

**Evaluation of an innovative, employee-driven sign on hand washing behavior changes
using video observation**

Matthew W. Schroeder

Dissertation submitted to the faculty of the Virginia Polytechnic Institute and State University in
partial fulfillment of the requirements for the degree of

Doctor of Philosophy

In

Food Science and Technology

Joseph D. Eifert, Chair

Renee R. Boyer

Melissa Chase

Sergio Nieto-Montenegro

October 22, 2015

Blacksburg, VA

Keywords: pictograms, poultry, video observation, hand washing, signs

Evaluation of an innovative, employee-driven sign on hand washing behavior changes using
video observation

Matthew W. Schroeder

ABSTRACT

Signs are commonly used in the foodservice industry to portray food safety messages. However, many of these signs do not consider employee preferences or current needs in the industry. Employee perceptions can provide crucial information about the design of effective food safety messages. Surveys were conducted with meat and poultry processing employers in the mid-Atlantic region to determine food safety needs in the industry. Follow-up focus groups in both English (5) and Spanish (5) were conducted based on language availability and size. The most important food safety topics were hand washing (60.9%), cleaning/sanitizing (78.3%), and cross contamination (69.9%). Employees believe that color, text, and multiple language options could increase employee recognition and retention of intended messages. New, employee-driven hand washing signs were developed from the information in the focus groups. Signs were evaluated by video observation through five hand washing practice behaviors (soap use, complete wash, time to wash, complete rinse, and towel use) at two different poultry processing facilities in the mid-Atlantic at three different time points (baseline, short term, and long term). Soap use significantly increased at both facilities when baseline data was compared to short term and long term time periods. Facility B showed a significant increase in washing, time, and rinsing when baseline data was compared to short term, which indicates that a new sign could increase hand washing compliance. Sign color had a significant effect on behavior for washing and time of washing, while time had a significant effect on behavior for four of five variables tested. New

signs could be a useful way to encourage compliance to food safety message for multicultural employees; however, they may need to be frequently changed as workers tend to refer back to old habits.

ACKNOWLEDGEMENTS

I would first like to thank all the faculty and staff of the Department of Food Science and Technology at Virginia Tech, especially my committee members Dr. Boyer, Dr. Chase, and Dr. Nieto-Montenegro. I would like to especially thank Dr. Eifert for giving me the opportunity to work with him over the past 6 years. Not only have you been a fantastic mentor to me, you have also been a great friend. I am honored to have been part of your lab. I would also like to offer sincere thanks to Oscar Galagarza and Lily Yang for their help. Without your hard work and dedication, this project would have never been possible. Thanks also goes to LISA, in particular Lin and Daniel for their help with the statistical analysis. I am sincerely grateful for the help of Grant Martin and David Flicek, who allowed me to use their facilities for the observation portion of the project.

I would also like to send a special thanks to all my fellow graduate students in the department. The friendships I have made here at Virginia Tech are something I will cherish and remember for the rest of my life. From everyone department and many countries, the relationships I have made here are truly remarkable. Virginia Tech was a special place for me because of you all. I would like to thank all the players and coaches from the Virginia Tech Club Lacrosse Team. Thank you for the opportunity to work with you and most importantly, the stress relief. The friends I have made within this organization are unique and I will cherish them all. Winning games and championships was amazing, but the friends I have made here can never be replaced. Special thanks to my parents, sister, and soon to be wife, Georgianna. Your unwavering support during these years has been incredible. I love you each so very much and am so grateful to have you in my life.

DEDICATION

I dedicate this body of work to my parents, David and Judy Schroeder and my grandparents, William and Jean Schroeder and Judy Shelley. You taught how to be passionate about what I love and more importantly, how to love. I am the man I am today because of you all. This degree simply is not possible without your love and support.

TABLE OF CONTENTS

Abstract.....	ii
Acknowledgements.....	iv
Dedication.....	v
List of tables and figures.....	viii
Chapter 1: Introduction and Literature Review.....	1
Food risk communication	
Methods of information conveyance to food service workers, consumers, and the general public	
Microbial food safety of processed poultry	
Socio-demographics of food chain workers in the United States	
Evaluation of training: Methods to determine effectiveness	
Do training programs change food safety behavior?	
Education through pictograms	
References.....	36
Chapter 2: Employee perceptions of food safety pictograms at meat and poultry processing plants leads to new hand washing pictogram.....	48
Abstract	49
Introduction.....	50
Materials and Methods.....	52
Results.....	55
Discussion.....	65
References.....	70
Tables and Figures.....	73
Chapter 3: Evaluation of meat and poultry processing employees hand washing	

practices from signs using video observation.....	80
Abstract.....	81
Introduction.....	82
Materials and Methods.....	85
Results.....	89
Discussion.....	92
References.....	98
Tables and Figures.....	101
Conclusions.....	105
Appendix A: Survey sent to QA/Food safety managers.....	107
Appendix B: Focus group consent forms (English and Spanish).....	114
Appendix C: Focus group protocol (English and Spanish).....	118
Appendix D: Pictogram example document during focus group.....	120
Appendix E: IRB 14-003 approval letter for all phases of research project.....	121
Appendix F: Experimental hand washing signs.....	122
Appendix G: Example camera position (“bird’s eye view”). About 7’ above ground.....	123
Appendix H: Plant manager agreement of video ownership.....	124
Appendix I: Changes in camera angle at turkey/chicken further processing facility due to changes in wall surface overnight.....	125

LIST OF TABLES AND FIGURES

Table 1. Summary of focus group discussions on interpretation, use and design of signs in meat/poultry processing plants in the mid-Atlantic region based on the analysis of employees' perception of pictograms with their facility.....	73
Figure 1. QA/Food safety manager perception of most important food safety topics in their meat or poultry processing facility in the mid-Atlantic region (n=46).....	77
Figure 2. QA/Food safety manager perception of most important aspects of signs in their meat or poultry processing facility in the mid-Atlantic region (n=45).....	78
Figure 3. Example of hand washing sign created from opinions of meat and poultry processing employees in the mid-Atlantic region.....	79
Table 2. Percentage of employees who performed behavior for all variables (soap, wash, 10s, rinse, and towel) at all time points (baseline, short term, long term) for facility A (raw) for both sinks combined.....	101
Table 3. Percentage of employees who performed behavior for all variables (soap, wash, 10s, rinse, and towel) at all time points (baseline, short term, long term) for facility B (RTE) for both sinks combined.....	102
Figure 4. Hand washing pictogram example designed from target population opinions evaluated by video observation.....	103
Figure 5. Hand washing matrix for evaluation of hand washing practices for meat and poultry processing employees (Robertson et al., 2013).....	104

Chapter 1: Introduction and Literature Review

The workforce in the United States is very diverse. In the food industry alone, there are 1.4 million immigrants and surveys suggest that 25% of food chain workers are Hispanic (Ruggles et al., 2010; Madera et. al., 2011). Training these employees on food safety principles and safe food handling can be very difficult especially with a multicultural employee population. Such topics in food safety trainings include: personal hygiene, time/temperature abuse, and cooking practices. Pictures or signs could be utilized to create a universally accepted message related to food safety that could increase employee retention and understanding of common food safety principles.

Pictograms, or pictographs are “a diagrammatic representation using pictures rather than words to convey a hazard warning or safety message, but which can include text or alphanumeric information” (Davies et al., 2000). They offer an easily accessible medium to communicate information (Harris and Bonn, 2000). Pictograms have been used for years in other industries such as healthcare, transportation, advertising, and construction. They have a single goal. They are used to attract the users’ attention so that they will comply with the information portrayed in the picture (Fierro et al., 2013).

Research has shown that pictograms offer several key benefits and functions. They are a “language free” medium, meaning they can effectively communicate with different cultures, backgrounds, and educational levels (Davies et al., 1998; Tijus et al., 2012; Fierro et al., 2013). They also allow information to be processed quickly and can ease the comprehensibility of messages (Tijus et al., 2012; Houts et al., 2006). Pictograms are many times more noticeable than verbal messages, and grab the attention of the user (Tijus et al., 2012).

With the diverse workforce in poultry processing, pictograms can offer food safety training and knowledge that is language free and easily comprehensible for low literacy and educational levels. The goal of this research is to design and evaluate a food safety pictogram to see whether multicultural employees hand washing practices improve over a period of time in the poultry processing industry.

Objectives

The overall goal of this research is to evaluate whether pictograms used in the poultry processing industry can enhance hand washing behavior. The research objectives include:

- 1) Identify current demographics, training status, and current sign usage of meat and poultry processing facilities in the mid-Atlantic region
- 2) Assess the use of signs to deliver food safety messages
- 3) Utilize target employee population to effectively design pictograms that could be displayed in the facility
- 4) Evaluate the effectiveness of hand washing signs on employee behavior change using video observation in the short term and after a period of several weeks

1. Food Risk Communication

In the early 2000s, the World Health Organization (WHO) saw a need to place more emphasis on public health through the safe handling of food by handlers and consumers (Mwamakamba et al., 2012). Thus, in 2001, the WHO introduced the five keys to safer food: personal hygiene, separation of cooked and uncooked food, cooking thoroughly, avoiding time/temperature abuse, and use of clean food and water. In hopes of preventing foodborne illness, these messages were targeted towards homes, schools, food service establishments, and hospitals (Mwamakamba et al., 2012).

Foodborne illness could be preventable if handlers and consumers alike understand and practice these principles (Jacob et al., 2010). However, still many people do not comply with proper food handling practices and fail to identify the risks associated with proper food safety. In 1998, the FDA conducted a survey on quick-service restaurants and full-scale restaurants about compliance with the Food Code. Only 60% of quick-service restaurants and 74% of full scale restaurants were compliant (FDA, 2000). A national survey suggests 98% of homemakers in the United States understand that they play some role in proper safe food handling practices; however, knowledge and proper behavior do not always coincide (American Dietetic Association Foundation and ConAgra Foods, 1999; Cho et al. 2010). Proper food risk communication to the general public or food system workers could help prevent the spread of bacterial illness. The best way to achieve proper food risk communication is through food safety education (Medeiros et al., 2011). Food safety education “can be defined as the delivery of facts and skills to any person who handles food at any step in the food system requiring sufficient resources, appropriate facilities, relevant training, and good communication channels, as well as motivated workers and management” (Richard et al., 2013; Nieto-Montenegro et al., 2004). The key to

effective food safety education and communication involves understanding the particular target audience (Jacob et al. 2010). However, 32% of food chain workers did not receive training at the start of their job. In addition, training inadequacies were reported by 16% of workers (Ruggles et al., 2010).

2. Methods of information conveyance to food service workers, consumers, and the general public

In 2004, the Center for Disease Control (CDC) recommended more focused food safety education measures (Chapman et al., 2010). In today's society there are a variety of different ways to convey food safety information, but the experimentation with new methods may help to reduce the incidence of foodborne diseases (Chapman et al., 2010).

2.1 Direct Lecture Training and Modeling

In many food chain working environments, a variety of language barriers exist, making it difficult for managers to communicate with employees (Neal et al., 2011). However, before a behavior change can occur, a basic knowledge of the food safety practices must be employed. Direct lecture training can help instill basic food safety principles (Egan et al., 2007). The most common form of food safety training in most studies is on-the-job training conducted by the manager (Rowell et al., 2013). Time and cost of direct lecture may be of concern, but many times an employee knowledge increase will be observed (Cotterchio et al., 1998). A study conducted by Rajagopal (2012) found that employee knowledge of hand washing increased from 84% to 97% following direct lecture training. In a review article by Egan et al. (2008), nine studies found a statistically significant increase between pre- and post-test scores after food

safety and food hygiene trainings were conducted. Anding et al. (2007) found that self-reported behaviors for proper hand washing and proper sanitizing of cutting boards increased from 68.7% to 92.7% and 74.3% to 91.1%, respectively, before and after completing the Certified Food Manager exam. This exam is sometimes required by state or local health departments to promote safe food handling practices to reduce the incidence of foodborne illness. Food safety knowledge and practices can also be conveyed by modeling. In a teaching exercise, students were assigned recipes in English and non-English and asked to complete the recipe without using words. Students were randomly designated as the “manager” or “employee.” The study found that when using thermometers for food doneness, the employees imitated the managers’ behaviors (Neal et al., 2011).

2.2 Brochures/Infosheets

Direct lecture training can certainly increase food safety knowledge and awareness, but sometimes workers over time could forget proper techniques if not utilized on a daily or weekly basis, especially if a manual is not provided. Another way to offer enhanced, readily accessible food safety information is through the use of infosheets or brochures. Cates et al. (2004) found that a brochure for pregnant woman on listeriosis would be helpful to encourage safe behaviors during pregnancy. Because women were unfamiliar with *L. monocytogenes*, they developed a brochure that could be displayed at various locations that would be convenient for women. A concise, but informative brochure targeted for at risk populations can be helpful to receive necessary food safety information (Cates et al., 2004).

Chapman et al. (2010) evaluated food safety infosheets as a method of training for foodservice staff through video observation. The infosheets were distributed to food handlers

weekly in food service operations and contained information about a foodborne illness outbreak as a result of food handler behavior. Mean hand washing attempts significantly increased after infosheets were introduced and cross contamination events significantly decreased. A study conducted by Manes et al. (2014) compared food safety knowledge scores for restaurant food handlers using a brochure and a comic book. The comic book (10 point increase) and brochure group (6 point increase) showed an overall knowledge increase for both the English and Spanish groups (Manes et al., 2014)

2.3 Video and Music

Though much of the training that occurs in the food system chain is done through direct lecture, in recent years, more modern techniques of communicating food safety information has become more popular. The video medium is readily available in homes, schools, work environments, and businesses, thus creating an opportunity to communicate with a variety of people (Wilkinson, 2007). In 1995, the Colorado Department of Public Health and Environment developed a video tape for commercial foodservice establishments (Smith and Shillam, 2000). The video, about basic food safety messages, was shown two or three times per year to current employees and at the time of new hiring. The results from pre- and post- test results showed a significant knowledge increase (average mean increase of 7.8 points) of on how to handle food safely. In another study, conducted by Soon and Baines (2012), a video was shown to produce farm workers about farm food safety topics and more than 80% found the video more practical than a training booklet and presentation.

Music is capable of educating a diverse audience such as children or individuals with learning disabilities (Winter et al., 2009). They developed educational food safety messages

from contemporary songs using altered lyrics. They sampled school foodservice supervisors and managers, culinary arts instructors and students, family and consumer science teachers and children at a youth summer program. A majority (90-96%) of the workers and managers remembered the main message of the song. Winter et al. (2009) reported that music and food safety knowledge showed a positive correlation for all the audiences sampled. Contemporary communication such as video and music offer a variable supplemental method of educating diverse audiences about food safety.

2.4 Media Campaigns

Some studies have used media campaigns to convey food safety messages. Because food safety messages need to be conveyed to a wide variety of people, including young children, adults, multilingual/multicultural individuals, and people with low education levels, using a combination of educational tools can help increase compliance and understanding. One study, particularly designed for young adults in college, used and evaluated refrigerator magnets, posters, table tents, cartoon videos, advertisements in student newspaper, and radio skits (Abbot et al., 2012). Self-reported post-test ratings of food safety knowledge were significantly higher than pre-test ratings (Abbot et al., 2012). All campaign specific materials had been encountered by 65% of individuals, while 90% had seen or heard about the campaign (Abbot et al., 2012).

The Fight BAC! campaign, part of President Clinton's Food Safety Initiative, was launched in 1997 to educate consumers on safe food handling practices (Dharod et al., 2004). A study took this campaign and delivered it to the Latino population through television, radio, newspapers, posters, stickers, brochures, and coloring books in Connecticut and southwest Massachusetts (Dharod et al., 2004). A majority (82-92%) liked the campaign and 70-72%

found the information helpful, depending on the particular medium (Dharod et al., 2004). Those exposed to the campaign were significantly more likely to have adequate food safety knowledge (Dharod et al., 2004). These large campaigns which utilize a variety of mediums (television, radio, posters, magnets, etc.) to convey food safety messages have the unique opportunity to reach a vast majority of people in hopes of a behavior change.

2.5 Mass Mailings

Within the past 30 years, the United States government has conducted mass mailings to the general public about urgent health related issues (Rudd et al., 2003). A 1988 brochure was developed about HIV/AIDS, while the 2001 postcard was developed for the anthrax scare (Rudd et al., 2003). The “Understanding Aids” brochure was sent to 107 million households about the transmission of AIDS and risky behaviors associated with the disease (Rudd et al., 2003). A “Message to Americans” postcard was sent less than a month after the terrorist attacks on September 11 to all households about mail safety and the anthrax scare (Rudd et al., 2003). These messages reached millions of people, but the creators of these tools had to consider an average American’s reading level (Rudd et al., 2003). Though a mass mailing strategy has never been used to educate consumers about food safety information, understanding the target audience and the difficulty of text included is an important consideration for all educational material.

There are many ways to convey messages or train people about proper food safety or health related topics. In the past, much of the training has been conducted by direct lecture; however, with the evolution of marketing techniques, there is a wider range of mediums available for educators (i.e. supervisors, managers, etc.) to introduce or reinforce important information. Regardless of medium utilized, the desired outcome is always a behavior change.

3. Microbial Food Safety of Processed Poultry

In 2012, the Food and Agriculture Organization (FAO) of the United Nations reported poultry production increased 1.8% over the past few years to 103.5 million metric tons (FAO, 2012). This is consistent with the moderate production increase of global meat production (poultry, pig, sheep and beef) (FAO, 2012).

Though the main food safety concerns related to poultry safety are preventing contamination from *Salmonella* and *Campylobacter* because these pathogens are inherently found in poultry, cross contamination from workers could still contribute to foodborne illness due to other pathogens. Poultry safety begins on the farm and continues through slaughter completion. Contamination from *Campylobacter*, once birds become colonized, has been seen in up to 100% of birds tested (Keenor et al., 2004). Because this initial colonization can occur on the farm which is followed by increased bacterial shedding during transport to slaughter facility, bacterial contamination is a main concern in the meat and poultry processing industry. Proper worker training and knowledge of potential sources of cross contamination are important to delivering safe product to the consumer. While most potential microbial hazards occur during slaughter and processing, feed withdrawal 8-12 hours before birds are scheduled to be slaughtered decreases bacterial shedding (Hardin, 2013). However, once birds enter the processing facility, controlling microbial hazards is a primary concern.

Logistic scheduling offers a possible solution to flock cross contamination. The slaughter of *Campylobacter* or *Salmonella*-negative flocks before *Campylobacter* or *Salmonella* positive flocks may reduce cross contamination between flocks (Potturi-Venkata et al., 2007). Proper sanitation of equipment such as belts, chill/scald/defeathering tanks may also reduce cross

contamination between flocks (Hardin, 2013; Schmidt, 2013). The use of in-process sanitizers such as cetylpyridinium chloride (CPC) and/or trisodium phosphate (TSP) can reduce the levels of bacteria on carcasses (Hardin, 2013).

3.1 Personal Hygiene: Hand washing

Personal hygiene behavior of workers, such as glove use and hand washing, can help reduce the potential of cross contamination (Green et al., 2006). Human noroviruses are responsible for 58% of foodborne illness of known etiology and are frequently introduced into food by poor hygienic practices (Fraser et al., 2012). Richard et al. (2013) used concealed-direct observation of bodegas in Pennsylvania to evaluate a training program for Spanish-speaking workers. Before implementation of the training program, 10% of workers used gloves properly, while 6 months after training, 38% used gloves properly (Richard et al., 2013). Compliance with correct hand washing procedure in various studies depended on time and work activity (Green et al., 2006; York et al., 2008). When workers started their shift, 75% of observed workers correctly washed their hands (York et al., 2008). Only 41% correctly washed their hands before food preparation (Green et al., 2006). Green et al. (2006) found that 46% of workers attempted to wash their hands before food preparation. After touching their own body, only 10% of restaurant workers washed their hands correctly (Green et al., 2006). Similarly, only 5.7% of restaurant workers washed their hands after touching their own body parts (York et al., 2008). Because viruses and diseases can easily be transmitted from person-to-person, personal hygiene along the farm to fork continuum needs to be addressed through training. Compliance with food safety guidelines, such as the Food Code, can be misunderstood or underutilized due to lack of adequate training (York et al., 2008). In a survey of the core food occupation industries, 32% of

workers reported no training before job commencement, while 74% saw no ongoing job training (Food Chain Workers Alliance, 2012).

Hand washing is critical in preventing the spread of foodborne disease transmission and key to the compliance with good manufacturing practices (GMPs) and sanitation standard operating procedures (SSOPs) (Frederick, 2005; Jensen et al., 2015a). The U.S. Food and Drug Administration (FDA) and the Center of Disease Control and Prevention (CDC) recommends wetting hands with running warm or cold water, lathering hands with soap, washing for 10-20 seconds, rinsing under running water, and drying with a single use paper towel or air dryer (FDA, 2009; CDC, 2014). The FDA Food Code (2009) also lists appropriate times to wash hands including, but not limited to: after touching bare human body parts, after using the bathroom, when switching between raw and ready-to-eat food (RTE), and during food preparation.

Jensen et al. (2015b) conducted an internet search of hand washing signs in restaurants, cafeterias, hospitals, and schools. Of the 81 hand washing signs identified, 37 had a specific lather time and 24 suggested using warm water. Foodservice hand washing signs had an average lather time of 19 seconds. Jensen et al. (2015a) studied hand washing practices as it relates to the reduction of microorganisms. When a five second wash was completed with no soap, a 1.0 log CFU reduction of *E. aerogenes* was observed. When a 20 second wash with soap was completed, a 1.7 log CFU reduction of *E. aerogenes* was found, which showed a statistically significant difference between this wash and the minimal wash (5s with no soap) for the reduction of *E. aerogenes*.

Farm workers who come in direct contact with animals can help prevent the transmission of novel viruses from humans to animals or animals to human (Odo et al., 2015). Hand washing

was the most common practice observed among poultry and swine workers in the Midwest United States and Thailand. Participants responded that they “always” wash their hands after coming in contact with animals 42% of the time (Odo et al., 2015).

Hand washing studies have been extensively researched in the healthcare industry as well, particularly in hospitals. The WHO’s “Five moments for hand hygiene” outlines the correct time to hand wash in a healthcare facility (WHO 2015). These include before patient contact, before aseptic task, after body fluid exposure risk, after patient contact, and after contact with patient surroundings. Those these moments do not apply to a food service application, they do have similarities. Food service employees should wash their hands after touching their own bodies for example. Randle et al. (2012) found 74% overall hand washing compliance for healthcare workers at a hospital and 71% of intensive care unit (ICU) workers using continuous video surveillance (Nishimura et al., 1999).

3.2 Poultry Industry Occupational Safety

The United States Bureau of Labor Statistics in 2004 found that workers in the poultry processing industry accounted for the sixth highest occupational illness rate (Bureau of Labor Statistics, 2005). Illnesses or injuries common in the poultry industry, including dermatological, respiratory, and musculoskeletal, were reported by 28% of workers in a year (Quandt et al., 2006). Sore throat and difficulty swallowing was reported by 35% of workers. Though workers were not asked to attribute illnesses to poultry work exclusively, upset stomach, vomiting, and nausea was reported by 25% of workers over a one month period (Quandt et al., 2006). The Food Chain Workers Alliance survey found that 58% of workers had no access to health care coverage, thus 53% reported working while sick (Food Chain Workers Alliance, 2012).

