)
- ○ College of Engineering (6)
- ○ College of Human Sciences (7)
- ○ College of Media and Communication (8)
- ○ College of Visual and Performing Arts (9)
- ○ School of Law (10)

What is your cumulative GPA?

____

Appendix B, Continued

Pre-knowledge questions

Please answer the following questions to the best of your ability:

30,000 Genetically Modified Organisms exist on grocery store shelves

- ○ True (4)
- ○ False (5)
- ○ I don't know (6)

The crops in the U.S. that are primarily genetically modified are soybeans, cotton, and corn.

- ○ True (1)
- ○ False (2)
- ○ I don't know (3)

Cross-species - or transgenic - genetic manipulation has gone as far as to combine fish DNA with strawberries and tomatoes

- ○ True (1)
- ○ False (2)
- ○ I don't know (3)

A GMO is a direct manipulation of an organisms DNA.

- ○ True (1)
- ○ False (2)
- ○ I don't know (3)

Appendix B, Continued

The USA is the largest producer of GM crops.

- True (1)
- False (2)
- I don't know (3)

Pre-perception scale

Please rate your agreement with the following statements about genetically modified (GM) food.

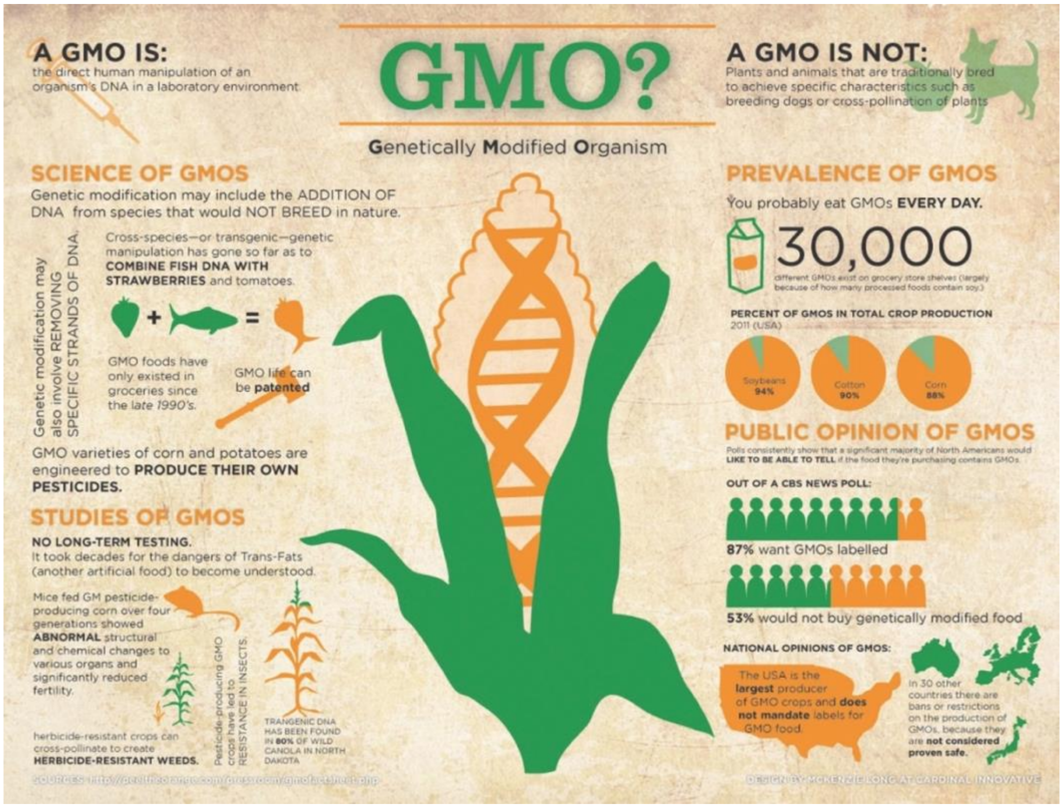
	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
I believe GM foods are fundamentally against nature (1)							
GM food is pretending to be natural (2)							
GM food is authentic food (3)							
GM food production is out of touch with nature (4)							

Appendix B, Continued

GM foods are artificial foods (5)	○	○	○	○	○	○	○
GM food production tampers with nature (6)	○	○	○	○	○	○	○
GMO-FREE food production means making products the way they should be (7)	○	○	○	○	○	○	○
GM food production is a good idea (8)	○	○	○	○	○	○	○
GM food production is an unwise decision (9)	○	○	○	○	○	○	○
I am strongly against the production of GM food (10)	○	○	○	○	○	○	○

Appendix B, Continued

Stimuli exposure



Appendix B, Continued

Please read the following narrative:

Science of GMOs
A Genetically Modified Organism (GMO) is a human manipulation of an organism's DNA. Genetic modification may include the addition of DNA from species that would not breed in nature. The process may also involve removing specific strands of DNA. A cross-species – or transgenic – genetic manipulation has gone so far as to combine fish DNA with strawberries and tomatoes. Some GMO varieties of corn and potatoes are engineered to produce their own pesticides. GMO life can be patented. A GMO is not a plant or animal that has been traditionally bred to achieve specific characteristics such as breeding dogs or cross-pollination of plants.

