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Reducing the Risk: Psychological and Technological Approaches for Improving Handwashing Practices in the Foodservice Industry

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Reducing the Risk: Psychological and Technological Approaches for Improving Handwashing Practices in the Foodservice Industry

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Food Science

by

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Abstract

As Americans are spending greater portions of their dollar on food consumed outside the home, the foodservice industry plays more of an integral part of daily existence compared to previous generations. Given the numerous annual foodborne illness outbreaks that threaten human lives while undermining confidence in the food supply, food safety is a pertinent issue for industry stakeholders, government regulators, and consumers. Food worker handwashing reduces the risk of foodborne illness transmission, yet compliance with this simple behavior is a complex problem. This dissertation addresses, predominantly, the issue of sub-optimal handwashing practices through applying psychology and technology, including wearable computers and a video game.

Chapter one discusses prior efforts to improve handwashing compliance, while providing a theoretical framework to guide industry professionals through strategies that consider the potentially negative psychological effects of interventions on employees. Chapter two highlights handwashing practices of early childhood center food handlers. While average compliance was 22%, strict adherence to the guidelines would have required 12 minutes/hour devoted to handwashing.

Chapter three explores handwashing in relation to organizational climate factors; managerial commitment was the only significant predictor of handwashing. Chapter four shows wearable technology-based training is preferred by food handlers. Chapter five indicates how participants who viewed strictly video-based training were four times as likely to wash hands compared to participants trained with smart glasses. Chapter six highlights the efficiency of handwashing training with smart glasses.
Chapter seven includes the design and development of a video game played while washing hands. Perceptions of the device were only slightly positive, showing the need for either improved reward mechanisms or alternative strategies to motivate handwashing.

Chapter eight evaluates the relationship between risk classification of foodservice establishments and food safety violation rates. High priority facilities had significantly higher food safety violation rates compared to medium and low priority facilities.

In looking to the future of foodservice, many jobs are highly susceptible to automation; emotional intelligence may translate to greater job security in the coming years. Chapter nine evaluated perceptions of job insecurity rendered by automation in relation to emotional intelligence. There was no correlation between the two variables.
Acknowledgements

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Dedication

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Introduction

Sometimes, small changes make a big difference. From a public health perspective, hand hygiene certainly falls into that category. Over 150 years ago, Ignaz Semmelweis discovered antiseptic agents applied to the hands can significantly decrease nosocomial infections (Pittet & Boyce, 2001). Numerous studies have solidified his legacy in showing how poor hand hygiene is a causal agent that contributes to illness transmission (Stewardson, Allegranzi, Sax, Kilpatrick, & Pittet, 2011). This applies to both the hospital and the kitchen, as food worker handwashing reduces the risk of foodborne illness transmission (FDA, 2010). However, compliance with this simple behavior is a complex problem. Sub-optimal handwashing compliance rates observed in the food industry (Todd et al., 2010) show the need for greater understanding of the factors that influence it with an aim for finding ways to increase compliance. This dissertation reflects just that, taking a multi-faceted approach to tackle a multi-faceted problem.

Handwashing is not a behavior performed by robots void of wills and emotions. Ignaz Semmelweis took an aggressive approach through berating people to wash hands, resulting in employees revolting (Nuland, 2003). New technology in the present day has the capacity to force or influence compliance to varying degrees, which raises questions about some of the psychological ramifications for employees. Chapter one involves creating a taxonomy of current handwashing intervention strategies juxtaposed with employee perceptions of freedom. It is intended that the framework serves as a useful tool for industry professionals looking to employ appropriate strategies that foster handwashing compliance.

Hypothesizing about different strategies is not enough to push the needle to improve handwashing practices, and a greater understanding of handwashing behavior through direct
observation is warranted. The second chapter of this dissertation quantifies compliance rates of food handlers in an early childhood center.

Many barriers undermine handwashing compliance, such as the belief systems of managers, prioritization of food production over adequate handwashing, and a lack of rewarding of food safety behaviors (Arendt, Strohbehn, & Jun, 2015; Griffith, Livesey, & Clayton, 2010). Researching the organizational climate of a foodservice establishment helps understand barriers to compliance. To date, little is known about the direct link between food safety climate, considered a subcomponent of food safety culture consisting of shared employee attitudes (De Boeck et al., 2015), and handwashing behavior. The third chapter aims to elucidate that link.

For the food industry, properly trained employees contribute to lowering the risk of transmitting foodborne illnesses, which globally affect approximately 600 million people annually, leading to 420,000 deaths (World Health Organization, 2015). There are three factors that affect transfer of training knowledge to behavior: work environment, trainee characteristics, and training design (Baldwin & Ford, 1988). To the best of our knowledge, little work in the food industry has explored the effects of food safety training design on training outcomes, such as trainee reactions. Chapter four compares employee reactions between handwashing training filmed in the first person and third person perspective, in light of prior research which has shown the first person perspective has several advantages for learning (Rohbanfard, 2011).

Globally, the demand for food eaten outside the home is expected to increase over the next decade (Cushman & Wakefield, 2017). Foodservice entities thus have a significant need to train workers effectively and quickly on safe food handling practices. Smart glasses are a form of wearable computers that allow for hands free workplace training and have proved advantageous in the healthcare industry (Dougherty & Badawy, 2017). To date, smart glasses have not
undergone controlled testing that juxtaposes it with traditional training modalities that involve passive learning, and little is known how smart glasses impact training transfer in foodservice. The fifth chapter seeks to address those gaps in our knowledge through a prospective memory-based experiment comparing handwashing training modalities.

Understanding the functionality and limitations of using smart glasses for training purposes can help food industry stakeholders make better informed decisions about whether to supplant existing instructional delivery methods with this new technology. The goal of chapter six was to understand properties of smart glasses-based foodservice training in comparison with a more traditional, strictly video-based training platform. The experiment looked at the properties of efficiency, hands-free access to information, and freed-up space in the work environment.

Handwashing is a behavior executed largely out of habit, which necessitates unique, habit-focused interventions (Wood & Neal, 2016), yet there is sparse evidence for food safety training that uses a habit-based approach. A handwashing video game could serve as a tool that integrates habit formation mechanics, as gamifying common behaviors can increase the intrinsic motivation to perform them through fun and enjoyment (Lewis, Swartz, & Lyons, 2016). The video game technology was meant to be used with the pillars of habit formation including response repetition and stable cues (Wood & Neal, 2016). Chapter seven sought to assess perceptions of a video game designed to promote handwashing habits in foodservice to estimate acceptance prior to installation in a foodservice establishment.

The last two chapters take a deviation from the topic of handwashing to explore other problems that affect the food industry. For example, greater use of automation in foodservice may lead to significant job displacement in the next ten years (Manyika et al., 2017). To avoid job displacement away from the foodservice industry, managers and employees alike may need
to have high social skills and emotional intelligence (Manyika et al., 2017). Chapter eight investigated how hospitality management undergraduates perceive their future job stability working in hospitality as affected by the increasing prevalence of robotics and automation and how their perceptions correlate with emotional intelligence.

The link between health inspections and risk of foodborne illness outbreaks is muddled by conflicting evidence, raising questions of how frequently foodservice establishments should be inspected. There is more conclusive evidence for conducting inspections based on risk classification schemes that reflect food establishment food handling practices. However, prior studies have not accounted for the variations associated with conducting health inspections, such as whether food safety practices are applicable or observed at the time of inspection. The aim of chapter nine was to control for these nuances in determining the relationship between food safety violation rates and foodservice establishment risk classification designated by the Arkansas Department of Health. Information from this study could have policy ramifications for public health and fiscal ramifications for state expenditures on environmental health.
Chapter 1: Literature Review

Climbing the Intervention Ladder to Handwashing Compliance: A Review and Directions for Future Research


Abstract

Proper handwashing is a simple, cost effective means for reducing the risk of foodborne disease transmission. Low compliance rates are often observed among food handlers, and a wide range of interventions have attempted to increase compliance, often with little success. Promoting lasting behavior change is difficult, and theoretical models like the Intervention Ladder developed by the Nuffield Council on Bioethics function as useful paradigms to help guide and promote behavior change.

While the Intervention Ladder was developed to address issues like infectious disease, obesity, and drug use, it is applicable to the food industry with regards to promoting food safety practices like handwashing. The aim of this review is to expand on the Intervention Ladder and describe its application in the food industry. We believe the Intervention Ladder can serve as a model to benefit food industry stakeholders through providing strategies to promote handwashing compliance. We have modified the original model to include various levels of employee freedom that might impact which strategy is most appropriate depending on the circumstances. Limitations for each strategy are also considered, and directions for future research are included to help guide and expand the knowledge base of food safety behavior change strategies.
**Introduction**

Food safety is a public health issue of prime importance. Worldwide, foodborne hazards were estimated to cause 600 million illnesses and 420,000 deaths in 2010 (World Health Organization, 2015). Foodborne diseases in the United States cost an estimated to $151 billion annually when accounting for damage to human lives, decreased work output, and healthcare expenses (Scharff, 2010). There are an estimated 48,000,000 illnesses, 128,000 hospitalizations, and 3000 deaths annually linked with foodborne disease in the United States (Scallan, Hoekstra, et al., 2011; Scallan, Griffin, Angulo, Tauxe, & Hoekstra, 2011). Foodborne outbreaks are defined by the FDA as the occurrence of two or more individuals acquiring the same illness from a suspected food item (Center for Food Safety and Applied Nutrition, n.d.), and an estimated 1,000 outbreaks occur each year in the United States (Scallan, Hoekstra, et al., 2011; Scallan, Griffin, et al., 2011). Poor hygiene of foodservice workers is among the leading contributing workplace factors that may lead to foodborne disease (FDA, 2009). This is significant in light of cross-sectional data of dietary patterns showing increases in the proportion of food consumed outside the home (Smith, Ng, & Popkin, 2013), and over a third of every dollar in the United States spent eating out (Canning, 2011).

Observations of institutional, retail, and restaurant food establishments show proper personal hygiene as ranking consistently lower on compliance compared to other risk factors like inadequate cooking and improper holding. In a study of 300 foodborne outbreaks, insufficient personal hygiene was the second highest factor leading to outbreaks, with close to 60% of total outbreaks caused by bare hand contact with food (Michaels et al., 2004). Both hand hygiene and handwashing are instrumental in mitigating the spread of disease. Hand hygiene refers to any form of hand cleansing, including use of alcohol-based hand rubs or soap and water, while
handwashing (HW) refers exclusively to hand cleansing with soap and water (Larson, 1995). FDA guidelines prohibit use of alcohol-based hand rubs as a substitute for handwashing (Glassman, Fan, & Over, 2013), making HW necessary for following government standards in a number of food establishments.

HW compliance refers to both how often an employee should clean their hands and how well they clean their hands (Todd, Greig, et al., 2010), based upon current FDA guidelines for food service (Glassman et al., 2013). Compliance rates among foodservice workers are highly variable, with a review by Todd et al. (2010) indicating values in the range of 5 to 60%. One extensive study that observed over 31,000 food handler actions found proper HW occurred just a third of the time (Clayton & Griffith, 2004). Problematic compliance extends to the restroom as well, as researchers who observed HW rates in restaurant restrooms found proper HW compliance to be just over 50% (Sha, Borchgrevink, & Kim, 2011).

Sustainable behavior change is difficult to achieve, especially when considering how foodservice establishments like restaurants can experience employee turnover at a 50% higher rate compared to the rest of the private sector (Bureau of Labor Statistics, 2016). Employers must design effective, affordable, timely, and culturally-specific interventions that incorporate strategies maximizing HW compliance to reduce foodborne disease risk, while being mindful of employee freedom and ethical considerations. Promoting changes in employee behavior must be well thought out from beginning to end before strategies are implemented in the workplace. Managers must achieve
long-term HW compliance while maintaining the optimal balance of employee satisfaction with the time and money available.

The aim of this review is to provide an expanded model to improve HW compliance in the food industry through modification and expansion of the Intervention Ladder. We elaborate on its relevance in allied industries such as healthcare, give examples of how it might be practically implemented in a foodservice establishment, shed light on limitations in the model, as well as introduce directions for future research to aid in increasing the knowledge base for food safety behavior change interventions.

**The Original Intervention Ladder**

The Nuffield Council on Bioethics created an intervention ladder, IL, as part of their report “Public Health: Ethical Issues,” designed to guide public health officials in designing effective interventions (Nuffield Council on Bioethics, 2007). The ladder (Table 1) consists of 8 “rungs” or strategies that government and policy makers can use in their approach to behavior change in the general population. The IL has been used in whole or in part in a range of contexts to address issues like infectious disease spread, obesity, and drug use. While the IL was initially geared towards government and health care policy makers in the public health domain, we believe it can serve as model for the foodservice industry that will help increase HW compliance. To the best of our knowledge, the IL has never been adapted as an employee motivation model for guiding food safety interventions, and yet offers a unique perspective to better understand and approach significant food safety issues like poor HW compliance.
<table>
<thead>
<tr>
<th>Steps</th>
<th>Definition</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eliminate choice</td>
<td>Regulate in such a way as to entirely eliminate choice</td>
<td>Compulsory isolation of patients with infectious diseases.</td>
</tr>
<tr>
<td>Restrict choice</td>
<td>Regulate in such a way as to restrict the options available to people with</td>
<td>Removing unhealthy ingredients from foods</td>
</tr>
<tr>
<td></td>
<td>the aim of protecting them</td>
<td></td>
</tr>
<tr>
<td>Guide choice through</td>
<td>Fiscal and other disincentives can be put in place to influence people not</td>
<td>Taxes on cigarettes</td>
</tr>
<tr>
<td>disincentives</td>
<td>to pursue certain activities</td>
<td></td>
</tr>
<tr>
<td>Guide choices through</td>
<td>Regulations can be offered that guide choices by fiscal and other incentives</td>
<td>Tax-breaks for the purchase of bicycles that are used as a means of travelling to work</td>
</tr>
<tr>
<td>incentives</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Guide choices through</td>
<td>Make ‘healthier’ choices the default option on restaurant menus</td>
<td>Menus could be changed to provide healthier options as standard (i.e. salad as the default side</td>
</tr>
<tr>
<td>changing the default</td>
<td></td>
<td>rather than chips</td>
</tr>
<tr>
<td>policy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enable choice</td>
<td>Enable individuals to change their behaviors</td>
<td>Building cycle lanes</td>
</tr>
<tr>
<td>Provide information</td>
<td>Inform and educate the public</td>
<td>Campaigns to encourage people to walk</td>
</tr>
<tr>
<td>Do nothing</td>
<td>Simply monitor the situation</td>
<td>Collecting longitudinal data on obesity rates</td>
</tr>
</tbody>
</table>

*Note: Reprinted from *Public Health: Ethical Issues*, by Nuffield Council on Bioethics, 2007*
The Handwashing Intervention Ladder

The original IL model carries the underlying assumption that as one progresses up the ladder, the more an individual’s freedoms are restricted. However, it is possible to have varying levels of freedom within each strategy, given how freedom simply refers to hindrances in an individual’s ability to act on their desires (Christman, 2011) and not necessarily correlated with utilization of increasing force. We uphold this construct for freedom in our model and throughout this review. The foodservice industry is made up of a diverse workforce, and strategies to promote behavior change may vary by culture (Pellegrino, Crandall, O’Bryan, & Seo, 2015). Brehm’s theory of psychological reactance provides a framework for understanding how people respond to impediments of freedom, which can increase motivation to find ways to subvert the desired behavior (Brehm, 1966). However, even this may vary depending on whether an individual is willing to sacrifice individual rights in favor of the common good (Hofstede, 1980).

We present a model with tools to promote behavior change that elaborates on the previous IL and serves as a taxonomy to classify prior food safety interventions. Our proposed IL model (Table 2) offers a template for designing interventions, and each strategy offers several options depending on how employees might respond. This model is based on prior behavior change theories and fits the criteria of being a good theory due to it being testable, providing new insights, and bringing cohesiveness to prior observations about HW compliance (Klein & Zedeck, 2004).
Monitor Compliance

The very bottom rung of our modified IL involves monitoring employee behavior, foundational and necessary for gathering baseline levels of HW compliance. Surveillance cameras are considered the gold standard for accurate determination of HW practices, as employees are more likely to forget the presence of the cameras and act with high freedom in accord with their typical behavior (Chapman, Eversley, Fillion, Maclaurin, & Powell, 2010; Powell et al., 2013). More intrusive observations involve use of radio frequency identification (RFID) tags that track employee movement and interface with soap or alcohol-based hand rub (ABHR) dispensers to determine HW compliance (Levchenko, Boscart, & Fernie, 2013; Marra et al., 2014; Staats, Dai, Hofmann, & Milkman, 2015). In person observations are a less resource intensive means for monitoring HW that may obstruct freedom, depending on individual perception (Stewardson, Allegranzi, Sax, Kilpatrick, & Pittet, 2011). While this rung in the IL implies no corrective action taken, numerous studies show evidence for the Hawthorne effect inflating HW compliance whenever employees are cognizant of being observed (Hagel et al., 2015; Srigley, Furness, Baker, & Gardam, 2014; Yin et al., 2014).

Each method for monitoring compliance comes with a set of limitations that should be carefully considered when designing interventions to improve HW compliance. While surveillance cameras are beneficial for capturing an arguably more accurate representation of employee behavior, there is a significant cost in amount of time required to code behavior patterns to estimate HW compliance. RFID tags are the most costly in terms of hardware required to execute and maintain (Marra et al., 2014), and may function more to facilitate rather than drive behavior (Patel, Asch, & Volpp, 2015). In person observations, as a form of direct
observation, capture behavior in a small window of time and are thus a gross estimate of actual compliance.

Future research could focus on developing affordable tracking systems capable of accurately monitoring HW compliance behavior with less labor. Current sensor-based systems that are available could be used in food service to assess how HW compliance changes over time (Judah, Witt, Drassal, & Aunger, 2017).

**Train for Compliance**

The next rung is providing effective training that instills procedural knowledge and skills of proper HW compliance. Employees need to be trained in order to reinforce awareness of important food safety behaviors, especially given current guidelines that designate anywhere from 11-20 different scenarios that would prompt HW (CDC, 2015b; Glassman et al., 2013; Strohbehn, Sneed, Paez, & Meyer, 2008). Training can also serve as a conduit for improving attitudes about HW (Jan Mei Soon, Baines, & Seaman, 2012), significant considering how attitudes can contribute to a large portion of the variance in HW malpractices observed (Clayton & Griffith, 2008).

Training transfer models suggest training design can impact the efficacy of training to lead to behavior outcomes (Baldwin & Ford, 1988). Deviating from lecture-based training to more participatory instruction grants food handlers greater freedom in decision making, which can drive job satisfaction and improve cognitive outcomes like confidence levels to perform well (Latham, 2012). Learning is enhanced through discussions that value worker contributions and allow employees to learn from one in another through a variety of activities (Merriam & Bierema, 2013). Qualitative data from food handlers reflects desires to take on a more
participatory role in food safety training exercises (Clayton et al., 2015), and more hands on training has been shown to impact HW practices (Lillquist, McCabe, & Church, 2005).

A review of hand hygiene training programs suggests evidence for its effectiveness at improving behaviors is limited (Egan et al., 2007); studies are often plagued by methodological disparities that do not incorporate a control group or item analysis in knowledge tests (Viator, Blitstein, Brophy, & Fraser, 2015). Lack of knowledge of when to hand wash has been cited as one factor for poor HW compliance (Arendt et al., 2015; Clayton et al., 2015), but this is contradicted by studies showing hygiene knowledge to be generally high among food handlers (Andrew, Young, & Papadopoulos, 2017; Panchal, Bonhote, & Dworkin, 2013; Siau, Son, Mohhiddin, Toh, & Chai, 2015) and the negative impact high workload has on hygiene behaviors (Benjamin Chapman et al., 2010; O’Boyle, Henly, & Larson, 2001). Additionally, there is limited evidence for the effectiveness of knowledge-based training to improve food safety practices among food handlers (da Cunha, Stedefeldt, & de Rosso, 2014).

Amidst the shortcomings of food safety training, future research may need expand on an alternative, more behavior-based approach. One study that utilized a behavior-based training model, which targets the consequences for food safety execution, found increases in HW compliance rates among food handlers (Yu, Neal, Dawson, & Madera, 2017). The infrequency food safety training is conducted (Egan et al., 2007) may also explain the gap between training and behavior, and future research could explore the role of short refresher trainings on improving food safety outcomes. Neuroscience research has shown the capacity for training design to impact learning and behavior outcomes (Garland & Sanchez, 2013; Jackson, Meltzoff, & Decety, 2006; Maeda, Kleiner-Fisman, & Pascual-Leone, 2002; Rohbanfard, 2011; Watanabe et al.,
yet little research in the food industry has explored this possibility with food safety behaviors like HW.