Employees will work while sick due to fear of losing their job, have few to no paid sick days, or immigration concerns (Food Chain Workers Alliance, 2012; Quandt et al., 2006). Foodborne illness can frequently be spread by the fecal-oral route through poor personal hygiene; sick employees could contaminate product or other workers.

4. Socio-demographics of Food Chain Workers in the United States

Food chain workers include farm workers, slaughterhouse and processing facility workers, and retail workers (restaurant and foodservice) (Food Chain Workers Alliance, 2012). In the United States, one of the largest employers of non-native speaking employees is the foodservice industry, providing work for 1.4 million immigrants (Madera et al., 2011; Fraser and Alani, 2009). The American Community survey, a nationwide survey to provide timely data on demographics, economic, and housing information every year, suggests approximately 25% of food chain workers in the United States are Hispanic (Ruggles et al., 2010). More specifically, the Bureau of Labor Statistics notes that 38% of animal slaughtering and processing industry workers are Hispanic or Latino (Bureau of Labor Statistics, 2010). Historically, within the poultry industry, minority workers, especially African-Americans have comprised the workforce (Quandt et al., 2006). However, within the past few decades, immigrants, particularly from Mexico and Guatemala have replaced these workers (Grey and Woodrick, 2002; Quandt et al., 2006). Due to poor wages, tough working conditions, and long hours, 31% of food chain workers were at their job for less than one year (Food Chain Workers Alliance, 2012). A high turnover rate can cause challenges for both employers and workers. Problems for the employer include screening, hiring, and retraining costs (Food Chain Workers Alliance, 2012). In

addition, many (58%) food chain workers have a high school degree or less (Ruggles et al., 2010).

4.1 Literacy and Language

There are over 311 spoken languages in the United States (Vistawide, 2009). In the United States, 62.3% of people speak Spanish or Spanish Creole at home (Shin and Kominski, 2007). In 2006, the National Restaurant Association (2006) found that 26% of employees speak a language other than English at home. Because many foodservice workers speak little to no English, language issues could cause miscommunication that could lead to potential food safety problems (Fraser and Alani, 2009; Paul, 2013; Lindhout and Ale, 2009). United States economists report \$65 billion are lost annually due to limited English proficiency of foreign-born workers (Neal et al., 2015). In some cases, migrant workers could be illiterate, which could potentially cause concern if their job required reading (Paul, 2013).

In a poultry processing plant in Arkansas, 152 workers were hospitalized after a worker mixed sodium hypochlorite with an acidic antimicrobial solution, which caused chlorine gas to be released (Whitlow et al. 2012). There was a warning label on the drum; however, the worker could not read English (Whitlow et al., 2012). Because most training in the foodservice industry in the United States is conducted in English, those workers with limited to no English language proficiency could potentially misunderstand important information about food safety (Fraser and Alani, 2009). Even food safety signs accompanied by written text could be misunderstood. Because safety culture, communication and language are related, food safety information in multiple, simplified languages should be made available (Schein, 1996; Lindhout and Ale, 2009).

4.2 Education Level

The average adult citizen in the United States reads at an 8th to 9th grade level (Houts et al., 2006). The American Community Survey estimates that 58% of food chain workers in the United States have a high school degree or less (Food Chain Workers Alliance, 2012). Po et al. (2011) suggests that educational resources should be based on the literacy levels of your target population. Sinclair et al. (2003) evaluated a safety training program across three different foodservice companies. The study found that higher test scores were achieved by those with a higher education level. Their reading skills and knowledge intake ability most likely increased their score (Sinclair et al., 2003).

4.3 Training considerations for non-native English speaker employees

Food safety training for non-English speaking workers may present challenges including cultural differences, low literacy, and low education levels (Neal et al., 2011; Ratnapradipa et al., 2011). Because such communication barriers may exist, there are several important aspects to food safety training that may increase worker acceptability and retention of information.

Food safety information is available in English, Spanish, and Chinese (Fraser and Alani, 2009). In today's food chain jobs, much of the training is conducted by direct lecture in English (Fraser and Alani, 2009). However, because communication barriers exist and many classes do not address cultural specific behaviors, sometimes employees misunderstand or misinterpret information portrayed during training (Neal et al., 2015). Several studies have shown that training in employees' native language can have tremendous benefits (Holladay, 2004; Tyler, 2005; Ratnapradipa et al., 2013).

Ratnapradipa et al. (2013) compared training of eastern European restaurant workers by their own children in their native language against a Salt Lake Valley Health Department instructor. Participants trained by their own children in their native language showed significant improvement in food handling practices compared to those trained by an English instructor (Ratnapradipa et al., 2013). Aside from the possibility of increased knowledge when training is conducted in their native language, employee morale and retention can also be enhanced (Tyler, 2005). Employees feel more appreciated and respected when training is conducted in their native language (Tyler, 2005). Employers should consider trying to eliminate the language barrier between employee and employer. Holladay (2004) suggests conducting classes or training in Spanish by a native speaker with the appropriate background. Understanding cross cultural communication, including mannerisms and social nuances, can help increase successful communication with Hispanic employees. Construction companies in the UK have translators accompany migrant workers to ensure safety (Bust et al., 2008). HR Executive Leeann Storino says “developing a training program in their native language only makes sense. If they are more comfortable, they are more apt to learn, retain and participate” (Tyler, 2005).

Many of the workers in the food chain probably do not comprehend the importance of food safety. When conducting training to these groups, making the information relevant is very important. Cho et al. (2010) found that better food safety behaviors are demonstrated when Latino restaurant employees think proper food behaviors could increase customer or manager satisfaction and kitchen efficiency. If you demonstrate to workers the perceived hazard or risk associated with their behavior, they will be more likely to comply (Wogalter 1999). Studies have shown that when health risk perception is high and workers can personally change the outcome, they will change their behavior (Witte, 1994; Witte, 1997). Exposure to food handling

training appears to increase risk perception of foodborne illness, which could increase relevance (Howard and Wignarajah, 2008). When employers reach a level of trust through making information relevant, message acceptance will be increased (Jacob et al., 2010).

Po et al. (2011) notes that the most important aspect in training ethnic populations is to know the target audience. When training ethnic audiences, employers should consider: level of education, appropriate translation, and culture distinctions. The employer should also customize food safety educational resources that are culturally appropriate and take into account the target audience while addressing particular industry needs (Po et al., 2011; Nieto-Montenegro et al., 2006).

5. Evaluation of Training: Methods to determine effectiveness

Evaluation is a critical part of any food safety training program (Nieto-Montenegro et al., 2008; Egan et al., 2007). Evaluation techniques assess the program's effectiveness and offer a check of program objectives (Nieto-Montenegro et al., 2008; Egan et al., 2007). Because the main objective of any training program is a behavioral change, evaluation techniques need to be utilized to check outcomes. There are many different methods to evaluate a program's effectiveness including: direct or concealed observation, survey/questionnaire, self-reported behaviors, and video observation.

5.1 Self-Reported Data: Survey/Questionnaire

Surveys are the most common instrument for collecting information about a particular trend or behavior (Manun'Ebo et al., 1997). Surveys or questionnaires can be given at any location and can be offered to many people without the researcher being present (Godwin and

Chambers, 2009). However, response rates for surveys can be low as well. Nulty et al. (2008) examined response rates of paper versus online surveys and found paper surveys (55-75%) were more likely to be taken than online surveys (20-47%). Surveys have been used in conjunction with other techniques such as direct observation to confirm or deny reported survey behaviors (Manun'Ebo et al., 1997; Bermudez-Millan et al., 2004; Kendall et al., 2004). They can also be used to provide needs assessment food safety data in a particular field (Pivarnik et al., 2007). Pivarnik et al. (2007) used a survey to assess the usefulness of an internet-based training program for food processors, wholesalers, and distributors. The survey found 75% of workers would still like in-house training, but 42% would be interested in internet training with audio (Pivarnik et al., 2007).

5.2 Self-reported versus observed behavior

Many studies show poor agreement between survey data and observed behavior (Manun'Ebo et al., 1997; Bermudez-Millan et al., 2004; Worsfold and Griffith, 1995; Curtis et al., 1993; Stanton et al., 1987; Robertson et al., 2013). Manun'Ebo et al. (1997) and Robertson et al. (2013) compared questionnaire data with direct observation about hygiene practices. Washing hands with soap and water before eating was reported by 14.2% of mothers/caregivers, but only observed in 2.4%. In grocery store deli/bakeries, 95% of food preparers reported correct hand washing practices but less than 50% of observed hand washing behavior was correct (Manun'Ebo et al. 1997; Robertson et al., 2013). Bermudez-Millan et al. (2004) compared survey data and direct observation about hygiene practices as well and found that 97% of respondents claimed to use soap and water to wash their hands, while this practice was only observed in 10%. Kendall et al. (2004) found 97% of respondents during an interview answered

correctly about washing hands after handling raw meat, chicken, or seafood; however, only 20% were observed performing this practice correctly.

5.3 Direct and Concealed-direct Observation

Direct observations studies can provide the best descriptive data on a particular group's food safety practices (Green et al., 2006). Whether evaluating the food handlers or the consumers, direct observation can provide a more accurate and reliable assessment of food safety practices than self-reported behaviors (Nieto-Montenegro et al., 2008; Green et al., 2006). Self-reported behaviors do not always match observed behaviors (Nieto-Montenegro et al., 2008; Redmond and Griffith, 2006). Green et al. (2006) used direct observation as a method to evaluate hand washing among food workers and found that only 27% of workers used appropriate hand washing techniques. Redmond and Griffith (2006) used direct observation via checklist before and after a social marketing campaign during meal preparation. Results showed that post-campaign, 79% of participants' short-term food safety behaviors improved. However, after 4-6 weeks only 71% of participants' behaviors improved pre-campaign. A study conducted by Bermudez-Millan et al. (2004) used direct household observations with a checklist to evaluate food preparation practices of Puerto Rican women living in Hartford, Connecticut. Results showed that 80% of women only washed their hands with water, 30% washed the cutting board with soap and water, and none used a meat thermometer (Bermudez-Millan et al., 2004). When observed behaviors were compared to self-reported behaviors, there were drastic differences. Survey data reported 97% of women claimed to wash their hands with soap and water, while this practice was only observed in 10% of the participants (Bermudez-Millan et al., 2004).

One problem with direct observation is the possibility of behavior changes amongst participants called the Hawthorne Effect (Chapman et al., 2013; Chiesa and Hobbs, 2006). The Hawthorne Effect occurs when research participants, because they are being studied, change their behavior (Payne and Payne, 2004). This is especially problematic in research as it can distort the findings. Richard et al. (2013) utilized a direct-concealed form of evaluation in Hispanic-owned bodegas in Reading, PA. In direct-concealed observation, the researcher acts as a normal customer in a retail establishment in hopes that the workers do not alter their behavior (Richard et al., 2013). Direct-concealed observation before and after training showed an increase for proper glove use from 10% to 38% at a 6 month behavioral check (Richard et al., 2013). Other potential issues with observational studies are the time required to conduct investigations, the possible introduction of bias, and the requirement of quick coding decisions while watching several workers simultaneously. (Godwin and Chambers, 2009; Chapman et al., 2013).

5.4 Video Observation

Video observation allows researchers to view behaviors with participants who frequently forget they are involved in the study (Chapman et al., 2010). Because video can be reviewed as many times as needed by various researchers, coding bias can be eliminated and time can be saved (Chapman et al., 2010). Multiple angles and multiple participants can be observed at the same time (Chapman et al., 2013).

Video observation has been utilized to assess safe food handling practices in several studies (Chapman et al., 2010; Chapman et al., 2013; Jay et al., 1999; Anderson et al., 2004; Bruhn 2014). Chapman et al. (2010) placed video cameras in view of the grill, deli, and preparation area to assess food handling practices. Results showed there was a significant

increase in hand washing attempts and a significant decrease in indirect and direct cross contamination rates post-intervention. Chapman et al. (2013) developed a method for coding video observation of the foodservice industry.

Video observation was conducted by Jay et al. (1999), Anderson et al. (2004), and Bruhn (2014) in domestic kitchens. Results showed that participants often did not wash their hands before beginning food preparation (Jay et al., 1999). Prior to meal preparation, 65% of preparers did not wash their hands, while 40% did not wash their hands after handling raw chicken (Bruhn 2014). Hand washing lasted for 20 seconds or longer for only 10% of preparers and 36% of hand washing opportunities lasted five seconds or shorter (Bruhn 2014). Similar results were seen by Anderson et al. (2004). Anderson et al. (2004) saw inadequate surface cleaning, inadequate vegetable cleaning, little thermometer use, and 20.4% of participants did not wash their hands after handling raw meat or poultry. Though video observation offers many benefits, the process is expensive, and sometimes time consuming to view video footage (Chapman et al., 2013). Pairing video observation with other instruments such as surveys or interviews offers a reliable and effective tool to observe food handling practices (Chapman et al., 2013).

6. Do training programs change food safety behavior?

The goal of any training program is to increase knowledge in hopes of a behavior change. In the food industry, training programs will hopefully decrease the likelihood of foodborne diseases by encouraging safe food handler behavior. Some studies have shown that increased knowledge can lead to safer food handling practices; however, most studies indicate that training alone does not always translate to a change in food safety behavior (Cho et al., 2010; Roberts et al., 2008; Mathias et al., 1994). Roberts et al. (2008) found that food safety knowledge increased

as a result of training; however, corresponding behaviors did not always change. Knowledge alone does not always change behavior, since this can depend on education level, ethnicity, age, region or gender (Roberts et al., 2008). Cho et al. (2010) found that Latino restaurant employees became more aware of foodborne illness after receiving food safety knowledge, but this did not affect food safety behavior. Mathias et al. (1994) reported that there was no correlation between number of individuals trained and violations of foodborne illness after a one or two day food safety education course. Patil et al. (2005) found that 91% of individuals with less than a high school education reported knowing good hygienic practices, but only 65% used good hygienic practices. However, 73% of those with greater than a high school diploma reported knowing good hygienic practices and 78% used good hygienic practices (Patil et al., 2005). Garayoa et al. (2005) found 76.1% of men knew about hand washing, while only 8.5% practiced proper hand washing. A majority (81.5%) of those aged 20 or older had knowledge of hand washing, but only 10.8% practiced safe hand washing.

6.1 Value of Recurring Food Safety Training

As with any type of information or knowledge, it will become lost over a period of time if not triggered frequently. To change behavior, more than just training is needed (Rajagopal, 2012). Many studies have looked at different amounts of time post-training to evaluate long term retention of information. Cotterchio et al. (1998) saw that inspection score improvements in the restaurant industry were sustained post-training for up to two years. However, Sparkman et al. (1984) saw a return to pre-training practices for supervisors in the foodservice industry eight weeks post-training. McIntyre et al. (2013) found that FOODSAFE-trained workers' knowledge decreased over time. They predicted that four to five years after certification, 95% of

food handlers would score less than the requirement of 70% to pass the examination. Lynch et al. (2003) found no significant difference between food safety knowledge scores of restaurant managers trained two years prior to those recently trained. Worsfold and Griffith (2003) found that most retail and catering businesses did not hold refresher training and training was conducted one time. Wogalter and Sojourner (1997) evaluated safety pictorials one week post-training and six months post-training and found no significant difference between the correct retention of pictorials one week and six months post-training. Thus, effective food safety training should incorporate understanding in the short term and ensure comprehension over time (Wogalter and Sojourner, 1997).

7. Education through Pictograms

Pictograms or pictographs, a “diagrammatic representation using pictures,” have been used for decades in a variety of different settings and industries (Davies et al., 2000). The use of pictograms has been studied extensively in other industries such as construction, healthcare, and transportation (Schellekens and Smith, 2004; Borowsky et al., 2008; Erdinc, 2010; Delp and Jones, 1996; Shinar and Vogelzang, 2013). Most industries have used pictograms as a way to convey safety or hazard information with the use of little to no text associated. The International Organization for Standardization (ISO) 9186 standard, for public information signs, says a sign is accepted if 67% of the control group comprehends the sign (Tijus et al., 2007; Cowgill and Bolek, 2003). The American National Standards Institute (ANSI) published ANSI Z535 in 1992, which describes product safety signs and labels (Young et al., 2002). According to this standard, in the United States, a pictogram becomes standardized if it is understood correctly by 85% of the users (Tijus et al., 2007; Hancock et al., 2004).

Of the tens of thousands of pictograms that exist in society, Dreyfuss (1984) created three distinct categories of pictograms: representational, abstract, and arbitrary. Representational symbols are the easiest to comprehend since they are accurate pictorial representations of the actual object (Davies et al., 2000; Tijus et al., 2007). Abstract symbols only slightly resemble the object, while arbitrary symbols are completely invented and do not resemble reality (Davies et al., 2000; Tijus et al., 2007). All pictograms are comprised of three different parts: the representamen, the object, and the interpretant (Nicol and Tuomi, 2007). The representamen, or sign proper, is the represented object. The object is the law, rule, code, etc. that is supposed to be represented by the sign. The interpretant is the meaning of the sign.

7.1 Pictogram Comprehension to Behavior Change: How does it occur?

The goal of any safety sign or pictogram is to inform the target audience about the hazard and hopefully promoting safe behavior. To achieve a behavior change, several earlier processing stages must be successfully completed (Wogalter, 1999). When a warning message is introduced, it must first attract attention and be noticed. Once attention has been drawn, it must be comprehended and then agree with the person's attitudes and beliefs. The final stage before a behavioral change is the user's motivation to act on the intended message. These four processing stages are sequential, thus potential "roadblocks" could prevent reaching a behavioral change (Wogalter, 1999). For example, if the sign does not attract attention, it will never be noticed, subsequent stages cannot be reached and no behavior change could be achieved (Wogalter, 1999). In the same manner, if the message does not agree with the user's attitudes and beliefs, they will not be motivated to comply with the intended message, and no behavior change will

occur (Wogalter, 1999). Thus, each of the four stages are dependent on one another and in order to reach the ultimate goal of a behavior change, stages must be completed in order.

7.2 Benefits of Pictograms

There are several key benefits to use pictograms including: comprehensibility, speed, culture and language independent, “attention grabbing”, and better memory recall (Davies et al., 2000). Pictograms can be used especially for those with low literacy or educational level (Davies et al., 2000; Houts et al., 2006). Bernardini et al. (2000) evaluated the comprehensibility of package leaflets with symbols and pictograms for medicinal products. The study found that a majority of participants (74.3%) thought the pictograms and symbols were helpful in finding information (Bernardini et al., 2000). Delp and Jones (1996) studied cartoon illustrations on patient comprehension of medical instructions. A majority (98%) of patients thought that readability of instructions was very easy with cartoon illustrations (Delp and Jones, 1996). Dowse and Ehlers (2005) found that 95.2% of patients receiving medicinal label instructions in both written and pictorial form understood the instructions; while only 69.5% understood the instructions with just the written form. However, very few pictograms are universally understood (Davies et al., 2000). This could be due to a lack of requisite knowledge, cultural differences, age differences, or lack of familiarity (Tijus et al., 2007; Davies et al., 2000; Shinar and Vogelsang, 2013; Fierro et al., 2013).

Pictograms can act as an “instant reminder” because they can be interpreted and processed more quickly and accurately than words (Tijus et al., 2007). Ells and Dewar (1979) evaluated the speed and comprehension of traffic signs and found that symbolic traffic signs were understood more quickly than text only signs. However, Shinar and Vogelzang (2013)

found that reaction time comprehension was shorter for text traffic signs as compared to the corresponding symbolic signs. The speed of comprehension, especially with traffic signs, depends on distance from sign, familiarity, and cultural distinctions (Shinar and Vogelzang, 2013). Boelhouwer et al. (2013) found that response rates to survey questions were faster when pictograms were presented on safety data sheets and labels.

Pictograms are “language free” and are used to increase comprehension. With 13 different languages spoken in Europe, Davies et al. (1998) investigated the comprehension of standardized and non-standardized safety pictograms. Pictograms that were abstract in nature were not well understood, while the woolmark and flammable pictograms were correctly understood by greater than 85% of the participants (Davies et al., 1998). Therefore, the pictograms were more representative of the intended message and less abstract which can increase the comprehensibility among different cultures and languages. One study compared textual and symbolic (cartoon)/textual instructions to patients who were discharged from the hospital for laceration injuries (Delp and Jones, 1996). A vast majority (98%) of the patients who received the cartoon and textual instructions read the instructions, while only 79% read the instructions who received just the textual instructions (Houts et al., 2006; Delp and Jones, 1996).

Picture variables, such as shape, size, color, material, and location can also increase a sign’s noticeability (Nicol and Tuomi, 2007). Young et al. (1991) evaluated picture, color, signal icon, and border on alcohol labels and found that pictorials, color, and icons increased noticeability.

7.3 Pictograms for Food Safety

Pictograms have been used in the food industry as a way to convey proper food safety handling practices and foodborne illness. The USDA has launched several educational social media campaigns, such as Fight BAC! and Thermy the Thermometer™ to ensure proper handling and cooking temperatures (Dharod et al., 2012; Jacob et al., 2010). In a classroom study, Neal et al. (2010) evaluated the use of pictures to guide instruction on food handling practices. No significant differences between the group that received picture instructions and those that did not receive picture instructions were determined for handwashing frequency, temperature checks, or cross contamination checks (Neal et al., 2010). This result may have occurred because when students in the picture group went to wash their hands, they were followed by students in the non-picture group (Neal et al., 2010). Chapman et al. (2010) evaluated safe food storytelling infosheets among foodservice handlers. Overall results showed infosheets had a positive influence on food handling practices. With the diverse food chain worker population, new food safety messages and mediums can be explored to encourage proper food handling and preparation practices (Powell et al., 2007; Chapman et al., 2010).

7.4 Pictograms in Other Industries

Pictograms have been utilized in a variety of other industries ranging from advertising to transportation. Phillips (1997) evaluated consumer interpretation of pictorial metaphors used in color advertisement. A majority of the participants were able to correctly identify the primary message of the advertisement, which generally matched the intention of the advertisement producer. Pictograms are very common in healthcare, medicinal, and pharmaceutical industries as well (Dowse and Ehlers, 2005, 2006; Chan and Chan, 2013; Fierro et al., 2013; Delp and Jones, 1996). Since these industries have to convey important information to a wide variety of

educational and cultural backgrounds, pictograms can be used to improve adherence to prescribed instructions (Dowse and Ehlers, 2005). Those patients receiving instructions with both text and pictograms understood and adhered to instructions 95.2% and 89.6%, respectively (Dowse and Ehlers, 2005). The demographics showed 81% of participants had 1-7 years of schooling and 57% were unable to read at all (Dowse and Ehlers, 2001). Even for the group that had 5-7 years of schooling, there was not complete comprehension of the written instructions. However, as education level increased, pictogram comprehension increased (Dowse and Ehlers, 2001).