Prevalence of GMOs
GMO have only existed in food since the late 1990's, but now you probably eat GMOs every day. More than 30,000 different GMOs exist on grocery store shelves (largely because of how many processed foods contain soy). In 2011, the GMOs compromised 94% of total crop production in soybeans, 90% in cotton, and 88% in corn.

Studies of GMOs
It took decades for the dangers of trans-fats (another artificial food) to become understood. Mice fed GM pesticide-producing corn over four generations showed abnormal structural and chemical changes to various organs and significantly reduced fertility. Pesticide-producing GMO crops have led to resistance in insects, and herbicide-resistant crops can cross-pollinate to create herbicide-resistant weeds. Transgenic DNA has been found in 80% of wild canola in North Dakota.

Public Opinion of GMOs
Polls constantly show that a significant majority of North Americans would like to be able to tell if the food they are purchasing contains GMOs. Out of a CBS news poll, 87% want GMOs labeled, and 53% would not buy genetically modified food. The USA is the largest producer of GMO crops and does not mandate labels for food containing GMOs. In 30 other countries, there are bans or restrictions on the production of GMOs because they are not considered proven safe.

Distraction Video

https://www.youtube.com/watch?v=Vmb1tqYqyII#action=share

Free recall question

List any information you ca recall from the infographic/narrative you viewed:

Appendix B, Continued

Cued recall questions

You viewed an infographic/narrative that contained information about GMOs. What crops in the U.S. are primarily GM?

____

What country is the largest producer of GM crops?

____

Fill in the blank: A GMO is a direct manipulation of an organism's________:

Cross-species - or transgenic - genetic manipulation has combined the DNA of what two organisms?

____

Because of the large amount of foods that contain soy, how many GMOs exist on grocery store shelves?

____

Information recognition questions

China is the country that produces the largest amount of GM crops.

○ True (1)

○ False (2)

30,000 GMOs exist on grocery store shelves

○ True (1)

○ False (2)

Appendix B, Continued

The crops in the U.S. that are primarily GM are soybeans, cotton, and corn.

○ True (1)

○ False (2)

A GMO is an organism grown without alteration to its DNA.

○ True (1)

○ False (2)

Cross-species - or transgenic - genetic manipulation has gone as far as to combine fish DNA with strawberries and tomatoes

○ True (1)

○ False (2)

The crops in the U.S. that are primarily GM are grapes, alfalfa, and cantaloupe.

○ True (1)

○ False (2)

Only 10 kinds of GMOs exist on grocery store shelves.

○ True (1)

○ False (2)

A GMO is a direct manipulation of an organisms DNA.

○ True (1)

○ False (2)

Appendix B, Continued

Cross-species - or transgenic - genetic manipulation has combined the DNA of a monkey with a cauliflower plant.

- True (1)
- False (2)

The USA is the largest producer of GM crops.

- True (1)
- False (2)

Post-perception scale

Please rate your agreement with the following statements about genetically modified (GM) food.

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
I believe GM foods are fundamentally against nature (1)	○	○	○	○	○	○	○
GM food is pretending to be natural (2)	○	○	○	○	○	○	○
GM food is authentic food (3)	○	○	○	○	○	○	○
GM food production is out of touch with nature (4)	○	○	○	○	○	○	○

Appendix B, Continued

GM foods are artificial foods (5)	○	○	○	○	○	○	○
GM food production tampers with nature (6)	○	○	○	○	○	○	○
GMO-FREE food production means making products the way they should be (7)	○	○	○	○	○	○	○
GM food production is a good idea (8)	○	○	○	○	○	○	○
GM food production is an unwise decision (9)	○	○	○	○	○	○	○
I am strongly against the production of GM food (10)	○	○	○	○	○	○	○

Disclaimer Statements

The infographic you viewed does not fully represent the views of the agriculture industry. The 2012 study that reported a connection between mice fed GM pesticide-producing corn and the development of abnormalities was later retracted due to misrepresentation of the data. Genetically modified foods have not been proven to cause any negative health effects in the people or animals that consume them. For accurate information about GM foods, you can find infographics and reports at http://isaaa.org. Thank you for taking the time to complete this survey and contribute to research within agriculture.