**Enable Compliance**

Enabling compliance is accomplished by providing employees with the necessary resources, materials, and job structure needed to hand wash at the appropriate times. The FDA Food Code (2013) mandates that food establishments devote a specific sink that has a supply of soap, some type of drying agent, and proper waste disposal. Interventionists in hospital settings helped better enable compliance through providing more readily accessible hand hygiene resources (Bischoff, Reynolds, Sessler, Edmond, & Wenzel, 2000; Thomas, Berg-copas, Vasquez, Jackson, & Wetta-hall, 2009), which was shown to have a significantly greater effect on improving HW compliance compared to education and feedback in one study (Bischoff et al., 2000).

A low-cost step that encourages employee freedom is enabling compliance through promoting open lines of communication between management and employees. Positive relationships between management and employees have been shown to encourage food safety behaviors, resulting in employees feeling free and less threatened to speak up when potential issues arise (Clayton et al., 2015). Supervisors who shown concern for employee well-being and value input help foster transparency in the workplace. Job restructuring, suggested by Green et al. (2006), would be a low cost option to increase HW compliance by allowing only certain employees to handle raw food and others to handle ready-to-eat food. This would potentially cut down on the number of HW opportunities and time required for each employee to spend HW. However, it may also impede employee freedom by confinement to a specific task that conflicts
with desires to engage in task diversification, which can affect job depression levels (Parker, 2003).

In terms of high cost options, managers could install sensor-based automated sinks and potentially mitigate the effects of role overload typically experienced by foodservice employees. Employees are commonly faced with role overload, in which they are required to complete more tasks than they are physically able to accomplish in a given time period (Brown, Jones, & Leigh, 2005). This results in greater risk taking behavior, like poor HW, and a unique reward system where eliminating or reducing HW allows employees to serve more customers and meet food production quotas (Hofmann & Stetzer, 1996). One study found replacing normal sinks with automated sinks led to significantly better HW effectiveness (Larson et al., 1991). Employers may consider installing automated HW stations (Meritech, 2016) which could improve the desirability of HW by lessening the effort expended to properly hand wash and increasing the novelty of this behavior. Enabling compliance by decreasing role overload would come at a cost, as managers may to update HW facilities or include more workers in day to day operations, driving up labor expenses.

The capacity for enabling compliance to improve HW compliance is affected by health code guidelines, particularly those in the United States which do not allow hand sanitizers to be used in place of HW (Glassman et al., 2013). Evidence from the healthcare sector shows replacing HW sinks with alcohol dispensers increases hand-cleansing rates (Girou & Oppein, 2001). Given the large portion of time food handlers would have to devote to maintain HW compliance standards in the United States (Fraser, Arbogast, Jaykus, Linton, & Pittet, 2012), giving food handlers the choice to use alcohol-based hand sanitizers could yield significant health outcomes. Benefits of automated, sensor-based sinks have been offset by negative
perceptions and attitudes of employees, which lead to a significant, concomitant decrease in compliance compared to use of the traditional sink in one study (Larson et al., 1991).

Future research on enabling compliance should consider the propensity for behavior fluctuation in the individual and the role of perception of the physical environment. In this way, enabling compliance could be conceptualized as the by-product of providing the necessary physical alterations of the environment to promote HW compliance. HW can be an automatic process contingent on one’s reactions to a context (Aunger et al., 2016; Sladek, Bond, & Phillips, 2008), and altering the interior design of a space could take advantage of this principle. One explanation for why HW rates vary depending on the environmental context (Berry, Fournier, & Porter, 2012; Borchgrevink, Cha, & Kim, 2013; Cha et al., 2011; Mariwah, Hampshire, & Kasim, 2012) is embodied cognition, which theorizes that our mental constructs are not just abstract representations, but rather are situated in how we interact with our environment (Adam & Galinsky, 2012; Chiel & Beer, 1997; Wilson, 2002). The environment triggers abstract concepts, which then influence the initiation of the associated behavior (Wilson, 2002). For example, one study found that more people recycled in a sustainably designed building compared to a building lacking this facet of pro-environmentalism (Wu, DiGiacomo, & Kingstone, 2013). BP gas stations, in an attempt to boost their company image, re-built their restrooms to include color schemes associated with cleanliness, and avoided colors associated with dirt (Treasure, 2011; Pijls & Groen, 2012). BP’s story reflects how the appearance of the environment plays a critical role in the perception of cleanliness (Whitehead, May, & Agahi, 2007), and interior design components like color, sound, and texture all function as cues in making this judgment (Pijls & Groen, 2012). To date, there have been no controlled experiments that have looked at how increasing the perception of cleanliness in a restroom or workspace affects HW compliance.
<table>
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<th>Definition</th>
<th>Examples</th>
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<td>Employees have no choice but to comply</td>
<td>Infrastructure; hand wash to enter a facility</td>
</tr>
<tr>
<td>Freedom: Low</td>
<td></td>
<td>Enforcement by management</td>
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<tr>
<td>Freedom: Medium</td>
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<td>Enforcement by peers</td>
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<tr>
<td>Deter Non-compliance</td>
<td>Motivate via physical or emotional discomfort</td>
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<td>Visuals that trigger humor; praise from management</td>
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<tr>
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<td>Employees assigned to a very specific job duty</td>
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<td></td>
<td></td>
<td>Convenient access to automated sinks that cut down on effort to hand wash</td>
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<td></td>
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<td>Train for Compliance</td>
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**Note:** Adapted from *Public Health: Ethical Issues*, by Nuffield Council on Bioethics, 2007.
Reward Compliance & Deter Non-Compliance

Foodservice leaders can combat the issue of poor HW compliance through guiding choice via incentives and punishments, the next two rungs on the IL. Rooted in these strategies are underlying assumptions in behaviorism, specifically the law of effect which states that actions are more likely to be repeated if accompanied by a reward (Thorndike, 1911). Libertarian paternalism, heavily influenced by behavioral economics, undergirds these sentiments of behaviorism and involves subtly guiding individuals to make the right decision through “nudges” in the form of incentives and salient feedback (Thaler & Sunstein, 2008).

**Reward.** Rewards, both extrinsic, such as money or verbal praise, and intrinsic, such as doing an activity for the simple pleasure of it, can shift behavior patterns by providing motivation and reallocating attention resources to the desired behavior (Anderson, Folk, Garrison, & Rogers, 2016; Skinner, 1953). One of the simplest ways to reward HW compliance is through humorous messages, which has been shown in two different interventions to positively affect HW rates (Chapman et al., 2010; Judah et al., 2009). This results in evaluative conditioning in which a positive experience is encoded onto the environment (Hofmann, De Houwer, Perugini, Baeyens, & Crombez, 2010), encouraging behavior propagation. Strategies that involve humor or more intrinsic forms of motivation disrupt the environmental context of an employee, thus functioning as motivational cues conducive to habit formation (Wood & Neal, 2007). Posters allow for more employee freedom by separating the reward from the performance. Rewarding employees through incentives like candy or financial gain promote the contingency between behavior and outcome (Nieto-Montenegro, Brown, & LaBorde, 2008; Rowiaye et al., 2015; York, Brannon, Shanklin, Roberts, Barrett, et al., 2009), and employees may thus be more
inclined to act against their desire for non-compliance. As such, less freedom may be experienced by employees for this type of strategy.

The effectiveness of rewards are hindered by the potential for operant extinction, in which reinforcement of a behavior ceases, subsequently followed by a decrease in the behavior (Skinner, 1953). In order for a sustained change in behavior to occur, rewards must be given consistently, systematically, and have a low contingency with behavior, characteristic of intermittent reinforcement (Dickinson, 1985; Wood & Neal, 2009). This type of reward system may allow for more employee freedom, but is extremely difficult for foodservice managers to implement and maintain, given the frequent, sometimes sporadic circumstances that necessitate HW.

Reinforcement conducive for habit formation has been untested in the food industry. This approach could range from high cost, more technologically advanced systems, to lower cost options, such as increasing intrinsic motivation by elevating the inherent desirability of HW, like triggering empathy for those one’s actions are likely to affect (Sassenrath, Diefenbacher, Siegel, & Keller, 2015). Persuasive technology (Fogg, 2003), which has been used to promote healthy eating, smoking cessation, and dental health (Orji & Moffatt, 2016), is a growing field and serves as one means through which HW compliance could be guided through incentives. Persuasive technology that incorporates elements of a game has been shown to improve HW compliance in a healthcare setting (Higgins & Hannan, 2013), but has not been applied in food service.

**Deter.** Foodservice supervisors may also drive behavior through punishing non-compliance, such as by triggering negative emotions or through mild physical discomfort in the form of RFID tags and disgust-based stimuli. Posters grant maximal freedom, as they are unobtrusive, stationary, and encountered usually at just the point of HW (Jenner, Jones, Fletcher,
Posters that utilize minimal fear appeals compared to more extreme fear appeals may be more effective at promoting HW (Janis & Feshbach, 1953). An intervention that sought to decrease hospital acquired infections used posters to evoke fear and showed some success in increasing HW compliance (E. E. Williams, 1987). Providing knowledge of risk in the form of fear tactics might appear to be a useful strategy, as it has been shown to promote HW behavior in a study that analyzed HW practices in the midst of an influenza pandemic (Miao & Huang, 2012). Advances in technology have yielded RFID tags and sensors that track employee movement to detect HW compliance. One successful intervention relied on sensors that emitted a high pitched sound that would continue for 60 seconds or until the employee activated the soap dispenser (Møller-Sørensen, Korshin, Mogensen, & Høiby, 2016). This strategy involves low freedom by impeding an employee’s capacity to act on their desire for non-compliance.

Disgust, a universal emotion theorized to serve as a self-protection based response to pathogen or infection avoidance (Curtis, 2007; Miller, 2013), can motivate HW across a wide range of cultures and scenarios (Curtis, Danquah, & Aunger, 2009). A study conducted by Porzig-Drummond et al. (2009) incorporated disgust into HW training videos, which, compared to the education-based and control video, induced greater occurrences of HW. In another study, messages targeting disgust proved more effective at inducing soap and water usage in restrooms among men in comparison to social norms or knowledge activation (Judah et al., 2009). Positive changes in HW behavior were observed on a college campus after a HW campaign focused on disgust-based messages. Pellegrino et al. (2015) found that a disgust-based olfactory cue significantly increased the likelihood of HW compared to disgust-based aural cues and posters.

Deterring HW through punishing non-compliance is limited by the potential for employee backlash through psychological reactance (Brehm, 1966) and message fatigue. Ignaz
Semmelweis, pioneer for HW compliance, would utilize negative reinforcement, which led to hospital staff avoiding HW or hindering his efforts (Nuland, 2003). An intervention that installed sensors with obtrusive sounds to encourage soap usage observed decreased visitation by employees to one of the facilities a sensor was located (Møller-Sørensen et al., 2016). Employees may circumvent the effectiveness of deterrents by avoiding the behavior altogether or adjusting behavior patterns to subvert the punishment. Message fatigue is a form of habituation where an emotional stimulus, such as fear or disgust no longer evokes a response (Groves & Thompson, 1970), which can occur with fear-based strategies to increase HW compliance.

To date, little research has explored the role of disgust-base interventions in promoting behavior change in the food industry. Handwashing can been induced through disgust by targeting the senses of sight, smell and hearing (Botta, Dunker, Fenson-Hood, Maltarich, & McDonald, 2008; Pellegrino, Crandall, & Seo, 2015); questions remain as to how the role of touch might factor into this equation. Studies have looked at what characteristics are associated with disgust and texture, most notably objects that are wet, mushy, sticky, or slimy (Curtis & Biran, 2001; Oum, Lieberman, & Aylward, 2011). A study by Vogt (2011) found that participants were more likely to wash their hands when exposed to a disgust condition comprised predominantly of objects resembling biologically active substances. Their research also confirmed how exposure to disgusting stimuli can create an attentional bias towards stimuli that represent cleanliness. Questions remain about the utility of this approach in food service and how habituation might affect compliance rates over time.

**Force Compliance**

The top rung on our modified IL involves restricting and eliminating choice by forcing compliance. Overtly burdensome supervising that limits freedom can restrict the ability of the
employee to work effectively (Ryan & Smith, 1954). Therefore, our inclusion of both high, medium, and low levels of freedom for forced compliance might first appear to be a paradox and counterproductive to promoting HW. However, as Griffiths et al. (2015) shows, it is possible to have high levels of freedom in this scenario as long as employee desires for HW are concomitant with the desires of the organization. Forcing compliance would be low in freedom if it posed a restriction on employee desires, unless those desires matched up with that of the organization for high HW compliance. Employee perceptions of freedom are sometimes dependent on cultural background (Hofstede, 1980).

Forcing compliance could occur through in person enforcement by management or use of peer pressure. These approaches are progressively less structured in nature, thus involving increased employee freedom. An alternative approach to heavy management enforcement would be designing an environment that would force individuals to hand wash before leaving or upon entering a facility, such as a door or gate that unlocks only after prescribed HW. This is a tactic that has been used in food production facilities, in which a proper hand wash unlocks a turnstile, which then allows for entrance to the production area (PHS Hygiene, n.d.).

Forcing compliance as a strategy to promote HW is limited by ethical concerns (Nuffield Council on Bioethics, 2007), the difficulty of maintaining this level of enforcement given how HW the times required can be impractical (Fraser et al., 2012), and the potential for negative employee reactions (Brehm, 1966; Nuland, 2003). Use of infrastructure for forcing compliance would be contingent on the nature of the foodservice job. Forced compliance from management may be labor intensive, and relying on peer enforcement may be inconsistent and could have negative ramifications in the work environment, depending on employee relations.
Future research could focus on the role of individual perceptions of freedom related to cultural background. More individualistic cultures like the U.S. place an emphasis on individual freedom, interests, and expression, while collectivist cultures like China ascribe value to interdependency and protection of group interests, even if individual autonomy is sacrificed along the way (Hofstede, 1980). Therefore, it is plausible that different people groups may have different reactions to forced compliance-based behavioral interventions. To date, this facet of food safety behavior enforcement has yet to be explored.

Conclusion

Proper HW is a simple, yet powerful procedure shown to combat infection transmission, antibiotic resistance (Trampuz & Widmer, 2004), diarrhea (Ejemot-Nwadiaro, Ehiri, Meremikwu, & Critchley, 2012), and reduce the risk of foodborne disease (FDA, 2009). Poor HW compliance, despite millions of dollars spent and numerous interventions, remains a problem (Stewardson et al., 2011). As B.F. Skinner points out, “Human behavior is perhaps the most difficult subject to which the methods of science have ever been applied” (Skinner, 1953), with this truth reflected in the obstacles faced by HW interventionists and food industry leaders in creating lasting behavior change (Erasmus et al., 2010; Gawande, 2004; Jan Mei Soon et al., 2012; Viator et al., 2015). The Nuffield Council on Bioethics created a tool in the form of the Intervention Ladder to help address public health issues, and we applied an expanded Intervention Ladder to HW to help chisel away at the problem of poor compliance. We have elaborated on the Intervention Ladder to include varying levels of employee freedom. We believe this model is of benefit to industry interests, through helping managers pick the optimal combination of strategies to increase compliance and by providing a framework to guide HW interventions. Furthermore, we contribute to the current knowledge base of food safety practices
in presenting a modified paradigm for classifying HW studies and by posing directions for future research.

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Chapter 2: Hand Washing Compliance in an Early Childhood Center

An Observational Study of Hand Washing Compliance in an Early Childhood Center


Abstract

Background: Handwashing (HW) compliance, although an effective means of limiting childhood illness, remains low among personnel in early childhood centers (ECCs). Our study determined HW compliance and efficacy of ECC personnel.

Methods: Surveillance cameras were used to determine HW opportunities, compliance, occurrences, and effectiveness based on child-care oriented criteria.

Results: We observed 349HW triggering events, with 14 events per hour; a median of 2 personnel (caregivers, paraprofessional aides, or parents) were present at any given time period. Compliance was 30% (caregivers), 11% (paraprofessional aides), and 4% (parents), with an overall compliance of 22%. Between room and between-age groups of children being cared for and compliance of caregivers and paraprofessional aides were not found to be significantly different (P < .05). For all personnel between the 10 different rooms, the median compliance was 20.2% (95% confidence interval, 8%-35%). Only 7% of personnel taking care of 2- to 3-year-old children washed their hands, the lowest compliance per age group. Of all steps in HW, paper towel usage had the highest compliance, with a 97% adherence, whereas turning off the faucet with a paper towel was the lowest at 17%.
Conclusions: Methods and strategies need to be developed to increase compliance. Current technology provides an effective means of gathering data for determining HW compliance in ECCs.

Introduction

Out-of-home child care services play an important role in ensuring the well-being of >32 million children annually across the United States (Census Bureau, 2013). Caregivers of these children are responsible for providing care and education to this younger population in the absence of their parents or guardians. Keeping children healthy is a huge responsibility made even more difficult because children <5 years old have only partially developed immune systems, increasing their susceptibility to communicable diseases (Peate & Gormley-Fleming, 2014). Bacterial infections, such as those caused by methicillin-resistant Staphylococcus aureus, are sometimes acquired by children through community child care settings (Herold, 1998). The risk of infection is 2-3 times greater for children cared for at an early childhood center (ECC) than those cared for only in a home (Nesti & Goldbaum, 2007), with respiratory and gastrointestinal infections posing the highest risks (Barros, 1999). A key component in reducing the risks to this vulnerable population involves minimizing microbial cross-contamination through proper handwashing (HW) among child care professionals and teachers. Proper HW is crucial to removing the causative organisms responsible for the spread of infections (Pittet & Boyce, 2001).

Children, especially those ≤5 years old, are highly susceptible to rotavirus, a diarrheal disease commonly transmitted in child care facilities because of poor hygiene (CDC, 2015a). Annual costs, including medical treatment and work missed by parents for child care, have been estimated at $1 billion (CDC, 2015a). Several studies and interventions have shown the positive
effects of increasing HW compliance in ECCs, including alleviating the burdens of childhood illness (Black et al., 1981; Huskins, 2000; Roberts et al., 2000; Soto et al., 1994). The cost of a successful HW intervention has been estimated to be a mere 1% of the cost of infection treatment (Pittet, Sax, Hugonnet, & Harbarth, 2004). In a review investigating 9 HW interventions, the authors determined that proper HW education in ECCs and school settings has the potential to prevent or reduce diarrhea cases by approximately one-third (Ejemot-Nwadiaro et al., 2012). Soto et al. (1994) conducted HW education in ECCs and observed a 72% decrease in cases of diarrhea and a 54% decrease in cases of colds among the children. Researchers in Georgia implemented HW interventions in 2 ECCs, with 2 others serving as controls (Black et al., 1981). After 35 weeks, the diarrhea rates of the control group were double that of the intervention group. A review encompassing infection interventions in ECCs highlighted 6 studies that included HW training as leading to decreases in the rates of upper respiratory infections and diarrhea (Huskins, 2000), and one in particular saw a 17% drop in upper respiratory infections (Roberts et al., 2000). The benefits of HW extend to the adults as well, especially given the ability for pathogens, such as respiratory syncytial virus, to spread from infants to child care personnel (Pearson, 2004).

The Centers for Disease Control and Prevention (CDC) recommend that all volunteers, teachers, and children within the ECCs comply with HW guidelines. The National Association for Education of Young Children also requires that accredited programs stipulate that “children and adults wash their hands on arrival (in their room) for the day” in addition to other key points in the schedule. This is why many programs, including the program where we made observations extend identical HW requirements to parents. It is postulated that because parents touch potentially contaminated surfaces and sometimes interact with children within the care
environment, they too may carry bacteria to children. Such a requirement also serves an educational purpose. Standard 2.4.3.2 of the CDC regulations recommends that the centers serve as an educational hub for parenting information, including the importance of HW.

Despite the various benefits, several studies have shown low HW compliance in the child care setting (Lee et al., 2005; Strohbehn et al., 2008; Zomer, Erasmus, Van Beeck, et al., 2013). Out of 572 observed instances in which food service workers at an ECC should have washed their hands, only 200 HWs occurred, a rate slightly <35% (Strohbehn et al., 2008). Zomer et al (2013) observed a 29% compliance rate for caregivers before eating, a 25% compliance rate after touching bodily fluids, and an overall compliance rate of 42% for >2,000 HW opportunities. A survey given to parents whose children attended a child care center discovered only one-third of the respondents regularly washed their hands after wiping their child’s nose (Lee et al., 2005).

To our knowledge, to date, no study has been conducted using cameras as a means of determining HW compliance at an ECC, despite the advantages this form of data collection offers. Research on HW conducted by Judah et al (2009) suggests observations minimizing researcher-subject contact aid in developing intervention strategies. Furthermore, it has been shown that human monitoring alone can contribute to altered behaviors and outcome (Carabin et al., 1999; Spano, 2006). Video observations have been used in a variety of settings, including hospitals (Diller et al., 2014; Shah, Patel, Shah, Phatak, & Nimbalkar, 2015), a veterinary clinic (Anderson, Sargeant, & Weese, 2014), and an elementary school (Pickering, Blum, Breiman, Ram, & Davis, 2014), to determine HW compliance, frequency, and efficacy based on adherence to guidelines. Shah et al (2015) measured the quality of HW events as defined by the World Health Organization (WHO) using motion-sensing cameras placed directly over the HW area in a neonatal intensive care unit. Over 1 week they were able to capture >1,000 handwashes
from doctors, nurses, and parents. Despite the fact that all persons who entered the neonatal intensive care unit washed their hands at least once, 14.5% of all handwashes were considered unacceptable (omitted at least 3 of the 6 WHO steps deemed important and when washing time failed to be $>20$ seconds), with the unacceptability rate being $>34\%$ for parents.