Fierro et al. (2013) evaluated pictograms for a Spanish-speaking audience on medications. The study found that 90.5% of drivers with a license understood the meaning of the pictogram, while 67.4% without a drivers' license understood the meaning. They also found that correct interpretation of a medicinal pictogram increased with higher education level. Chan and Chan (2013) studied pharmaceutical sign guessability among young Hong Kong Chinese. Occupation, age, and education level significantly affected guessability; however, the mean guessability score for 25 pictograms was 64.8% (Chan and Chan, 2013). Delp and Jones (1996) found that using cartoons for laceration (cut) instructions was an effective strategy for conveying information with a 77% compliance rate for correct daily wound care. Clawson et al. (2012) provided 33 images about medical maladies to English-speaking physician assistants and nurse practitioners working with the United States military overseas. Results showed that illustrated versions of instructions were more likely to be read, remembered, and followed (Clawson et al., 2012).

Studies have shown that in the healthcare industry, people remember 29-72% of the information that a doctor tells them (Ley, 1982). When studies assess recall of information, it

can be through free recall or cued recall. Free recall involves remembering information without a stimulus or prompt (Houts et al., 2006). Delp and Jones (1996) assessed free recall of wound care instructions for patients three days after their release by telephone survey. Forty-six (46%) percent of the patients who received cartoon instructions answered all four wound care questions correctly, while only 6% of patients who only received textual instructions answered all four questions correctly (Delp and Jones, 1996). This was confirmed by Childers et al. (1986) who found that free recall for product information was superior for pictorial information than verbal information. Cued recall involves remembering information when a prompt or cue is presented (Houts et al., 2006). Houts et al. (2001) studied cued recall of medical instructions in people with low reading abilities. They found that, on average, of the 192 instructions, people could remember 72% of instructions when presented with a picture prompt (Houts et al., 2001).

Pictograms can also be used in long-term recall of information. Wogalter et al. (1997) found that 6 months after training, pharmaceutical pictorials were recalled by 87%, which was not significantly different than the one week post-training test. Filion et al. (2011) analyzed a hand sanitizer poster intervention over a five week period and found hygiene attempts occurred more frequently after the introduction of the poster.

In the transportation industry, pictograms have been used for traffic signs and flight manuals (Erdinc, 2010; Shinar and Vogelzang, 2013; Ells and Dewar, 1979; Borowsky et al., 2008). Borowsky et al. (2008) determined that the location and expectancy of traffic signs plays a key role in compliance. Ells and Dewar (1979) and Shinar and Vogelzang (2013) showed symbolic signs are generally understood more quickly and at greater distances than corresponding textual messages. A group of Turkish military pilots were tested for comprehension and hazard perception of three symbols in a flight manual (Erdinc, 2010). The

skull and cross bones meaning “loss of life” was correctly matched by 90.7% of pilots and the plane with a broken wing signifying “damage to material” was correctly matched by 87% (Erdinc, 2010).

Wilkinson et al. (1997) evaluated the use of pictograms as safety precautions on agricultural pesticide containers. On labels, it was determined that information was easier to understand in text only form; however, labels with pictograms had a higher adherence rating for correct storage precautions (Wilkinson et al., 1997; Tijus et al., 2007). Mixing and applying precautions for pesticide safety information were not enhanced with the addition of pictograms which indicates the difficulty with using pictograms for procedural information (Wilkinson et al., 1997; Tijus et al., 2007).

7.5 Variations in Sign Design

Signs or pictograms are used in various industries to transcend language barriers and present information in a consolidated form that can be understood by diverse populations (McDougall et al., 2000). The recognition rate is a key measurement characteristic of any sign design (Ou and Liu, 2012). Familiarity, concreteness, complexity, meaningfulness, and semantic distance are five criteria used to measure sign design (McDougall et al., 2000; Ou and Liu, 2012). Familiarity refers to the frequency or use of the sign in daily life (Ou and Liu, 2012). Ou and Liu (2012) and Rosson (2002) found that sign familiarity will improve comprehension. Sign concreteness refers to the closeness the sign object is to the real world object (Ou and Liu, 2012; Chan and Chan, 2013; Osborne, 1999). Passini et al. (2008) found that computer icons that represented real world applications were more quickly and accurately detected than abstract ones. Actual, real-world signs had a higher guessability score for 25 pharmaceutical signs (Chan

and Chan, 2013). Simplicity refers to the amount of detail in a sign. Simple, realistic signs can improve comprehension (Dowse and Ehlers, 1998; Dewar, 1999; Osborne, 1999). Mayer and Laux (1989) found that clear, simple pictorials were more identifiable than symbols for protective equipment. The meaningfulness of a pictogram refers to the user's comprehension about the intended message (Ou and Liu, 2012). When a target population believes the pictogram has value/importance, they are more likely to understand (Ou and Liu, 2012). Hancock et al. (2004) found that mandatory action symbols had high comprehension levels, while Preece et al. (1994) found that guessability was increased with meaningful signs. Osborne (1999) suggests pictures that show a person doing an action, rather than simply decorative, are more effective. Semantic distance refers to the relationship between the pictogram itself and the function it is portraying (Ou and Liu, 2012). Links between sign illustration and intended function have facilitated greater user comprehension and proper behavior (Chan and Chan, 2013). All these characteristics are interrelated to hopefully create a pictogram that will increase compliance and understanding for different demographics of people (McDougall et al., 2000).

7.6 Pictogram Semantics

Signs are very complex. In just a simple sign design, the manufacturer should consider size, shape, color, picture, text, font, and location for example. Cultural implications can also influence the importance of sign semantics. Though pictograms “should not be particular to a specific culture,” they should keep in mind the target population (Cowgill and Bolek, 2003; Wogalter, 1999). Some target population characteristics that should be considered include: age, gender, culture, education level, impairments such as vision or hearing, and language (Cowgill and Bolek, 2003; Wogalter, 1999; Houts et al., 2006). For example, a thumbs up symbol in the

United States means “OK;” however, in the Japanese culture, it means “money” (Cowgill and Bolek, 2003). When creating pictograms for a particular target population, they should be involved in the creation of the pictograms (Houts et al., 2006).

7.6.1 Color, Font Size, and Shape

Colors have frequently been used in pictograms to identify the intensity of a hazard (Luximon et al., 1998; Adams and Edworthy, 1995). Red is known as the highest perceived danger level, which could cause death or injury (Kandler, 2008; Luximon et al., 1998). Yellow and orange are medium hazard level colors, normally indicating caution or warning, respectively (Kandler, 2008; Luximon et al., 1998). When the hazard perception of different colors was compared between Chinese and Westerners, the only difference in hazard perception was the color orange (Luximon et al., 1998). The Chinese saw orange as a lower hazard rating than Westerners. Hanna and Remington (1996) studied colored versus black and white shapes during a study and test period. Participants were asked whether they had seen a particular shape during the study period. When colors were used in both the study and test period, recognition performance was better than without color (Hanna and Remington, 1996). This experiment showed that color is associated with long-term memory (Hanna and Remington, 1996). Color is suggested when a signal is essential; however, color can be used to make a sign more noticeable (Davies et al., 2000).

Sussman and Gifford (2012) tested if a large sign, small sign, or no sign would be effective in communicating energy conservation. They found that no sign was ineffective, small signs were six times more effective than no sign, and large signs were 1.8 times more effective than small signs (Sussman and Gifford, 2012). Because signs need to be noticed in order to

achieve a behavioral change, size of sign could play an important role in overall sign effectiveness (Sussman and Gifford, 2012).

Certain sign shapes are used to convey certain messages or information (Kandler, 2008). Triangle or diamond shaped signs are normally orange or yellow and convey hazard alerts; while circular signs, which are characteristically blue, are mandatory actions (Kandler, 2008). Square/rectangular signs are for informational purposes and are usually green (Kandler, 2008). Research suggests that “pointed” shapes such as triangles or diamonds more effectively demonstrate hazard warnings than other shapes like a circle or rectangle (Collins, 1982; Davies et al., 2000).

7.6.2 Location and Medium

A sign is only effective if it can be seen. When signs are located in expected locations or in close proximity to where the behavior is supposed to be conducted, compliance is increased (Sussman and Gifford, 2012; Russell et al., 1999; Borowsky et al., 2008). When a group of experienced drivers was exposed to “expected” traffic sign location and “unexpected” traffic sign location, drivers were more likely to comply with traffic signs if they were in expected locations (Borowsky et al., 2008). Shapiro and Nielson (2013) studied changing logo location during the course of an advertisement. They found that brand logos had a greater preference when they changed location during the ad rather than remained stationary (Shapiro and Nielson, 2013).

With emerging technology available in many industries, sign location can be expanded beyond the normal wall. Computers have been used in the workplace to display pictograms (Tijus et al., 2007). Animation of pictograms with computers was studied by Bodner (1994). The function of animated pictograms was identified more often than the static pictograms (83%

vs. 68%) (Bodner, 1994). With many different mediums available in a poultry processing facility, pictograms could be displayed in a variety of ways.

7.6.3 Text

Paivio's Dual Coding theory suggests that using symbols with verbal messages increases memory and recovery of information (Erdinc et al., 2010; Paivio, 1991). When one piece of the code is lost or unavailable, the other piece can be recovered through memory (Lesch, 2003). When designing a pictogram, there has been argument about whether verbal messages should be included with the pictogram. The pictorial superiority effect suggests that recall is enhanced when text is used with the picture (Nelson et al., 1976). Wiseman et al. (1985) showed 42 pictures to undergraduate students. Some of the pictures were followed by a sentence that would help them remember. For the pictures that had a related sentence associated with the picture, the students recognized it 89% of the time. Shinar and Vogelzang (2013) found that symbolic traffic signs are useful if the symbol is familiar; however, if unfamiliar, text signs are better and more quickly comprehended. However, at greater distances, symbolic traffic signs are more identifiable (Shinar and Vogelzang, 2013; Ells and Dewar, 1979). Nicol and Tuomi (2007) compared text and no text sign presentation among illiterate adults in South Africa. They found that 42.9% correctly identified the sign meaning when presented only the sign, which indicates a sign alone is inadequate in communicating messages. When the sign was accompanied by written translations, comprehension was increased to 55.4% (Nicol and Tuomi, 2007). Though these adults claimed to be illiterate, they may have had some limited reading ability. Whether or not to augment pictures with text depends on the target audience. Populations with limited reading ability may by-pass the text and try to interpret the meaning of the pictogram themselves

(Houts et al., 2006). If abstract language is used, that may cause confusion among a variety of users and cause misinterpretation of the sign (Houts et al., 2006). When designing a pictogram, involving the target population in the sign design process can increase their likelihood of compliance.

REFERENCES

- Abbot, J.M., P. Policastro, C. Bruhn, D.W. Schaffner, and C. Byrd-Bredbenner. 2012. Development and evaluation of a university campus-based food safety media campaign for young adults. *J. Food. Prot.* 75:1117-1124.
- Adams, A.S. and J. Edworthy. 1995. Quantifying and predicting the effects of basic text display variables on the perceived urgency of warning labels: tradeoffs involving font size, border weight, and colour. *Ergonomics* 38:2221-2237.
- American Dietetic Association and ConAgra Foods. 1999. Home food safety benchmark survey. Available at: <http://www.prnewswire.com/news-releases/americans-today-are-more-aware-of-home-food-safety-76732762.html>. Accessed: 8 October 2013.
- Anderson, J.B., T.A. Shuster, K.E. Hansen, A.S. Levy, and A. Volk. 2004. A camera's view of consumer food-handling behaviors. *J. Am. Diet. Assoc.* 104:186-191.
- Anding, J.D., C. Boleman, and B. Thompson. 2007. Self-reported changes in food safety behaviors among foodservice employees: impact of a retail food safety education program. *J. Food Sci. Educ.* 6:72-76.
- Bermudez-Millan, A., R. Perez-Escamilla, G. Damio, A. Gonzalez, and S. Segura-Perez. 2004. Food safety knowledge, attitudes, and behaviors among Puerto Rican caretakers living in Hartford, Connecticut. *J. Food Prot.* 67:512-516.
- Bernardini, C., V. Ambrogi, L. Perioli, M.C. Tiralti, and G. Fardella. 2000. Comprehensibility of the package leaflets of all medicinal products for human use: a questionnaire survey about the use of symbols and pictograms. *Pharm. Res.* 41:679-688.
- Bodner, R. 1994. A comparison of identification rates of static and animated buttons. *Proceedings of CASCON*. Toronto, Canada.
- Borowsky, A., D. Shinar, and Y. Parmet. 2008. Sign location, sign recognition, and driver expectancies. *Transp. Res. Part F.* 11:459-465.
- Boelhouwer, E., J. Davis, A. Franco-Watkins, N. Dorris, and C. Lungu. 2013. Comprehension of hazard communication: Effects of pictograms on safety data sheets and labels. *J. Saf. Res.* 46:145-155.
- Bruhn, C.M. 2014. Chicken preparation in the home: an observational study. *Food Prot. Trends* 34:318-330.
- Bureau of Labor Statistics. 2005. Incidence rate and number of nonfatal occupational injuries by industry, 2004. Available at: www.bls.gov/iif/oshwc/osh/ostb1479.pdf. Accessed: 1 August 2013.

- Bureau of Labor Statistics. 2010. Occupational employment statistics. Available at: http://www.bls.gov/oes/oes_dl.htm. Accessed: 1 July 2013.
- Bust, P.D., A.G.F. Gibb, and S. Pink. 2008. Managing construction health and safety: migrant workers and communicating safety messages. *Saf. Sci.* 46:585-602.
- Cates, S.C., H.L. Carter-Young, S. Conley, and B. O'Brien. 2004. Pregnant women and listeriosis: preferred educational messages and delivery mechanisms. *J. Nutr. Educ. Behav.* 36:121-127.
- Cates, S.C., C.L. Viator, S.A. Karns, and M.K. Muth. 2007. Food safety practices of poultry slaughter plants: Findings from a national survey. *Food Prot. Trends.* 27:957-966.
- Centers for Disease Control and Prevention (CDC). 2008. Preliminary FoodNet data on the incidence of infection with pathogens transmitted commonly through food—10 states, 2007. *Morb. Mortal. Wkly. Rep.* 57:366–370.
- Centers for Disease Control and Prevention (CDC). 2014. Hand washing: clean hands save lives. Available at: <http://www.cdc.gov/handwashing/when-how-handwashing.html>. Accessed: 3 June 2015.
- Chan, A.H.S. and K.W.L. Chan. 2013. Effects of prospective-user factors and sign design features on the guessability of pharmaceutical pictograms. *Patient Educ. Couns.* 90:268-275.
- Chapman, B., T. Eversley, K. Fillion, T. MacLaurin, and D. Powell. 2010. Assessment of food safety practices of food service food handlers (risk assessment data): testing a communication intervention (evaluation of tools). *J. Food. Prot.* 73:1101-1107.
- Chapman, B., T. MacLaurin, and D.A. Powell. 2013. Video observation and data coding methods to assess food handling practices at food service. *Food Prot. Trends.* 33:146-156.
- Chiesa, M. and S. Hobbs. 2006. Making sense of social research: how useful is the Hawthorne Effect? *Eur. J. Soc. Psychol.* 38:67-74.
- Childers, T.L., S.E. Heckler, and M.J. Houston. 1986. Memory for the visual and verbal components of print advertisements. *Psychol. Mark.* 3:137-150.
- Cho, S., J. Hertzman, M. Erdem, and P. Garriott. 2010. Changing food safety behavior among Latino(a) food service employees: the food safety belief model. Available at: http://scholarworks.umass.edu/referred/CHRIE_2010/Friday/22. Accessed: 17 July 2013.
- Clawson, T.H., J. Leafman, G.M. Nehrenz, and S. Kimmer. 2012. Using pictograms for communication. *Mil. Med.* 77:291-295.
- Collins, B.L. and N.D. Lerner. 1982. Assessment of fire safety symbols. *Hum. Factors* 24:75-84.

Cotterchio, M., J. Gunn, T. Coffill, P. Tormey, and M.A. Barry. 1998. Effect of manager training program on sanitary conditions in restaurants. *Public Health Rep.* 113:353-358.

Cowgill, J. and J. Bolek. 2003. Symbol usage in health care settings for people with limited English proficiency. Available at: <http://www.segd.org/images/content/4/6/46422/pt1evaluation.pdf>. Accessed: 10 August 2013.

Curtis, V., S. Cousens, T. Mertens, E. Traoré, B. Kanki and I. Diallo. 1993. Structured observations of hygiene behaviours in Burkina Faso: validity, variability, and utility. *Bulletin of the World Health Organization* 71: 23–32.

Cutter, C., S. Nieto-Montenegro, and A. Richard. Survey for food safety training materials for retail grocery store associates. Penn State Cooperative Extension.

Davies, S., H. Haines, B. Norris, and J.R. Wilson. 1998. Safety pictograms: are they getting the message across? *Appl. Ergon.* 29:15-23.

Davies, S., H.M. Haines, and B.J. Norris. 2000. The role of pictograms in the conveying of consumer safety information. Available at: http://www.ergo-eg.com/uploads/digi_lib/362.pdf. Accessed: 2 July 2013.

Delp, C. and J. Jones. 1996. Communicating information to patients: the use of cartoon illustrations to improve comprehension of instructions. *Acad. Emerg. Med.* 3:264-270.

Dewar, R. and P. Arthur 1999. Design and evaluation of public information symbols. In: Zwaga, H.J.G., Boersema, T., Hoonhout, H.C.M. (Eds.), *Visual Information for Everyday Use: Design and Research Perspectives*. Taylor and Francis, London, pp. 111-118.

Dewar, R., 1999. Design and evaluation of public information symbols. In: Zwaga, H.J.G., Boersema, T., Hoonhout, H.C.M. (Eds.), *Visual Information for Everyday Use: Design and Research Perspectives*. Taylor and Francis, London, pp. 285-303.

Dharod, J.M., R. Perez-Escamilla, A. Bermudez-Millan, S. Segura-Perez, and G. Damio. 2004. Influence of the Fight BAC! food safety campaign on an urban Latino population in Connecticut. *J. Nutr. Educ. Behav.* 36:128-134.

Dowse, R. and M.S. Ehlers. 1998. Pictograms in pharmacy. *Int. J. Pharm. Pract.* 6:109–118.

Dowse, R. and M.S. Ehlers. 2001. The evaluation of pharmaceutical pictograms in a low-literate South African population. *Patient Educ. Couns.* 45:87-99.

Dowse, R. and M. Ehlers. 2005. Medicine labels incorporating pictograms: do they influence understanding and adherence? *Patient Educ. Couns.* 58:63-70.

Dreyfuss, H. 1984. *Symbol sourcebook: an authoritative guide to International symbol*. New York. Van Nostrand. Reinhold.

- Egan, M.B., M.M. Raats, S.M. Grubb, A. Eves, M.L. Lumbers, M.S. Dean, and M.R. Adams. 2007. A review of food safety and food hygiene training studies in the commercial sector. *Food Cont.* 18:1180-1190.
- Ells, J.G. and R.E. Dewar. 1979. Rapid comprehension of verbal and symbolic traffic sign messages. *Hum. Factors* 21:161-168.
- Erdinc, O. 2010. Comprehension and hazard communication of three pictorial symbols designed for flight manual warnings. *Saf. Sci.* 48: 478-481.
- FAO. 2012. Food outlook. Available at: <http://www.fao.org/giews/english/fo/index.htm>. Accessed: 10 July 2013.
- FDA. 2000. Report on the FDA retail food program database on foodborne illness risk factors. Available at: <http://www.fda.gov/downloads/Food/GuidanceRegulation/ucm123546.pdf>. Accessed: 8 October 2013.
- FDA. 2009. FDA Food Code: Chapter 2- Management and Personnel. Available at: <http://www.fda.gov/Food/GuidanceRegulation/RetailFoodProtection/FoodCode/ucm181242.htm#part2-3>. Accessed 3 June 2015.
- Fierro, I., T. Gomez-Talegon, and F.J. Alvarez. 2013. The Spanish pictogram on medicines and driving: the population's comprehension and attitudes towards its use on medication packaging. *Accid. Anal. Prev.* 50:1056-1061.
- Filion, K., K.S. KuKanich, B. Chapman, M.K. Hardigree, and D.A. Powell. 2011. Observation-based evaluation of hand hygiene practices and the effects of an intervention at a public hospital cafeteria. *Am. J. Infect. Cont.* 39:464-470.
- Food Workers Chain Alliance. 2012. The hands that feed us: challenges and opportunities for workers along the food chain. Available at: <http://foodchainworkers.org/wp-content/uploads/2012/06/Hands-That-Feed-Us-Report.pdf>. Accessed: 8 August 2013.
- Fraser, A.M. and S.R. Alani. 2009. Food safety education for Arabic speakers in the food service industry. *J. Environ. Health* 72:30-32.
- Fraser, A., J.W. Arbogast, L. Jaykus, R. Linton, and D. Pittet. 2012. Rethinking hand hygiene in the retail and foodservice industries: are recommended procedures based on the best science and practical under real-world conditions? *Food Prot. Trends.* December, pp. 750-758.
- Frederick, T. 2005. The do's and don'ts of food plant personal hygiene practices. *Food Saf. Magazine.* Dec. 2004/Jan. 2005.

- Garayoa, R., M. Cordoba, I. Garcia-Jalon, A. Sanchez-Villegas, and A.I. Vitas. 2005. Relationship between consumer food safety knowledge and reported behavior among students from health sciences in one region of Spain. *J. Food. Prot.* 68:2631-2636.
- Godwin, S.L. and E. Chambers IV. 2009. Observational research: a tool for collecting behavioral data and validating surveys. In: *Proceedings SPISE 2009: Food Consumer Insights in Asia*, ed. Abdi, H., Valentin, D., and Nguyen, D.H., Vietnam National University – HoChiMinh City Publishing House. pp 29-35.
- Green, L.R., C.A. Selman, V. Radke, D. Ripley, J.C. Mack, D.W. Reimann, T. Stigger, M. Motsinger, and L. Bushnell. 2006. Food worker hand washing practices: an observational study. *J. Food Prot.* 69:2417-2423.
- Grey, M.A. and A.C. Woodrick. 2002. Unofficial sister cities: meatpacking labor migration between Villachuato, Mexico and Marshalltown, Iowa. *Hum. Organ.* 61:364-376.
- Hancock, H.E., W.A. Rogers, D. Schroeder, and A.D. Fisk. 2004. Safety symbol comprehension: effects of symbol type, familiarity, and age. *Hum. Factors* 46:183-195.
- Hanna, A. and R. Remington. 1996. The representation of color and form in long-term memory. *Mem. Cognit.* 24:322-330.
- Hardin, M.D. 2013. Poultry safety in an ever-changing world. *Food Safety Magazine.* 32-35;56-57.
- Harris, K.J. and M.A. Bonn. 2000. Training techniques and tools: evidence from the foodservice industry. *J. Hosp. Tour. Res.* 24:320-335.
- Hirsch, D.W. and C.N. Cutter. 2007. A survey for small and very small meat and poultry processors in the Northeast. University of Connecticut.
- Holladay, N. 2004. Working with Hispanics. Available at: www.nrcs.usda.gov/Internet/FSE.../nrcs142p2_007143.pdf. Accessed: 8 August 2013.
- Houts, P.S., J.T. Witmer, H.E. Egeth, M.J. Loscalzo, and J.R. Zabora. 2001. Using pictographs to enhance recall of spoken medical instructions II. *Patient Educ. Couns.* 43:231-42.
- Houts, P.S., C.C. Doak, L.G. Doak, and M.J. Loscalzo. 2006. The role of pictures in improving health communication: a review of research on attention, comprehension, recall, and adherence. *Patient Educ. Couns.* 61:173-190.
- Howard, M. and K. Wignarajah. 2008. Perceptions of food hygiene risk in a group of Tamil food handlers living in the UK. *J. Foodservice* 19:119-126.
- Jacob, C., L. Mathiasen, and D. Powell. 2010. Designing effective messages for microbial food safety hazards. *Food Cont.* 21:1-6.