Appendix B, Continued

The narrative you read does not fully represent the views of the agriculture industry. The 2012 study that reported a connection between mice fed GM pesticide-producing corn and the development of abnormalities was later retracted due to misrepresentation of the data. Genetically modified foods have not been proven to cause any negative health effects in the people or animals that consume them. For accurate information about GM foods, you can find infographics and reports at http://isaaa.org. Thank you for taking the time to complete this survey and contribute to research within agriculture.

Email address

To participate in the follow-up survey to this study and earn extra SONA credit, please provide your Texas Tech email. The follow-up survey will take approximately 10 minutes.

____

Delayed Post-Test Questionnaire Instrument

Delayed free recall question

You took a survey a week ago in which you read a narrative/viewed an infographic. Please recall any information you can recall from the narrative you read/infographic you viewed:

____

____

____

____

____

Delayed cued recall questions

You read a narrative/viewed an infographic that contained information about GMOs. What crops in the U.S. are primarily GM?

____

Appendix B, Continued

What country is the largest producer of GM crops?

____

Fill in the blank: A GMO is a direct manipulation of an organism's________:

Cross-species - or transgenic - genetic manipulation has combined the DNA of what two organisms?

____

Because of the large amount of foods that contain soy, how many GMOs exist on grocery store shelves?

____

Delayed Information recognition questions

China is the country that produces the largest amount of GM crops.

- ○ True (1)
- ○ False (2)

30,000 GMOs exist on grocery store shelves

- ○ True (1)
- ○ False (2)

The crops in the U.S. that are primarily GM are soybeans, cotton, and corn.

- ○ True (1)
- ○ False (2)

A GMO is an organism grown without alteration to its DNA.

- ○ True (1)
- ○ False (2)

Appendix B, Continued

Cross-species - or transgenic - genetic manipulation has gone as far as to combine fish DNA with strawberries and tomatoes

○ True (1)

○ False (2)

The crops in the U.S. that are primarily GM are grapes, alfalfa, and cantaloupe.

○ True (1)

○ False (2)

Only 10 kinds of GMOs exist on grocery store shelves.

○ True (1)

○ False (2)

A GMO is a direct manipulation of an organism's DNA.

○ True (1)

○ False (2)

Cross-species - or transgenic - genetic manipulation has combined the DNA of a monkey with a cauliflower plant.

○ True (1)

○ False (2)

The USA is the largest producer of GM crops.

○ True (1)

○ False (2)

Appendix B, Continued

Delayed perception scale

Please rate your agreement with the following statements about genetically modified (GM) food.

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
I believe GM foods are fundamentally against nature (1)	○	○	○	○	○	○	○
GM food is pretending to be natural (2)	○	○	○	○	○	○	○
GM food is authentic food (3)	○	○	○	○	○	○	○
GM food production is out of touch with nature (4)	○	○	○	○	○	○	○
GM foods are artificial foods (5)	○	○	○	○	○	○	○
GM food production tampers with nature (6)	○	○	○	○	○	○	○

Appendix B, Continued

GMO-FREE food production means making products the way they should be (7)	○	○	○	○	○	○	○
GM food production is a good idea (8)	○	○	○	○	○	○	○
GM food production is an unwise decision (9)	○	○	○	○	○	○	○
I am strongly against the production of GM food (10)	○	○	○	○	○	○	○

Email address

Please provide your email address. This will not be used to contact you further, but simply to match responses between the two surveys. Please provide the same email you provided in the first survey.

APPENDIX C: ORAL SCRIPT

This information was orally presented to the participants upon entering the media laboratory to participate in the survey. This oral script was approved by the HRPP during the IRB approval process.

Hello, I am Kassie Waller, a master's student within the Department of Agricultural Education and Communications. I am conducting research for my thesis comparing infographics to text to determine which form of communication is better for teaching complex subjects within agriculture.

In this study, you will be asked to view one of these forms of communication and take a survey via a computer. You will be providing invaluable knowledge to the fields of agricultural communications. Your participation is completely voluntary. Dr. Meyers, who is the primary researcher of this study, and the Institutional Review Board have reviewed the questions and think you can answer them comfortably.

We are asking for 20 minutes of your time. There will be a delayed survey that you will receive a link to via email a week from today that will ask some of the same questions that you will see in today's survey. You will receive extra SONA credit if you take this survey, and it should take about 10 minutes to complete.