The purpose of our study was to collect baseline data using video observations to determine the quality and frequency of HW practices in an ECC in the Northwest Arkansas region caring for infants and children up to 5 years of age.

**Materials and Methods**

To properly determine the number of HW opportunities and to assess the quality of HW occurrences, wide-range, robotic surveillance cameras (ClearVIEW HD-19; Vaddio, Minnetonka, MN) were used. Two cameras were placed in each of the 10 classrooms in the early childhood facility. The cameras, secured to the walls and connected to the facility’s video capture system, allowed for clear views of the sinks used for adult HW. The 2 cameras were placed on opposite sides of the room and were situated approximately 2m above the ground on shelving or cabinets and were used simultaneously to assess behavior. Both cameras captured recordings that were then automatically displayed side by side when viewed for researcher’s coding purposes. In the event that a caregiver moved from one side of the room to the other, the use of 2 cameras made their transition seamless; the opposite camera picked up the behavior right when personnel exited the frame of view from the initial camera. Key room features captured by the cameras included 1 handwashing sink per room located at the entrance to each room and a sink located proximal to child feeding areas. There were 4 rooms responsible for care of infants in the age range of 2-22 months that were equipped with an additional handwashing sink adjacent to a diaper changing station (Fig 1).
Fig 1. Room layout used for collecting handwashing compliance and efficacy data for children 2-22 months old. White space indicates areas in the room cameras were able to record. Dotted lines emanating from cameras define field of vision.

The cameras were able to film most of the space of the room, and handwashing opportunities were assessed based only on visible footage. The study was found to be exempt from further review by the Institutional Review Board of the University of Arkansas on the premise of maintaining individual anonymity of the personnel observed. Ten hours of video footage (a full operational day in the ECC) of caregivers, paraprofessional aides (PAs), and parents were obtained from each of 10 different classrooms on 10 separate days over the course of a month. The ages of the children in the 10 rooms varied from <1 year old to 5 years old. A random, 2.5-hour time slot was selected from each of the 10 rooms for a total of 25 hours of footage, which was later coded for HW by a researcher and assistant; these randomly selected time slots encompassed all hours of the 10-hour work day. HW opportunities and events were based on guidelines for early child care established by the American Academy of Pediatrics et al. (2011). Briefly, use warm water, moisten hands with water, apply soap to hands, rub hands
together vigorously out of the water until a soapy lather appears, continue for at least 20 seconds, rinse hands under running water, leave the water running while drying hands with a paper towel, and turn taps off with paper towel.

The percentage of HW compliance for this article, as defined by Zomer et al.(2013), is defined as the number of times a person washes their hands divided by the number of handwashing opportunities. The percentage of compliance was also figured for each of the recommended components of HW recommended by the CDC(Boyce & Pittet, 2002). The researchers carefully observed each of these components to determine which steps in the sequence were most often omitted or slighted. R Version 3.2.5 (The R Foundation for Statistical Computing, Vienna, Austria) was used to calculate compliance, medians, and 95% confidence intervals (CIs).

Coding criteria were based on ECC quality indicators in the Environmental Rating Scales(Morvai & Szabó, 2015) and were adapted from the “Caring for Our Children” guidelines(American Academy of Pediatrics, 2011) (Table 1), and were adapted from the coding scheme in Green et al.(2006) Minor modifications were made to this criteria, including the addition of cell phone handling as a HW opportunity because of the present body of research highlighting the role of cell phones as fomites for disease(Morvai & Szabó, 2015).
Table 1. Handwashing opportunities coded for based on early childhood center quality indicators and “Caring for Our Children” guidelines

<table>
<thead>
<tr>
<th>After</th>
<th>Before and after</th>
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<tbody>
<tr>
<td>Entering the classroom</td>
<td>Food and drink preparation and handling</td>
</tr>
<tr>
<td>Handling a cell phone</td>
<td>Eating</td>
</tr>
<tr>
<td>Contact with bodily fluids</td>
<td>Diapering</td>
</tr>
<tr>
<td>Taking out or touching garbage</td>
<td></td>
</tr>
<tr>
<td>Cleaning</td>
<td></td>
</tr>
<tr>
<td>Touching sand</td>
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</table>

Because of the continuous nature of the recorded footage, it was inevitable that multiple HW opportunities could be attached to 1 HW event, such as if a caregiver were to enter the classroom, wash their hands, and then immediately prepare food. To account for this, such a circumstance would have been coded as 2 HW opportunities and 2 corresponding HW events, despite only 1 actual HW taking place. Therefore, we distinguished between corresponding and actual HW events. In calculating HW compliance, we divided the number of corresponding HW events over the number of HW opportunities.

Establishing satisfactory interrater reliability (IRR) is a critical component of conducting a HW compliance study because it assures the integrity of the observations and HW criteria when limited time and resources may necessitate multiple coders to individually examine a large sample of data. Although some studies have relied on percentage agreement between users (Green et al., 2006), this method fails to account for chance in contributing to agreement, leading to an overestimation of consensus (Hallgren, 2012). Cohen κ has been used previously in determining IRR for hand hygiene observations (Borchgrevink et al., 2013), but it offers less flexibility in the event of missing data (Hallgren, 2012). Krippendorf α (1970) was selected as the test statistic of choice because it has been shown to account for the shortcomings of percentage
agreement and Cohen \( \kappa \) while being more suited for the unstructured observations (Swert, 2012) characteristic of our study. IRR was established between the researcher and assistant using extraneous footage not part of the 25 hours selected for data collection. An IRR score of 92%, considered well above average for reliability tests (Swert, 2012), was obtained using SPSS Statistics version 23 (IBM, Armonk, NY) and Krippendorf \( \alpha \) (Swert, 2012) as the test statistic before the 25 hours of footage were coded.

**Results**

There were a total of 349 HW opportunities in the random 25 selected to code from between the 10 classrooms, equating to roughly 14 HW opportunities per hour. The median number of caregivers in a classroom at any given time was 2, with a range of 2-6. For students, the median number in the room was 1, with a range of 0-5. Seventy-eight corresponding HW events took place, and overall compliance was 22%. Compliance, defined as the number of corresponding HW events over the number of HW opportunities, was highest among caregivers because they handwashed 30% of the time; PA compliance was 11%, and parent compliance was 4%. Because each room was frequented by a predominantly different group of caregivers, PAs, children, and parents, calculating the median compliance gave us an indication of how compliance rates varied among the caregivers and personnel overall (Table 2). Median compliance of caregivers between the 10 rooms was 27.5% and 21.2% for between the 14 activities. After comparing between-room compliance of teachers and PAs, no significant difference (\( P < .05 \)) was found between the 2 groups of personnel. The 95% CI of compliance for caregivers between rooms was 30% (16%-44%), and between activities it was 24% (12%-36%). Although compliance rates from PAs and parents were informative, the number of HW opportunities for these groups was low and therefore not appropriate for individual statistical
analysis for interquartile differences and 95% CIs. As such, we used PA and parent compliance rates, along with caregiver compliance rates, to determine overall interquartile differences and 95% CIs.

**Table 2.** Compliance characteristics of DCC personnel in relation to the different rooms footage was taken and the activities triggering HW

<table>
<thead>
<tr>
<th></th>
<th>Interquartile Differences of Compliance</th>
<th>Compliance (%) (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Between rooms n=10</td>
<td>Between activities n=12</td>
</tr>
<tr>
<td>Caregivers*</td>
<td>14%</td>
<td>27%</td>
</tr>
<tr>
<td>Overall**</td>
<td>13%</td>
<td>11%</td>
</tr>
</tbody>
</table>

*Paraprofessional aides and parents values too low as to warrant individual analysis

**Includes caregivers, paraprofessional aides, parents

Caregivers were responsible for 64% of all HW opportunities, followed by PAs (23%), and parents (13%). For caregivers, “before child food, drink preparation, handling” was the most frequently occurring activity that warranted HW, with “after touching/playing with sand” and “after taking out or touching items in the garbage” comprising the least. The most frequent HW opportunity for PAs was “after entering the classroom,” with “after taking out or touching items in the garbage” the least. Of the 12 categories of HW opportunities measured, “after diapering” had the highest compliance rate for caregivers (67%) and “after entering the classroom” had the highest compliance rate for PAs (47%). “After eating,” “after taking or touching items in garbage,” and “after touching or playing with sand” had the lowest compliance rates for caregivers, with “after eating” contributing to the most HW opportunities16 from these 3 activities. For PAs, “before child food, drink preparation, handling” had the most
opportunities of the activities with 0% compliance, which was all but 3. Of the 46 HW opportunities for parents, only corresponding HW events took place, and “after entering the classroom” comprised most, with a compliance rate of 6%. “After entering the classroom” had the highest overall compliance among caregivers, PAs, and parents at 32%. To clarify, based on the “Caring for Our Children” guidelines, this was considered a HW opportunity when personnel entered the classroom at the start of a work shift, after a break, or after switching child groups.

Overall compliance of personnel by age group are as follows: for the ≤1-year-old age group there was 21% compliance in 2 rooms, in the 1- to 2-year-old age group there was 29% compliance in 2 rooms, in the 2- to 3-year old age group there was 7% compliance in 2 rooms, and in the 3- to 5-year old age group there was 29% compliance in 4 rooms. There was an average of close to 35 triggering events per classroom. A comparison between age group compliance of teachers to PAs showed no significant difference ($P < .05$). Regarding the occurrence of HW opportunities, in some cases, there was no corresponding after to a before because of the adherence to a 2.5-hour video segment limit, therefore inhibiting the viewing of a potential subsequent event.

Of the 78 corresponding HW events, caregivers comprised approximately 85%, PAs comprised 13%, and parents comprised 3%. Of the actual HW events, there were 63 total between caregivers (50 events), PAs (11 events), and parents (2 events). Only 2% of the HW events by caregivers and 18% by PAs reached the minimum recommended HW time of ≥20 seconds (Table 3). Of the 5 designated time slots for HW time, 6-10 seconds comprised the most of the actual HW events for caregivers (38%), and 1-5 seconds (27%) and 6-10 seconds (27%) for PAs. One actual HW event of the parents was 1-5 seconds and the other was ≥20 seconds.
The average HW duration was approximately 10 seconds overall and individually for caregivers and PAs.

**Table 3.** Overall number of occurrences of key components of HW steps and % total for caregivers, paraprofessional aides, and parents.

<table>
<thead>
<tr>
<th>Length of HW (sec)</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-5</td>
<td>20</td>
<td>32%</td>
</tr>
<tr>
<td>6-10</td>
<td>22</td>
<td>36%</td>
</tr>
<tr>
<td>11-14</td>
<td>11</td>
<td>17%</td>
</tr>
<tr>
<td>15-19</td>
<td>6</td>
<td>10%</td>
</tr>
<tr>
<td>20+</td>
<td>4</td>
<td>6%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HW Criteria</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Used Soap</td>
<td>59</td>
</tr>
<tr>
<td>Wetted hands prior to soap addition</td>
<td>18</td>
</tr>
<tr>
<td>Lathered w/ soap outside of running water</td>
<td>11</td>
</tr>
<tr>
<td>Dried hands w/ paper towel</td>
<td>61</td>
</tr>
<tr>
<td>Turned off faucet w/ paper towel</td>
<td>10</td>
</tr>
</tbody>
</table>

Our HW event criteria was divided into 7 measurable steps, excluding such protocols as using 60°F-120°F (15°C-60°C) water and the efficacy of the personnel in removing visible dirt and soap. Every room was equipped with sufficient paper towels and soap, in part having an influence on the high paper towel and soap usage we observed by personnel. PAs used soap 91% of the time and never missed an opportunity to dry their hands with paper towels. Of the 2 corresponding HW opportunities in which gloves were worn by caregivers, they were removed both times before HW. Caregivers and PAs rarely turned off the faucet with a paper towel, complying with this step 27% and 0% of the time, respectively.
Discussion

The average compliance rate we observed of 22% was lower than the rates in ECC studies mentioned previously of Zomer et al. (2013) with 42% and Strohbehn et al. (2008) at approximately 35%. However, our study was unique in using video surveillance compared with direct observation, which could in part explain the discrepancy. Furthermore, our population differed from Zomer’s in that we included PAs and parents, both of whom had much lower compliance than the caregivers in our study and the Strohbehn study, which focused on food service workers in the ECC setting. We also used slightly different criteria as to what warranted HW and used different methodologies for recording HW opportunities. In the ECC of our study, beginning PAs are not authorized to engage in several behaviors that warrant HW, such as changing diapers and taking out trash; this could account for, in part, the disproportionate amount of HW opportunities observed for the children’s actual caregivers compared with PAs. We were unable to make the distinction between beginning and more experienced PAs, and the calculated compliance rates reflect this. Therefore, this may further explain our lower compliance rates compared with prior studies. We were not surprised by the low level of compliance parents demonstrated toward the handwashing regulations even though several teachers posted HW reminders on the classroom doors. Parents are often rushed at drop-off and pickup times. Teachers, too, are rightfully more engaged with children than with policing the sink area at these times. Furthermore, teachers, many of whom are young, are often too intimidated to confront parents.

Looking at just the caregivers, we compared compliance rates to what Zomer observed using the similar, applicable HW criteria. In some cases, multiple activities Zomer documented were analogous to just one activity we documented. The comparable HW activities followed by
the percentage compliant were as follows: “before child food, or drink preparation, handling” (Clark study: 36%)/ “before food handling” (Zomer study: 31%); “after diapering” (Clark study: 67%)/ “after changing a diaper with feces” and “after changing a wet diaper when the child was lying down” (Zomer study: 61%); and “after contact with bodily fluids from child or self” (Clark study: 18%)/ “after contact with body fluids” (Zomer study: 25%). Whether or not these differences in compliance observed are marginal or significant remains to be seen, but they could be a matter of slightly divergent interpretations as to what constitutes each HW opportunity and the variation in sample size.

We documented the fewest number of HW opportunities (349) in relation to the 2 other comparable studies for ECCs by Zomer (2,003) and Strohbehn (572). Questions continue as to what constitutes an adequate sample size for determining representative HW compliance, but the WHO suggests a minimum of 200 HW opportunities per specific setting and time period (WHO, 2009). Our study fits these criteria in focusing on a single ECC and through randomly selected footage that encompassed all 10 hours of the day children were present. A successful intervention has been conducted with as few as 294 HW opportunities, which was divided between multiple time frames of baseline, postintervention, and follow-up periods (Tromp et al., 2012). We exceeded this amount of opportunities as part of a baseline period alone.

According to the “Caring for Our Children” guidelines used in our study, HW should last ≥20 seconds (American Academy of Pediatrics, 2011); our data indicate a 6% overall adherence rate to this recommendation. Hand sanitizing is an approved means of quickly and safely reducing bacterial loads on the hands when no visible dirt or soil is present. Arkansas regulations do not allow hand sanitizer usage to substitute for HW in childcare, and therefore it
stands to reason that in the 25 hours of footage we reviewed, there was not a single instance in which hand sanitizer was used. However, given the low adherence to the duration a HW should be and the overall low compliance rates of caregivers, PAs, and parents, the state regulation might benefit from a review that would allow use of hand sanitizer in certain instances.

We observed a greater portion of actual HW events that lasted ≥15 seconds compared with several other studies (Borchgrevink et al., 2013; Monk-Turner et al., 2005), one of which, conducted by Drankiewicz & Dundes (2003), showed only 1 in 50 HW events lasting ≥10 seconds. These differences could in part be attributed to the slight variance in criteria as to what defines a HW; Borchgrevink et al. (2013) considered the duration of a HW to be how long an individual’s hands were in contact with water, whereas ours was from when an individual turned on the water to when they turned it off. Sample size and demographics could also play a role in our differing results. The average duration of an actual HW event we observed (approximately 10 seconds) is similar to what some studies have shown in hospitals (Shanks & Peteroy-Kelly, 2009) and about twice as long as what has been documented at the university setting.

To our knowledge, this is the first study to use video surveillance to determine HW compliance in the ECC setting. Although the cameras were visible to personnel, knowledge of the intentions for this study remained anonymous. In such a way, the cameras functioned as covert observers, much like studies done previously in which the observer had a less authoritative role within the setting (Pan et al., 2013) or disguised their intentions (Zomer, Erasmus, Van Beeck, et al., 2013). Furthermore, prior to the start of this study, personnel were accustomed to being monitored, with security cameras (not used for this study) and 2-way mirrors already put in place by the ECC.
Our strategy of using cameras has been used previously in different settings (M. E. . Anderson et al., 2014; Diller et al., 2014; Pickering et al., 2014; Shah et al., 2015) as a means of limiting the effects of observers on behavior (Spano, 2006), which has been shown to inflate HW frequencies and impact behavior (Hagel et al., 2015; Parsons, 1974; Srigley et al., 2014). Commonly known as the Hawthorne effect, this refers to the potential for an experiment to alter behaviors (Parsons, 1974) and is often associated with affecting the results of observational studies. Although some evidence suggests the Hawthorne effect to be minimal (Yin et al., 2014), this has been shown to be only true if observations are limited to 15 minutes; such a time frame has obvious limitations by impeding the ability of the researcher to observe HW behavior throughout the course of a day.

Our methodology of using video observations provided several advantages, including that we could rewind and review our recordings if necessary. This allowed us to meticulously code the behaviors to give us an accurate indication of HW opportunities, compliance, and efficacy. Surveillance and observations conducted where the researcher is present have been shown to yield similar results for determining HW compliance (Pickering et al., 2014), therefore validating our method for data collection. In recording the audio of the classrooms, we were better able to pinpoint when HW began, based on aural cues. The sound provided insight into specific HW compliance strategies used by caregivers as aids directed toward the children, such as songs and frequent reminders. HW was a common practice enforced for children on entering the classroom, but based on a low overall compliance rate (32%) for caregivers, PAs, and parents for this activity, perhaps the HW strategies used should be geared toward both children and adults. This is further reinforced given the large difference in compliance rates for all activities between caregivers (30%), PAs (11%), and parents (4%).
With respect to the discrepancies in compliance rates between personnel groups, they could, in part, be caused by the large variance in amount of HW opportunities observed. The larger number of HW opportunities observed for caregivers potentially gave a slightly more accurate indication of HW practices. Varying levels of HW training exposed to by the personnel groups could also have contributed to the broad range of compliance. Regardless of the source of the discrepancy, this study reinforces the need to institute comprehensive, effective HW training for all persons involved with child care. Also, considering that there was no significant difference in compliance between teachers and PAs either between rooms or between age groups, the hypothesis that more training leads to increased HW compliance could be brought to bear on this question.

Apart from gleaning strategies for future HW interventions, our footage provided evidence of potential sources for cross contamination, such as clipboards and pens used immediately after diaper changes but before HW. This information sheds light on the location of potential fomites and highlights the need for a thorough update and review of cleaning and sanitizing policies. Although HW frequency is important in mitigating the spread of disease, the order in which HW takes place compared with other tasks could also play a role, as suggested by our study.

The study did have some limitations, one of which was the use of cameras that were only able to capture a portion of the room. This had the potential to alter the compliance rates we observed because we were limited to behaviors viewed on screen. The positioning of the caregivers, PAs, and parents in relation to the HW sink inhibited our ability to properly assess HW procedures of certain actual HW events, such as lathering with soap. Furthermore, we were not able to observe HW behavior in relation to outdoor activity or when caregivers left the
classroom to take children to play in the indoor play room; more HW opportunities could have occurred unknown to us.

A more thorough examination of the “Caring for Our Children” guidelines after data were collected and analyzed revealed another recommended scenario for HW, that of HW after assisting children HW. We were unable to include this event in our analysis, which, in doing so, could have affected the amount of HW opportunities observed and compliance rates calculated. Future coding will include this extra criterion.

We recognize our decision to base HW compliance from 12 criteria from the “Caring for Our Children” guidelines as being rather extensive and prone to overestimation of how often personnel needed to HW in light of respective risk of spreading contamination. Fraser et al. (2012) reached a similar conclusion in their evaluation of hand hygiene guidelines and expectations in the foodservice industry. Combining their methods of calculating total time required for a HW event and the number of HW opportunities we observed in our study, with an average of 14 events per hour, to achieve 100% compliance, personnel would have spent 12 minutes, or 20% of each hour, in HW. Much like the difficulty a line cook faces in the pressure of ensuring customer satisfaction with quick food production times versus HW at the prescribed frequency, ECC personnel have the same difficulty when prioritizing the care of a crying infant versus meeting HW compliance demands. Our study supports the need within child care and food service for a more risk-based approach to required HW events as posited by Fraser et al. (2012).