Jay, L.S., D. Comar, and L.D. Govenlock. 1999. A video study of Australian domestic food-handling practices. *J. Food Prot.* 62:1285-1296.

Jensen, D.A., M.D. Danyluk, L.J. Harris, and D.W. Schaffner. 2015a. Quantifying the effect of hand washing duration, soap use, ground beef debris, and drying methods on the removal of *Enterobacter aerogenes* on hands. *J. Food Prot.* 78:685-690.

Jenson, D.A. and D.W. Schaffner. 2015b. Quantitative analysis of recommendations made in hand washing signs. *Food Prot. Trends.* 35:270-279.

Kandler, B. 2008. Stop! Don't ignore the value of safety signs. Available at: <http://ohsonline.com/articles/2008/12/value-of-signs.aspx>. Accessed: 3 Dec. 2012.

Keener, K. M., M. P. Bashor, P.A. Curtis, B.W. Sheldon, and S. Kathariou. 2004. Comprehensive review of *Campylobacter* and poultry processing. *Comp. Rev. Food Sci. Food Saf.* 3:105-116.

Kendall, P.A., A. Elsbernd, K. Sinclair, M. Schroeder, G. Chen, V. Bergmann, V.N. Hillers, and L.C. Medeiros. 2004. Observation versus self-report: validation of a consumer food behavior questionnaire. *J. Food. Prot.* 67:2578-2586.

Lesch, M.F. 2003. Comprehension and memory for warning symbols: age-related differences and impact of training. *J. Saf. Res.* 34:495-505.

Ley P. 1982. Satisfaction, compliance and communication. *Br. J. Clin. Psychol.* 21:241-54.

Lindhout, P. and B.J.M. Ale. 2009. Language issues, an underestimated danger in major hazard control. *J. Hazard Mater* 172:247-255.

Luximon, A., L.W. Chung, and R.S. Goonetilleke. 1998. Safety signal words and color codes: the perception of implied hazard by Chinese people. Proceedings of the 5th Pan-Pacific conference on occupational ergonomics pp. 30-33.

Lynch, R.A., B.L. Elledge, C.C. Griffith, and D.T. Boatright. 2003. A comparison of food safety knowledge among restaurant managers, by source of training and experience, in Oklahoma City, Oklahoma. *J. Environ. Health* 66:9-14.

Madera, J.M., J.A. Neal, and M. Dawson. 2011. A strategy for diversity training: focusing on empathy in the workplace. *J. Hosp. Tour. Res.* 35:469-487.

Manes, M.R., L. Liu, A. Burke, and M.S. Dworkin. 2014. Food for thought: effective evidence-based brochure and comic book interventions designed for restaurant food handlers. *Food Prot. Trends.* 34:68-82.

Manun'Ebo, M., S. Cousens, P. Haggerty, M. Kalengaie, A. Ashworth, and B. Kirkwood. 1997. Measuring hygiene practices: a comparison of questionnaires with direct observation in rural Zaire. *Trop. Med. Int. Heal.* 2:1015-1021.

Mathias, R. G., P. D. Riben, E. Campbell, M. Wiens, W. Cocksedge, A. Hazlewood, B. Kirshner, and J. Pelton. 1994. The evaluation of the effectiveness of routine restaurant inspections and education of food handlers: restaurant inspection survey. *Can. J. Public Health* 85(Suppl. 1):S61-66.

Mayer, D.L. and L.F. Laux. 1989. Recognizability and effectiveness of warning symbols and pictorials. *Proceed. Hum. Fact. Ergo. Soc. Ann. Meet.* 33:984.

Medeiros, C.O., S.B. Cavalli, E. Salay, and R.P.C. Proenca. 2011. Assessment of the methodological strategies adopted by food safety training programmes for food service workers: a systematic review. *Food Cont.* 22:1136-1144.

McDougall, S.J.P., O. de Bruijn, and M.B. Curry. 2000. Exploring the effects of icon characteristics on user performance: the role of icon concreteness, complexity, and distinctiveness. *J. Exp. Psychol.* 6:291-306.

McIntyre, L., L. Vallaster, L. Wilcott, S.B. Henderson, and T. Kosatsky. 2013. Evaluation of food safety knowledge, attitudes and self-reported hand washing practices in FOODSAFE trained and untrained food handlers in British Columbia, Canada. *Food Cont.* 30:150-156.

Mwamakamba, L., P. Mensah, F. Fontannaz-Aujoulat, M. Hlabana, F. Maiga, F. Bangoura, C. Mohamed, and L. Ingenbleek. 2012. The WHO five keys to safer food: a tool for food safety health promotion. *African J. Food Agri. Nutr. Devel.* 12:6245-6259.

National Restaurant Association. 2006. Restaurant industry facts. Available at: www.restaurant.org/research/ind_glance.cfm. Accessed 18 July 2013.

Neal, J., P.G. Crandall, M. Dawson, and J. Madera. 2015. Food safety and language barriers on the processing line. *Food. Saf. Magazine.* Feb./Mar. 2015:22-28.

Neal, J.A., M. Dawson, and J.M. Madera. 2011. Identifying food safety concerns when communication barriers exist. *J. Food Sci. Educ.* 10:36-44.

Nelson, D.L., V.S. Reed, and J.R. Walling. 1976. Pictorial superiority effect. *J. Exp. Psychol. Hum. Learn.* 2:523-528.

Nicol, A. and S. Tuomi. 2007. Hazard sign comprehension among illiterate adults. *Stellenbosch Papers in Linguistics* 37:67-88.

Nieto-Montenegro, S., J.L. Brown, and L.F. LaBorde. 2004. Evaluating food safety needs in the food industry using a "worker-experience protocol." *Food Prot. Trends* 24:1-6.

- Nieto-Montenegro, S., J.L. Brown, and L.F. LaBorde. 2006. Using the Health Action Model to plan food safety educational materials for Hispanic workers in the mushroom industry. *Food Cont.* 17:757-767.
- Nieto-Montenegro, S., J.L. Brown, and L.F. LaBorde. 2008. Development and assessment of pilot food safety educational materials and training strategies for Hispanic workers in the mushroom industry using the Health Action Model. *Food Cont.* 19:616-633.
- Nishimura, S., M. Kagehira, F. Kono, M. Nishimura, and N. Taenaka. 1999. Handwashing before entering the intensive care unit: What we learned from continuous video-camera surveillance. *Am. J. Infect. Cont.* 27:367-369.
- Nulty, D.D. 2008. The adequacy of response rates to online and paper surveys: what can be done? *Assess. Eval. Higher. Educ.* 33:301-314.
- Occupational Safety and Health Administration (OSHA). 2010. OSHA training standards policy statement. Available at: <http://www.osha.gov/dep/standards-policy-statment-memo-04-28-10.html>. Accessed: 6 December 2012.
- Odo, N.U., P.C. Raynor, A. Beaudoin, R. Somrongthong, J.M. Scheftel, J.G. Donahue, and J.B. Bender. 2015. Personal protective equipment use and hand washing among animal farmers: a multi-site assessment. *J. Occ. Environ. Hygiene.* 12:363-368.
- Osborne, H. 1999. In other words...teaching with pictures. *Boston Globe's On Call Magazine.*
- Ou, Y.O and Y. Liu. 2012. Effects of sign design features and training on comprehension of traffic signs in Taiwanese and Vietnamese user groups. *Int. J. Ind. Ergon.* 42:1-7.
- Paivio, A. 1991. Dual Coding Theory: retrospect and current status. *Can. J. Psychol.* 45:255-287.
- Passini, S., F. Strazzari, and A. Borghi, 2008. Icon-function relationship in toolbar icons. *Displays* 29:521-525.
- Patil, S.R., S. Cates, and R. Morales. 2005. Consumer food safety knowledge, practices, and demographic differences: findings from a meta-analysis. *J. Food Prot.* 68:1884-1894.
- Paul, J.A. 2013. Improving communication with foreign speakers on the shop floor. *Saf. Sci.* 52:65-72.
- Payne, G. and J. Payne. 2004. Key concepts in social research. Chp.: The Hawthorne Effect. Sage Publications, London. 108-112.
- Phillips, B.J. 1997. Thinking into it: consumer interpretation of complex advertising images. *J. Advert.* 26:77-87.

Pivarnik, L.F., D. Hicks, M. Jahncke, and K. Gall. 2007. Needs assessment survey of sanitation, good manufacturing and hygienic training practices for food processors, wholesalers and warehouse operators. *Food Prot. Trends*. June, 400-408.

Po, L.G., L.D. Bourgain, L.G. Occeea, and E.C. Po. 2011. Food safety education for ethnic audiences. Available at: <http://www.foodsafetymagazine.com/magazine-archive1/junejuly-2011/food-safety-education-for-ethnic-audiences/>. Accessed: 8 August 2013.

Potturi-Venkata, L.P., S. Backert, S.L. Vieira, and O.A. Oyarzabal. 2007. Evaluation of logistic processing to reduce cross-contamination of commercial broiler carcasses with *Campylobacter* spp. *J. Food Prot.* 70:2549-2554.

Powell, D. A., B. V. Surgeoner, S. M. Wilson, and B. J. Chapman. 2007. The media and the message: risk analysis and compelling food safety information from farm-to-fork. *Aust. J. Dairy Tech.* 62:55-59.

Preece, J., Y. Rogers, H. Sharp, D. Beryon, S. Holland, and T. Carey. 1994. *Human-computer Interaction*. Addison-Wesley, England. 99-122.

Quandt, S.A., J.G. Grzywacz, A. Marin, L. Carrillo, B.L. Coates, B. Burke, and T.A. Arcury. 2006. Illnesses and injuries reported by Latino poultry workers in Western North Carolina. *Am. J. Ind. Med.* 49:343-351.

Rajagopal, L. 2012. Use of visuals for food safety education of Spanish-speaking foodservice workers: a case study in Iowa. *J. Ext.* 50:1-13.

Randle, J., J. Firth, and N. Vaughan. 2012. An observational study of hand hygiene compliance in paediatric wards. *J. Clin. Nurs.* 22:2586-2592.

Ratnapradipa, D., D. Quilliam, L. Wier, and D.L. Rhodes. 2011. Food safety education: child-to-parent instruction in an immigrant population. *J. Environ. Health* 73:70-75.

Redmond, E.C. and C.J. Griffith. 2006. A pilot study to evaluate the effectiveness of a social marketing-based consumer food safety initiative using observation. *Brit. Food J. Hyg. Rev.* 108:753-770.

Richard, A.E., J.L. Brown, R.B. Radhakrishna, E.P. Yonder, S. Nieto-Montenegro, and C.N. Cutter. 2013. Development and implementation of a “counter-top” training program to increase retention of food safety knowledge, alter behavior, improve attitude and increase skills of Spanish-speaking retail employees. *Food Prot. Trends* 33:10-19.

Roberts, K.R., B.B. Barrett, A.D. Howells, C.W. Shanklin, V.K. Pilling, and L.A. Brannon. 2008. Food safety training and foodservice employees’ knowledge and behavior. *Food Prot. Trends* 28:252-260.

Robertson, L.A., R.R. Boyer, B.J. Chapman, J.D. Eifert, and N.K. Franz. 2013. Educational needs assessment and practices of grocery store food handlers through survey and observational data collection. *Food Cont.* 34:707-713.

Rosson, M.B. 2002. *Usability Engineering: Scenario-Based Development of Human-Computer Interaction*. Academic Press, San Francisco. 119-125.

Rowell, A.E., M. Binkley, L. Thompson, S. Burris, and C. Alvarado. 2013. The impact of food safety training on employee knowledge of food safety practices for hot/cold self-serve bars. *Food Prot. Trends.* 33:376-386.

Rudd, R.E., J.P. Comings, and J.N. Hyde. 2003. Leave no one behind: improving health and risk communication through attention to literacy. *J. Health Commun.* 8:104-115.

Ruggles, S., J.T. Alexander, K. Genadek, R. Goeken, M.B. Schroeder, and M. Sobek. 2010. Integrated public use microdata series: version 5.0. Available at: <http://usaipums.org>. Accessed: 10 August 2013.

Russell, W.D., D.A. Dzewaltowski, and G.J. Ryan, 1999. The effectiveness of a point-of-decision prompt in deterring sedentary behavior. *Am. J. Health Promot.* 13:257-259.

Schein, E.H. 1996. Three cultures of management: the key to organizational learning, *Sloan Manage. Rev.* 38: 9–20

Schellekens, P. and J. Smith. 2004. Language in the construction industry: communicating with second language speakers. Available at: <http://past.cilt.org.uk/pdf/languages%20in%20the%20construction%20industry.pdf>. Accessed: 15 July 2013.

Schmidt, R. 2013. Food equipment hygienic design: an important element of a food safety program. *Food Safety Magazine.* 14-17; 52.

Shapiro, S.A. and J.H. Nielson. 2013. What the blind eye sees: incidental change detection as a source of perceptual fluency. *J. Consum. Res.* 39:1202-1218.

Shin, H.B. and R.A. Kominski. 2007. Language use in the United States: 2007. Available at: www.census.gov/prod/2013pubs/acs-22.pdf. Accessed: 8 July 2013.

Shinar, D., and M. Vogelzang. 2013. Comprehension of traffic signs with symbolic versus text displays. *Transp. Res. Part F.* 18:72-82.

Sinclair, R.C., R. Smith, M. Colligan, M. Prince, T. Nguyen, and L. Stayner. 2003. Evaluation of a safety training program in three food service companies. *J. Saf. Res.* 34:547-558.

Smith, K. and P. Shillam. 2000. An evaluation of food safety training using videotaped instruction. *Foodservice Res. Int.* 12:41-50.

Soon, J.M. and R.N. Baines. 2012. Food safety training and evaluation of hand washing intention among fresh produce farm workers. *Food Cont.* 23:437-448.

Sparkman, A. F., M.E. Briley, and M.B. Gillham. 1984. Validated food service training manual for supervisors with limited experience. *J. Am. Diet. Assoc.* 84:1475-1478.

Stanton, B.F., J.D. Clemens, K.M.A. Aziz, and M. Rahaman. 1987. Twenty-four-hour recall, knowledge-attitude-practice and direct observations of sanitary practices: a comparative study. *Bulletin of the World Health Organization.* 65:217-222.

Sussman, R. and R. Gifford. 2012. Please turn off the lights: the effectiveness of visual prompts. *Appl. Ergo.* 43:596-603.

Tijus, C., J. Barcenilla, B. Cambon de Lavalette, and J. Meunier. 2007. The design, understanding and usage of pictograms. *Studies in Writing.* 21:17-32.

Tyler, K. 2005. Clear Language. Available at: <http://www.shrm.org/Publications/hrmagazine/EditorialContent/Pages/1205tyler.aspx>. Accessed 12 July 2013.

Vistawide. 2009. Top 20 countries by number of languages. Available at: http://www.vistawide.com/languages/20_countries_most_languages.htm. Accessed: 10 August 2103.

Whitlow, A., S. Louie, C. Mueller, B. King, E. Page, and B. Bernard. 2012. Chlorine gas release associated with employee language barrier- Arkansas, 2011. *Morb. Mortal. Wkly. Rep.* 61:981-985.

Wilkinson, R.L., J.W. Cary, N.F. Barrs, and J. Reynolds. 1997. Comprehension of pesticide safety information: effects of pictorial and textual warnings. *Int. J. Pest. Manage.* 43:239-245.

Wilkinson, L.C. 2007. A developmental approach to uses of moving pictures in intercultural education. *Int. J. Intercult. Relat.* 31:1-27.

Winter, C.K., A.M. Fraser, J.B. Gleason, S.K. Hovey, S.M. McCurdy, and O.S. Snider. 2009. Food safety education using music parodies. *J. Food Sci. Educ.* 8:62-67.

Wiseman, S., C.M. MacLeod, and P.J. Lootsteen. 1985. Picture recognition improves with subsequent verbal information. *J. Exp. Psych: Learn. Mem. Cognit.* 11:588-595.

Witte, K. 1994. Fear control and danger control: a test of the extended parallel process model (EPPM). *Commun. Monogr.* 61:113-34.

Witte, K. 1997. Preventing teen pregnancy through persuasive communications: realities, myths and the hard-fact truths. *J. Commun. Health.* 22:137-54.

Wogalter, M.S. and R.J. Sojourner. 1997. Comprehension and retention of safety pictorials. *Ergonomics*. 40:531-542.

Wogalter, M.S. 1999. Factors influencing the effectiveness of warnings. In: Zwaga, H.J.G., Boersema, T., Hoonhout, H.C.M. (Eds.), *Visual Information for Everyday Use: Design and Research Perspectives*. Taylor and Francis, Inc., London, pp. 93-110.

World Health Organization (WHO). 2015. Five moments for hand hygiene. Available at: http://who.int/gpsc/tools/Five_moments/en/. Accessed 3 June 2015.

Worsfold, D. and C. Griffith. 1995. A generic model for evaluating consumer food safety behavior. *Food Cont.* 6:357-363.

York, V.K., L.A. Brannon, C.W. Shanklin, K.R. Roberts, B.B. Barrett, and A.D. Howells. 2008. Intervention improves restaurant employees' food safety compliance rates. *Int. J. Contem. Hosp. Manag.* 21:459-478.

Young, S.L. 1991. Increasing the noticeability of warnings: effects of pictorial, color, signal icon and border. *Proceedings of the Human Factors Society 35th Annual Meeting*.

Young, S.L., J.P. Frantz, T.P. Rhoades, and K.R. Darnell. 2002. Safety signs and labels: does compliance with ANSI Z535 increase compliance with warnings? *Prof. Saf.* September pp. 18-23.

**Chapter 2: Employee Perceptions of Food Safety Pictograms at Meat and Poultry
Processing Plants Leads to New Hand Washing Pictogram**

Matthew Schroeder,^{1*} Oscar Galagarza,¹ Joseph Eifert,¹ Renee Boyer,¹
Melissa Chase,¹ and Sergio Nieto-Montenegro²

¹Dept. of Food Science and Technology (0924)

Virginia Tech, 1230 Washington Street SW, Blacksburg, VA 24061, USA

²Food Safety Consulting and Training Solutions, LLC, 2300 George Dieter Dr.

El Paso, TX 79936, USA

Corresponding author:

Phone: +1 540.231.6806; Fax: +1 540.231.9293

Email: matths4@vt.edu

ABSTRACT

Pictograms are commonly used in the retail food service industry to portray safety messages. Involving the target population can provide valuable insight into worker preferences for the design of pictograms. Employee perceptions of pictograms can provide crucial information regarding how to create effective messages. To develop a pictogram effective in portraying food safety messages to meat and poultry processing employees, surveys were conducted with meat and poultry food safety coordinators in the mid-Atlantic region. Follow-up focus groups were conducted with employees at facilities that responded. These were administered in both English (5) and Spanish (5) based on language availability and size. Of the 308 surveys sent, 47 (15.3%) were returned and analyzed. Only 53.3% (24/45) of facilities currently use pictograms, and the most important food safety training topics were hand washing (60.9%), cleaning/sanitizing (78.3%), and preventing cross contamination (69.6%). Employees believed color, text, and multiple language options increase employee recognition and retention of intended messages. Understanding the food safety needs of meat and poultry processing facilities combined with employee preferences can help create relevant food safety pictograms. Based on the survey and focus groups' feedback, a new hand washing sign with minimal English and Spanish text was created.

INTRODUCTION

The meat and poultry industry generates approximately \$864.2 billion annually, which represents 6% of the United States GDP (28). Food safety for this industry begins on the farm and continues through consumer. Though the main pathogen concerns in poultry are *Salmonella* and *Campylobacter*, proper worker hygiene and knowledge of potential sources of cross contamination are important in order to deliver a safe product to the consumer.

The food industry, which includes farm workers, slaughterhouse and processing facility workers as well as retail workers typically has a diverse workforce. The Bureau of Labor Statistics (1) noted in 2010 that 38% of animal slaughtering and processing industry workers were Hispanic or Latino. The National Restaurant Association (23) reported that 26% of employees speak a language other than English at home and in some cases, foodservice workers speak little to no English (12). In addition, 58% of food chain workers in the United States are estimated to have a high school degree or less (11). Language difficulties coupled with a lack of formal education can make communication between employer and employee difficult.

Cultural differences, high turnover rate, low literacy, and low education levels can create challenges when conducting food safety and occupational safety trainings (24, 31). Training by direct lecture in English is still the most common form today (12). Some facilities show videos or utilize training programs such as SafeStart[®] for occupational or personal safety training, but these are commonly conducted in English. Because language and cultural barriers can exist, information can be misinterpreted or misunderstood by employees (25). Trainings conducted in employees' native language have shown tremendous benefits including: increased morale and retention, feeling of appreciation and respect, and increased level of trust (18, 31,

35). When conducting training for ethnic populations, employers should know and understand their target population.

Signs have been used extensively in the healthcare, transportation, advertising, and construction industries. Most pictograms currently used in the meat and poultry processing industry deal with occupational hazards such as hand/arm cutting warnings on machines, fire hydrant locations, wet floor cautions, eye wash station locations, exit signs, and chemical warnings. When used for food safety applications, pictograms can offer a language-free medium to communicate an intended food safety message to populations with different backgrounds and educational levels (10, 34). Pictograms could also act as a method to offer recurring food safety knowledge without the need for additional trainings. However, before pictograms can effectively be created, the target population needs to be considered. The meaning of the pictogram is created through the semantics. Employee perceptions of semantics can help create an effective, relevant food safety sign. Once the target population's opinions are expressed, a relevant pictogram can hopefully enhance food safety practices.

The specific objectives of this study were to (1) identify current demographics, training status, and current pictogram usage in meat or poultry processing facilities in the mid-Atlantic region, (2) identify preferred pictogram semantics from meat or poultry processing employees (target population), and (3) create a food safety pictogram for meat or poultry processing employees.

MATERIALS AND METHODS

Survey (Appendix A)

Surveys (n=308), along with an introduction letter about the research, were sent to meat and poultry processing facilities in the mid-Atlantic region including: Delaware, Maryland, Virginia, Pennsylvania, West Virginia and North Carolina. Directories from both the United States Department of Agriculture – Food Safety and Inspection Service (USDA-FSIS) and Virginia Department of Agriculture and Consumer Services (VDACS): Office of Meat and Poultry Services were used to generate potential survey participants. The preferred method of conducting the survey was initially using a phone interview. To facilitate this, an E-mail was sent to quality assurance (QA)/food safety managers requesting a return E-mail of interest in participating in the study. The intent was to then conduct a phone survey at a mutually agreed upon time; however, there was a very low response rate.