Your name will not be linked to any documentation and any use of this material in reports, publications, or presentations will never be associated with participants in this study without permission. No one other than the researchers associated with this project have access to the raw data. All related documentation will be stored in the researcher's office on a password protected computer. If you have questions about this study, you can contact Dr. Meyers from the Department of Agricultural Education and Communications at Texas Tech University by email at courtney.meyers@ttu.edu, or myself at kassie.waller@ttu.edu.

TTU also has a Board that protects the rights of people who participate in research. You can ask them questions at (806) 742-2064. You can also mail your questions to the Human Protection Program, Office of the Vice President for Research, Texas Tech University, Lubbock, Texas 79409, or email them to hrpp@ttu.edu. If you are interested in participating, please contact me at kassie.waller@ttu.edu.

Figure C.1. Oral script read to participants for information about the study.

APPENDIX D: CONSENT FORM

Information about this study

What is this project studying?
This study is called "The Effect of Infographics on Recall of Information about Genetically Modified Foods." The research findings will be used to inform future research about communication and education techniques in the field of agricultural communications.

What would I do if I participate?
In this study, you will be asked to take a survey via computer. In this survey, you will be asked to answer questions about your knowledge and perception of GMOs, as well as view an infographic or read a paragraph. You will be asked to answer questions about whichever medium you view. If you agree to provide your email address, you will be sent a follow up survey a week later that contains questions about this study. You will receive additional study credit if you take the delayed survey.

Can I quit if I become uncomfortable?
Yes. Your participation is completely voluntary. You are free to discontinue participation at any point during the survey. Your thoughts and opinions are valued and participating is your choice.

How long will participation take?
Participation will take about 30 minutes of your time, including the follow up survey.

How are you protecting privacy?
All data collected will be kept on a secure, password protected computer in the researcher's office. Any responses you provide will not be linked to your identity. You will be asked to provide your email address at the end of the survey for a follow up survey. Your email address will not be available to anyone but the researchers of this study. After the follow up survey has been sent, all email addresses will be destroyed from storage.

How will I benefit from participating?
You will be providing invaluable knowledge to the agriculture industry. You will also be receiving study credit.

If I have questions about the study, who can I ask?
The principal investigator for this study is Dr. Courtney Meyers. If you have questions, you can direct them to Kassie Waller via phone (806-834-6362) or email (kassie.waller@ttu.edu) or Dr. Meyers via phone (806-742-2816) or email (courtney.meyers@ttu.edu). Additionally, Texas Tech has a board that protects the rights of people who participate in research. You can call to ask them questions at 806-742-2064. You can mail questions to the Human Research Protection Program, Office of the Vice President for Research, Texas Tech University, Lubbock, TX, 79409, or email questions to hrpp@ttu.edu.

______________________________   ______________
Signature   Date

____
Printed Name

This consent form is not valid after 3/31/2019

Figure D.1. Consent form read and signed by all participants.

APPENDIX E: IRB APPROVAL

TEXAS TECH UNIVERSITY
Human Research
Protection Program

Apr 16, 2018 4:29 PM CDT

Courtney Meyers
Ag Education and Communication

Re: IRB2018-200 The Effect of Infographics on Recall of Information about Genetically Modified Foods

Findings: Approved.
Expiration Date: *March 31, 2019*

Dear Dr. Courtney Meyers, Kassie Waller:

A Texas Tech University IRB reviewer has approved the proposal referenced above within the expedited category of:
7. Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

The approval is effective from April 16, 2018 to March 31, 2019. The expiration date must appear on your consent document(s).

Expedited research requires continuing IRB review. You will receive an automated email approximately 30 days before March 31, 2019. At this time, should you wish to continue your protocol, a **Renewal Submission** will be necessary. Any change to your protocol requires a **Modification Submission** for review and approval before implementation.

Your study may be selected for a Post-Approval Review (PAR). A PAR investigator may contact you to observe your data collection procedures, including the consent process. You will be notified if your study has been chosen for a PAR.

Should a subject be harmed or a deviation occur from either the approved protocol or federal regulations (45 CFR 46), please complete an **Incident Submission** form.

When your research is complete and no identifiable data remains, please use a **Closure Submission** to terminate this protocol.

Sincerely,

Kelly C. Cukrowicz, Ph.D.
Chair, Texas Tech University Institutional Review Board
Professor, Department of Psychological Sciences
357 Administration Building. Box 41075

Lubbock, Texas 79409-1075
T 806.742.2064 F 806.742.3947
www.hrpp.ttu.edu

Figure E.1. IRB approval letter.