Nevertheless, we calculated overall compliance using the 6 HW criteria recommended by the state’s Division of Child Care and Early Childhood Education and local health department for ECCs (Arkansas Department of Human Services, 2012), which involved food preparation,
eating, and diapering. Interestingly, overall compliance for these 6 categories was 22%, the same percentage we observed when all 12 criteria were included in our analysis.

**Conclusion**

HW is an important component of reducing illness transmission among children in ECCs, especially for the adults in charge of their care. Our study shows the need to adopt creative strategies to increase compliance and efficacy, to mitigate the potential for cross-contamination via fomites, and to consider usage of current technology in assessing behaviors.

**Acknowledgments**

We thank the early childhood center for their cooperation with this study. We also acknowledge assistance with coding from Amanda Krotke-Crandall and Erika Hawkins.

**References**


Chapter 3: The Influence of Food Safety Climate on Handwashing

Exploring the Influence of Food Safety Climate Indicators on Handwashing Practices of Restaurant Food Handlers


Abstract

Recent models have conceptualized food safety climate as a subcomponent of food safety culture that consists of the shared values and perceptions of employees. The present study sought to understand how food safety climate indicators including commitment, role overload, and contingent rewards affect handwashing frequency of restaurant food handlers (n=124). Managerial commitment was the only variable significantly correlated with handwashing frequency r(120)=.313, p < .001. A multiple regression model showed managerial commitment was a significant predictor of handwashing frequency, F(1,117)=12.70, p < .001, R2=.098. Role overload moderated the relationship between goal level and handwashing frequency, but only when role overload was low, b=.530, (115) t=2.02, p=.046, suggesting the presence of competing subcultures. Managers should prioritize a food safety culture and structure jobs in such a way that promotes food safety behavior execution.

Introduction

Organizational culture has been implicated as a significant factor in achieving desirable safety outcomes over a breadth of industries: the nuclear power plant industry (Wiegmann, 2004), aviation, healthcare (Sabin, Bigda-Peyton, & Brown, 2012), and the food industry (Nyarugwe, Linnemann, Hofstede, Fogliano, & Luning, 2016). Food Safety Culture (FSC) is a subset of organizational culture and was initially defined as “…the shared attitudes, values and
beliefs about the food safety behaviors that are routinely demonstrated in food handling organizations” (Griffith, Livesey, & Clayton, 2010, p. 434). Nyarugwe et al. (2016) expanded on this definition and identified six indicators of FSC, including characteristics of overseers, employees, employees as a collective group, the Food Safety Management System, the facilities with proper equipment and available resources, and food safety performance.

A food establishment’s FSC can compete with other subcultures within an organization, such as production demands and maximizing profits (Griffith, Livesey, & Clayton, 2010). Given the estimated cost of foodborne illnesses in terms of damage to human lives (Scallan, Hoekstra, et al., 2011a; Scallan, Griffin, et al., 2011b) and expenses associated with lost work and medical bills (Glassman et al., 2013), food safety should be the dominant subculture (Griffith, 2013; Nyarugwe et al., 2016). The strength of a food safety culture can manifest itself in the food safety climate, which can be defined as the shared attitudes, beliefs, values, and practices of the workforce (De Boeck, Jacxsens, Bollaerts, & Vlerick, 2015). To better understand food safety climate, researchers and practitioners must focus on those established influencers of employee behavior. This can be accomplished through investigating the correlation between food safety behaviors and food safety climate at the level of the individual (De Boeck, Mortier, Jacxsens, Dequidt, & Vlerick, 2017).

**Purpose of the Study**

Fostering a dominant food safety culture among restaurant workers contributes to the health of both customers and businesses in the hospitality industry. To date, few studies have explored the link between food safety climate and specific behavioral outcomes (De Boeck et al., 2017). The aim of the present research was to expand on the body of knowledge of FSC by 1.) Assessing three predominant indicators of food safety climate (commitment, rewards, and role
overload) using a goal setting theory-based framework. 2.) Determine the relation between these food safety climate indicators and food safety behaviors. 3.) Determine the reliability of food safety climate variables as predictors of food safety behavior. Our research focuses on two of the six identified indicators of FSC (Nyarugwe et al., 2016), namely employee beliefs and food safety performance.

**Literature Review and Hypothesis Development**

It has been hypothesized that the reason foodborne outbreaks continue to afflict the food system is a misallocation of time and resources to study the pathogens rather than the employees that play a role in transmitting the pathogens (Griffith, 2013). Many of the estimated 48 million foodborne illnesses in the U.S. (Scallan, Hoekstra, et al., 2011a; Scallan, Griffin, Angulo, Tauxe, & Hoekstra, 2011b) and 600 million foodborne illnesses worldwide that occur annually (World Health Organization, 2015) are linked with poor food safety practices among food handlers (FDA, 2009). The FDA (2009) has identified five risk factors that contribute to foodborne illness outbreaks, including reliance on unsafe sources for food, insufficient cooking, improper time and temperature holding, contaminated equipment, and poor personal hygiene. One study that examined 300 foodborne disease outbreaks attributed poor personal hygiene with bare hand contact with food as a significant factor associated with causing the outbreaks (Michaels et al., 2004). Proper cleaning of the hands is, therefore, instrumental in decreasing the risk of foodborne disease transmission.

Hand hygiene (HH) refers to cleaning the hands through use of alcohol based hand rubs and/or soap and water (E. Larson & Kretzer, 1995) and deserves special attention for several reasons. Griffith and Sofos (2013) describe four factors as to why HH may be one of the most important food safety behaviors of food handlers. 1.) HH is required frequently, yet compliance, in terms of how often and how well hands are cleaned, can be low. 2.) Hands can carry a high
microbial load. 3.) Hands frequently touch contaminated surfaces and objects before touching ready-to-eat food. 4.) HH impacts all steps of food production, from farm to fork.

Despite its importance, numerous barriers prevent food handlers from achieving adequate HH compliance, including organizational indicators like management belief systems, production quotas that supersede HH demands, and insufficient rewarding of food safety behaviors (Arendt, Strohbehn, & Jun, 2015; Griffith et al., 2010). Practitioners have sought to understand the interplay of these barriers through studying the Food Safety Culture (FSC) of a food establishment. FSC is a broad construct that includes food safety outcomes such as employee behaviors and antecedents to these outcomes such as the food safety management system, infrastructure, and employee beliefs (Nyarugwe et al., 2016). FSC as a nascent field of research is apparent through the paucity of studies that link specific, quantitative, organizational indicators and food safety outcomes, such as behavior (De Boeck, Jacxsens, Bollaerts, Uyttendaele, & Vlerick, 2016; De Boeck et al., 2017). Measuring observable behaviors alongside indicators of food safety performance is key to understanding the interconnectedness of the role of the individual, the environment, and the organization (Wiegmann, 2004). A recent model of FSC has echoed these sentiments in highlighting the importance of food safety climate (De Boeck et al., 2015). While FSC and food safety climate are sometimes used interchangeably, for the present research we define food safety climate as the shared values and perceptions of employees and managers (De Boeck et al., 2015). As such, food safety climate is a distinct component of FSC that differs from other food safety indicators such as the Food Safety Management System.

Food safety climate functions as a barometer of the leadership, commitment, communication, risk awareness, and allotment of resources an organization devotes to food
The food safety climate, as part of the overarching FSC of an establishment, serves as a system of preventative measures for reducing foodborne illness risk by prioritizing leadership and employee behavior when legal authorities or third parties are not present to audit or enforce (Powell et al., 2013). In tandem with other indicators such as the Food Safety Management System, the food safety climate can influence food safety performance outcomes, including microbiological output and employee behavior (De Boeck et al., 2016, 2017). In one study that compared affiliated and non-affiliated butcher shops, food safety climate components of leadership and communication were associated with a stronger food safety management system and superior microbiological hygiene (De Boeck et al., 2016).

To date, despite the number of FSC assessments that have been developed, sparse research has used them to predict behavior. One FSC assessment that was utilized to predict behavior showed a significant positive relationship between food safety climate and employee behavior (De Boeck et al., 2017). However, the survey used to measure behavior had several methodological shortcomings. The self-reported measure used may be prone to response bias, and thus may not accurately reflect food safety practices; food safety behaviors such as handwashing are particularly vulnerable to over-reporting (Contzen, De Pasquale, & Mosler, 2015). Additionally, the survey measured compliance with general food safety practices, rather than targeting specific behaviors. HH is a unique behavior, and the factors that influence its execution may vary from other food safety practices, such as the proper storage and temperate control of foods.

Social cognitive theories such as the Theory of Planned Behavior (TPB) have been utilized to predict and understand the HH behaviors of food handlers in the context of food safety climate. One study conducted with 115 food handlers found that the TPB accounted for 34% of
the variance observed in HH behavior (D. A. Clayton & Griffith, 2008). With 66% of the variance in behavior unaccounted for by this model, more research is needed that investigates what other organizational factors influence HH amidst the limitations of this theory. The TPB may not always take into consideration situational factors like work intensity, which can significantly undermine HH compliance of food handlers (S. Arendt et al., 2015). Additionally, the baseline assumption of the TPB is that behavior execution relies on conscious, planned intentions, while neglecting automatic, reflexive decision-making that may reflect the degree to which a behavior has become habitual (Gardner, Abraham, Lally, & de Bruijn, 2012).

Food safety researchers have relied mostly on FSC assessments and social psychology theories, with little attention given to the field of organizational psychology, which helped birth Goal Setting Theory (GST) (Locke & Latham, 1990). GST is a comprehensive framework for understanding, predicting, and motivating behavior, and has been empirically validated in over 500 published studies (Seijts & Latham, 2001). The premise of GST is based on forming a specific intention to achieve a difficult behavioral outcome (Webb & Sheeran, 2006). While some argue that goals represent a more specific target than intentions (Latham, 2012), experimental evidence suggests greater similarities than differences between the two terms (Webb & Sheeran, 2006). FSC encompasses a wide variety of indicators and finding an appropriate assessment tool to explore pertinent aspects can be difficult (Nyarugwe et al., 2016). FSC assessments need to include reliable food safety climate indicators that show the extent to which food safety is prioritized and practiced among employees (De Boeck et al., 2015; Griffith, 2013).

GST was selected as the theoretical framework to test our hypotheses, as it has been tested with attitudes more explicitly considered part of the food safety climate (De Boeck et al.,
2015; Fatimah, Arendt, & Strohbehn, 2014) compared to a previous study that predicted HH behavior (D. A. Clayton & Griffith, 2008). These attitudes include commitment, perception of rewards given for behavior, and perception of work intensity (Latham, 2012). Handwashing (HW), as opposed to hand sanitizing through use of alcohol-based hand rubs, was chosen as the food safety behavior of interest due to food code restrictions in the United States that prohibit use of alcohol-based hand rubs as a substitute for HW (FDA, 2009).

The Moderating Role of Employee Commitment on Handwashing Frequency

Meyer (2001; p. 299) defines commitment as “a force that binds an individual to a course of action of relevance to a target” and is not contingent on positive attitudes as drivers of behavior. Commitment was an indicator of food safety climate in several assessments (Ball, Wilcock, & Colwell, 2010; De Boeck et al., 2015; Fatimah, Arendt, et al., 2014; Neal, Binkley, & Henroid, 2012; Reynolds, Rajagopal, & Sapp, 2017). Employee commitment can be thought of as the combination of how likely a worker considers a goal, such as adhering to HW guidelines, to be attainable and the importance they assign to that goal (Latham, 2012). GST states that an individual’s commitment to a goal can moderate the relationship between goal level and performance (Locke & Latham, 1990). We define goal level as the targeted goal for how frequently an employee washes their hands when they should. Therefore:

H1. Employee commitment will moderate the relationship between goal level and HW frequency.

Employee Commitment and Managerial Commitment

Management belief systems form one of the six indicators of FSC, and play a role in shaping employee attitudes (Nyarugwe et al., 2016). Authority figures have a central role as main influencers who create and shape culture (Lee, Almanza, Jang, Nelson, & Ghiselli, 2013;
Schein, 2010). Prior research in the hospital setting has shown interventions targeting organizational change through involvement of top-level management can increase HW frequency more than twice as much as hospitals not exposed to the intervention (Larson, Early, Cloonan, Sugrue, & Parides, 2000). The intervention hospital was also associated with a 41% decrease in Vancomycin-resistant Enterococci infections compared to the control hospital. Furthermore, management commitment can positively affect food safety training outcomes through motivating employees to adhere to food safety practices (Nieto-Montenegro et al., 2008). Therefore:

**H2. Managerial commitment will be significantly correlated with employee commitment.**

**The Moderating Influence of Role Overload**

Role overload, in the context of food safety, can be defined as the extent to which food handlers feel they have inadequate time, training, and/or resources to wash their hands as often and as proficiently as they should (A. P. Jones & James, 1979; Kahn, Wolfe, Quinn, Snoek, & Rosenthal, 1964). Role overload reflects organizational culture and often forces employees to spend time on the primary priority, which then dictates that taking short cuts is necessary with lower priority behaviors (Hofmann & Stetzer, 1996). For example, this might include obviating food safety behaviors (lower priority) to wait on customers (primary priority) at the counter. This creates an un-intentional incentive system (Hofmann & Stetzer, 1996) where employees are rewarded with extra time for having poor HW compliance. Role overload has a negative impact on performance when goal level is high (Brown et al., 2005), as reflected in studies that have shown negative correlations between time pressure and HH compliance (Arendt et al., 2015; M. L. Clayton, Clegg Smith, Neff, Pollack, & Ensminger, 2015). While similar indicators of role overload have been studied as part of FSC (Fatimah, Strohbehn, & Arendt, 2014), to date it has not been studied directly as a moderator or predictor of HW frequency.
**H3.** Role overload will moderate the relationship between goal level and HW frequency.

**Contingent Rewards and Habit Strength**

Operant Theory states that behavior change can be brought about through incentives (Blackman, 1974), and this strategy has been used in several HH interventions (Fuller et al., 2012; Mayer et al., 2011; Nieto-Montenegro et al., 2008; York, Brannon, Shanklin, Roberts, Barrett, et al., 2009). Rewards play an important role in increasing the propensity for habit learning (Wood & Neal, 2007), and the extent to which rewards are given out by management is thought to reflect the strength of the FSC of an establishment (Arendt, Ellis, Strohbehn, & Paez, 2011; De Boeck et al., 2015). Therefore:

**H4.** Managerial commitment will be significantly correlated with contingent rewards.

**H5.** Contingent rewards will be significantly correlated with habit strength.

**Habit Strength and Handwashing Frequency**

Goals do not always have a direct, main effect on behavior. An individual’s habits, defined as automatic responses to a context (Wood & Neal, 2007), are shown to have a direct or moderating effect on the goal-behavior relationship (Gardner, 2015; Triandis, 1977). Habitual adherence to food safety practices could be considered a barometer for FSC. One study that examined HH practices of doctors found automatic cognition, associated with spontaneous decision making and habit formation, as more predictive of compliance than deliberate cognition, associated with planned behaviors (Sladek, Bond, & Phillips, 2008). The strength of HH compliance habits can therefore be understood as the extent to which it has become automatic in nature (Gardner, 2012; Verplanken & Orbell, 2003). To date few studies have examined the relationship between habits and behavioral-based food safety practices (Hinsz, Nickell, & Park, 2007; Mullan & Wong, 2009; Mullan, Allom, Fayn, & Johnston, 2014), and only one study, to
the best of our knowledge, has incorporated habits in predicting HH compliance (Zomer, Erasmus, Van Empelen, et al., 2013). Therefore:

**H6.** Habit strength will significantly correlate with HW frequency.

**Intention Behavior Link**

A meta-analysis of 47 peer-reviewed articles showed medium to large changes in intention can yield small to medium changes in behaviors (Webb & Sheeran, 2006). Among consumers, there is mixed evidence for intentions predicting food safety behaviors (Young et al., 2017). Concerning food handlers, while one study failed to find significant correlations (Pilling, Brannon, Shanklin, Howells, & Roberts, 2008), several other studies have shown strong relationships between intentions and both self-reported (Hinsz et al., 2007; Hinsz & Nickell, 2015) and actual food safety behavior (D. A. Clayton & Griffith, 2008). Therefore:

**H7.** Goal level and HW frequency will significantly correlate.

**Methods**

**Sample Selection**

The county health department was contacted and provided a list of valid permit holders of retail food establishments. Retail food establishments from this list were selected for this study based on two criteria: 1.) Status as a restaurant, defined by Green et al. (2006, p. 2418) as “establishments that prepare and serve food or beverages to customers but that are not institutions, food carts, mobile food units, temporary food stands, supermarkets, restaurants in supermarkets, or caterers” 2.) Vendor of high risk foods, or “ready-to-eat foods which, under favorable conditions, support the multiplication of pathogenic bacteria and are intended for consumption without further treatment that would destroy the pathogens” (Sprenger, 1999; p. 8). Restaurants from the list that served high risk foods were randomly selected based on a cluster sampling procedure of zip codes. Restaurants were then contacted either by phone, email, or in
person. This mixed method for recruiting was necessitated by limitations in gaining the required approval to conduct on-site employee interviews, such as managers or owners not always being present during time of initial contact. Furthermore, some restaurants required company authorization, and the researchers were able to obtain approval only through phone calls or emails. A minimum sample size of 120 participants was targeted for multiple regression purposes to allow for at least 20 data points per independent variable. Participants were limited to English-speaking food handlers in non-management positions who worked with or prepared unwrapped or packed food, including drink and ice (Food Safety and Hygiene Working Group, 1997).

Procedure

Approval for this study was obtained by the university Institutional Review Board prior to data collection. The principal investigator and research helper trained in the study procedures partook in data collection. Participants were informed that the purpose of the study was to understand food handler practices, and, after signing a consent form, were interviewed to determine HW frequency. The interviews were conducted using script-based covert recall, a method shown by Contzen et al. (2015) to correlate more closely with actual HW behavior compared to self-reportings. After the interview, participants were given a survey assessing food safety climate indicators related to HW frequency. This survey included employee commitment, managerial commitment, role overload, contingent rewards, goal level, and habit strength. Participants were given a monetary compensation for partaking in the study.

Measures

Interview prompts were based on the format suggested by Contzen et al. (2015), where participants are given a scenario and told to describe exactly how they complete the process. Five
scenarios in which HW is required according to the Arkansas Food Code (Arkansas Department of Health, 2012) were selected for the interview, including after first entering the workplace and before preparing food, after handling raw meat and before handling ready-to-eat food, in-between changing gloves, after handling dirty equipment and before handling ready-to-eat food, and after eating or drinking as part of a break and before handling food. The interview prompts did not encompass all required opportunities for HW, including after restroom usage, after coughing or sneezing, and after touching exposed parts of the body not including clean, exposed hands and arms. This was due to the nature of the data collection method in which such prompts could have raised suspicion of the purpose of the study and increased over-reporting of actual HW behavior patterns. An example interview prompt was, “So you have just walked into work on a typical day. Please describe exactly what you do from the moment you walk in the door to the moment you start handling food.” For each prompt, mention of HW was coded as a maximum of “1” and no mention of HW was coded as a “0.” Distractor questions unrelated to HW were asked in between prompts as an additional measure to decrease suspicion, including asking about personal background in food service, the types of food prepared by the employee, and cleaning responsibilities.

The instructions for the survey included reminders on when to hand wash that were reflective of the scenarios given in the interview prompts. Demographic information was also collected after survey completion. Compliance with the guidelines for HW frequency was worded as “washing your hands when you should” and “washing your hands when you’re supposed to.” The survey was composed of 23 questions. Goal level was assessed with, “What is your targeted goal for washing your hands the times that you should?” on a five-point Likert Scale ranging from “Never wash my hands when I should” to “Always wash my hands when I
should.” The remaining 22 questions were answered on a seven-point Likert scale ranging from “Strongly Disagree” to “Strongly Agree.”

Both employee commitment and managerial commitment were measured using two, separate modified versions of Klein et al.'s (2001) scale. Scale constructs were revised to increase reliability, which included omitting one question that was the same for both employee and managerial commitment to HW. Two questions were reverse coded, including “For me or [My manager believes], it's hard to take this goal seriously of always washing my hands when I should.” Role overload with HW was measured using a three item scale adapted from Brown et al. (2005), and was also revised by omitting one question to increase reliability. An example question was, “The amount of work I do interferes with how often I’m supposed to wash my hands.” To measure habit strength, we used an adapted version of the Self-Report Behavioral Automaticity Index (Gardner et al., 2012) which consists of four items. This scale was used previously in assessing food safety behavior habit strength (Mullan et al., 2014), and all 45 reliability assessments conducted by Gardner et al. (2012) with this scale had α >.65. An example question was, “Washing my hands when I should is something I do without having to consciously remember.” Contingent rewards were measured using an adapted version of Waldman et al.'s (1990) six question scale. An example question was, “My manager praises me for handwashing when I should.”