Surveys were then sent through regular mail addressed to QA/food safety managers using directories provided by USDA-FSIS and VDACS. A stamped return envelope was included with the survey for ease of return to the Virginia Tech Department of Food Science and Technology. Participation was voluntary and consent was implied if participants returned a written survey. Survey questions included background information about the slaughter/processing facility, demographics of workers, current training provided to employees, food safety training topics, and current facility pictogram usage and perception. The purpose of the survey was to determine particular food safety message needs in the meat and poultry industry so that a current food safety pictogram could be designed. Survey questions were adapted and modified from a survey for small and very small meat and poultry processors in the Northeast (15) and survey for food safety training materials for retail grocery store associates (5).

Focus groups

Participants (employees) for focus groups were recruited from companies who responded to the survey. To be included in focus group participation, the company must have: Spanish speaking employees and current training for their employees in food safety. Ten companies were contacted for possible participation. From these criteria, a convenience sample of five facilities was selected for focus group participation. Participation was voluntary.

Focus groups were conducted in both English and Spanish (separately) at all five facilities, lasted one hour, and were based on the methodology of Krueger and Casey (21). Written consent forms (Appendix B) were read to participants, and they were required to sign in order for the focus group to begin. There was no incentive for participation. Each session was audio recorded for accuracy and completeness of participant responses using an Olympus DS-30 digital voice recorder (Olympus America Inc., Center Valley, PA). Participants were asked questions about current food safety pictograms and training programs in their facility (Appendix C). Participants were then shown ten different glove usage pictograms (as an example) previously designed by the Virginia Food Safety Task Force. Each of the ten pictograms had differing semantics: color, orientation, verbiage, and shape (Appendix D). Participants were asked about their impressions of each sign and if they had any suggestions about possible changes. Focus groups concluded by asking about ideal pictogram semantics and implications in their facility.

Immediately after the English focus group was concluded, the Spanish focus group began. Spanish focus groups were conducted by a native Spanish-speaking researcher from the Virginia Tech Department of Food Science and Technology. Procedure was the same as above; however, all forms, including consent forms, signs, and communication were in Spanish. Both

English and Spanish focus group audio recordings were transferred from the voice recorder to a secure computer immediately upon focus group completion. Focus group discussions were then transcribed, coded by theme, and ordered into categories based on similar coding. This project (survey, focus groups) was approved by the Virginia Tech Institutional Review Board (IRB) as part of IRB 14-003 (Appendix E).

Pictogram design (Appendix F)

Based on the data collected from survey and focus groups, a new pictogram portraying a food safety message was developed. Pictograms (11" by 17") were made by designers at a co-principal investigator's company (Food Safety Consulting and Training Solutions, LLC, El Paso, TX).

Data analysis (focus group)

Qualitative analysis of transcribed focus group discussions followed a comparative method utilizing joint coding and analysis (8, 32). Transcripts were transcribed independently by English and Spanish-speaking researcher verbatim from recordings. Transcripts were then coded based on theme. A code is a specified label applied to an excerpt of the transcript that describes both the implicit and explicit meanings. For example, if employees talked about how numbering steps and cartoon images would improve behavior compliance, a code could be "numbered steps and cartoon images are effective." Similar codes were put into categories that formed the basis for reporting results. For example, the code about numbering steps in a sign or using a cartoon picture in a sign would be categorized as "employee suggestions to improve signs." Inter-rater reliability of codes was confirmed by another member of the research team.

RESULTS

Survey

A total of 308 surveys were sent to meat and poultry processors in the mid-Atlantic region. A total of 47 surveys were completed with a response rate of 15.3%. Five surveys were conducted by phone and 42 were returned by mail. One survey was excluded from analysis due to a majority of the questions not being answered. Most of the returned surveys were completed by QC/QA managers (52.1%) and owners (43.5%) of meat and poultry processing facilities. Beef (54.3%), pork (58.7%), and poultry (47.4%) were the most frequent animals processed amongst the returned surveys. Most facilities (34/46; 73.9%) had a small number of employees (1-100). Twenty-five of the 46 (54.5%) surveys mentioned that some employees did not speak English.

Most facilities (37/46) had an established food safety training program within their facility. Facilities provided training to manager/supervisory personnel in 74.4% (32/43) of facilities, line/production personnel in 88.4% (38/43), and maintenance/sanitation personnel in 67.4% (29/43). Most training was conducted by supervisory personnel (69.8%) and QC/food safety/HACCP personnel (65.1%). Training was offered in another language in 43.9% (18/41) of facilities. Food safety training/education was conducted in-house/one-on-one for 76.7% (33/43) of facilities or in-house using computers for 44.2% (19/43) of facilities. Training was completed off site or through workshops offered by universities for 23.3% (10/43) of facilities. Participants were asked the three most important food safety training topics in their facilities. The top three responses were proper hand washing (28/46; 60.9%), cleaning and sanitizing (36/46; 78.3%), and preventing cross contamination (32/46; 69.6%) (Figure 1). These three food

safety topics were addressed in more detail during the focus groups to determine a single topic to create a new pictogram.

The final part of the survey investigated each facilities' current pictogram usage as well as the participants' perception of pictograms. A total of 24 out of 45 (53.3%) facilities currently use pictograms. Most (23/24; 95.8%) of those have some text associated with them and provide instruction on proper hand washing (26/27; 96.3%). Pictograms are frequently found on the wall (21/26), in bathrooms (21/26) and near sinks/faucets (21/26). Respondents (36/44; 81.8%) think signs are a useful way to convey food safety knowledge or information. Participants believed that the wall and the employee break/lunch room were the most appropriate location for pictograms. Participants also suggested that location (93.3%), size (60.0%) and intended message (73.3%) are the most important aspects to a food safety sign (Figure 2).

Focus groups

The facilities represented by the five focus groups ranged in size from 15 employees to >500 employees. Focus group size ranged from two to seven employees and included a total of 42 participants. Both raw and further processing meat and poultry facilities were sampled. The saturation point of focus group responses was reached after 10 total focus groups. Saturation is the point where no new information is being received, the range of ideas has been covered, and there is no longer a need to conduct more focus groups (21).

The analysis of employees' perception of pictograms within meat and poultry processing facilities could be organized into 16 categories. The results are summarized in Table 1. Categories formed the framework to organize the key findings from the focus groups. Although discussed separately, categories were not experienced in isolation of one another.

1. Employees in meat and poultry processing are multicultural with limited English proficiency and understanding. Participants represented the wide range of ethnic groups that work in the meat and poultry industry. English and Spanish were the primary languages spoken. However, at the larger companies, ethnic differences were more evident. Employees at the large facilities mentioned that people from Hispanic, American, Asian, Chinese, and Russian descent were all employed at the facility. An English-speaking employee described how they at times feel like the minority group. With many different ethnicities and cultures in a single workplace, communication can be challenging.

Employees described that some workers have limited or no literacy levels and limited English-speaking capabilities. One employee gave an example of an occupational accident that occurred because the Hispanic employee could not read English. The diversity of employees can make communication between employees difficult as well. Training for multicultural employees can also be difficult for supervisors and managers.

2. Current pictograms are mainly occupational safety related. Employees described current signs and pictograms within their facility. There was an agreement among the group that employees had difficulty remembering current signs within their facility. English was the common language of facility signs, and signs tended to be heavy with text. Most current signs in our sample were focused on occupational risk and employee hazards including hand/arm cutting warnings on machines, fire hydrant locations, wet floor cautions, eye wash station locations, exit signs, and chemical warnings. Employees also described the personal protective equipment sign that was outside their facility before they entered the plant. Food safety signs were uncommon though employees did mention hand washing, especially in restroom areas, and the difference between utensil wash and hand washing stations.

3. Current pictograms tend to be overlooked and are usually in common worker areas.

Employees agreed that signs have increased over the past few years, but in some cases there are now too many and people tend to overlook them. Signs may become overlooked because they become background for employees. Though they are supposed to be a constant reminder, employees expressed that they become surroundings.

Signs are located all throughout the facilities and are encountered as workers entered the plant. One employee expressed that signs began at the guard tower, while at another facility, signs began right before entering the facility processing area. Signs were located in common employee areas such as the lunch room, locker room area, and bathroom. However, employees mentioned that some of the signs are inaccessible and unseen because of objects blocking them.

4. More emphasis on training today, but length of time varies. Some of the employees, both English and Spanish-speaking, worked at their current facility for 20 or 30 years. Those employees expressed the differences between training now and in previous years. In the mid-80s and early 90s, there was no training. Employees described that they attended work, were examined by a nurse, and immediately placed on the processing room floor. In some cases, because employees were experienced, they did not receive much training. Employees mentioned that over the past few years, there has been an increased emphasis on training: both occupational and food safety. Length of time for training varied greatly and differed by department at some plants. Facility trainings ranged from a few hours to several weeks. Recurring training in both food safety and occupational safety varied as well. Some facilities conduct recurring training meetings monthly and some were completed yearly.

5. Current methods of training include standardized videos and mentorship. Employee training was conducted in a variety of ways. Both English and Spanish-speaking employees at

the large facilities (>500 employees) received training in their native language. Training was conducted by human resources staff, supervisors, and managers. In some cases, outside trainers conducted training in food safety. Videos and movies were utilized most frequently at all facilities for food safety and occupational safety training. Standardized occupational safety classes, such as SafeStart[®], are also now being utilized in meat and poultry processing facilities. Employees voiced displeasure with these safety videos as there was not much human interaction, and many times the messages in the videos were common sense.

Employees from both large and small meat and poultry processing explained that much of their training happened on the job. Experienced employees tended to mentor younger employees and increased their workload when new employees were learning the task. Employees expressed that mentors helped aid in the learning process and increased their knowledge.

6. Sign message needs to be relevant to employee activities. Employees generally believed pictograms could be an effective way to communicate safety messages. However, they expressed the need to have a message that was relevant to the plant or the sign could go unnoticed. This applies to the overall sign and its contents as well. One employee described that a handrail sign was irrelevant because the use of the handrail cannot be done. People tended to carry boxes down the staircase with no free hands available; thus, many employees mocked or disregarded the message. To the employees, sign and content relevance seemed to be an important factor of sign semantics.

7. A sign needs a title. Meat and poultry processing employees were shown a sign during the focus group that did not contain a title. All employees believed that a title was necessary with any sign. A title added clarification, meaning, and importance to a sign message. The title gave

the employees an ability to understand the overall meaning of the sign without looking at the text or pictures. One employee described that the title has the ability to attract people and draw them to the message. Another employee added that a sign without a title is boring.

8. Importance of pictures to employees' understanding of sign intended message:

Stand alone quality. The contents of the sign, or pictures, are important for the design and implementation of the sign. As some employees in the food service industry are illiterate, the pictures can dictate the message of the sign. Employees expressed that pictures should be easy to understand without the use of text and can aid in the memory of the intended message of the sign. Pictures should have the ability to be understood without text and stand alone. The idea that pictures could communicate the intended message of the sign was paramount for employees. Words and text can help clarify the intended message if needed, but employees believed that pictures need to be independent to communicate sign meaning. Employees indicated that pictures were the first thing noticed on signs, which confirmed their importance to the sign design.

Employees expressed some confusion and misunderstanding when images were distorted in example glove use pictograms. When employees did not understand an image or images were unclear, employees did not approve of the sign.

9. Addition of correct size text to pictograms adds clarification and reason. Text can help enhance and clarify pictorial images for those with different learning styles. Employees were shown signs that had instructional words, which indicated more information about the intended message as well as direction words such as “wash hands” or “rinse.” Employees dictated that instructional words with pictures would be useful for those employees with less

experience. The instructional words also gave further meaning and clarification to the intended sign message, which employees commented could reduce errors during processing.

Direction words were found above the picture that gave employees specific instructions as it related to the overall sign message. Employees expressed the need to have such words since they gave meaning to each individual picture. Employees also expressed the need for direction words to be large and visible on the sign. As some signs may be distant from the intended area of compliance, small text could induce a lack of compliance with the intended message. The pictures should be able to stand alone and indicate the intended message, but instructional and directional text can help clarify, enhance, and elaborate sign meaning.

10. Multicultural signs are needed. With a diverse employee population in meat and poultry processing facilities, employees dictated there is a need for signs to have multiple languages. Employees described that some current signs at facilities were only in English, while other facilities had multilingual signs.

Some facilities had identical signs in other languages, while other facilities had multiple languages on the same sign. Employees disagreed about which languages should be present on signs, especially at larger processing facilities. Though a majority of employees are native English or Spanish speakers, other languages such as Chinese, Russian, and Creole are also present. However, employees expressed the necessity to have at least two languages on signs. Most employees expressed that multiple languages should be on the same sign. For example, English text would be first and then Spanish text would be directly underneath the English text, possibly separated by a slash mark or picture.

11. Horizontal sign orientation is more logical and sequential. When asked if they preferred horizontal or vertical layout, employees mentioned that orientation could depend on

location. As some ideal sign locations in the facilities were small, there may be times where a horizontal or vertical layout would be preferred. Most English-speaking employees tended to like the horizontal orientation over the vertical orientation. They suggested the horizontal signs were more logical and easy to follow, though the exact reasons for this belief were unclear. Because English-speaking employees are accustomed to reading from left to right, some workers commented the horizontal sign seemed to flow better. One employee described that since the vertical orientation began at the top, his eyes were not immediately drawn there. He would have started at the left and worked his way over to understand the intended message.

When asked about the vertical orientation, employees had difficulty explaining why they approved of the vertical layout. For some employees, the vertical layout was more stepwise since the sign started from the top and the user would work their way down the page. Overall, employees seemed to have a preference for the horizontal orientation, while those that liked the vertical layout were unclear as to their reasons for the preference.

12. Use of color with pictograms is attention grabbing. English-speaking and Spanish-speaking employees agreed that color has great importance within the sign design. Employees explained that color tends to grab the attention of the user and attract them to the sign. Color also caused the employees to focus on the sign. Some employees regarded color as the most important sign semantic factor. Black and white signs were common in the facilities and employees commented that these could easily be overlooked and unnoticed.

Example glove use images were shown in yellow and red, common sign colors in society. Employees had differing opinions about these common colored signs. Some workers believed the common colors were necessary. Employees expressed that red and yellow colored signs would be relevant to safety related activities in the processing plant. However, other employees

commented that different colored signs, such as blue, might draw attention better. Since employees are accustomed to red and yellow signs being associated with some type of warning or caution, some employees preferred these colors. Regardless, all employees agreed that color is paramount in sign design for its attention grabbing capabilities.

13. Use of company colors might encourage attention. Participants were shown a sign that contained different colors than the normal red and yellow. Employees were asked their perception of the blue and yellow sign. Some employees liked the new colors, while others did not think blue was appropriate. Since employees have been trained to pay attention to red and yellow, blue might be a distraction and signs could go unnoticed. However, employees also expressed that if signs were in company colors, worker compliance could be increased as company colors had a perceived importance. One employee explained the idea of signs being in company colors, “Because it would mean something important if it’s in company colors and if it’s something important, they would stop and look.”

14. Pictogram size and location attracts attention. Workers indicated that overall size of sign and location would attract attention. Workers said the size would also be an indicator of the perceived importance of the message. A small size sign could go easily unnoticed. Evacuation signs at one facility were large, and those employees believed that to be of more importance than the small signs. Sign placement near area of compliance was important as well. For example, a hand washing sign should be near the appropriate sinks and at a level that all employees can access. One employee described how signs were not at eye level for the shorter employees, and she could notice more infrequent compliance with the message.

15. Employee suggestions to improve sign semantics. After example glove use pictograms were shown to employees, they were asked about suggestions to improve sign

semantics. Workers commented that the use of a funny picture or cartoon image may attract attention. Since most signs in society utilize a real person or a stick figure, a funny picture could attract more attention and hopefully improve compliance. Some employees also wanted the steps to be numbered. If the steps are numbered, workers commented the sign would flow more easily and would be simpler to follow. A final suggestion was a color coding system for signs. Each unique activity or area of the plant would have its own color designation. For example, all blue signs would be for hand washing, while yellow could be for cleaning/sanitizing.

16. Employee suggestions for new pictogram message and location. Employees provided insight into possible locations for new signs that would be accessible to all workers. Areas such as hallways, cafeterias, and in heavily trafficked locations would be the most appropriate. Signs should also be visible and relevant to location of intended practice. For example, a hand washing sign should be near heavily trafficked sinks.

Employees were asked about ideas for possible new signs in meat and poultry processing facilities. Some employees suggested occupational safety hazards such as running with knives, slipping risks, and finger compression risk. Food safety risks were also mentioned as possible new signs in the facility. Practices such as spitting on ready-to-eat (RTE) and raw side processing floors, using torn gloves, not removing aprons before entering restroom facility, and hand washing were concerning to employees. One employee mentioned that a new hand washing sign that included how much time to wash would be helpful in their facility.

Design of a new hand washing sign

The investigators determined that a new hand washing sign would be most appropriate and relevant for meat and poultry processors from survey and focus group confirmation (Figure 3). All design elements were based on focus group participants' preferences. The new sign

incorporated company colors, title, a horizontal orientation, and minimal Spanish and English text within the same sign. The pictures within the sign were designed to be understood independently and were numbered for ease of compliance. Steps of sign were added at the request of participants and pictures were standard hand washing images. Because hand washing compliance is an important food safety practice, practical, yet standard pictures were chosen instead of cartoon images. Cartoon images could minimize significance of hand washing compliance.

DISCUSSION

The meat and poultry processing industry workforce is diverse, comprised of employees from different cultures and education levels. The Bureau of Labor Statistics (1) found that 38% of animal slaughtering and processing industry workers were Hispanic or Latino. This was confirmed by focus group participants that noted languages such as Russian, Spanish, Creole, and Chinese could all be found at processing facilities. Hirsch and Cutter (15) in a survey of small and very small meat and poultry establishments found that 44% of respondents had employees who did not speak English. This diverse workforce can make training and communication between employee and employer difficult, which can lead to the miscommunication or misinterpretation of information.

Training for the employees was typically conducted once, at the time of hire by supervisory personnel. Typically, training was done one-on-one/in house for 76.7% of survey respondents which agrees with Cates et al. (2) who found that 78.2% of training was conducted on the job. Focus group participants noted that much of their training was conducted through mentoring. Mentoring can be beneficial or detrimental in terms of food safety practices.

Workers with similar cultures and backgrounds can teach each other standard operating procedures and food safety guidelines, but mentoring could lead to inappropriate practices if not demonstrated correctly (24). Little formal training in food safety could allow for onsite educational opportunities such as using signs as a means to communicate proper food safety practices. Training was only offered in multiple languages in 43.9% establishments that responded to that question. Many establishments likely do not have training in multiple languages due to lack of time, funds and language resources (15). Hirsch and Cutter (15) found that 65% of respondents thought that training in their native language would benefit non-English speaking employees and studies have shown that training in employees' native language can have tremendous benefits (16, 31, 35). Training in their native language gives employees a sense of comfort and respect. When employees feel respected and comfortable, they are more inclined to learn, retain, and practice (35). When conducting training with multicultural audiences, Po et al. (29) suggests that knowing the level of education and cultural idiosyncrasies of the target audience can improve the dissemination of food safety messages.

The most important food safety related topics that survey respondents noted were proper hand washing, procedures for cleaning and sanitizing, and preventing cross contamination. Personal hygiene and hand washing in particular proves important for preventing microbial cross contamination (19). With many people moving throughout a processing facility, employees could be a vector for spreading microbial contamination (13). Cates et al. (2) found that 90.1% of respondents sanitize hands or gloves that contact RTE product and 81.0% sanitize hands or gloves that contact raw product in further processing areas. Employers (47.0%) were somewhat interested in employee health and hygiene policies (2); however, most employees mentioned occupational safety hazards and signs during focus group conversation. This result was

unsurprising as 20,000 poultry workers in 2004 reported missing work or seeking medical care for occupational injuries or illnesses (30). Signs such as cutting hazards, exit signs, and knife warnings were mentioned, while few food safety signs were described. This could be due to lack of training/knowledge in food safety or food safety signs blending into the background and becoming unnoticeable.

Employers and employees believed that signs would be a useful way to convey information which agreed with previous research in both food science and other industries (3, 7, 9, 17). In a representative database search of hand washing signs, 26 out of 81 (32.1%) signs were targeted for foodservice audiences (19). Most hand washing signs were observed in the restroom facilities, but not within the processing plant. This observation agrees with Jensen and Schaffner (19) who found that 11 of 12 foodservice hand washing signs were intended for restroom users. Little research has been done on creating a hand washing sign specifically targeted for the processing floor in meat and poultry facilities.

Sign designers need to keep in mind the target population and their age, gender, culture, education level, and language (4, 17, 37). Focus group participants expressed that color, text, and pictures were the most important aspects of signs. These results helped to guide the creation of the new hand washing pictogram. In order for a behavior change to occur, the ultimate goal of any sign, the sign must first attract attention and be noticed (37). Color has been shown to increase long term memory and can make a sign more noticeable (6, 14). The new hand washing sign utilized colors that were common within their respective companies, which employees expressed had a perceived importance. Blue and green, the principle colors of the new pictograms, are also associated with safety messages (20, 36). Though studies have shown that

red and yellow are commonly used for warning and caution messages (20, 22), “different” colors such as blue and green could grab attention of employees.

Sign size can also help with the effectiveness of a sign (33). Sussman and Gifford (33) found that large signs were 1.8 times more effective than small signs, while small signs were six times more effective than no signs. Observations of signs in the facilities found that most signs were on standard 8.5" by 11" paper. Size of sign can depend on how far away people should be able to read/see it. For this project, it was determined through focus group questioning that optimal size was 11" by 17", which is large enough for employees to notice, but not so large that it covers too much wall space. Horizontal orientation of the new size was utilized with numbered steps next to each picture which was requested by the focus group participants. The employees likely preferred the horizontal orientation based on reading and writing tendencies.

The pictorial superiority effect suggests that recall is enhanced when text is used with the picture (26). Focus group participants explained that text in multiple languages was important for sign comprehension, but pictures should be able to stand alone. Employees likely wanted multiple languages due to the diversity of employees at the facility. Especially with populations with limited reading abilities, signs with text may be overlooked and unnoticed (17). However, text associated with pictures can help to enhance a message and empower those who are visual learners (26), which was confirmed by focus group results. Nicol and Tuomi (27) found that when a sign with text is presented to illiterate adults in South Africa, comprehension was increased from 42.9% to 55.4%. Employees suggested using simple language such as “wash” or “rinse,” which could be understood and comprehended quickly by employees. This result agrees with research by Waterson et al. (36) that found that signs for children on board trains should be kept short and simple. This result led to the new hand washing sign having minimal text, but

contained both English and Spanish translations. The individual pictures within the sign offered a “stand alone” quality, which was confirmed by focus group participants as an important aspect of a sign.