**Data Analysis**

Results were analyzed using the Statistical Package for the Social Sciences (SPSS version 24). Compliance with HW frequency for each participant was calculated as a percentage of scenarios the food handler mentioned HW, over total scenarios. For example, if the participant mentioned HW in three of the five scenarios, they would receive a HW frequency score of 60%.
This percentage would be regressed on the mean for each survey variable for each participant. The mean was calculated for each survey variable as the average of scale items, along with standard deviation and Cronbach’s alpha for internal consistency. Available case analysis was used with missing data for the correlation matrix and multiple regression model. Moderating effects of employee commitment and role overload in the goal level-handwashing frequency relationship were determined with the PROCESS macro (Hayes, 2013).

Results

Out of 530 potential high-risk restaurants eligible for this study, 66 participated, for a participation rate of 12%. The participation rate we observed was lower than previous studies focused on HH, which had rates of 29% and 41% (D. A. Clayton & Griffith, 2008; Green et al., 2006). This was attributed to several factors. While restaurants were initially deemed eligible based on the list provided by the county health department, further investigation revealed that some restaurants did not meet the selection criteria. Additionally, a portion of eligible restaurants declined to participate, had a small number of employees with no manager, were not currently in business, did not contact the researcher back, did not have management on site to approve the study, or were otherwise unobtainable. Barriers to recruitment of participants included employees lacking time and company policies that prevented data collection from employees. A total of 132 employees agreed to participate, slightly higher than a prior study that examined attitudes and HH behaviors of food handlers (D. A. Clayton & Griffith, 2008). Usable data was collected from 124 participants. Data from one participant was unusable due to a lack of English proficiency, and five data points had to be discarded because during the interview process it became clear this person was in a management position. One data point was not used due to
participant admittance of knowing the purpose of the study ahead of time, and one other data point contained a largely incomplete survey and was not used in the analysis.

There was an equal percentage of males and females who participated in the study. Slightly over three fourths of participants were aged 18-29. The percentage of participants who had less than one year, 1-3 years, 4-7 years, and 8 or more years of foodservice experience was, respectively, 12%, 31%, 23%, 34%. Fifty percent of participants had worked at their current establishment for less than a year, 68% were full time workers, and 89% had received food safety training prior to the study.

Table 1 shows the relation between HW frequency and survey variables. Managerial commitment was the only variable that significantly correlated with HW frequency, $r(120) = .313, p < .001$. The hypothesized relationships between habit strength and HW frequency (hypothesis 6) and goal level and HW frequency (hypothesis 7) were not confirmed. All variables except for contingent rewards were significantly correlated with goal level at $p < .01$. Role overload was significantly negatively correlated with goal level $r(118) = -.283, p = .002$, employee commitment $r(122) = -.521, p < .001$, managerial commitment $r(121) = -.225, p = .012$, and habit strength $r(121) = -.348, p < .001$. Managerial commitment was significantly correlated with employee commitment, $r(121) = .412, p < .001$, confirming our second hypothesis. Contingent rewards were significantly correlated with managerial commitment, $r(120) = .291, p = .001$, confirming our fourth hypothesis. As contingent rewards were not significantly correlated with habit strength, $r(120) = .154, p = .091$, our fifth hypothesis was not confirmed. The greatest correlation was observed between role overload and employee commitment, $r(122) = -.521, p < .001$ and the weakest correlation was between role overload and contingent rewards $r(121) = -.009, p = .918$. 
Table 1. Intercorrelation coefficients for study variables

<table>
<thead>
<tr>
<th>Measure</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Handwashing frequency</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Goal Level</td>
<td>.13</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Employee commitment</td>
<td>.14</td>
<td>.41**</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Managerial commitment</td>
<td>.31*</td>
<td>.31**</td>
<td>.41**</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Habit strength</td>
<td>.11</td>
<td>.29**</td>
<td>.43**</td>
<td>.20*</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Role overload</td>
<td>.02</td>
<td>-.28**</td>
<td>-.52**</td>
<td>-.23*</td>
<td>-.35**</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>7. Contingent rewards</td>
<td>.13</td>
<td>.04</td>
<td>.10</td>
<td>.29**</td>
<td>.15</td>
<td>-.01</td>
<td>1</td>
</tr>
</tbody>
</table>

Note: **p<.01. *p<.05

Mean values for the survey variables employee commitment, habit strength, managerial commitment, goal level, contingent rewards, and role overload were, respectively: 6.12 ±.83, 6.09 ±1.0, 5.83 ±1.01, 4.64 ±.53, 3.57 ±1.32, 2.31 ±1.08. Reported goal level to hand wash the times required ranged from sometimes to almost always (M=4.64, SD = .53) (see Table 2). Close to two-thirds of participants (65%) reported a personal goal of almost always washing their hands when they should. A post-hoc dependent samples t-test was conducted between employee commitment (M=6.12, SD=.83) and managerial commitment (M=5.83, SD=1.01) to compare how employees perceived their personal and their manager’s commitment to HW frequency. This revealed a significant difference between the two variables t(120) = 3.09, p = .002, d = 0.279.
Table 2. Survey components with means and Cronbach’s alpha.

<table>
<thead>
<tr>
<th>Survey variable</th>
<th>Number of Items</th>
<th>Example question</th>
<th>Mean (SD)</th>
<th>Cronbach’s α</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employee commitment</td>
<td>4</td>
<td>I think washing my hands when I should is a good goal to aim for.</td>
<td>6.12 (.83)</td>
<td>.64</td>
</tr>
<tr>
<td>Habit strength</td>
<td>4</td>
<td>Washing my hands when I should is something I do automatically.</td>
<td>6.09 (1.0)</td>
<td>.82</td>
</tr>
<tr>
<td>Managerial commitment</td>
<td>4</td>
<td>My manager is strongly committed to pursuing the goal of washing my hands when I’m supposed to.</td>
<td>5.83 (1.01)</td>
<td>.73</td>
</tr>
<tr>
<td>Goal level</td>
<td>1</td>
<td>What is your targeted goal for handwashing the times that you should?</td>
<td>4.64 (.53)</td>
<td>N/A</td>
</tr>
<tr>
<td>Contingent rewards</td>
<td>6</td>
<td>My manager praises me for handwashing when I should.</td>
<td>3.57 (1.32)</td>
<td>.84</td>
</tr>
<tr>
<td>Role overload</td>
<td>3</td>
<td>The amount of work I do interferes with how often I’m supposed to wash my hands</td>
<td>2.31 (1.08)</td>
<td>.67</td>
</tr>
</tbody>
</table>

The hypothesized interaction, number 1, of employee commitment in the goal level-HW frequency relationship was not found to be statistically significant, \( F(1,115) = 1.02, p = .786, R^2 = .026 \). Hypothesized moderating effects of role overload on the relationship between goal level and HW frequency (hypothesis 3) were also found not to be statistically significant, \( F(3,115) = 1.39, p = .249, R^2 = .035 \). However, exploratory analysis of the conditional effect of goal level on HW frequency at varying levels of role overload showed statistical significance when role overload was low, \( b = .530, t(115) = 2.02, p = .046 \).

Odds ratios were calculated to determine which variables best predicted HW frequency with each of the five scenarios (Table 3). Our results demonstrated that managerial commitment was positively associated with HW frequency after cleaning dirty equipment (OR, 1.82; 95% CI:
1.04-3.22), and after taking a break (OR, 2.23; 95% CI: 1.06-4.71). A positive association was
found between goal level and HW frequency in between changing gloves (OR, 2.55; 95% CI:
1.03-6.3), which suggests goal setting may be appropriate for motivating compliance with this
HW opportunity. No other statistically significant associations were observed in the comparison
between HW scenarios and independent variables.
Table 3. Univariate odds ratios of survey variables with handwashing scenarios analyzed using logistic regression.

<table>
<thead>
<tr>
<th>Goal level</th>
<th>Employee Commitment</th>
<th>Managerial commitment</th>
<th>Role overload</th>
<th>Habit strength</th>
<th>Contingent rewards</th>
</tr>
</thead>
<tbody>
<tr>
<td>After first entering the workplace and before preparing food</td>
<td>.73</td>
<td>.76</td>
<td>1.45</td>
<td>.89</td>
<td>1.24</td>
</tr>
<tr>
<td>After handling dirty equipment and before handling ready-to-eat food</td>
<td>.97</td>
<td>1.12</td>
<td>1.83*</td>
<td>1.14</td>
<td>1.22</td>
</tr>
<tr>
<td>After handling raw meat and before handling ready-to-eat food</td>
<td>1.19</td>
<td>.96</td>
<td>1.58</td>
<td>.98</td>
<td>1.30</td>
</tr>
<tr>
<td>After eating or drinking as part of a break and before handling food</td>
<td>.306</td>
<td>2.98</td>
<td>2.23*</td>
<td>.96</td>
<td>.89</td>
</tr>
<tr>
<td>In-between changing gloves</td>
<td>2.55*</td>
<td>1.09</td>
<td>1.18</td>
<td>1.48</td>
<td>1.26</td>
</tr>
</tbody>
</table>

*p<.05

To further investigate how managerial commitment could predict HW frequency, a stepwise multiple regression model was created using HW frequency as the dependent variable and the six survey components as independent variables. Residual plots were analyzed after the regression model was run, which confirmed the normality, linearity, and homoscedasticity of the data. Inspection of tolerance and VIF values confirmed absence of multicollinearity between variables. Managerial commitment was the only significant predictor in the model $F(1,117) =$
12.70, \( p < .001 \), \( R^2 = .098 \). Thus, managerial commitment accounted for close to 10% of the variance in HW frequency documented.

Using the script-based covert recall method for obtaining HW frequency data, an average of 75% (SD = 21) of the 124 food handlers interviewed reported washing their hands when they should have (see Table 4). The median and mode for the HW frequency data was 80%. There were no food handlers who reported never washing their hands as part of the five scenarios. The greatest percentage of food handlers reported HW when going on break to eat and before returning to work to handle food (92%, SD = 27). The lowest percentage was observed for the scenario that required a glove change (41%, SD = 49).

| Table 4. Total percentage of food handlers (n=124) who reported handwashing as part of the scenario. |
|-----------------|-----------------|-----------------|-----------------|-----------------|
| After first entering the workplace and before preparing food | After handling dirty equipment and before handling ready-to-eat food | After handling raw meat and before handling ready-to-eat food | After eating or drinking as part of a break and before handling food | In-between changing gloves | Overall |
| Mean (SD) | Mean (SD) | Mean (SD) | Mean (SD) | Mean (SD) | Mean (SD) |
| 66% (48) | 86% (35) | 91% (29) | 92% (27) | 41% (49) | 75% (21) |

**Discussion**

The aims of our study were to use a goal setting theory-based framework to assess and determine how food safety climate indicators correlate with one another and to be able to predict food safety behavior. Our results support the premise that management attitudes and values may
be the most important components of a healthy food safety climate. Out of the six attitude-based variables tested, only managerial commitment to HW significantly correlated and was a reliable predictor of HW frequency. This differs from previously reported work with FSC that showed food safety indicators like microbiological hygiene and safety between food establishments did not correspond with differences in commitment (De Boeck et al., 2016). While a recent application of a FSC model confirmed the relationship between commitment and food safety performance indicators (De Boeck et al., 2017), our study was unique in focusing only on HW. As such, we identified the organizational beliefs that not only influence overarching categories of food safety behaviors, but also specific actions. Our multiple regression model showed that managerial commitment is a significant predictor of HW frequency overall. Our logistic regression model suggests high managerial commitment is more likely to result in employee HW after cleaning dirty equipment and after a break prior to food handling. This is an especially pertinent finding given how poor employee hygiene and contaminated equipment are two of the top five risk factors that contribute to foodborne illness outbreaks (FDA, 2009).

Our first hypothesis was not confirmed, as employee commitment was found to have no moderating effect on the goal-HW frequency relationship. Interestingly, employee commitment was shown to be significantly higher than managerial commitment. This discrepancy could be explained by the Dunning-Kruger effect where cognitive bias can impede accurate self-evaluation (Kruger & Dunning, 1999), and employees may then have a more inflated view of their commitment to routinely perform a required food safety behavior as compared to management’s.

Previous research demonstrated how employee motivation can partially explain why food safety climate indicators like managerial commitment affect food safety behavior (De Boeck et
al., 2017). Analogous to our study was the potential for employee commitment to mediate the relationship between managerial commitment and HW behavior. However, mediation was not possible given how employee commitment was not found to significantly correlate with HW behavior. A *post hoc* analysis of our data on the indirect effect of employee commitment confirmed this, $b = .008$, SE = .041, 95% CI = -.046, .093. The lack of consensus between De Boeck et al.’s (2017) results and ours may be due to differences in study sample and methodologies, or may point to how the influence of FSC is not generalizable to a broad spectrum of food safety behaviors.

Based on our exploratory analysis, our data suggests significance between goal level and HW frequency when role overload is low. In other words, when employees feel they have sufficient time, resources, and training to wash their hands as often as they should, their HW goals are more likely to align with their HW behavior. Our research supports prior work highlighting the importance of job structuring and scheduling in minimizing foodborne illness risk (Green et al., 2006). Managers, as part of their job duties, should design workflows that decrease cross contamination points that would necessitate HW. Adhering to these workflows would be critical for employees responsible for high production quotas, such as restaurant line cooks.

The discrepancy we observed between goal level and HW frequency when role overload is low can be explained in light of dual process models of self-control that distinguish between planned and impulsive behavior (Hofmann, Friese, & Strack, 2009). Planned, long term goals of food handlers might include HW to prevent sickness, pass health inspections, and comply with food safety guidelines. Long term goals may be at odds with more impulse-driven, short term goals like rapidly producing food or serving tables to generate income from tips. Thus, by
measuring individual, employee goals, we showed the presence of organizational subcultures that compete with, and perhaps interfere with, food safety practices. This research suggests that to fully understand FSC, researchers and practitioners should concomitantly measure potential competing subcultures within an organization.

We found habit strength, measured as part of hypothesis 6, was high among employees, which suggests that HW is regarded as a largely automatic behavior that occurs in response to a context (Gardner, 2012; Wood & Neal, 2007). However, the significant relationship between goal level and HW frequency when role overload is low suggests HW is also a planned behavior under volitional control that can be directed by intentions. The significant negative correlation observed between habit strength and role overload may point to the impact of organizational culture on food safety habits, and future research is needed to better clarify this relationship.

Of interest is the almost non-existent correlation we observed between habit strength and contingent rewards. This might be due to the nature of the content of the survey variable in which changes in HW frequency would lead to clear changes in rewards received from management. Prior research suggests intermittent reinforcement, or rewards given on a random, unpredictable basis, may be more conducive to habit formation than contingent rewards (Verplanken & Wood, 2006). Given the nature of food service activities, HW opportunities can be sporadic and difficult to observe at a predictable point in time. Therefore, the type of intermittent reinforcement conducive for HW habits may be impractical to implement in food service unless more advanced technological systems are developed (J. Clark, Crandall, & O’Bryan, 2018).

Our multiple regression model explained close to 10% of the variance in HW behavior, lower than a previous study that applied the TPB to explain HH behavior (Clayton & Griffith,
This could be attributed to several factors, including differences in methodologies. Due to feasibility concerns, our model omitted several indicators of FSC and Goal Setting Theory that may have added to the variance in HW frequency observed (Latham, 2012; Nyarugwe et al., 2016). Secondly, it has been shown that organizational culture can vary between companies and food establishments (De Boeck et al., 2016; Sheridan, 1992). Given how our study sample encompassed a wide variety of restaurants, this may have impacted our results. Nevertheless, the aims of our study emphasized the relation of food safety climate indicators and their capacity to predict handwashing practices, which was upheld in our results.

**Limitations**

Due to budgetary and time constraints, restaurants were recruited through cluster sampling as opposed to simple random sampling or stratified sampling. Our sampling method was still superior to convenience sampling, which involves no random selection of subjects. There is the possibility that restaurants did not participate due to fear of revealing poor food safety practices, thus potentially biasing our sample. Direct observation is considered the gold standard for assessing food safety behavior (D.A. Powell et al., 2013), and our study was limited in using a proxy in the form of script-based covert recall, based on interview-style questions. However, the interview approach we used has been shown to better reflect actual HH practices compared to self-reports (Contzen et al., 2015). Future studies are needed to further explore the relationship between actual behavior and that reported in script-based covert recall. Two of our variables, role overload and employee commitment, had comparatively lower reliabilities, which may have impacted our analysis. While all participating restaurants served high risk foods (Sprenger, 1999), not all food handlers or restaurants prepared raw meat. In these circumstances, the respective interview question functioned as a hypothetical scenario rather than a component
of routine. Nevertheless, HW behavior with this question was high, with 91% of food handlers reporting washing their hands after preparing raw meat. While no manipulation checks were conducted to question participants regarding the purpose of the study, a lack of suspicion is evident by the low percentage of food handlers who reported washing their hands in between glove changes (41%). This was the last question as part of the interview, and a high percentage would have implied high participant awareness that the research involved HW.

**Conclusion**

We focused on understanding three facets of FSC through the lens of Goal-Setting Theory that encompassed food safety performance and employee beliefs that make up the food safety climate. Given the role of personal hygiene in lowering the risk of foodborne outbreaks, we measured HW frequency through a novel, interview-based method. Our data collected from 124 restaurant food handlers suggests commitment of leaders may be one of the most predominant components of food safety climate affecting food safety outcomes. We found managerial commitment significantly correlated with and predicted HW frequency based on a multiple regression model. We were also able to identify that managerial commitment could have a significant influence on HW after cleaning dirty equipment and HW before handling food after returning from a break. Moderation analysis on the impact of role overload on the goal-behavior relationship exposed competing subcultures that conflict with food safety goals. Lastly, we found that management rewarding of HW was not related to HW frequency. Food safety culture is a complex phenomenon influenced by a myriad of factors. Future research should focus on refining and developing models that account for competing subcultures and can explain more variance observed in food safety behaviors.
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Chapter 4: Wearable Technology Effects on Training

Wearable Technology Effects on Training Outcomes of Restaurant Food Handlers


Abstract

Food safety training does not always result in behavior change, perhaps because of flaws inherent in traditional training designs. New technologies such as augmented reality headsets or head-mounted action cameras could transform the way food safety training is conducted in the food industry. Training conducted with wearable technology presents visual content in the first person or actor’s perspective, as opposed to the traditional third-person or observer perspective. This visual hands-on first-person perspective may provide an effective way of conveying information and encouraging behavior execution because it uses the mirror neuron system. There is little published literature about the impact of perspective on food safety training outcomes, such as motivation. The present study included a repeated-measures design to determine how first- and third-person camera angles affected hand washing training reactions among 108 currently employed restaurant food handlers. Participants were assessed on their post-training compliance intentions, compliance self-efficacy, perceived utility of the training, overall satisfaction with the training, and video perspective preference. A significant proportion of food handlers (64%) preferred the first-person video perspective ($z \approx 5.00$, $P < 0.001$), and a significant correlation was found between compliance intentions and compliance self-efficacy ($r(108) \approx 0.361$, $P = 0.001$) for the first-person video. No significant differences in video preference were found for demographic variables, including age ($\chi^2 (2, n = 104) \approx 1.69$, $P = 0.430$), which suggests that the first-person training format appeals to a diverse workforce. These
findings support the application of wearable technology to enhance hand washing training outcomes across a wide range of demographic groups. This research lays the framework for future studies to assess the impact of instructional design on compliance concerning hand washing and other food handling behaviors.

**Introduction**

Training is an integral component for organizations that must prepare their workforce to perform proper behavior as part of their job duties. Training can be defined as a “systematic approach to learning and development to improve individual, team, and organizational effectiveness” (Goldstein & Ford, 2002). Properly trained employees are more confident, effective, and efficient at their job (Aguinis & Kraiger, 2009). A meta-analysis that looked at 162 studies on organizational training effectiveness found training had a medium to large effect size on learning, reaction, and behavior (Arthur, Bennett, Edens, & Bell, 2003). For the food industry, properly trained employees contribute to decreasing the burden of foodborne illness, which globally affects an estimated 600 million people annually, leading to 420,000 deaths (World Health Organization, 2015). Under the Food Safety Modernization Act, food establishments in the U.S. are required to train employees on safe food handling practices (FDA, 2017b). Despite the importance of food safety training, two major reviews have revealed only limited evidence for its effectiveness at changing behavior (Egan et al., 2007; Viator et al., 2015). Implicit in these findings is the problem of poor transfer of training where knowledge, skills, and attitudes presented in training modules fail to lead to long-term adopted changes in employee behavior (Baldwin & Ford, 1988).