In conclusion, signs could be a method to reinforce employee compliance with food safety related practices. However, in order to create an effective sign, the opinions of the target population need to be addressed. Results from survey and focus groups helped to understand meat and poultry food safety needs and preferred sign semantics. All aspects of sign creation were based on opinions expressed from focus group participants. These results aided in the creation of a new hand washing sign that will be displayed in meat and poultry processing facilities for evaluation. Though signs will not be shown to employees for final review prior to evaluation due to time constraints, signs might be modified after evaluation should there be a request from employees. As a result of focus group, additional occupational safety hazard signs could be created at another time. Since this study wanted to investigate food safety practices, these were not considered for development at this time.

REFERENCES

1. Bureau of Labor Statistics. 2010. Occupational employment statistics. Available at: http://www.bls.gov/oes/oes_dl.htm. Accessed 1 July 2013.
2. Cates, S. C., C. L. Viator, S. A. Karns, and M. K. Muth. 2007. Food safety practices of poultry slaughter plants: Findings from a national survey. *Food Prot. Trends*. 27:957-966.
3. Chapman, B., T. Eversley, K. Fillion, T. MacLaurin, and D. Powell. 2010. Assessment of food safety practices of food service food handlers (risk assessment data): testing a communication intervention (evaluation of tools). *J. Food. Prot.* 73:1101-1107.
4. Cowgill, J., and J. Bolek. 2003. Symbol usage in health care settings for people with limited English proficiency. Available at: <http://www.segd.org/images/content/4/6/46422/pt1evaluation.pdf>. Accessed 10 August 2013.
5. Cutter, C., S. Nieto-Montenegro, and A. Richard. N.Y. Survey for food safety training materials for retail grocery store associates. Penn State Cooperative Extension.
6. Davies, S., H. M. Haines, and B. J. Norris. 2000. The role of pictograms in the conveying of consumer safety information. Available at: http://www.ergo-eg.com/uploads/digi_lib/362.pdf. Accessed 2 July 2013.
7. Delp, C., and J. Jones. 1996. Communicating information to patients: the use of cartoon illustrations to improve comprehension of instructions. *Acad. Emerg. Med.* 3:264-270.
8. Denzin, N., and Y. Lincoln. 2005. The sage handbook of qualitative research. 3rd ed. Thousand Oaks, California: Sage Publications.
9. Dowse, R., and M. Ehlers. 2005. Medicine labels incorporating pictograms: do they influence understanding and adherence? *Patient Educ. Couns.* 58:63-70.
10. Fierro, I., T. Gomez-Talegon, and F. J. Alvarez. 2013. The Spanish pictogram on medicines and driving: the population's comprehension and attitudes towards its use on medication packaging. *Accid. Anal. Prev.* 50:1056-1061.
11. Food Workers Chain Alliance. 2012. The hands that feed us: challenges and opportunities for workers along the food chain. Available at: <http://foodchainworkers.org/wp-content/uploads/2012/06/Hands-That-Feed-Us-Report.pdf>. Accessed 8 August 2013.
12. Fraser, A. M., and S. R. Alani. 2009. Food safety education for Arabic speakers in the food service industry. *J. Environ. Health* 72:30-32.

13. Frederick, T. 2005. The do's and don'ts of food plant personal hygiene practices. *Food Saf. Magazine*. Dec. 2004/Jan. 2005.
14. Hanna, A., and R. Remington. 1996. The representation of color and form in long-term memory. *Mem. Cognit.* 24:322-330.
15. Hirsch, D. W., and C. N. Cutter. 2007. A survey for small and very small meat and poultry processors in the Northeast. University of Connecticut.
16. Holladay, N. 2004. Working with Hispanics. Available at: www.nrcs.usda.gov/Internet/FSE.../nrcs142p2_007143.pdf. Accessed 8 August 2013.
17. Houts, P. S., C. C. Doak, L. G. Doak, and M. J. Loscalzo. 2006. The role of pictures in improving health communication: a review of research on attention, comprehension, recall, and adherence. *Patient Educ. Couns.* 61:173-190.
18. Jacob, C., L. Mathiasen, and D. Powell. 2010. Designing effective messages for microbial food safety hazards. *Food Control* 21:1-6.
19. Jenson, D. A., and D. W. Schaffner. 2015. Quantitative analysis of recommendations made in hand washing signs. *Food Prot. Trends.* 35:270-279.
20. Kandler, B. 2008. Stop! Don't ignore the value of safety signs. Available at: <http://ohsonline.com/articles/2008/12/value-of-signs.aspx>. Accessed 3 Dec. 2012.
21. Krueger, R. A., and M. A. Casey. 2009. Focus groups: A practical guide for applied research. SAGE Publications, Thousand Oaks, CA.
22. Luximon, A., L. W. Chung, and R. S. Goonetilleke. 1998. Safety signal words and color codes: the perception of implied hazard by Chinese people. Proceedings of the 5th Pan-Pacific conference on occupational ergonomics pp. 30-33.
23. National Restaurant Association. 2006. Restaurant industry facts. Available at: www.restaurant.org/research/ind_glance.cfm. Accessed 18 July 2013.
24. Neal, J. A., M. Dawson, and J. M. Madera. 2011. Identifying food safety concerns when communication barriers exist. *J. Food Sci. Educ.* 10:36-44.
25. Neal, J., P. G. Crandall, M. Dawson, and J. Madera. 2015. Food safety and language barriers on the processing line. *Food. Saf. Magazine*. Feb./Mar. 2015:22-28.
26. Nelson, D. L., V. S. Reed, and J. R. Walling. 1976. Pictorial superiority effect. *J. Exp. Psychol. Hum. Learn.* 2:523-528.
27. Nicol, A., and S. Tuomi. 2007. Hazard sign comprehension among illiterate adults. *Stellenbosch Papers in Linguistics* 37:67-88.

28. North American Meat Institute. 2015. The United States meat industry at a glance. Available at: <https://www.meatinstitute.org/index.php?ht=d/sp/i/47465/pid/47465>. Accessed 2 July 2015.
29. Po, L. G., L. D. Bourgain, L. G. Occeea, and E. C. Po. 2011. Food safety education for ethnic audiences. Available at: <http://www.foodsafetymagazine.com/magazine-archive1/junejuly-2011/food-safety-education-for-ethnic-audiences/>. Accessed 8 August 2013.
30. Quandt, S. A., J. G. Grzywacz, A. Marin, L. Carrillo, B. L. Coates, B. Burke, and T.A. Arcury. 2006. Illnesses and injuries reported by Latino poultry workers in Western North Carolina. *Am. J. Ind. Med.* 49:343-351.
31. Ratnapradipa, D., D. Quilliam, L. Wier, and D. L. Rhodes. 2011. Food safety education: child-to-parent instruction in an immigrant population. *J. Environ. Health* 73:70-75.
32. Rossman, G., and S. Rallis. 2012. Learning in the field: an introduction to qualitative research 3rd ed. Thousand Oaks, California: Sage Publications.
33. Sussman, R., and R. Gifford. 2012. Please turn off the lights: the effectiveness of visual prompts. *Appl. Ergo.* 43:596-603.
34. Tijus, C., J. Barcenilla, B. Cambon de Lavalette, and J. Meunier. 2007. The design, understanding and usage of pictograms. *Studies in Writing* 21:17-32.
35. Tyler, K. 2005. Clear Language. Available at: <http://www.shrm.org/Publications/hrmagazine/EditorialContent/Pages/1205tyler.aspx>. Accessed 12 July 2013.
36. Waterson, P., C. Pilcher, S. Evans, and J. Moore. 2012. Developing safety signs for children on board trains. *Appl. Ergo.* 43:254-265.
37. Wogalter, M. S. 1999. Factors influencing the effectiveness of warnings, p. 93-110. In Zwaga, H. J. G., Boersema, T., Hoonhout, H.C.M. (eds.), Visual Information for Everyday Use: Design and Research Perspectives. Taylor and Francis, Inc., London, UK.

Table 1. Summary of focus group discussions on interpretation, use and design of food safety signs in a meat/poultry processing plants in the mid-Atlantic region based on the analysis of employees' perception of pictograms within their facilities.

Overall category	Description of category	Quotes
Sign purpose and usage	The meat/poultry processing workforce is diverse, and for many their command of the English language is limited.	<p>“Well, here in this company, there are many races of people working: Hispanic, Americans, Asian... there are Chinese, but very few.”</p> <p>“I have several people I work with that don't [speak English]—like they're not literate at all so the picture is important.”</p>
	Current signs in meat/poultry processing focus mainly on occupational safety and the only food safety sign mentioned was hand washing	<p>“Like in the bathrooms they have the signs like to wash—before leaving the bathroom you should your hands and take certain time to wash your hands and like these are all hygienic things and then before entering the plant there are signs like how you should be dressed up before you enter the plant.”</p>
	Current signs are in “common” locations around the plant, but tend to be overlooked	<p>“I think they [signs] are helpful, but there is just too many. There is just so many throughout the plant. I guess they're not really paying attention to them because there is so many different ones.”</p>
	Most training conducted in English, and the length of training varies	<p>“We are educating people much more about safety. And we are working very hard so that everyone is working safely. We are focused on that, that big campaigns have occurred...”</p>

Employee training	Training methods include videos and movies and “learning by watching”	<p>“Well they have a buddy system. It’s like you go to the line, you’re supposed to buddy up with someone which they don’t tell you that...So once the trainers take you to the line you buddy up with someone—that’s basically what happens.”</p> <p>“We had, like she said, when you first come here you have orientation which all the safety videos and stuff, which I find to be COMMON SENSE, you know.”</p>
Sign message characteristics	Signs need to be relevant to everyday operations of employees	<p>“No I’m not but I’m still telling you like to me it doesn’t mean anything. Here we don’t do that kind of stuff—well maybe one or two people, okay like you have to pass—but majority, no.”</p> <p>“Well the image of the table did not catch my attention because it was not relevant.”</p>
	Signs need a title to give an overall meaning	<p>“The more attractive the title is, believe me, the more people are going to look up at it.”</p> <p>“Because it [title] draws you to it [sign]. Without it, it’s just boring.”</p>
	Pictures on signs (without text) should be easy to understand	<p>“It doesn’t make a difference to me if it’s cartoon or real, but it is important to have the pictures because just like some people don’t speak English or Spanish, some people don’t read good. I have several people I work with that don’t—like they’re not literate at all so the picture is important.”</p>

Sign format characteristics	Instructional words and larger text size on signs help employees with lesser experience	<p>“People will gain an understanding of why things are done. That I should remove my gloves? Well, I take it off because it is contaminated.”</p> <p>“Right, because if you look at a sign with small print, you do not pay much attention to it, so that can make a difference.”</p>
	Signs should be in English and Spanish which can be on the same sign or identical signs	<p>“We’ve had an issue over in evisceration and the sign was only in English and not in Spanish and we had a lady—a Spanish lady walk up to the machine—didn’t know no better—no picture or nothing and her sleeve was down and we have rollers there and her sleeve got into the rollers. So they need to have pictures and both languages.”</p> <p>“Honestly, that would be a bit overloaded with text if included in a single sign. Here, for example, they use a sign in English, and another in Spanish.”</p>
	Horizontal sign orientation is more logical to follow than a vertical one	
	Color on signs attracts attention; black/white signs are overlooked	<p>“The color is number one. Because it grabs my—that’s the first thing that’s going to grab my attention. And then the title.”</p> <p>“That is human nature—anything different will catch your attention more in the plant and all the time you will see like okay red and yellow, red and yellow everywhere, right. Not only in the plant, everywhere. Anything different is going to—that’s human nature.”</p>
	A sign that uses company colors could express its	<p>“Because it would mean something important if it’s in company colors and if it’s something important, they would stop and look.”</p>

	importance	
	Sign size could indicate importance and signs should be located near an area of compliance	“For sure and the location because I was saying about the hand wash versus the utensil wash station, it’s and eight and a half by 11 and a little sign that’s right above the thing—nobody looks up there, it’s not at eye level and the people don’t even notice it. Still don’t do that because the sign is up here and they are washing their hands down here and they don’t see it and it’s black and white.”
Suggested sign improvements	Signs could be improved with numbered steps or funny pictures	<p>“Something a little bit—a little bit funny [laughing], because you know most people like to laugh and so you stop “Did you see that sign?” You know they start telling everybody.”</p> <p>“Ok so you know that blue is more your sanitize color or whatever and this is the bathroom color so if we had a different things that you know—ok this means that it’s for this area—that doesn’t bother me.”</p>
	New signs should be placed in a location common to most employees	“Putting it in the right place, it would have more impact.”

Figure 1. QA/Food safety manager perception of most important food safety topics in their meat or poultry processing facility in the mid-Atlantic region (n=46).

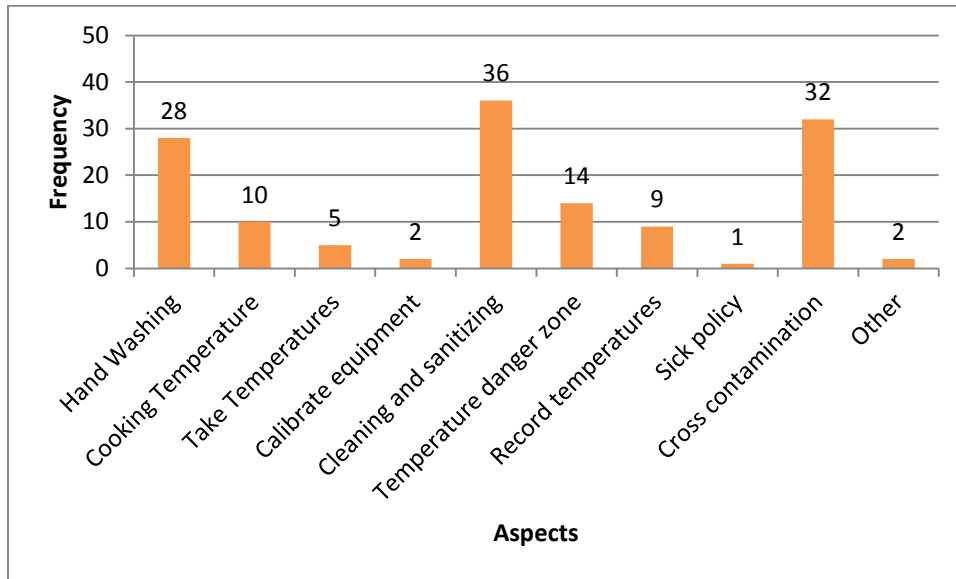


Figure 2. QA/Food safety manager perception of most important aspects of signs in their meat or poultry processing facility in the mid-Atlantic region (n=45).

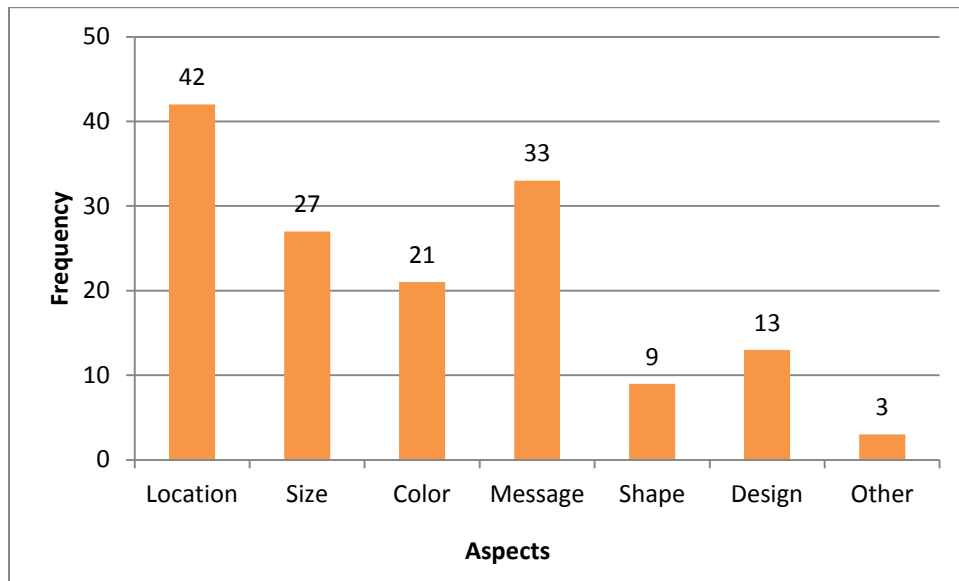


Figure 3. Example of hand washing sign created from opinions of meat and poultry processing employees in the mid-Atlantic region.



Chapter 3: Evaluation of meat and poultry processing employees hand washing practices from signs using video observation

Matthew Schroeder^{a*}, Lily Yang^a, Joseph Eifert^a, Renee Boyer^a, Melissa Chase^a, Sergio Nieto-Montenegro^b

^aDepartment of Food Science and Technology (0924)

Virginia Tech

1230 Washington Street SW

Blacksburg, VA 24061

United States

^bFood Safety Consulting and Training Solutions, LLC

2300 George Dieter Dr.

El Paso, TX 79936

United States

Corresponding Author

Email: matths4@vt.edu

Phone: 540-231-6806

ABSTRACT

Signs can offer recurring training on food safety practices for food processing multicultural employees. Current signs in meat and poultry processing facilities tend to be text-heavy and deal with occupational hazard safety. The purpose of this study was to evaluate the effectiveness of newly-developed hand washing pictograms on employee behavior change using video observation. Employee hand washing behavior was evaluated first with original, already present company signs (baseline) and compared to hand washing behavior (short term and long term) after experimental hand washing signs were displayed. Five hand washing practice behaviors (soap use, wash completeness, wash time, complete rinsing, and towel use) were observed by video camera at three different time points (baseline, one day after baseline, and two weeks after baseline) at a raw poultry slaughter facility (Facility A) and a further processing poultry facility (Facility B). Both facilities showed a significant increase in soap use at both short and long term time periods when compared to the baseline data. Facility B employees showed a significant increase in washing, time, and rinsing when baseline data was compared to short term, which indicates that a new sign could increase hand washing compliance. Sign background color had a significant effect on behavior for washing and time of washing, while time of sampling had a significant effect on behavior for four of the five variables tested. Signs could be a useful tool to offer recurring food safety training for food processing employees, but employees tend to refer back to old habits after a short period of time. Frequent changing of signs could enhance worker compliance with safe food handling practices.

Keywords: poultry; hand washing; video observation; pictograms

INTRODUCTION

The United States workforce, and foodservice employees in particular, is diverse and multicultural. The Bureau of Labor Statistics (2010) noted that 38% of animal slaughtering and processing industry workers were Hispanic or Latino. Since an estimated 58% of food chain workers in the United States have a high school degree or less, and many of these employees do not speak English at home, food safety training with these employees can be difficult (Food Workers Chain Alliance, 2012). Knowing and understanding the target population, such as education level and cultural distinctions, proves crucial when providing training to these employees. Most food safety training is conducted in English by direct lecture, which can lead to miscommunication or misinterpretation from employees (Fraser and Alani, 2009).

In 2001, the World Health Organization (WHO) introduced the five keys to safer food which included: personal hygiene by keeping clean, separation of cooked and uncooked food, cooking thoroughly, keeping food at safe temperatures, and using clean food and water. In poultry processing facilities, microbial contamination from *Salmonella* and *Campylobacter* are the main concern; however, worker hygiene practices such as proper glove use and hand washing can help to reduce the incidence of cross contamination (Green et al., 2006). The “Clean Hands Save Lives” campaign by the Center of Disease Control and Prevention (CDC) provides recommendations as to when and how to hand wash. The agency suggests wetting hands with running warm or cold water, lathering hands thoroughly with soap, scrubbing for at least 20 seconds, rinsing under clean, running water, and drying with a clean towel or air dryer (CDC, 2014). However, hand washing signs and recommendations across the healthcare and food service industries vary widely. Jensen and Schaffner (2015) analyzed 81 different hand washing

signs across healthcare, foodservice, and public arenas and found discrepancies in time to wash, water temperature, and number of steps to complete.

Pictograms, which offer a language free medium, are “a diagrammatic representation using pictures rather than words” (Davies et al., 2000). Their goal is to attract users’ attention to encourage a behavior change based on the intended message. Wogalter (1999) suggests that there are four processing stages that must be sequentially followed in order for a behavior change to occur. A sign must first be noticed and attract attention. If noticed, the sign must be comprehended and agree with the attitudes and beliefs of the observer. Finally, the user must be motivated to act on the intended message. Because these stages are sequential, a “roadblock” at one stage could prevent the ultimate goal of a behavior change. For example, if a sign is black and white and therefore unnoticed, the process to a behavior change cannot continue. Each of the four stages are dependent on one another and these stages are important to consider when creating a pictogram that would appropriate in the meat and poultry processing industry (Wogalter, 1999).

Signs have been used in the healthcare, transportation, construction, and pharmaceutical industries for a variety of messages. Because worker training in poultry processing facilities can be difficult with multicultural employees, pictograms offer a possible training solution that can be understood by a variety of audiences. Hand washing pictograms are currently being used widely in food service applications, but many of them do not consider employee preferences. When creating training materials such as signs, employee thoughts and ideas need to be considered. A relevant sign can hopefully change food safety practices after considering the opinions of the target population. However, in order to determine the effectiveness of signs, they

must be evaluated. There are several ways to evaluate observational data to determine if signs are an effective tool to change employee behavior.

Redmond and Griffith (2003) suggest that observational data can be participatory or non-participatory. Participatory data involves the researcher being present during data collection; whereas non-participatory occurs when data is captured and then viewed at a later time. Problems with participatory observation include observer bias and changes in participant behavior as a result of being observed, commonly called the Hawthorne effect (Chapman et al., 2013). Some of these challenges can be overcome by non-participatory observation. Video observation can be less intrusive on participants and allows researchers to study behaviors without being directly in range of participants. Multiple angles and multiple participants can be studied as well, which can aid in the reduction of coding bias (Chapman et al., 2013). Coding bias can also be reduced through video observation by several researchers investigating the recorded video. Though sometimes expensive, video observation has been used in several studies to assess safe food handling practices (Chapman et al., 2010; Chapman et al., 2013; Jay et al., 1999; Anderson et al., 2004; Bruhn, 2014).

Our previous research utilized survey and focus group data to analyze worker pictogram semantic preferences and then created appropriate hand washing signs based on feedback (Schroeder et al., 2015). In this study, the influence of these developed signs on hand washing practices was studied through video observation. The specific objective of this study was to evaluate the effectiveness of the hand washing pictograms on employee behavior change using video observation in the short term and after a period of two weeks.

MATERIALS AND METHODS

Pictogram Design (Appendix F)

The design of two hand washing pictograms was based on data collected from previous study (Schroeder et al., 2015). Pictograms (11” by 17”) were made by designers at co-principal investigator’s company based on recommendations by principle investigator (Food Safety Consulting and Training Solutions, LLC, El Paso, TX). Hand washing pictograms were exact replicas besides color differences (Figure 4). The main colors of green and blue were based on employee preference for company colors expressed during the focus group (data not shown).

Site Selection

Sites for video observation were based on selection criteria from a previous study (Schroeder et al., 2015). For this study, a convenience sample of two meat and poultry processing facilities that participated in survey and follow-up focus group were selected to participate based on size of facility (>500 employees) and having Spanish-speaking employees. One facility (Facility A) was a poultry slaughter plant and one was a poultry further processing plant (Facility B).

Camera Information and Placement

All video observations were collected by a GoPro® Hero 3 White or GoPro® Hero 3+ White (GoPro®, Inc, San Mateo, CA) using the following settings: Mode: Video; Resolution: 720; Frames per second: 60. All other settings were kept as GoPro® default settings. Two cameras were used per trip (one per sink). Cameras were mounted on the two sinks most commonly used by employees at each facility (according to the plant manager). MicroSD cards

(64GB and 32GB) were used to capture footage (Micron Consumer Products Group, Inc., Milpitas, CA). Additional GoPro® rechargeable batteries and dual battery charger were purchased for continuous video capture (GoPro®, Inc, San Mateo, CA). GoPro® cameras were used due to their waterproof nature, small size, ease of battery change, wide angle capability, and memory. Cameras were mounted on the wall above the sink (looking down; Appendix G) using the suction cup mount and extension arm (GoPro®, Inc, San Mateo, CA). Cameras were placed seven feet above the ground with a “bird’s eye” view of the sinks. Though cameras were visible to employees, they were not in their immediate eye level visual range. Cameras were concealed as practically as possible while still positioned for observing employee hand washing behavior. Cameras were only removed to change battery or SD card if necessary. Cameras were removed from wall at the conclusion of each observation day. All video observation was approved by plant manager and corporate management where appropriate. No identifying information of employees was collected and video was only available to members of the research team.

Hand washing matrix

Frequency of hand washing was collected by counting number of observations over the course of the observational period. Correctness of hand washing practices was completed using a modified matrix from Robertson et al., 2013 (Figure 5). Researchers defined correctness of hand washing practices using the following definitions:

- Variable 1: Used soap: did the employee use soap to wash their hands? (yes/no)
- Variable 2: Washed all surfaces of hands: complete washing of both sides of their hands, both middle of hand and top of hand, regardless of using soap or not (yes/no)

- Variable 3: Washed for at least 10 seconds: time began when employee added soap to hands and stopped when hands were removed from under the water, regardless of using soap or not. Ten seconds was based on the FDA Model Food Code suggestions (yes/no)
- Variable 4: Rinsed well: complete rinsing of both sides of hands with water (yes/no)
- Variable 5: Dried hands with paper towel or air dryer : (yes/no)

Video Observation of Hand Washing Practices Data Collection

Exploratory Visit

Exploratory visits at each facility were conducted to determine: which sinks were most appropriate for hand washing observation, number of people washing their hands per unit of time, camera set up position, and if an original company hand washing sign was in place. The plant managers at each facility allowed us access and were required to sign a consent form explaining sole ownership of the video data belonged to the researchers (consent form in Appendix H).

Baseline data collection

Two weeks following exploratory visits, baseline data (pre-experimental pictogram implementation) was collected. The purpose of baseline data collection was to observe hand washing behaviors with existing company hand washing signs to compare with behaviors after experimental pictograms were displayed. Hand washing data was collected during one day for five hours (2 P.M.-7 P.M).

Both correctness and frequency of hand washing practices were recorded using the hand washing matrix in section 2.4. A waiver of informed consent was approved by the Virginia Tech

Institutional Review Board (IRB) since researchers only observed hand washing practices under IRB 14-003.

Experimental Pictogram- Short Term

After baseline data was collected, the existing company hand wash sign was removed and replaced by the experimental pictogram (section 2.1). The following day, video observation was recorded in the same manner as the subsequent day. Researchers ensured that the experimental pictogram was still present before beginning video observation. Video camera placement was different in one processing facility (facility B) due to previous mount position being removed (Appendix I). Cameras were placed on 1) side of sink facing down towards the length of the sink about three feet above the ground and 2) high above sink facing down from an angle about 10 feet above the ground. Other camera locations at raw plant (facility A) remained the same. Both correctness of hand washing and frequency of hand washing practices were recorded using the matrix in section 2.3. Recording began at 8:30 A.M and was continuous until 2:00 P.M.

Experimental Pictogram- Long term

A second video observation period was recorded two weeks following the short term observations. The original placement of the experimental pictogram was confirmed before beginning video observation. Video observation was conducted with the same cameras and locations as previously described in section 2.5.3.

Data Analysis

Observational data was viewed by two individuals of the primary research team in an attempt to eliminate coding bias. After full analysis of data independently, disagreements in coding of variables were reinvestigated together until 100% agreement was achieved. For example, if coder one thought the employee washed well, but did not rinse well and coder two thought the employee washed and rinsed well, the researchers would replay the observation to come to agreement on whether the employee rinsed well. Replaying the observation and coming to agreement gives an accurate assessment of hand washing behaviors and allows for statistical analysis of observational data. Logistic regression for binary responses was used to analyze observational data. All tests of difference were at a statistical level of $p=0.05$. Calculations were performed using R statistical software (R Foundation; Vienna, Austria).

RESULTS

A total of 894 hand washing observations were counted from a total of 53.5 hours of video that was collected. This includes both sinks at both facilities and each time of observation (baseline, short term, and long term). Facility A had a total of 511 observations, and facility B had a total of 383 observations. Of the 894 total observations between both facilities, 622 (69.5%) used soap and 422 (49.4%) washed all surfaces of their hands. In addition, only 351 (39.2%) employees washed for at least 10 seconds. A complete rinse was observed for 458 (51.2%) individuals and 785 (87.8%) employees dried their hands with a paper towel or used an air dryer. Correct behavior for all five variables tested was observed for 230 (25.7%) of the 894 total observations.

Facility A was a raw poultry slaughter operation. Sinks selected were only for hand washing purposes and were already identified as such in the plant. Workers from these two areas

tended to be separate, though the plant does have an open floor plan. A total of 511 observations were counted from all sampling times and sinks combined. When both sinks data was combined, 271 (53.0%) employees used soap and 259 (50.7%) employees washed all surfaces of their hands. Only 164 (32.1%) employees washed for 10 seconds, while 249 (48.7%) rinsed their hands well. It was observed that 407 (79.7%) employees used a towel or air dryer. The results from the three times of observation (baseline, short term, and long term) for all five variables tested can be seen in table 2. All five hand washing variables were correctly completed for 19.0% (97/511) of the observations at facility A. A significant difference ($p < 0.05$) was identified for variable 1 and 5 (using soap and using towel, respectively) when short term and long term time points were compared to the baseline. The odds of using soap at the short term time point were 89.7% higher than the odds for baseline, while the odds of using soap at the long term time point were 112% higher than the odds at baseline. All other variables (wash, 10s, and rinse) showed a significant difference ($p < 0.05$) only when baseline was compared to long term. The percentages for these variables decreased over time.

Facility B was a further processing operation. Sinks were specified for hand washing purposes as identified by the facility. Both areas contained RTE (ready-to-eat) products. A total of 383 observations were counted when both sinks and all sampling time points were combined. Of the 383 observations, 351 (91.6%) employees used soap for hand washing, while only 183 (47.8%) employees washed all surfaces of their hands. A 10s hand wash was observed for 187 (48.8%) employees and 209 (54.6%) employees rinsed their hands well. Most (378/383; 98.7%) workers used a paper towel or hand dryer for their hands. The results from the three times of observation (baseline, short term, and long term) for all five variables tested can be seen in table 3. All five hand washing variables were correctly completed for 34.7% (133/383) of the

observations at facility B. All five hand washing variables were correctly completed by 22.0% (26/118) total observations at baseline. During short term observation, 54.1% (73/135) of the observations were completely correct for all five variables. Short term and long term time percentages for variable 1 (using soap) were significantly different ($p < 0.05$) when compared to baseline. The odds of using soap was 16 times higher at short term when compared to baseline. Even at long term, the odds were 4.2 times higher when compared to baseline for variable 1. All other variables except use of towel showed a significantly higher ($p < 0.05$) proportion of employees using correct hand washing practices when baseline data was compared to short term data. The odds of washing well and washing for 10s at short term was 3.3 times higher than the odds at baseline. No significant difference ($p > 0.05$) was identified for these variables when long term data was compared to baseline data. Using the alcohol wipe on the bump camp and hands after washing was observed for 346 (90.3%) of employees.

Pictograms at each sink at both facilities were exact replicas of one another except for color. Company colored signs were randomly placed at the debone sink of facility A, and the chicken sink at facility B. Company colored pictograms on sinks from both facility A and B were combined to see if color had an effect on behavior for all variables. Color and time had a significant effect ($p < 0.05$) for variables 2 and 3 (washing well and 10s). Color did not have a significant effect ($p > 0.05$) on behavior for all other variables (soap, rinse, and towel). Time (short term and long term) also had a significant effect ($p < 0.05$) on behavior for variables 1 and 5 (using soap and using a towel).

DISCUSSION

Signs have been used extensively in other industries such as transportation, healthcare, construction, and advertising to portray information. The goal of any sign is to attract the users' attention and hopefully create a behavior change. Signs have become more popular in the food service and processing industry due to its diverse employee population. Since most food safety training is still conducted by direct lecture by supervisory personnel, signs could act as recurring food safety training without the loss of production time or need to compensate trainers (Rowell et al., 2013).

Hand washing signs were created due to the importance of personal hygiene to produce safe products through the opinions expressed by facility personnel in a previously conducted survey (Schroeder et al., 2015; Mwamakamba et al., 2012). Jensen and Schaffner (2015) reviewed hand washing signs for the healthcare, foodservice and general public and found differences in suggested lather time and number of steps. The study found that there is a wide discrepancy in hand washing sign design. However, when creating a sign intended for a particular target audience, it is important to gather their opinions (Houts et al., 2006). During exploratory visits to large and small meat and poultry facilities in the mid-Atlantic region, most hand washing signs were text-heavy, black and white with few pictures. Many signs were located in restroom facilities and contained both English and Spanish translations. New, innovative employee-driven hand washing signs were created based on the opinions expressed by employees during previously conducted focus groups (results not shown). Previous research on hand washing signs has focused on food service retail establishments (Allwood et al., 2004; Chapman et al., 2010). Few, if any, studies have focused on the evaluation of a new, employee driven sign within the processing environment.

Video observation has been used in several other studies to assess safe food handling practices (Chapman et al., 2010; Chapman et al., 2013; Jay et al., 1999; Anderson et al., 2004; Bruhn, 2014). Jay et al. (1999) and Bruhn (2014) found that prior to meal preparation, personal hygiene practices were insufficient. In an observational study, Bruhn (2014) reported 65% of preparers did not wash their hands. Jay et al. (1999) found that improper hand washing techniques was a common unhygienic practice in domestic kitchens. Anderson et al. (2004) found that 20.4% of participants did not wash their hands after handling raw meat and poultry. Video observation can be expensive and time-consuming; however, coding bias can be eliminated, while multiple angles and multiple participants can be viewed simultaneously (Chapman et al., 2013). In addition, video observation allows the Hawthorne effect to be minimized. The Hawthorne effect occurs when a target population changes their behavior because they know they are being studied (Payne and Payne, 2004). Cameras in this study were placed about seven feet above the ground within view of participants. Though participants could see cameras, they did not interfere with hand washing practices and may become unnoticed background for employees. The cameras were placed in a location that was not in the immediate eye level range for employees, but could capture all hand washing observations.

Signs were evaluated at three different time points (baseline, short term, and long term) at both facilities to evaluate if the new hand washing signs changed employee behavior. Facility A, a raw poultry slaughter facility, had a percentage decrease for three of the five variables tested at short term and long term points compared to baseline. Time can impact food safety practices as Sparkman et al. (1984) saw a return to pre-training practices eight weeks post-training in the foodservice industry. A significant difference ($p < 0.05$) was only identified for variables two, three, and four between baseline and long term. McIntyre et al. (2013) found that FOODSAFE-

trained workers' knowledge would slowly decrease over time and after five years, 95% of workers would fall below the 70% pass rate. No significant difference ($p < 0.05$) was identified for variables two, three, and four between baseline and short term. This decrease could be due to the open layout of the facility. Employees have access to all sinks and can move freely throughout the facility, which may explain the decrease in percentage. However, a significant increase ($p < 0.05$) was seen for variable one and variable five when baseline was compared to short term and long term. Drying and washing with soap are critical steps to reduce cross contamination, thus an increase in these variables is significant (Jensen et al., 2015; Patrick et al., 1997). Using soap is the first step to microbial reduction, thus an increase in soap use between baseline and short term and long term could help in reducing cross contamination.

Facility B was a further processing poultry facility. The sinks studied were in the RTE areas and a significant difference ($p < 0.05$) was identified for variables one through four between baseline and short term. In addition, all five variables were correctly completed by 54.0% of employees at short term compared to 22.0% at baseline. This result could demonstrate that signs have an impact on employee behavior for a short time. Wogalter and Sojourner (1997) found an increased comprehension of pictorial messages one week after training. An increase in all five variables being correctly completed could indicate that a new change to a sign increases compliance with the intended message. No significant difference ($p > 0.05$) was identified for variables two, three, and four between baseline and long term, which indicates employees tend to return to previous practice. Lynch et al. (2003) found no significant difference between food safety knowledge scores of restaurant managers trained two years prior to those recently trained. This increase in the short term could also be explained by the layout of the facility. There were railings blocking entrance to the processing area so to mandate hand washing before entering.

Since the sinks were in RTE areas, employees had to wash hands before entering the processing area. Since the signs were new, employees may tend to look at them for a few days and then return to normal behavior once the signs become background. It was observed in video analysis that 22 people were seen looking directly at new signs between facility A and B. These observations indicate that employees were noticing new signs, which is the first step to a behavior change as noted by Wogalter (1999).

Facilities (A and B) were not combined together to compare variables at the different time points. Since facilities were so different (raw vs. RTE), no comparison could be made to accurately describe trends in hand washing practices. In addition, since only two facilities were evaluated in this study, no generalizations about the hand washing practices of meat and poultry processing facilities statistically could be achieved. This study was interested in evaluating the raw and RTE hand washing trends separately to determine employee practices at each facility type.

Signs were designed based on employee recommendations through focus groups. Employees expressed that color, particularly company color, had an impact on the perceived importance of the sign. Signs were made in company colors of facility A and B and evaluated to see if color of sign had an impact on employee behavior. Company color had a significant impact ($p < 0.05$) on behavior for variables two and three. A red colored clock that indicated the time employees should wash their hands was placed on the sign. Since red did not appear anywhere else on the sign, this “different” color may have an impact on length of hand washing. Red is known as the highest perceived danger level, so it is possible that employees noticed that portion of the sign and complied with the recommendation to wash for 10s (Kandler, 2008; Luximon et al., 1998).

The CDC Guideline for Hand Hygiene in Healthcare Settings recommends 20s for hand washing; however, the matrix used in this study was interested in hand washing for 10s only (Boyce and Pittet, 2002; U.S. Dept. of Health and Human Services, 2013). The FDA Model Food Code (2013) suggests washing hands for 10-15 seconds. Jensen et al. (2015) found that a 5s wash with no soap reduced bacterial populations on hands by 90%, while Michaels et al. (2002) reported that a 15s wash with antimicrobial soap had a 1.5-2.5 log reduction of *Serratia marcescens*. These findings suggest a 10s wash time should be acceptable for microbial reduction on hands. Washes below 10s may be less effective; however, microbial reduction can be reduced by an increased hand washing duration (Jensen et al., 2015; Michaels et al., 2002). Jensen and Schaffner (2015) found that no sign suggested greater than 20s wash or less than 10s, so the time frame used in this study aligns with currently used signs.

Time had a significant effect ($p < 0.05$) on hand washing behavior for variables one, two, three, and five. Research varies on the length of time that information can be retained (Cotterchio et al., 1998; McIntyre et al., 2013; Lynch et al., 2003; Wogalter and Sojourner, 1997). Research suggests information can be retained for several weeks or several years. Over the course of the 53.5 hours, employees could be seen looking at the sign 22 times, which indicates that employees noticed the new addition of the sign. Due to time constraints, a longer term (six months or one year) could not be accomplished, but could be considered for future research.

Signs could be an effective way to offer recurring training on food safety practices. Both facility A and B showed significant increase in soap use when baseline data was compared to short term and long term points. Though facility A showed percentage decreases for some

variables, facility B showed percentage increases for four of five variables. Overall, signs can be an effective tool to portray food safety information to multicultural employees.

REFERENCES

- Allwood, P.B., Jenkins, T., Paulus, C., Johnson, L., & Hedberg, C.W. (2004). Hand washing compliance among retail food establishments workers in Minnesota. *Journal of Food Protection*, 67, 2825-2828.
- Anderson, J.B., Shuster, T.A., Hansen, K.E., Levy, A.S., & Volk, A. (2004). A camera's view of consumer food-handling behaviors. *Journal of the American Dietetics Association*, 104, 186-191.
- Boyce, J.M. & Pittet, D. (2002). Guideline for hand hygiene in health care setting. *Morbidity and Mortality Weekly Report*, 57, 521-524.
- Bruhn, C.M. (2014). Chicken preparation in the home: an observational study. *Food Protection Trends*, 34, 318-330.
- Bureau of Labor Statistics. (2010). Occupational employment statistics. Retrieved 07.01.13, from http://www.bls.gov/oes/oes_dl.htm.
- Centers for Disease Control and Prevention (CDC). (2014). Hand washing: clean hands save lives. Retrieved 06.03.15, from <http://www.cdc.gov/handwashing/when-how-handwashing.html>.
- Chapman, B., Eversley, T., Fillion, K., MacLaurin, T., & Powell, D. (2010). Assessment of food safety practices of food service food handlers (risk assessment data): testing a communication intervention (evaluation of tools). *Journal of Food Protection*, 73, 1101-1107.
- Chapman, B., MacLaurin, T., & Powell, D.A. (2013). Video observation and data coding methods to assess food handling practices at food service. *Food Protection Trends*, 33, 146-156.
- Cotterchio, M.J., Gunn, J., Coffill, T., Tormey, P., & Barry, M.A. (1998). Effect of manager training program on sanitary conditions in restaurants. *Public Health Reports*, 113, 353-358.
- Davies, S., Haines, H.M., & Norris, B.J. (2000). The role of pictograms in the conveying of consumer safety information. Retrieved 07.02.13, from http://www.ergo-eg.com/uploads/digi_lib/362.pdf.
- Food Workers Chain Alliance. (2012). The hands that feed us: challenges and opportunities for workers along the food chain. Retrieved 08.08.13, from <http://foodchainworkers.org/wp-content/uploads/2012/06/Hands-That-Feed-Us-Report.pdf>.
- Green, L.R., Selman, C.A., Radke, V., Ripley, D., Mack, J.C., Reimann, D.W., Stigger, T., M. Motsinger, M., & Bushnell, L. (2006). Food worker hand washing practices: an observational study. *Journal of Food Protection*, 69, 2417-2423.

Houts, P.S., Doak, C.C., Doak, L.G., & Loscalzo, M.J. (2006). The role of pictures in improving health communication: a review of research on attention, comprehension, recall, and adherence. *Patient Education and Counseling*, *61*, 173-190.

Jay, L.S., Comar, D., & Govenlock, L.D. (1999). A video study of Australian domestic food-handling practices. *Journal of Food Protection*, *62*, 1285-1296.

Jensen, D.A., Friedrich, L.M., Harris, L.J., Danyluk, M.D., & Schaffner, D.W. (2015). Cross-contamination of *Escherichia coli* O157:H7 between lettuce and wash water during home-scale washing. *Food Microbiology*, *46*, 428-433.

Jenson, D.A. & Schaffner, D.W. (2015). Quantitative analysis of recommendations made in hand washing signs. *Food Protection Trends*, *35*, 270-279.

Kandler, B. (2008). Stop! Don't ignore the value of safety signs. Retrieved 12.03.12, from <http://ohsonline.com/articles/2008/12/value-of-signs.aspx>.

Luximon, A., Chung, L.W., & Goonetilleke, R.S. (1998). Safety signal words and color codes: the perception of implied hazard by Chinese people. Proceedings of the 5th Pan-Pacific conference on occupational ergonomics pp. 30-33.

Lynch, R.A., Elledge, B.L., Griffith, C.C., & Boatright, D.T. (2003). A comparison of food safety knowledge among restaurant managers, by source of training and experience, in Oklahoma City, Oklahoma. *Journal of Environmental Health*, *66*, 9-14.

McIntyre, L., Vallaster, L., Wilcott, L., Henderson, S.B., & Kosatsky, T. (2013). Evaluation of food safety knowledge, attitudes and self-reported hand washing practices in FOODSAFE trained and untrained food handlers in British Columbia, Canada. *Food Control*, *30*, 150-156.

Michaels, B., Ganger, V., Schultz, A., Arenas, M., Curiale, M., Ayers, T., & Paulson, D. (2002). Water temperature as a factor in hand washing efficacy. *Food Service Technology*, *2*, 139-149.

Mwamakamba, L., P. Mensah, Fontannaz-Aujoulat, F., Hlabana, M., Maiga, F., Bangoura, F., Mohamed, C., & Ingenbleek, L. (2012). The WHO five keys to safer food: a tool for food safety health promotion. *African Journal of Food, Agriculture, Nutrition, and Development*, *12*, 6245-6259.

Patrick, D.R., Findon, G., & Miller, T.F. (1997). Residual moisture determines the level of touch-contact associated bacterial transfer following hand washing. *Epidemiology and Infection*, *119*, 319-325.

Payne, G. & Payne, J. (2004). Key concepts in social research. Chp.: The Hawthorne Effect. Sage Publications, London. 108-112.

Redmond, E.C. & Griffith, C.J. (2006). A pilot study to evaluate the effectiveness of a social marketing-based consumer food safety initiative using observation. *British Food Journal and Hygienic Review*, 108, 753-770.

Robertson, L.A., Boyer, R.R., Chapman, B.J., Eifert, J.D., & Franz, N.K. (2013). Educational needs assessment and practices of grocery store food handlers through survey and observational data collection. *Food Control*, 34, 707-713.

Rowell, A.E., Binkley, M., Thompson, L., Burris, S., & Alvarado, C. (2013). The impact of food safety training on employee knowledge of food safety practices for hot/cold self-serve bars. *Food Protection Trends*, 33, 376-386.

Schroeder, M., Galgarza, O., Eifert, J., Boyer, R., Chase, M., & Nieto-Montenegro, S. (2015). Employee perceptions of food safety pictograms at meat and poultry processing plants leads to a new hand washing pictogram. *Food Protection Trends*. Accepted manuscript.

Sparkman, A. F., Briley, M.E., & Gillham, M.B. (1984). Validated food service training manual for supervisors with limited experience. *Journal of the American Dietetic Association*, 84, 1475–1478.

U.S. Department of Health and Human Services, Public Health Service, Food and Drug Administration. (2013). Food Code, 2013 Recommendations of the United States Public Health Service, Food and Drug Administration. Retrieved 09.22.15, from <http://www.fda.gov/downloads/Food/GuidanceRegulation/RetailFoodProtection/FoodCode/UCM374510.pdf>.

Wogalter, M.S. & Sojourner, R.J. (1997). Comprehension and retention of safety pictorials. *Ergonomics*, 40, 531-542.

Wogalter, M.S. (1999). Factors influencing the effectiveness of warnings. In: Zwaga, H.J.G., Boersema, T., Hoonhout, H.C.M.. (Eds.), *Visual Information for Everyday Use: Design and research perspectives*. Taylor and Francis, Inc. London, UK.