Baldwin & Ford (Baldwin & Ford, 1988) cite three factors that affect transfer of training: work environment, trainee characteristics, and training design. Understanding these factors in the
context of the food industry helps to explain why food safety training may not always change behavior. Work environment reflects the degree food safety is prioritized by an organization and the amount of opportunity given to employees to practice food safety. Leadership commitment to food safety was found to be highly correlated with food safety behavior in one study (De Boeck et al., 2017). An extensive review noted how reinforcement of food safety training material is rare (Egan et al., 2007), reflecting low prioritization of food safety practices. High production demands can undermine training efforts by preventing employees from practicing food safety (C. J. Griffith et al., 2010). Trainee characteristics describe individual reactions to the training, motivation to apply the training material, ability, and personality. In a study of 115 food handlers, perceived behavioral control, a similar construct to ability, was the most significant predictor of hand hygiene practices, accounting for 21% of the variance observed in hand hygiene behavior (D. A. Clayton & Griffith, 2008). Poor self-efficacy to practice food safety is strongly linked with high production quotas and the work environment of a food establishment. Training design can affect training transfer to the extent to which it conforms to the notion of identical elements (E. L. Thorndike & Woodworth, 1901), or how much the training reflects the transfer setting. One study used this principle in a hands-on training module where participants practiced actual handwashing (Lillquist et al., 2005). Food handlers in the hands-on training group had higher knowledge scores compared to food handlers in lecture and video-based training groups. However, use of hands-on training is rare, and lectures that take place in settings removed from the performance context are more common (Medeiros, Cavalli, Salay, & Proença, 2011). Education and behavior change theories aid in designing effective training materials, yet are rarely utilized in food safety training interventions (Viator et al., 2015).
The relationship between work environment and food safety training outcomes is well established in the literature (De Boeck et al., 2016, 2015, 2017; C. J. Griffith et al., 2010; Douglas A. Powell, Jacob, & Chapman, 2011). However, the role of training design on food safety training outcomes remains underexplored. Advancements in our understanding of how knowledge translates into action can aid in designing more effective training modules. Interestingly, research in neuroscience has revealed how training design, specifically with regard to the perspective in which information is presented, can affect one’s ability to learn and imitate behavior (Garland & Sanchez, 2013; Jackson et al., 2006; Maeda et al., 2002; Rohbanfard, 2011; Watanabe et al., 2011, 2013). Perspective is classified as either egocentric, also known as the first-person/actor perspective, or allocentric, also known as the third-person/observer perspective (Jackson et al., 2006). Several studies comparing the efficacy of participants’ ability to imitate behavior have suggested that information presented in the first-person perspective allows for better facilitation and ease of learning (Watanabe et al., 2011, 2013). Significantly shorter lag times were observed when participants were asked to imitate foot and hand action sequences in a video where participants watched the first-person perspective compared to the third-person perspective (Jackson et al., 2006). These findings support the notion that greater similarities between training content and performance context can result in greater ease of task execution and better facilitate learning. Controlling for individual differences in cognitive ability, Garland and Sanchez (Garland & Sanchez, 2013) found improvements in performance outcomes for procedural learning tasks when the instructional media was first-person based. These findings are attributed to the first-person perspective coinciding with greater contiguity with the sensory motor system, decreased cognitive resources required to translate information for usage (Rohbanfard, 2011), and greater activation of the mirror neuron system (Jackson et al., 2006).
Evidence from digital gaming experiences has shown the first-person perspective results in a more immersive experience compared to the third-person perspective (Denisova & Cairns, 2015).

Innovation in and increased affordability of small, high-resolution wearable technology now can allow anyone to film training segments from the first-person perspective. While wearable technology is a broad term that can be applied to any small digital device that interacts with its user, of relevance to the present study are head-mounted displays (HMDs), such as Google Glass, and high-resolution personal action cameras (PACs), such as GoPros. HMDs are worn by the user much like a pair of glasses frames, and consist of a small, unobtrusive screen that allows the user to read instructions within his or her field of vision. While the potential of using HMDs in training is in its infancy, the technology has already been successfully adopted to present medical neurosurgery training to MD residents (Nakhla et al., 2017). Using HMDs in the food industry could radically transform how food safety training and auditing is conducted (Beach, 2017). PACs are typically mounted on the head and secured through a strap before recording. These devices capture very detailed first-person perspective footage for demonstrations or self-evaluation, and are being widely adopted in the medical field for applications such as orthopedic surgery (Karam et al., 2016), plastic surgery (Paro, Nazareli, Gurjala, Berger, & Lee, 2015), and eye surgery (Nair et al., 2015).

To date, little is known how training filmed in the first-person perspective using PACs affects employee reactions to the training. According to Kirkpatrick’s four tier model of training evaluation, when employers evaluate their employees’ reactions to the training, it demonstrates organizational concern for performance outcomes such as food safety behaviors (Kirkpatrick & Kirkpatrick, 2007). Additionally, employee feedback on training provides the data needed to re-
design elements of the training to better serve employees (Kirkpatrick & Kirkpatrick, 2007). Examples of training reactions that managers can collect include the participants’ perception of how useful the training is, overall satisfaction with the training, and self-efficacy, defined as one’s belief in one’s ability to perform the training material, and preference to other training types. An employee’s reaction to the training is beneficial for gauging job motivation. Job motivation may affect learning, a process characterized by changed attitudes and increased knowledge, which can lead to long-term changes in behavior (Rennie, 1995). Research on employee reactions to food safety training is overall limited and underdeveloped (Ehiri, Morris, & McEwen, 1997; Lillquist et al., 2005; Medeiros et al., 2011; J. M. Soon & Baines, 2012). To date, pre-and post-test knowledge scores have been the primary metrics of concern for the majority of food safety training interventions (Egan et al., 2007; Viator et al., 2015); however, knowledge-focused training may be inadequate for encouraging food safety behaviors (Douglas A. Powell et al., 2011). Whether food safety training module preferences affect training outcomes is inconclusive (Lillquist et al., 2005), while there is some evidence that suggests overall satisfaction with food safety training can have a positive impact on learning outcomes (Salazar, Ashraf, Tcheng, & Antun, 2005).

To the best of our knowledge, little work in the food industry has explored the effects of food safety training design on training outcomes, such as trainee reactions. Research is this area would provide a basis for future studies to test how instructional design impacts behavior. Furthermore, more research is needed to clarify the effect of viewpoint on training outcomes. One study that examined various imitation models found that while the first-person perspective led to faster, more perceptively easier imitation, participants were more accurate with the third-person perspective (Nishizawa, Kimura, & Goh, 2015). Separate studies found no significant
differences in observational learning between the first and third-person’s viewpoint (Rohbanfard, 2011).

The objectives of the present study were to: (a) develop first and third person based food safety training modules, (b) determine the relationship between camera perspective and training reactions, and (c) assess whether camera perspective affects employees’ post-training motivation to perform food safety behaviors.

Materials & Methods

Sample

Prior to data collection, the study was approved by the University of Arkansas Institutional Review Board for human subjects. The Washington County Health Department was contacted for a list of food establishments with valid permits. Participation was limited to food handlers from restaurants that served high risk foods. A food handler was defined as “any person involved in a food business who handles or prepares food whether open (unwrapped) or packaged (food includes drink and ice),” (Bristish Hospitality Association, 2016). High risk foods were defined as “ready-to-eat foods which, under favorable conditions, support the multiplication of pathogenic bacteria and are intended for consumption without further treatment that would destroy the pathogens” (Sprenger, 1999). Our definition of restaurants excluded institutions, food carts, restaurants located in supermarkets, supermarkets, mobile food units, caterers, and temporary food stands (Green et al., 2006). Due to resource restrictions, a cluster sampling procedure based on random sampling by zip code was used to contact and recruit restaurants.
Procedures

Informed consent was required before participation in the study. The order in which the handwashing training videos were presented to each participant was counterbalanced. Participants were first randomly assigned to view one of two food safety training videos and given a survey assessing post-training reactions. This was repeated with the remaining video, and, after watching both videos, participants were asked to indicate which training video they preferred. Basic demographic information was also obtained, and participants were given monetary compensation.

Training Development

Handwashing (HW) was chosen as the food safety behavior of emphasis due to pervasive poor compliance issues in the food industry (Todd, Greig, et al., 2010), and how poor personal hygiene is a major risk factor for foodborne illness (FDA, 2010). Training videos were filmed in a commercial kitchen. Each video depicted five scenarios requiring HW and proper HW procedure, according to the state food code (Arkansas Department of Health, 2012), including: 1.) Before food preparation, 2.) After handling raw food and before touching ready-to-eat foods, 3.) After handling dirty equipment, 4.) Before putting on gloves prior to food preparation, 5.) After eating or drinking.

Each scenario requiring HW and each step in proper HW procedure was indicated by a caption that flashed across the video screen. The third-person perspective video was filmed using a Sony α6000 camera with an 18-105mm power zoom lens, and the first-person perspective video was filmed using a GoPro Hero4 12.0 MP Action Camera. Both HW scenarios and proper HW procedures were filmed simultaneously, with one researcher filming the third-person
perspective and another researcher filming the first-person perspective (Figure 1). This served as an internal control step, since the exact same footage was used for each perspective. Each video was just under four minutes in length and was viewed without sound.

![Figure 1. Video footage used to train food handlers to wash hands, filmed from the first-person perspective (left) and the third-person perspective (right).](image)

**Training Assessment**

Post-training reaction to each video was assessed with ten questions (Table 1). Eight questions were based on the seven-point Likert scale ranging from “Strongly disagree” to “Strongly agree.” Five questions were on perceived training utility, modeled after Ruona, et al. (Ruona, Leimbach, F. Holton III, & Bates, 2002) and previously shown to have high reliability (Wilson Learning Corporation, 1995). Perceived utility describes the value employees assign to the training and is highly correlated with long-term implementation of the training (up to a year later) (Axtell et al., 1997). One question captured the food handlers’ overall satisfaction with the training video and two questions pertained to the handlers’ intentions to wash their hands after
having watched the training video (Lillquist et al., 2005). Two questions were based on self-efficacy to wash hands the recommended times and to wash hands the proper way, measured with confidence intervals on a scale of 1 to 10 ranging from “Can’t do at all” to “Highly certain I can” (Bandura, 1997, 2006). Self-efficacy may have an indirect effect on food safety behavior (B. A. Mullan & Wong, 2009) and a direct effect on routine food one safety behaviors such as HW (Hinsz et al., 2007). After watching both videos, participants were given one survey question on which video they preferred overall, which was indicated by the participant with a check mark next to either the first or third-person video choice.
Table 1. Mean values of repeated measures survey items comparing reactions to handwashing training videos filmed in the first and third-person perspective

<table>
<thead>
<tr>
<th>Survey Variable with Measurement Items</th>
<th>First-Person Video</th>
<th>Third-Person Video</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean ± SD</td>
<td>Mean ± SD</td>
</tr>
<tr>
<td>*Overall Satisfaction:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I would recommend the training video to others in my workplace.</td>
<td>5.31 ± 1.39</td>
<td>5.41 ± 1.33</td>
</tr>
<tr>
<td>*Compliance Intentions:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intention Frequency: Quite frankly, after watching this video, I would wash my hands just as much as I did before.</td>
<td>5.67 ± 1.44</td>
<td>5.78 ± 1.41</td>
</tr>
<tr>
<td>Intention Efficacy: Quite frankly, after watching this video, I would wash my hands just like how I did before.</td>
<td>5.48 ± 1.44</td>
<td>5.39 ± 1.59</td>
</tr>
<tr>
<td>*Perceived Utility:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The training video provided me with new ways of thinking about my job.</td>
<td>4.48 ± 1.59</td>
<td>4.49 ± 1.65</td>
</tr>
<tr>
<td>I was disappointed with the training I received from this video. (R)</td>
<td>5.35 ± 1.46</td>
<td>5.37 ± 1.36</td>
</tr>
<tr>
<td>My time was well spent watching this video.</td>
<td>5.09 ± 1.38</td>
<td>5.12 ± 1.30</td>
</tr>
<tr>
<td>The training objectives were met.</td>
<td>5.76 ± 1.02</td>
<td>5.82 ± 1.01</td>
</tr>
<tr>
<td>I learned something I can apply immediately to my work.</td>
<td>5.29 ± 1.58</td>
<td>5.36 ± 1.36</td>
</tr>
<tr>
<td>**Compliance Self-efficacy:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self-efficacy Frequency: Having watched this video, rate how confident you are about being able to wash your hands the times you should?</td>
<td>9.46 ± .88</td>
<td>9.36 ± 1.21</td>
</tr>
<tr>
<td>Self-efficacy Efficacy: Having watched this video, rate how confident you are about being able to wash your hands the right way?</td>
<td>9.45 ± 1.01</td>
<td>9.38 ± 1.30</td>
</tr>
</tbody>
</table>

* = Measured on a Likert scale from 1 (Strongly disagree) to 7 (Strongly agree).
** = Measured on a 10-point scale from 1 (Can’t do at all) to 10 (Highly certain I can)
(R) = Reverse coded
Data Analysis

Data was analyzed with IBM Statistical Package for the Social Sciences version 24 and R version 3.2.2 (R Development Core Team, 2015). A one proportion z-test was used to determine which video perspective was preferred more by employees. Dependent samples t-tests were used to determine differences in training reactions between the first and third-person videos. Pearson correlation coefficients were calculated to assess how the relationship between the attitudinal variables may have deferred between videos.

Results

Sample Demographics

A total of 108 food handlers from restaurants that served high risk foods in Northwest Arkansas participated in the study. Concerning demographic information, there was an even number of males and females that took part in the study. Over three fourths of our sample fell in the age range of 18-29 years, with a small percentage of participants who were 50 years old or older. Eighty-eight percent of the food handlers had at least one year of food service experience, and 50% had been working at their current place of employment for less than a year. One third of the employees worked part time at their food establishment, and 89% had received some form of food safety training prior to watching the HW videos.

Video Preference

Sixty-four percent of participants preferred the first-person video, compared to 36% that preferred the third-person video (Table 2). A one-proportion z-test showed a statistically significant greater proportion of food handlers 64% preferred the first-person video ($z = 5.00$, $p = <.001$). Chi-square tests were used to determine if the differences observed in video preference
were related to demographic variables. No significant relationships existed between the
demographic variables, including gender ($\chi^2 (1, N = 108) = .361, p = .548$), age ($\chi^2 (2, N = 108) = 1.69, p = .430$), years of foodservice experience ($\chi^2 (4, N = 108) = 2.22, p = .70$), years working
at current operation ($\chi^2 (3, N = 108) = 4.41, p = .220$), work status ($\chi^2 (1, N = 108) = .024, p
= .877$), and whether participants had received food safety training prior to viewing the videos ($\chi^2 (1, N = 108) = .045, p = .832$).

**Table 2.** Comparison by demographic variables of preference for handwashing
training video perspective filmed in the first and third-person.

<table>
<thead>
<tr>
<th></th>
<th>First-Person Video</th>
<th>Third-Person Video</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>52%</td>
<td>46%</td>
</tr>
<tr>
<td>Female</td>
<td>48%</td>
<td>54%</td>
</tr>
<tr>
<td><strong>Age (yrs)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18-29</td>
<td>77%</td>
<td>74%</td>
</tr>
<tr>
<td>30-49</td>
<td>16%</td>
<td>23%</td>
</tr>
<tr>
<td>50+</td>
<td>7%</td>
<td>3%</td>
</tr>
<tr>
<td><strong>Food service experience (yrs)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;1</td>
<td>12%</td>
<td>13%</td>
</tr>
<tr>
<td>1-3</td>
<td>29%</td>
<td>33%</td>
</tr>
<tr>
<td>4-7</td>
<td>26%</td>
<td>18%</td>
</tr>
<tr>
<td>8-12</td>
<td>20%</td>
<td>28%</td>
</tr>
<tr>
<td>13+</td>
<td>13%</td>
<td>8%</td>
</tr>
<tr>
<td><strong>Time at current operation (yrs)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;1</td>
<td>49%</td>
<td>51%</td>
</tr>
<tr>
<td>1-3</td>
<td>23%</td>
<td>33%</td>
</tr>
<tr>
<td>4-7</td>
<td>19%</td>
<td>5%</td>
</tr>
<tr>
<td>8+</td>
<td>9%</td>
<td>10%</td>
</tr>
<tr>
<td><strong>Work status</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full time</td>
<td>68%</td>
<td>67%</td>
</tr>
<tr>
<td>Part time</td>
<td>32%</td>
<td>33%</td>
</tr>
<tr>
<td><strong>Prior food safety training</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>88%</td>
<td>90%</td>
</tr>
<tr>
<td>No</td>
<td>12%</td>
<td>10%</td>
</tr>
<tr>
<td><strong>Overall Video Preference</strong>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>64%</td>
<td>36%</td>
</tr>
</tbody>
</table>

* $p < .001$
Comparing Post-training Motivation

Table 1 provides mean scores of survey items used in the study to compare training reactions between the first and third-person videos. The average overall satisfaction with the first-person and third-person videos was, respectively, 5.31, SD = 1.39, 5.41, SD = 1.33. The first and third-person videos had average compliance intentions that were, respectively, 5.57, SD = 1.25 and 5.58, SD = 1.39. The first-person video had an average perceived utility rating of 5.19, SD = 1.03, while the third-person video had a mean rating of 5.29, SD = 1.00. For the compliance self-efficacy construct, mean values for the first and third-person video were, respectively, 9.46, SD = .83 and 9.37, SD = 1.21.

No significant differences were found between the survey constructs, including overall satisfaction ($t(107) = -.936, p = .351$), compliance intentions ($t(107) = -.119, p = .906$), perceived utility ($t(107) = -1.75, p = .082$), and self-efficacy ($t(107) = -.928, p = .356$).

For both videos, the perceived utility of the training was significantly correlated with overall satisfaction, first-person video, $r(108) = .557, p < .001$; third-person video, $r(108) = .605, p < .001$ (Table 3). There was a significant correlation between compliance intentions and self-efficacy, $r(108) = .361, p < .001$, but only for the first-person video.
Table 3. Pearson correlation coefficients of repeated measures survey constructs from the first and third-person handwashing training videos based on overall satisfaction with the training, compliance intention to wash hands, perceived utility of the training, and compliance self-efficacy to wash hands.

<table>
<thead>
<tr>
<th></th>
<th>First-Person Video:</th>
<th></th>
<th></th>
<th>Third-Person Video:</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Overall satisfaction</td>
<td>1</td>
<td></td>
<td>Overall satisfaction</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Compliance intention</td>
<td>.140</td>
<td>1</td>
<td></td>
<td>Compliance intention</td>
<td>.067</td>
<td>1</td>
</tr>
<tr>
<td>Perceived utility</td>
<td>.557**</td>
<td>-.085</td>
<td>1</td>
<td>Perceived utility</td>
<td>.605**</td>
<td>-.136</td>
</tr>
<tr>
<td>Compliance self-efficacy</td>
<td>.169</td>
<td>.361**</td>
<td>.141</td>
<td>Compliance self-efficacy</td>
<td>.120</td>
<td>.181</td>
</tr>
</tbody>
</table>

** Correlation is significant at the 0.01 level (2-tailed).

Discussion

The purpose of the present study was to explore the effect of camera angle on post-training motivation of restaurant food handlers. Differences were observed between the two videos in how employees’ intentions to wash their hands and self-efficacy correlated with one another. This could have positive implications for trainers in the food industry, considering changes in intentions have been shown to lead to behavior change (Webb & Sheeran, 2006) and the role intentions play in affecting food safety behavior (D. A. Clayton & Griffith, 2008; Hinsz et al., 2007; B. A. Mullan & Wong, 2009; Shapiro, Porticella, Jiang, & Gravani, 2011; J. M.
Soon & Baines, 2012). Self-efficacy was significantly correlated with intentions for the first-person video, but not the third-person video. This may be due to the way in which the training was presented, in that the first-person video showed how a food handler might approach HW compliance from the perspective they work from, rather than from an observer’s point of view. In this regard, the first-person perspective adheres more closely to the notion of identical elements by mimicking how a food handler views and understands their work environment (E. L. Thorndike & Woodworth, 1901). Training design can be enhanced when there is greater continuity between the training and work setting (Fiorella, Van Gog, Hoogerheide, & Mayer, 2017). Viewing the first-person perspective may also have placed a lower demand on cognitive resources (Rohbanfard, 2011), making it easier for the employee to visualize performing the behavior. The employees may also have felt more involved with the first-person training perspective (Denisova & Cairns, 2015). These two factors could explain why a more concomitant relationship between self-efficacy and intention to hand wash frequently and effectively was observed.

Close to two-thirds of the food handlers in the study preferred the first-person video compared to the third-person video, a statistically significant higher proportion. While a slightly larger percentage of males preferred the first-person video compared to females, this was not found to be statistically significant. We also found that this preference for first-person training perspective was not related to years of food service experience, years working at the current operation, nor whether participants had received food safety training prior to watching the videos, and age. The food industry consists of employees from broad age ranges; thus, it is important to design trainings that will appeal to a wide age-demographic to ensure learner engagement. New technologies presented in training sessions can generate feelings of
uncertainty and incompetency, especially among older workers (Ravichandran, Cichy, Powers, & Kirby, 2015). This study shows that this first-person perspective instructional media style does not interfere with older worker acceptance of training modules that incorporate these methods. This is important considering that the proportion of workers age 55 and up is expected to increase through 2050 (Toossi, 2012). This facet of our findings has broader implications as use of augmented reality training grows (Barsom, Graafland, & Schijven, 2016) and advances are made in wearable technology design specifically for the food industry (Beach, 2017).