Table 2. Percentage of employees who performed behavior for all variables (soap, wash, 10s, rinse, and towel) at all time points (baseline, short term, long term) for facility A (raw) for both sinks combined.

	Time		
	Baseline (n=118)	Short Term (n=203)	Long term (n=190)
Used soap	39.8% ^a	55.7% ^b	58.4% ^b
Washed all surfaces	58.5% ^a	53.2% ^a	43.2% ^b
Wash 10 seconds	37.3% ^a	35.5% ^a	25.3% ^b
Rinsed well	54.2% ^a	51.2% ^a	42.6% ^b
Used towel	68.6% ^a	81.3% ^b	84.7% ^b
All 5 variables correct	20.3%	21.2%	15.8%

Significant differences ($p < 0.05$) in logistic regression statistic between columns are designated with a lower case superscript letter.

Both short term and long term data were only compared to baseline data. No comparison was made between short term and long term data.

Table 3. Percentage of employees who performed behavior for all variables (soap, wash, 10s, rinse, and towel) at all time points (baseline, short term, long term) for facility B (RTE) for both sinks combined.

	Time		
	Baseline (n=118)	Short Term (n=135)	Long term (n=130)
Used soap	80.5% ^a	98.5% ^b	94.7% ^b
Washed all surfaces	37.3% ^a	65.9% ^b	38.5% ^a
Wash 10 seconds	35.6% ^a	64.4% ^b	44.6% ^a
Rinsed well	46.6% ^a	69.6% ^b	46.2% ^a
Used towel	96.6% ^a	99.3% ^a	100% ^a
All 5 variables correct	22.0%	54.1%	26.2%

Significant differences ($p < 0.05$) in logistic regression statistic between columns are designated with a lower case superscript letter.

Both short term and long term data were only compared to baseline data. No comparison was made between short term and long term data.

Figure 4. Hand washing pictogram example designed from target population opinions and evaluated by video observation.



Figure 5. Hand washing matrix for evaluation of hand washing practices for meat and poultry processing employees (Robertson et al., 2013).

Hand Washing Practices			
Hand Wash # ____	Y	N	Comments
Used Soap			
Washed all surfaces of hands			
Washed for at least 10 seconds			
Rinsed well			
Dried hands w/ paper towel or air dryer			
Turned off water w/ paper towel if applicable			

Conclusions and Future Research

Within the poultry industry, there are many different sources of cross contamination and food safety practices that ultimately try to deliver safe products to consumer. With a diverse, multicultural workforce in meat and poultry processing, training and communication of food safety related principles can be challenging. A survey of meat and poultry QA/food safety managers revealed that the meat and poultry processing industry has different cultural groups as part of the workforce and some of those employees prefer to speak another language. The most important food safety topics were hand washing, cross contamination, and procedures for cleaning/sanitizing. Most (53%) are using pictograms currently in their facility; however, exploratory visits determined many of these pictograms were black and white, text heavy, and frequently located in bathroom facilities.

Since hand washing was an important topic and proved to be a key food safety practice for the employers, a new hand washing sign needed to be developed. Often signs are designed without the opinions of the target population, which could decrease compliance. Focus groups with employees in both English and Spanish revealed that color, multiple languages, short text, title and horizontal orientation are preferred characteristics of signs. There were disagreements about actual color of signs, but employees expressed that company colored signs were have a perceived importance for employees. Two new developed hand washing signs were designed and evaluated through video observation at two poultry facilities in Virginia.

Video observation at both facilities showed a significant difference for soap use when baseline data was compared to short term and long term time points. Facility B had significant increases for all variables except variable five when baseline data was compared to short term.

This suggests that signs may increase compliance with intended practice for short term, but employees tend to return to old practices after a period of time since no significant difference was found for variables one through four when baseline was compared to long term for facility B. Facility A showed percentage decreases for variables two, three, and four when baseline was compared to short term. This could be due to the open floor plan of the facility and possibly less emphasis on hand washing since it was a raw facility. Hand washing practices might change due to type of facility and type of training already in place. Overall, signs could enhance worker compliance with intended food safety messages but may need to be changed frequently to continue drawing attention.

Future research in this area could investigate these hand washing signs in other product industry, such as meat. Considering other food industries, are there other food safety principles that could be addressed by developing signage? A comparison study could be conducted between the hand washing data and the new food safety principles. The study might investigate the hand washing practices after a longer period of time, such as six months post-implementation. A further study might explore a sign variable change (color, shape, size) after a period of several months to see how those changes compare to baseline and short term changes. Since facility B showed an increase in hand washing compliance in the short term, the study of another variable change after several months could be considered.

Appendices

Appendix A: Survey sent to QA/Food Safety Managers

Thank you for agreeing to take the survey. I am going to ask you a series of questions about your facility. Please answer as truthfully and to the best of your knowledge. Thank you once again for agreeing to participate.

Facility Code: _____

Section 1: Background Information

Please complete each section by marking an "X" next to the best response or by filling in the blank with the response that best describes your facility.

1. Please check the title that best describes your position:

_____ QA/QC Manager

_____ Shift Supervisor

_____ HACCP Coordinator

_____ Owner

_____ Other (please describe) _____

2. Type of operation: (check all that apply)

_____ Raw, ground meat and poultry (including sausage)

_____ Raw, not ground meat and poultry products including beef trimmings and mechanically tenderized meat

_____ Mechanically separated meat/mechanically deboned poultry

_____ Thermally processed, commercially sterile meat and poultry (i.e.- canned)

_____ Irradiated meat and poultry products

_____ Meat and poultry products with secondary inhibitors, not shelf-stable (corned beef)

_____ Heat-treated, shelf stable meat and poultry products (jerky, summer sausage, etc.)

_____ Not shelf-stable, heat-treated, not fully cooked meat and poultry products (smoked sausage, bacon, partially cooked chicken patties)

_____ Fully cooked, not shelf-stable meat and poultry products (ham, roast beef)

_____ Not heat-treated, shelf-stable meat and poultry products (pepperoni, salami)

_____ Beef Slaughter

_____ Chicken Slaughter

_____ Pork Slaughter

_____ Other Slaughter (please describe)_____

3. What animals/species do you process?

_____ beef

_____ goat

_____ pork

_____ lamb

_____ poultry

_____ deer/elk

_____ bison

_____ ostrich/emu

_____ other (please name)_____

4. Years in business

_____ <1-5 years

_____ 6-10 years

_____ 11-15 years

_____ 16-20 years

_____ >20 years

5. Total Number of Employees

1-100 employees 101-200 employees 201-300 employees
 301- 400 employees 401-500 employees > 500 employees

6. Do you have employees who DO NOT SPEAK English?

Yes No Not sure

7. What language do MOST of your employees prefer to read, write, and speak?

English Spanish
 Other (please name) _____

Section 2: Current Training Practices

1. Do you have an established training program?

Yes No Don't know

If you answered “No” to question 1 above, please proceed to question 2 below, then proceed to question 10.

If you answered “Yes” to question 1 above, please proceed to question 3.

2. What keeps you from providing training in your operation? (choose all that apply)

Do not need training No time for training
 Lack of management support No funds to pay for cost of training
 Language issues Literacy or reading level
 No resources to support training
(room, equipment, personnel) Lack of interest

____ Supervisory employees do not have the knowledge/skills for training

3. Who do you provide training to? (choose all that apply)

____ Manager/supervisory personnel

____ Line/production personnel

____ Maintenance/sanitation personnel

4. How often do you provide training?

____ Once, at the time of hire

____ Every week

____ Once a month

____ A few times per year

____ Once a year

____ While preparing and serving foods

5. Who provides the training?

____ Supervisory personnel

____ University/Extension personnel

____ Quality control/food safety/HACCP personnel

____ Outside consultants or trainers

____ Other (please specify) _____

6. Does the person providing the training have any formal training in food safety, food science, or meat science?

____ Yes

____ No

____ Don't know

7. Was the training offered in multiple languages?

____ Yes

____ No

____ Don't know

8. How was the food safety training/education delivered? (choose all that apply)

_____ One-on-one/in house/on-the-job training

_____ In-house training classes using computers, videos, or CD presentations

_____ Off-site training or workshops given by universities, trade associations, etc.

_____ Booklets/brochures/pamphlets for at-home learning

_____ Bringing in outside trainers

_____ I paid for it myself

_____ Other (please specify)_____

9. In the last year, did you complete food safety training on these topics?

	Yes	No
Proper Hand Washing	_____	_____
Proper cooking temperatures for various products	_____	_____
How to take temperatures	_____	_____
How to calibrate equipment	_____	_____
Procedures for cleaning and sanitizing work areas	_____	_____
Recognizing the temperature danger zone	_____	_____
How to monitor and record temperatures	_____	_____
Employee sick policy	_____	_____
Cross-contamination issues (i.e.-pathogens, bare hand contact, etc)	_____	_____
Other (please specify)_____	_____	_____

10. Which of the following THREE food safety topics are MOST IMPORTANT in YOUR facility? (please choose 3)

- _____ Proper Hand Washing
- _____ Proper cooking temperatures for various products
- _____ How to take temperatures
- _____ How to calibrate equipment
- _____ Procedures for cleaning and sanitizing work areas
- _____ Recognizing the temperature danger zone
- _____ How to monitor and record temperatures
- _____ Employee sick policy

_____ Cross-contamination issues (i.e.-pathogens, bare hand contact, etc)
_____ Other (please specify)_____

Section 3: Pictograms (Pictorial messages) in the facility

1. Do you have pictograms (pictorial food safety signs) in your facility?

_____ Yes _____No _____Don't know

*If you answered "Yes", proceed to question 2 below.
If you answered "No", proceed to question 5.*

2. Is there any text associated with the sign?

_____ Yes, the signs are accompanied by written text

_____ No, the sign has no written text with it

3. Are there posted signs at work for the following?

	Yes	No
Proper cooking and holding temperatures for products	_____	_____
When to wash hands	_____	_____
How to clean your equipment	_____	_____
How to use equipment (knives, machines, etc.)	_____	_____
Bare hand contact with prepared foods	_____	_____
No signs posted, but are included in the company manual	_____	_____

4. Where are most of the signs located in your facility? (choose all that apply)

_____ Wall _____ Bathroom _____ Near sinks/faucets

_____ Computer screen _____ Near processing equipment

_____ Other (please specify)_____

5. Do you think signs are a useful way to convey food safety knowledge/information?

_____ Yes _____No _____Not sure

6. Why or why not?

7. Which medium do you think would be the most useful in your facility to convey food safety pictograms? (choose all that apply)

Wall Board Computer screen Electronic Message Board

On machinery/equipment Employee Break/Lunch room

Other (please specify) _____

8. What do you feel are important aspects of signs for your facility if you are/were to use them? (choose all that apply)

Location Size Color

Intended Message Shape Design

Other (please specify) _____

THANK YOU FOR YOUR TIME AND PARTICIPATION!!

Appendix B: Focus Group Consent Forms (English and Spanish)

Virginia Polytechnic Institute and State University Informed Consent for Participants in Research Projects Involving Human Subjects

Project Title: Modified pictograms improve compliance of meat/poultry industry workers with food safety practices

Investigators: Matthew Schroeder, Oscar Galagarza, Joseph Eifert

I. Purpose of Research

The purpose of this study is to investigate pictograms within the meat and poultry industry and see whether they improve compliance when a variable is manipulated. In this part of the research project, we want to involve you, the target audience and have you provide input into the designed pictorial representations of food safety knowledge. We want to see whether you (both English and Spanish) understand the intended message of signs and provide feedback to improve the pictograms. This research is being conducted as part of a dissertation research project and may be published.

II. Procedures

The second part of the study is a focus group that will ask questions related to the survey answers the facilities provided. This focus group session will take no more than 90 minutes and will be conducted in English and in Spanish in different locations (rooms). You will be shown pictograms on a piece of paper and asked to comment on them followed by questions and conversation about what you liked and did not like. One researcher will ask the questions while another records your answers. The focus groups will be audio recorded only to ensure accurate collection of participant comments. The audio recordings will be kept on a secure computer.

III. Risks

There are no known risks to the participants.

IV. Benefits

There are no direct benefits to you. However, you may contact the researchers for a summary of the study results.

V. Extent of Anonymity and Confidentiality

Protecting participants is a top priority of the researchers. Your information will be kept strictly confidential. Individual names will be assigned pseudonyms. At no time will information be released that allows an individual to be identified.

Only the research team will have access to the data. It is possible that the Institutional Review Board (IRB) may view this study's collected data for auditing purposes. The IRB is responsible for the oversight of the protection of human subjects involved in research.

VI. Compensation

There will be small refreshments (sodas and chips) served during the focus group session.

VII. Freedom to withdraw

You are free to withdraw from the study at any time without penalty. You are free not to answer any questions without penalty.

Should you have pertinent questions about this research and my rights, you may contact:

Matthew Schroeder
Graduate Assistant
Matths4@vt.edu
(410) 802-7683

Oscar Galagarza
Graduate Assistant
Oscar2@vt.edu

Joseph Eifert
Associate Professor
jeifert@vt.edu
(540) 231- 3658

Dr. David Moore
IRB Chair
moored@vt.edu
(540) 231-4991

VIII. Participant Signature to participate

Participant Signature

Date

Instituto Politécnico y Universidad Estatal de Virginia

Consentimiento Informado Para los Participantes de Proyectos de Investigación en Seres Humanos

Título del Proyecto: Pictogramas Modificados Mejoran el Cumplimiento de Prácticas de Seguridad Alimentario por Parte de los Trabajadores de las Industrias Avícola y de Carne.

Investigadores: Matthew Schroeder, Oscar Galagarza, Joseph Eifert

I. Propósito de Investigación

El propósito de este estudio es investigar pictogramas dentro de las industrias avícola y de la carne y ver si mejoran el cumplimiento cuando se manipula una variable. En esta parte del proyecto de investigación, queremos involucrarle a usted, la audiencia meta, y que realicen aportaciones acerca de las representaciones pictóricas diseñadas del conocimiento de la seguridad alimentaria. Queremos ver si los participantes (en ambos, Inglés y Español) entienden el mensaje deseado de las señales y proporcionan información de cómo mejorar los pictogramas. Esta investigación será realizada con la intención de su inclusión en un proyecto parte de una tesis doctoral, que probablemente sea publicado.

II. Procedimientos

La segunda parte del estudio, habrá un grupo de discusión que hará preguntas relacionadas con las respuestas de la encuesta que las instalaciones proveyeron. La sesión de este grupo tomará no más de 90 minutos y se llevará a cabo en Inglés y en Español en diferentes lugares (salas). A usted se le mostrarán pictogramas en un pedazo de papel y se le pedirá comentar sobre ellas. Esto será seguido de preguntas y una conversación acerca de lo que les gustó y no de los pictogramas. Uno de los investigadores hará las preguntas mientras otro estará encargado de grabar sus respuestas. El audio del grupo de discusión será grabado para asegurar la recolección exacta de los comentarios de los participantes. Las grabaciones de audio se guardarán en una computadora segura.

III. Riesgos

No se conoce que hayan riesgos para los participantes.

IV. Beneficios

No hay beneficios directos para usted. Sin embargo, usted puede ponerse en contacto con los investigadores para obtener un resumen de los resultados del estudio.

V. Alcance de anonimato y confidencialidad

La protección de los participantes es una de las prioridades de los investigadores. Su información del participante se mantendrá estrictamente confidencial. A nombres individuales se le asignarán seudónimos. En ningún momento la información se publicará para que permita a un individuo ser identificado.

Sólo el equipo de investigación tendrá acceso a los datos. Es posible que la Junta de Revisión Institucional (IRB en Inglés) pueda ver los datos recogidos de este estudio para fines de auditoría. El IRB es responsable de la supervisión de la protección de los sujetos humanos involucrados en la investigación.

VI. Compensación

Habrán pequeños refrigerios (refrescos y chips) servidos durante la sesión grupo de discusión.

VII. La libertad de retirarse

Usted tiene la libertad de retirarse del estudio en cualquier momento sin penalización. Usted tiene la libertad de no responder a cualquier pregunta sin penalización.

Si usted tiene preguntas pertinentes a esta investigación y a sus derechos, puede contactar a:

Matthew Schroeder
Asistente de Posgrado
matths4@vt.edu
(410)802-7683

Óscar Galagarza
Asistente de Posgrado
osgar2@vt.edu
(404)824-2607

Joseph Eifert
profesor adjunto
jeifert@vt.edu
(540)231-3658

Dr. David Moore
IRB Chair
moored@vt.edu
(540)231-4991

VIII. Firma del Participante (para que sea partícipe)

Firma del participante

Fecha

Appendix C: Focus Group Protocol (English and Spanish)

The session will begin with a review of the consent forms. The participants will be asked to read the document and sign. They will be given a second copy for their records.

The group discussion will be informal in nature.

Researcher will show pictograms (in color) on a piece of paper and ask participants what they like and do not like about the pictogram (see pictogram example document). I will ask them to rank the pictograms at the end.

Participants will be asked the following questions*:

- I. As a way to introduce ourselves, could you please tell us who you are and how long you have been employed at this particular facility?
- II. Recall the training material or workshop you attended related to food safety at this facility. Please describe that food safety training experience.
 - a. *How often? What was taught? Who taught it?*
- III. You may have seen some signs like these during your training and in your everyday work environment. Describe your experience with signs like these during your time of employment
 - a. *Where they are? Whether they help them remember? What they look like?*

At this point, we will show the signs to the participants and ask the questions on the pictogram example document.

- IV. Of the signs that you saw, which ones did the like the best and why?
 - a. *What made you like them? Was it the color? Picture? Text?*
- V. What do you think makes a sign “good” (noticeable)?
 - a. *Color, shape, size, picture, location, etc.*
- VI. If you could design your perfect food safety sign, what characteristics would it have?
- VII. We really want to make these signs useful and practical for you. Is there anything you want to add or comment on that we missed?

*Note: Questions may be slightly modified depending on participant response

La sesión iniciará con una revisión de los formularios de consentimiento. Se les pedirá a los participantes leer y firmar los documentos. Se les dará una copia de éstos para que los guarden.

La discusión grupal será informal.

El investigador distribuirá los pictogramas (a color) en un pedazo de papel, y le pedirá a los participantes lo que les gusta o no sobre el pictograma en cada imagen (ver documento ejemplo de pictograma). Al final, se les pedirá que clasifiquen los pictogramas.

Las siguientes serán las preguntas para los participantes*:

- I. Como una manera de presentarnos ¿nos podría decir quién es usted, y por cuánto tiempo ha sido empleado en esta instalación en particular?
- II. Recuerde el material de entrenamiento o taller relacionado a la inocuidad de los alimentos en esta instalación. Por favor describa la experiencia de ese entrenamiento.
 - a. ¿Qué tan frecuente fue? ¿Qué se enseñaba? ¿Quién lo enseñó?
- III. Usted pudo haber visto algunas señales como éstas durante su tiempo de formación y en su entorno de trabajo diario. Describa su experiencia con señales como éstas durante su tiempo de empleo
 - a. ¿Dónde están localizadas? ¿Servían para recordar? ¿Qué aspecto tenían?

En este momento, se les mostrarán las señales a los participantes. Seguidamente, se les plantearán las preguntas del documento ejemplo de pictograma.

- IV. De las señales que usted vio, ¿cuáles fueron de mayor agrado para usted, y por qué?
 - a. ¿Qué le gustó acerca de ellas? ¿Fue el color, imagen, o texto?
- V. ¿Qué cree que es lo que hace una señal “buena” (notable)?
 - a. Color, tamaño, forma, imagen, ubicación, etc.
- VI. Si pudiera diseñar una señal perfecta de seguridad alimentaria, ¿cuáles características incluiría?
- VII. Nosotros queremos que estas señales sean útiles y prácticas para usted. Habría algo en particular que le gustaría agregar o algún comentario sobre un detalle que se nos escapó?

*Nota: Las preguntas están propensas a ser modificadas en función de las respuestas del participante

Appendix D: Pictogram example document during focus group

Participants will be shown 5-10 alterations of this sign. One researcher will ask the questions, while the other researcher records some of the participants' responses. This will correspond to question 4 on the focus group protocol document.

Glove use example sign



What do you like about this sign?

What do you not like about this sign?

Is there anything you would change about this sign?

Overall comments:

Appendix E: IRB 14-003 approval letter for all phases of research project



Office of Research Compliance
Institutional Review Board
North End Center, Suite 4120, Virginia Tech
300 Turner Street NW
Blacksburg, Virginia 24061
540/231-4606 Fax 540/231-0959
email irb@vt.edu
website <http://www.irb.vt.edu>

MEMORANDUM

DATE: July 30, 2015
TO: Joe Eifert, Matthew W Schroeder, Oscar Andres Galagarza
FROM: Virginia Tech Institutional Review Board (FWA00000572, expires July 29, 2020)
PROTOCOL TITLE: Modified pictograms improve compliance of poultry industry workers with food safety practices
IRB NUMBER: 14-003

Effective July 30, 2015, the Virginia Tech Institution Review Board (IRB) Chair, David M Moore, approved the Continuing Review request for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report within 5 business days to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

All investigators (listed above) are required to comply with the researcher requirements outlined at:

<http://www.irb.vt.edu/pages/responsibilities.htm>

(Please review responsibilities before the commencement of your research.)

PROTOCOL INFORMATION:

Approved As: Expedited, under 45 CFR 46.110 category(ies) 6,7
Protocol Approval Date: August 28, 2015
Protocol Expiration Date: August 27, 2016
Continuing Review Due Date*: August 13, 2016

*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

FEDERALLY FUNDED RESEARCH REQUIREMENTS:

Per federal regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals/work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

The table on the following page indicates whether grant proposals are related to this IRB protocol, and which of the listed proposals, if any, have been compared to this IRB protocol, if required.

Invent the Future

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY
An equal opportunity, affirmative action institution

Appendix F: Experimental Hand Washing Signs



Appendix G: Example camera position (“bird’s eye view”). About 7’ above ground



Appendix H: Plant manager agreement of video ownership

Dear Plant Manager,

Thank you for agreeing to help with the evaluation portion of our food safety pictograms. This letter offers an agreement between the research team and your facility about the video footage and how the study will be carried out.

During the video observation portion of the study, no identifying information will be visible in the footage, including faces of employees. Only hands of employees' will be observed to determine both frequency and effectiveness of handwashing practices. The camera will be located near 2 sinks (not bathroom) in the facility at opposite ends of the plant. Camera placement will be at agreed upon location between the research team and the plant manager after exploratory visit to the facility. Only research team members will have access to camera during the duration of the project. At no time will employees/ supervisors/upper management have access to the video footage for any reason. Research team will tell plant manager when actual video recording is taking place and the duration of filming.

If the facility would like a summary of the findings, they can be provided at the conclusion of the study. Facilities will also be allowed to keep handwashing pictograms at the conclusion of the study if they desire.

Once again, we thank you for your time and help with our study.

_____	_____
Matthew Schroeder	Date
_____	_____
Joseph Eifert, Ph.D.	Date
_____	_____
Plant Manager	Date

Appendix I: Changes in camera angle at turkey/chicken further processing facility due to changes in wall surface overnight