Our data suggests neither video perspective significantly bolstered intentions to wash hands more frequently or effectively. Participants, on average, either somewhat agreed or agreed that watching the videos would not change their HW intentions. This could, in part be attributed to a potential ceiling effect of HW intentions, as previous research has shown intentions to perform food safety behaviors are generally high (D. A. Clayton & Griffith, 2008; Hinsz et al., 2007; Shapiro et al., 2011; J. M. Soon & Baines, 2012). Future studies could measure baseline HW intentions before the training to determine if the different camera angles change HW motivation or if the ceiling limitation affect holds true. The perceived utility of a training module can function as an antecedent that affects overall satisfaction with the training (Giangreco, Carugati, Sebastiano, & Della Bella, 2010). The results in this study confirmed that perceived utility was the only attitudinal variable significantly correlated with overall satisfaction for both first and third-person perspective videos, which also implies that camera angle did not affect the relationship.

This study was limited in measuring one of four tiers in Kirkpatrick’s model for training evaluation (Kirkpatrick & Kirkpatrick, 2007). Future studies could investigate the impact of instructional design on learning outcomes and behavior. Additionally, this study focused only on
handwashing, one of five food safety behaviors that contribute to increasing the risk for foodborne illness transmission (FDA, 2010).

**Conclusion**

To minimize the risk of foodborne illness transmission there is an urgent demand to train food handlers on proper food safety behaviors. Our study contributed to the growing body of knowledge on the impact of wearable technology and perspective on training outcomes. This study showed that handwashing training videos presented in the first-person perspective are preferred by employees, regardless of age or demographic background. Additionally, it was shown that perspective impacts the relationship between food handler behavior intentions for handwashing and self-efficacy to perform handwashing behaviors. While no significant differences were observed between the attitudinal variables, prior research suggests the first-person perspective still has advantages in contributing to a more immersive training experience. Future research could explore the relationship between training design and training outcomes for various food safety behaviors and measure the effects on compliance with these behaviors.

**References**


Chapter 5: Smart Glasses-based Foodservice Training

Assessing Smart Glasses-based Foodservice Training: An Embodied Learning Theory Approach


Abstract

The present study evaluated active, hands on foodservice training delivered through smart glasses compared to passive, strictly video-based training. Handwashing performance variables were measured, including frequency and efficacy. Participants in the strictly video-based group (N = 24) were four times more likely to wash hands than the smart glasses group (N = 25), (95% CI: 1.129 - 14.175). The results highlight how smart glasses training where participants physically practice handwashing can result in poorer learning outcomes compared to traditional training methods. This may be due to: (a) the nature of the instructional content which involved prospective memory, compared to previous studies with embodied learning and smart glasses that assessed retrospective memory and motor functions, or (b) the psychological effects of hand cleansing on memory experienced by the smart glasses group during training. Future research could explore the effect of simulation training with smart glasses on other foodservice tasks.

Introduction

Global demand for food consumed outside the home is on the rise, as all four major geographic regions of the world are forecasted to experience significant growth over the next ten years (Cushman & Wakefield, 2017). Americans alone are eating out more than ever before, spending larger portions of their food dollar on food consumed outside the home compared to thirty years ago (ERS, 2017). With these trends in mind, foodservice entities have a legal and moral responsibility to equip and train food workers to prevent cross contamination, cook food to
the proper temperature, store food properly, and maintain good personal hygiene (FDA, 2011; FDA, 2010). Adhering to these well-established food safety practices is instrumental in decreasing the risk of foodborne illness transmission (FDA, 2010). Foodborne illness is problematic in the U.S. and worldwide; the World Health Organization estimates that globally over 600 million people are sickened every year, leading to an estimated 420,000 deaths (World Health Organization, 2015).

To adapt to the changing spending habits of consumers, foodservice entities may also consider exploring other ways to conduct workplace training. The restaurant industry, under the umbrella of the hospitality industry, has the highest employee turnover rate of private sector industries (Grindy, 2017), which necessitates effective training. History reflects that the type of instructional media has little impact on instructional outcomes (Reiser, 2001). Prior studies on foodservice training have shown no differences in learning outcomes between using lectures or computers (Behnke & Ghiselli, 2004; Costello, Gaddis, Tamplin, & Morris, 1997). Therefore, the advantages, disadvantages, and unique properties of training methods should be carefully evaluated.

Passive training involving lectures and videos is commonly utilized in the foodservice industry, as it allows for a cost effective means to transmit large amounts of information (Egan et al., 2007; Medeiros et al., 2011). New instructional methods involving wearable computers such as smart glasses allow users to navigate through training by a scrolling touch pad located on the temple or by voice commands. Workers then physically complete tasks as they appear on the head-mounted, optical display. Smart glasses thus can entail simulated, hands free training where participants physically interact with the training content as compared to passively receiving the information in a lecture. This property of smart glasses training differs from traditional lectures
and may have a positive effect on learning outcomes given research on embodied learning (Johnson-Glenberg, Megowan-Romanowicz, Birchfield, & Savio-Ramos, 2016; Kontra, Lyons, Fischer, & Beilock, 2015).

Smart glasses have been used as alternative training modalities in manufacturing and healthcare (Li et al., 2017). Positive results from these industries further show the potential benefits of smart glasses application in the food industry. However, much of what is known about the impact of smart glasses training is limited to a few studies in the medical field that teach different skills than those utilized in the food industry (Dougherty & Badawy, 2017). Additionally, prior studies in healthcare on smart glasses training have typically involved small sample sizes (Dougherty & Badawy, 2017). Given the significant investment of training with smart glasses, more research could provide new knowledge that would help foodservice stakeholders make informed decisions on which training medium to use for instructing employees. While informal pilot studies have been conducted in the food industry (della Cavo, 2014), smart glasses have not undergone controlled testing that juxtaposes it with traditional training modalities that involve passive learning. To date, little is known how smart glasses impact training transfer in foodservice.

The present study evaluated how smart glasses-based training affects learning outcomes of handwashing behaviors. The goals of this study were to: (a) develop a smart glasses-based training module incorporating modern theories of cognition and adult learning and (b) compare handwashing performance outcomes between smart glasses-based and strictly video-based foodservice training modules.
Background

More modern theories of cognition, most notably embodied cognition, sometimes called grounded cognition, hold that much of the brain’s function is rooted in sensorimotor outputs and inputs (Barsalou, 2008; Wilson, 2002). In this regard, knowledge is not stored simply as symbols in the brain, but instead is represented by sensory-motor experiences (Barsalou, 2008). Simulation is a central feature of embodied cognition, which occurs when the brain processes interactions with the learning environment, then recreates those experiences. Multi-modal interactions that involve perception, motor activity, and introspection are used by the brain to create new knowledge structures that enable the learner to better recall the training in the future.

Simulations are rooted in the principle of identical elements, which states that greater training transfer occurs the more similar a training module is to the environment in which the training material is later implemented (E. L. Thorndike & Woodworth, 1901). This is evident by the seminal study on context dependent memory which found recall of words was 50% better when the learning and recall environment were identical (Godden & Baddeley, 1975). The principle of identical elements implies that the more training mimics the work environment of an employee, the greater the likelihood the employee will execute the learned behaviors. The present study focuses on one aspect of embodied learning based on the overarching tenet of embodied cognition: physical interaction with the training content may have a positive effect on learning outcomes (Wilson, 2002).

Recent evidence for embodied learning suggests physical experiences affected learning outcomes in a college physics course (Kontra et al., 2015). Students were divided into an action group and an observation group. Students in the action group, who participated in learning interaction by physically tilting a set of wheels, performed better on a quiz compared to the
observation group who only watched the action group. Brain images obtained through functional magnetic resonance imaging confirmed that greater activation of sensorimotor systems in the brain occurred with students in the action group. Additional research suggests incorporating principles of embodied learning leads to improved knowledge retention over time (Johnson-Glenberg et al., 2016).

There is a need to develop food safety curricula for workers that incorporates modern theories of cognition and adult learning theory principles (A. M. Fraser & Simmons, 2017), yet a review of 23 food safety training interventions found sparse reliance on education theory (Viator et al., 2015). Food safety training modules have relied heavily on traditional pedagogical approaches that involve a teacher in a classroom providing information to students with the belief that this will translate to behavior change (A. M. Fraser & Simmons, 2017; Medeiros et al., 2011). Under these circumstances, the student is expected to passively assimilate abstract food safety principles and procedures, while rarely engaging with the environment these principles are applied to. These methods require little participant involvement and engagement, while delaying practical application of the learning material. A review of 46 studies on food hygiene training found limited evidence for the effectiveness of passive, classroom-based training (Egan et al., 2007). This passive approach to learning is largely analogous to traditional theories of cognition that describe the mind as processing information apart from perceptual and motor systems, in stark contrast to the tenets of embodied learning (Wilson, 2002).

Principles of embodied learning, while not stated explicitly, have been featured in several food safety training interventions (Medeiros et al., 2011). Our understanding of how these methods affect training outcomes, however, is limited to knowledge assessments and employee preferences. Food handlers who received participatory handwashing training in addition to
traditional lecture/video training had higher knowledge scores than food handlers who received only lecture/video training (Lillquist et al., 2005). Hands-on activities are generally more engaging to employees (Dipietro, 2006; Lillquist et al., 2005) and allow employees to learn at their own pace (Dipietro, 2006).

Smart glasses are an alternative training modality for use in the foodservice industry and allow incorporation of embodied learning principles through physical execution of the training content. In this regard, smart glasses-based training incorporates modern theories of adult learning and cognition, notably embodied and self-directed learning. Research from the healthcare industry highlights how smart glasses may be applied in the food industry to train food handlers and facilitate learning of food safety practices. This research has encompassed patient interactions, treatment skills, and anatomy (Benninger, 2015; Iversen, Kiami, Singh, Masiello, & von Heideken, 2016; Son et al., 2017). For example, in a simulated operative setting designed to assess learned motor skills, surgery residents achieved lower error scores with needle placement after training with smart glasses compared to receiving directions only from an instructor (15 ± 4 vs. 18 ± 5, \( p < 0.05 \)) (Brewer, Fann, Ogden, Burdon, & Sheikh, 2016).

One study assessed vestibular examination skills which require high level psychomotor functions (Iversen et al., 2016). The researchers used a prospective, randomized controlled trial and found a combination of smart glasses and verbal instruction resulted in slightly better clinical skills scores compared to only verbal instruction (Median = 19 vs Median = 18, \( p < .05 \)). In another study, smart glasses were used as a form of technology-aided intervention to guide social interactions for children with autism (Kinsella, Chow, & Kushki, 2017). All participants were able to complete the intervention and reported positive experiences from the training. No comparisons were made to traditional intervention methods.
To the best of our knowledge, no prior studies have determined the impact of embodied learning with smart glasses compared to more hands-off training on food safety behaviors. Furthermore, evidence for embodied learning is limited to retrospective memory exercises characteristic of in class quizzes or exams where students are responsible for recalling information learned in the past. This differs from prospective memory exercises that require executing an action at a specific moment in the future (McDaniel & Einstein, 2007). Prospective memory typifies what foodservice employees utilize to implement learned food safety practices at appropriate times during food preparation (Author, 2015). The present study aims to shed additional light on the effects of embodied learning on prospective memory outcomes.

**Method**

**Procedures**

**Video Training.** Participants assigned to the strictly video-based training group completed one session consisting of the sandwich making and when and how to wash hands. Participants viewed the training from 2.5m away and the video was displayed as .65m in length, analogous to the smart glasses display which is equivalent to viewing a .65m T.V. from 2.5m away (Figure 2) (Google, 2018b). Participants watched but did not physically practice the six handwashing steps that were to be completed: (a) before handling the sandwich and (b) after handling cooked deli meat and before handling vegetables that went on the sandwich. The lack of physical interaction with the training content thus involved passive, as opposed to active learning.

**Smart Glasses Training.** Participants assigned to the smart glasses group completed two separate sessions of training. The first session familiarized participants with the technology
(Medrano, Nyhus, Smolen, Curran, & Ross, 2017). Video use is more ubiquitous than smart glasses use to date, and a lack of familiarity with smart glasses could serve as a confounding variable. Participants were given an instruction sheet made by the training software developer on how to use and navigate through training content with smart glasses. Participants were allowed the option of progressing through the training verbally by voice activation, manually by swiping and touching the scroll pad located on the side, or a combination of the two. Participants then learned how to clean and disassemble a deli slicer. This deli slicer training was a series of stills and text that involved no handwashing. The deli slicer blade had been previously removed and metal protrusions covered with Styrofoam to help ensure participant safety. Participants returned for a second session an average of 8.8 days later (SD = 3.5) to complete the sandwich and handwashing training. The sandwich making was a series of pictures with text, while the handwashing training consisted of the same video footage used in the strictly video-based training group. Participants manually or verbally progressed through the six handwashing video clips corresponding with the six steps on how to wash hands. This was done before handling the sandwich and after touching the cooked deli meat but before handling the vegetables that were placed on the sandwich, as instructed by the training. Handwashing was physically practiced at a sink with soap and paper towels, functioning as a simulation involving active and embodied learning.

**Prospective Memory Overview.** A prospective memory (PM) design was employed to test the effectiveness of the smart glasses and strictly video-based training modules at promoting handwashing (Figure 1). Prospective memory relies on planning an action to execute in the future, rather than the recollection of learned material characteristic of retrospective memory (McDaniel & Einstein, 2007). In this experiment, an ongoing task (or cover task) was used in
conjunction with target events, similar to prior experiments with PM (Guynn, McDaniel, & Einstein, 1998; Author et al., 2015). The four target PM events were presented to participants during training and included: (a) before handling food, (b) after cleaning, (c) after touching cooked deli meat and before touching vegetables, and (d) after touching money.

Figure 2. Smart glasses-based foodservice simulation training (a) and strictly video-based foodservice training (b).

**Prospective Memory Experiment.** Participants in both groups completed trainings that informed them that they were going to learn how to make a specific sandwich and that handwashing was important when working with food. Sandwich making was deemed an appropriate procedure to learn with handwashing. Before making the sandwich, the four target
PM events on when to wash hands were presented in a text format, which included: (a) before handling food, (b) after cleaning, (c) after touching cooked deli meat and before touching vegetables, and (d) after touching money. Participants were also instructed on the six steps on how to wash hands, according to the Centers for Disease Control and Prevention (CDC), consisting of wetting the hands, applying soap, lathering for 20 seconds, rinsing, drying, and turning off the faucet with the paper towel (CDC, 2015b). The sandwich making involved placing ten food items in a specific order and included handling cooked deli meat directly followed by touching carrots. Before handling carrots, participants were again trained on the six handwashing steps to reinforce the training content.

![Image of experimental procedure]

**Figure 1.** Experimental procedure for testing the target prospective memory events of when to wash hands.

Following the sandwich making, participants completed two distractor tasks, which served as buffers between the PM instructions and ongoing tasks. Participants were given one
minute to memorize a picture showing a bin with a random assortment of items, then given the same bin with the items jumbled and told to arrange them based on the recollection of the picture. This distractor task functioned as a control for potential discrepancies in hand cleanliness desirability between the two training groups, as the smart glasses group had practiced handwashing. This task was chosen based on prior research that has shown how bodily states can impact psychological states associated with perceived contamination (Koerner, 2015).

Participants were then shown a short video on basic, cooking-related volume conversions, then completed a quiz on the video to assess conversion knowledge.

Participants were then ushered into a separate room with a second researcher to complete the ongoing tasks. The first researcher who administered the training and distractor tasks made no contact with the second researcher who gave the ongoing tasks. The second researcher was blind to which training participants received. Five open, numbered bins were set up side by side on a counter. Handwashing facilities were located adjacent to the bins and consisted of a sink, soap, and paper towels. Inside each bin were two adjacent, paper plates. The plate on the left held either stopper holders, wooden popsicle sticks, pieces of cooked deli meat, tomatoes, or marbles. The cooked deli meat was of the same substance as that portrayed in the training modules but in a different shape. The plate on the right in each bin was empty.

For the ongoing tasks, the second researcher verbally administered 13 volume conversion problems that each corresponded with a specific bin number. A pilot study (n = 10) confirmed the appropriate difficulty of the ongoing tasks. Participants were told they would be responsible for portioning the appropriate number of items that corresponded with the bin and measurement called out by the second researcher before beginning. They were given an example problem of, “Bin 1: 6 teaspoons equal how many tablespoons?” In this case, the plate on the left in bin 1
contained stopper holders, with each stopper holder representing one tablespoon in this case. Participants were told the correct course of action, which was to go to bin 1 and transfer two stopper holders from the plate on the left to the plate on the right, since there are three teaspoons per tablespoon. Participants were informed they may be required to use the same bin for multiple problems, in which case they should continue to transfer items from the left plate to the right plate.

There was a total of three conversion problems that corresponded with two of the target PM events, including handling the tomatoes (before handling food), handling the cooked deli meat (before handling food), and handling the tomatoes right after handling the cooked deli meat (after touching cooked deli meat and before touching vegetables). Because of the specificity of the two target PM events, the 13 conversion problems were not randomized for each participant. Handwashing frequency, lather duration, and compliance with the CDC six steps were observed and documented by the trained second researcher during the ongoing tasks. Handwashing steps were coded as 1 or 0 for compliant or not compliant, respectively. Lathering for 20 or more seconds was considered compliant.

Demographic information was obtained on type of foodservice experience (if applicable) and whether participants had completed food safety training prior to the study (yes or no). The experiment lasted approximately 30 minutes.

Participants

This study was approved by the university’s Institutional Review Board for human subjects research prior to data collection. Participants were recruited on a rolling basis through university-wide emails. All participants were pre-screened using the Maudsley Obsessive
Compulsive Inventory Subscale (MOCI) (Foa et al., 2002), used in a previous study that measured handwashing behavior (Author et al., 2015). This pre-screening excluded individuals who scored a seven or higher on the MOCI, indicative of unusual sensitivities to handwashing in relation to an obsessive-compulsive disorder. Participants with food allergies or intolerances were excluded from the study. Participants who completed the smart glasses training (two, 30-minute sessions) and video training (one 30-minute session) received $40 and $20 in gift cards as compensation, respectively. Participants were informed that the study was on food handler training outcomes, but no other details were given. Participants were balanced between the two training groups based on their age, gender, foodservice experience (yes or no), MOCI score, and technology use. The technology use survey, based on a prior study (Agbatogun, 2013), contained a list of common interactive technologies, such as computers, the internet, mobile phones, tablets, and smart watches. Participants rated their use of each technology on a three-point scale ranging from frequently to never. Technology use for each participant was calculated as the sum of scores.

**Materials**

For both training groups, professional videographers shot all training content and a student from the university theatre department served as the acting food handler. Filming took place in a commercial kitchen. Glass, Enterprise Edition (Google, 2018a) was the brand of smart glasses used. Handwashing was chosen as the behavior of emphasis for the trainings due to low compliance issues in the food industry (Todd, Greig, et al., 2010), the association between poor hand hygiene and foodborne illness outbreaks (Todd, Michaels, et al., 2010), and the risk of foodborne illness transmission attributed to poor personal hygiene (FDA, 2010). The handwashing footage used for the trainings was identical.
Analytical Procedure

A total of 49 participants were recruited for this study. The average age for the smart glasses group was 27.48 years (SD = 12.47, range: 18-57) and for the video group was 26.75 years (SD = 10.67, range: 18-64) (Table 1). There were no significant differences between the two training types for all demographic variables including age ($t_{[47]} = 0.22$, $p = .827$), MOCI score ($t_{[47]} = 0.48$, $p = .64$), technology use ($t_{[47]} = -.22$, $p = .82$), gender ratio (smart glasses group: 5 men, 20 women; video group: 5 men, 19 women), foodservice experience ($\chi^2[1] = .18$, $p = .67$), and prior food safety training ($\chi^2[1] = 3.36$, $p = .07$).

Statistical Package for the Social Sciences version 24 was used to analyze the data set. The handwashing frequency data violated assumptions of normality for both training groups, as evident by a Shapiro Wilk’s test ($p < .001$ for both trainings). Additionally, the Levene’s test showed a lack of homogeneity of variance ($p = .001$). Given violations in these assumptions, a non-parametric Chi-square test was used to determine differences in handwashing frequencies between the smart glasses and strictly video-based training group (Mchugh, 2013). The Chi-square test relies on the assumption that in the contingency table of the dependent and independent variables, at least 80% of the cells have values of five or greater. In the 4x2 contingency table of the present study that consisted of handwashing frequency (never, once, twice, thrice) and training type, four of the eight cells had expected counts less than five. Therefore, handwashing frequency was collapsed into two categories of “never washed hands” and “washed hands at least once.”
TABLE 1: Demographic characteristics of the smart glasses and strictly video-based training groups.

<table>
<thead>
<tr>
<th></th>
<th>Smart glasses group (N = 25)</th>
<th>Video group (N = 24)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td>Male</td>
<td>25%</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>75%</td>
</tr>
<tr>
<td><strong>Age (average, yrs)</strong></td>
<td>27.5</td>
<td>26.8</td>
</tr>
<tr>
<td><strong>Foodservice experience (yrs)</strong></td>
<td>None</td>
<td>28%</td>
</tr>
<tr>
<td></td>
<td>&lt;1</td>
<td>16%</td>
</tr>
<tr>
<td></td>
<td>1-3</td>
<td>44%</td>
</tr>
<tr>
<td></td>
<td>4-7</td>
<td>8%</td>
</tr>
<tr>
<td></td>
<td>8+</td>
<td>4%</td>
</tr>
<tr>
<td><strong>Foodservice establishment type (% with experience)</strong></td>
<td>Restaurant</td>
<td>44%</td>
</tr>
<tr>
<td></td>
<td>School cafeteria</td>
<td>6%</td>
</tr>
<tr>
<td></td>
<td>Catering</td>
<td>22%</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>22%</td>
</tr>
<tr>
<td></td>
<td>Multiple</td>
<td>6%</td>
</tr>
<tr>
<td><strong>Prior food safety training</strong></td>
<td>Yes</td>
<td>52%</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>48%</td>
</tr>
</tbody>
</table>

To determine an odds ratio of handwashing likelihood, binomial logistic regression was performed with training group as the independent variable and handwashing frequency (two possible outcomes of washed hands at least once and never washed hands) as the dependent variable.

**Results**

**Handwashing Performance**

Five (20%) and 12 (50%) participants in the smart glasses and video training groups, respectively, remembered to wash hands at least once (Table 2). There was a statistically
significant difference in handwashing frequency between the two training groups ($\chi^2[1] = 4.86, p = .027$). Based on the logistic regression model, participants in the video group were four times more likely to wash hands compared to the smart glasses group (95% CI: 1.129 - 14.175).

Lathering for at least 20 seconds was the handwashing step most out of compliance between the two groups, which occurred in 73% of all handwashing attempts. The next step most out of compliance was turning off the faucet with a paper towel, which occurred in 18% of handwashing attempts.

**TABLE 2: Handwashing performance variables of the smart glasses and strictly video-based training groups**

<table>
<thead>
<tr>
<th>Handwashing frequency:</th>
<th>Smart glasses group</th>
<th>Video group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td>80%</td>
<td>50%</td>
</tr>
<tr>
<td>Once</td>
<td>20%</td>
<td>33%</td>
</tr>
<tr>
<td>Twice</td>
<td>-</td>
<td>13%</td>
</tr>
<tr>
<td>Thrice</td>
<td>-</td>
<td>4%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Handwashing event:</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Before handling food</td>
<td>-</td>
<td>18%</td>
</tr>
<tr>
<td>After touching meat</td>
<td>80%</td>
<td>70%</td>
</tr>
<tr>
<td>Other</td>
<td>20%</td>
<td>12%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Number of handwashing steps in compliance:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>40%</td>
</tr>
<tr>
<td>5</td>
<td>40%</td>
</tr>
<tr>
<td>6</td>
<td>20%</td>
</tr>
</tbody>
</table>

| Median lather time (seconds) | 14 | 16.33 |

High attention allocation to PM events and cognitive load are associated with decreased performance in ongoing tasks (Walter & Meier, 2014). To determine if this explained differences in handwashing attempts between the two groups, the number of bins with the correct number of
items on the plate on the right was calculated for each participant and compared across the two groups. Based on the results of a post-hoc, Man Whitney U test, there were no significant differences between the smart glasses and video training groups in the number of bins with a correct number of items, $U = 239.5, p = .586$.

**Discussion**

The purpose of the study was to assess smart glasses-based foodservice training in comparison to strictly video-based foodservice training. Participants in the strictly video-based training group were much more likely to remember to wash their hands.

The present research study incorporated principles of embodied learning into foodservice training modules that focused on translating knowledge (when to wash hands) into transferred action (applying the knowledge by handwashing at the appropriate times in the actual foodservice environment). As such, the experiment tested PM, or remembering to complete an action in the future, in contrast to prior studies on embodied learning that assessed learning through retrospective memory, or recollection of past actions or knowledge (Johnson-Glenberg et al., 2016; Kontra et al., 2015). Additionally, while research in the medical field with smart glasses has seen more positive results with hands on training, participants were instructed predominantly on use of motor skills and high level psychomotor functions (Brewer et al., 2016; Iversen et al., 2016). This fundamental difference in experimental design—the type of learning assessed—may provide one explanation for why physically interacting with the training material was less effective at promoting handwashing frequency, especially considering theories on embodied cleansing.
Embodied cleansing is a subset of embodied cognition and refers to how hygiene practices influence psychological outcomes (Koerner, 2015). Exposure to objects perceived as dirty can result in mental contamination, associated with feelings of uncleanliness and urges to remove the contamination. This process can occur without coming into physical contact with the disgusting items (Fairbrother, Newth, & Rachman, 2005; Rachman, 1994). In light of the present study, participants in both groups may have experienced some degree of mental contamination. Participants in the smart glasses group would have been able to immediately address these feelings through physically washing their hands twice during the training. However, for participants sitting in the strictly video-based training group, the problem of hygiene remained unsolved, potentially resulting in increased agitation and thus attentional resources to handwashing and improved PM performance. It was proposed that active participation in handwashing training would increase its relative importance for the smart glasses group, driving PM. However, this degree of importance may have been mitigated through the learners washing hands during the training. A PM event influenced by embodied cleansing may explain the poor embodied learning outcomes observed compared to a prior study that assessed retrospective memory events, such as quizzes (Kontra et al., 2015).

Another explanation for the results relates to the attentional demands associated with smart glasses use. In a study on visual attention, it was found that information presented on smart glasses can be highly disruptive to concurrent tasks (J. E. Lewis & Neider, 2016). Several other studies encompassing driver attention (Sawyer, Finomore, Calvo, & Hancock, 2014) and high angle climbing (associated with search and rescue teams or firefighting) (Woodham, 2015) have confirmed the distractive nature of wearing smart glasses. In this regard, the attention of learners in the smart glasses training was diverted to manually progress through the training, either
verbally by voice activation or tapping the side scroll pad. This additional cognitive load, while potentially less taxing on the attention system compared to prior studies with smart glasses, may have resulted in fewer attentional resources remaining available for the target PM events compared to the video group. Questions remain as to how increased practice using smart glasses may impact attention and distraction levels over time. The study results are of interest considering that participants in the smart glasses group came in for an additional session to familiarize themselves with the technology around nine days before the performance task.

**Limitations**

This study had several limitations. The smart glasses group came in for an additional session, and it is unknown whether this could have impacted handwashing performance after the training. Future work should consider an experimental design that entails equal time commitments between training groups, as well as controlling for differences in how participants proceed with the training. While attempts were made to control for discrepancies in hand cleanliness through the item arrangement task, this may have led to increased desirability for hand hygiene in the video group, thus having a greater effect on remembering to wash hands. Knowing when to and how to wash hands is sometimes learned at an early age (M. Whitby et al., 2007). Efforts were made to control for prior knowledge by instructing participants to wash hands for events not normally with handwashing. Future work should have participants complete knowledge assessments of how to wash hands as another control for the experiment.

The handwashing frequencies may have been affected by participant comfort level in interrupting the researcher to wash hands in between calling out bin instructions. In this regard, increases in handwashing frequencies may be observed for both training groups when participants are allowed more autonomy between conversion tasks. Total handwashing duration
and lathering times were determined by an observer, which may have introduced a margin of error. While the observer was trained, future work may consider filming handwashing performance that would allow for potentially more accurate determination of handwashing duration.

The perceived and actual cognitive load of training with smart glasses was not measured and future research would benefit by accounting for this variable. Additionally, this study was cross-sectional in design and was not able to measure the impact of training modality over time. Furthermore, this experiment was conducted in a laboratory setting to control for potentially moderating variables such as workload and time constraints. Future studies should consider comparing training modalities among currently employed food handlers in real world foodservice environments to examine the external validity of the present study’s results.

**Conclusion**

This study contributes to the growing body of knowledge of wearable computers in the workplace. Participants in the video group were significantly more likely to remember to wash hands compared to the smart glasses group. The results highlight how embodied learning may be contingent upon the nature of the training material; the present study examined prospective memory in contrast to prior research on embodied learning and smart glasses that has tested retrospective memory and motor functions. Differences observed in the treatment groups may also be attributable to discrepancies in mental contamination levels. While embodied learning through simulation is a novel, theoretically sound approach that has been shown to improve learning outcomes in previous studies, this research shows how it may be dependent on the type of learning assessed. New forms of computer-mediated training involving smart glasses have
potential to impact the food industry, but more research is needed on other food safety and food handling practices to translate this potential into reality.

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Chapter 6: Wearable Computers for Foodservice Training

Wearable Computers, a New Instructional Delivery Method for Foodservice Training


Abstract

Foodservice training delivered through wearable computers is a new type of instructional delivery method, yet little is known about how it impacts training outcomes. Three educational properties of a wearable computer-based foodservice training platform were compared to traditional, strictly video-based, classroom training. Results showed the efficiency of using the wearable computer as an on-the-job training method, as participants required less than 50% of the time to view and execute the training and food handling tasks compared to the strictly video-based group. Food industry stakeholders should weigh the costs and benefits of using wearable computers when considering upgrading existing training methods.

Introduction

Many companies struggle to ensure their employees are properly trained and perform their prescribed job duties. It is estimated that in 2012 corporations spent more than $164 billion in training, much of which failed to lead to changes in individual job performance (Beer, Finnstrom, & Schrader, 2016). Effective training of front-line personnel (cooks, servers, bussers) is foundational to foodservice and has been shown to boost both employee efficiency and their confidence in the workplace (Aguinis & Kraiger, 2009).

Foodservice owners and managers train their workers on tasks and procedures through different methods and forms of instruction. Much of this uses instructional media that can be defined as the “modes of communication in which teaching take[s] place” (IGI Global, 2018, para. 1) or the “means of transmitting knowledge and skills to the adult learners using electronic devices to ease [the] teaching – learning process” (IGI Global, 2018, para. 1). When trainers are
designing training programs, attention must be given to the selection of the most effective instructional media, as it can impact learning outcomes and training transfer (Tonhäuser, Büker, Tonh, & Laura, 2016). A review of food safety training methodologies found that videos were the most commonly used audiovisual resource, followed by posters, slides, illustrations, flip charts, music, and interactive media (Medeiros et al., 2011). However, improvements in the affordability and design of advanced training technologies have made computer-based training among the most popular instructional media in the foodservice industry (Mandabach, 2007).

Computer-based training provides a flexible learning platform where the employee can self-navigate through the content at their own pace (Pintauro, Krahl, Buzzell, & Chamberlain, 2005), saving on costs for dedicated trainers during normal shifts (Singh, Kim, & Feinstein, 2011). Self-navigation through training may increase motivation to learn through providing foodservice workers greater individual autonomy for their own learning (Hall II, 2015). Computer-based training can minimize variation in peer-to-peer training as well as inaccuracies and/or employee deviations from established job procedures (Hall II, 2015).

Costly, high turnover rates drive the need for effective and efficient training to ensure consistent product quality and safety. Employee turnover rates in the fast food industry average 150% (Spencer, 2018). Replacing low paying, high turnover jobs, such as that commonly associated with the food industry, costs employers an average of 16% of an employee’s annual wages (Boushey & Glynn, 2012). Because many computer-based training mediums are novel, they have been shown to arouse increased employee interest in routine training content (Fredricks, Blumenfeld, & Paris, 2004). A study of 96 healthcare workers enrolled in safety training found computer-based training motivated employees to a greater extent than videos or routine lectures (Rodgers & Withrow-Thorton, 2005).
While advantageous in some regards, there are several drawbacks to computer-based training, including cost concerns (Hall II, 2015) and its overall impact on learning compared to other types of instructional media. Some foodservice companies may be hesitant to invest in novel technologies that may become obsolete in a few years (Tanyeri, 2018). Concerning learning outcomes, a study comparing lecture-based to computer-assisted, interactive food safety training found both methods were equally effective at increasing food safety knowledge (Costello, Gaddis, Tamplin, & Morris, 1997). Behnke and Ghiselli (2004) found no significant differences in knowledge retention scores across two groups that received menu training through either a face-to-face lecture or computer. These studies are in line with Reiser’s (2001) finding that the type of instruction media has historically had minimal impact on improving the effectiveness of instructional practices. From a theoretical perspective, the instructional media serves as nothing more than a carrier of information and thus is unlikely to have a dramatic effect on the efficiency of the learning process (Clark, 1983, 1994).

Most of the aforementioned studies, however, are concerned with what might now be called traditional, computer-assisted methods. A new type of instructional-media involves the use of wearable devices which deliver step-by-step instruction while the trainee performs the action. Wearable computers are increasingly being used in the manufacturing and foodservice industry (della Cavo, 2014; Li et al., 2017). A wearable computer can be defined as a “fully functional, self-powered, self-contained computer that is worn on the body… [that] provides access to information” (Caudell & Barfield, 2001, p. 6). Wearable computers may take the form of smart glasses or virtual reality headsets. This technology carries a unique set of educational properties or features (Table 1). Wearable computers such as smart glasses can provide hands-free training that could affect how efficiently training is viewed and executed, potentially
affecting training expenses for companies. A new paradigm is emerging that suggests greater organizational outcomes can be achieved by educating workers through computer-based training and augmenting worker performance with the assistance of smart glasses (Abraham & Annunziata, 2017; Noone & Coulter, 2012). These plausible benefits must be weighed against some of the potential drawbacks associated with wearable computers as an educational tool (Table 1).

Table 1. Properties and disadvantages of wearable computers as a training delivery method.

<table>
<thead>
<tr>
<th>Properties</th>
<th>Disadvantages</th>
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<tbody>
<tr>
<td>• In situ contextual information</td>
<td>• Overreliance on wearable technology</td>
</tr>
<tr>
<td>• Recording</td>
<td>• Familiarization with the technology</td>
</tr>
<tr>
<td>• Simulation</td>
<td>• Small interface</td>
</tr>
<tr>
<td>• Communication</td>
<td>• Privacy</td>
</tr>
<tr>
<td>• Engagement</td>
<td>• Cost</td>
</tr>
<tr>
<td>• First-person view</td>
<td>• Technical Problems</td>
</tr>
<tr>
<td>• Hands free access to information</td>
<td>• Legal Issues</td>
</tr>
<tr>
<td>• In situ guidance</td>
<td>• Development of software</td>
</tr>
<tr>
<td>• Feedback</td>
<td>• Processing power</td>
</tr>
<tr>
<td>• Efficiency</td>
<td>• Distraction</td>
</tr>
<tr>
<td>• Presence</td>
<td></td>
</tr>
<tr>
<td>• Distribution</td>
<td></td>
</tr>
<tr>
<td>• Freed up spaces</td>
<td></td>
</tr>
<tr>
<td>• Gamification</td>
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</tbody>
</table>

Adapted from Bower and Sturman (2015)

To date, little is known of the impact of wearable computers on the food industry or its functionality in a training situation. Understanding the functionality and limitations of using wearable computers for training purposes can help food industry stakeholders make better informed decisions about whether to supplant existing instructional delivery methods with new technology. The objective of this study was to assess properties of wearable computer-based
foodservice training in comparison with a more traditional, strictly video-based training platform. This study looked at the properties of efficiency, hands-free access to information, and freed-up space in the work environment.

**Methods**

**Participants**

Prior to data collection, approval was obtained by the university’s Institutional Review Board for human subjects. To recruit participants, the study was posted in campus news emails sent out to students, faculty, and staff of the university. No affiliation with the university was necessary for study participation. Recruiting was conducted on a rolling “as-needed” basis, and participants were told the purpose of the study was to understand how food handler training affects food handling outcomes. Individuals were pre-screened for any food allergies, food intolerances, or predisposition to Obsessive-Compulsive Disorder related to excessive handwashing behavior (Pellegrino, Crandall, & Seo, 2015). Participants were balanced across the two treatment groups by age, gender, foodservice experience, and their familiarity with technology usage. To determine technology usage, participants were given a list of common, interactive technologies, which included smart watches, tablets, mobile phones, computers, and digital games among others (Agbatogun, 2013). Participants were asked how often they used each type of technology on a three-point scale, “1 = Never”, “2 = Sometimes”, “3 = Frequently.” Adding up the total score yielded technology usage for each participant.

**Research Instruments**

The wearable computer used in this study was Glass, Enterprise Edition (Google, 2018a) (Figure 1). Glass is worn by the user like a pair of eye glasses, and an optical display located in
the user’s field of vision shows training content. Users navigate through the training content through voice commands or a scroll pad embedded in the side frame.

![Figure 1](image_url) The wearable computer used in the study.

A team of professional videographers filmed the training content for both treatment groups, and a university theater student with prior acting experience served as the food handler. All training content was filmed in a commercial kitchen. The training included when and how to wash hands and a procedural learning task of making a sandwich. These tasks were selected because: (a) poor personal hygiene such as lack of handwashing is associated with an increased risk of foodborne illness transmission and foodborne illness outbreaks (Food and Drug Administration, 2010; Todd et al., 2010), b.) low handwashing compliance is often observed among food handlers (FDA, 2018), and c.) procedural learning is integral in the foodservice industry in which food handlers must remember to prepare food products with ingredients in a specific order and/or arrangement.
Handwashing training for both treatment groups utilized the same footage taken from the third-person, or observer perspective. This would be equivalent to watching a peer wash their hands. Participants were trained on handwashing steps based on U.S. Centers for Disease Control and Prevention (CDC) recommendations that included wetting the hands, adding soap, 20 seconds of lathering, rinsing the hands, drying the hands, and turning off the water with a paper towel (CDC, 2015b). Participants were shown four events of when to wash hands: (a) handwashing before touching food; (b) after cleaning; (c) after handling pre-cooked, processed meat, but before handling vegetables; and (d) after touching money. These events were chosen, in part, due to mandates in the 2017 FDA Food Code regarding washing hands before engaging in food preparation and after events that could contaminate the hands (FDA, 2017c). The researchers recognized that handling ready-to-eat pre-cooked meat may not constitute a hand contamination event. This event was used in the preliminary pilot study and could not be edited out by the researchers given the nature of the Glass software configuration. However, the event may be analogous to training procedures on avoiding cross contamination of allergens or for religious food handling procedures such as halal, kosher, etc.

For the procedural learning task, photo stills for the Glass training were extracted from video footage obtained simultaneously as that used for the strictly video-based training. Photo stills were obtained using a GoPro HERO4 which captures the first-person, or actor perspective (Figure 2). This would be like watching oneself perform a task from a bird’s eye view. The video footage used for the sandwich making with the strictly video-based training was captured from the third-person perspective. The sandwich training for both training groups included placing ten food items in a specific arrangement on a piece of bread marked as a grid.
Figure 2. Comparison of sandwich training between training methods. First-person perspective photo stills were used for the wearable computer training (left) and a third-person perspective video was used in the video training (right).

Procedures

Participants in both training groups were told that they were being trained to make a sandwich and that handwashing was important. While both groups executed the training content, overall time to wash hands and make the sandwich was recorded. Time was calculated as total time required to both view and execute the handwashing training. For the Glass group, viewing and execution occurred simultaneously, while for the video group viewing and executing the training were two separate events, i.e. in the classroom (viewing) and in the testing area (execution). For the video group, time to traverse between the classroom and testing area was not included in the calculations. Adherence to the CDC six handwashing steps and lathering time were recorded. Lathering times less than 20 seconds were recorded as a missed step in the handwashing process. Participants were surveyed on whether they had received food safety training prior to the study and duration and type of foodservice experience, if applicable. Then participants were debriefed and compensated with a $20 gift card.
Video Training Group

Participants in the strictly video-based training group viewed the training from eight feet from a 25-inch screen. To control for differences in instructional media display, the video size was calibrated to correspond with the Glass display which is analogous to watching a 25 inch television from eight feet away (Google, 2018b). Immediately afterwards, participants were ushered into the testing area with sandwich materials arranged in a similar manner as seen in the training video and available handwashing facilities. To minimize experimenter error, the same researcher was used to give and assess the training. Approximate time between training viewing and execution was two minutes. Then participants were told to make a sandwich based on the training they had just received.

Glass Training Group

In the testing area with handwashing facilities and sandwich materials arranged in a similar manner as the training, participants were provided an instruction sheet created by the training software developer. This gave information on how to go through the training step-by-step using voice activation and/or manually swiping and tapping a scroll pad embedded in the temple of the glasses to advance to the next step in the training sequence. Participants were allowed to familiarize themselves with device functionality by going through a deli slicer cleaning module until they felt comfortable. No deli slicer was present and participants were shown this training for the sole purpose of learning how to progress stepwise through the training. To control for navigation type and assess hands free access to information, participants were encouraged to advance to the next training step by voice activation by saying, “next step” out loud. After becoming familiar with Glass, participants were reminded by the researcher to
execute the training content physically. Participants then completed the sandwich making
training module using the device.

**Analytical Procedure**

Thirty participants were recruited and an equal ratio of men to women were placed in
each training group (5 men and 10 women) (Table 2). Average age of the Glass group and
strictly video-based training group was 32.1 years (SD = 12.4, range: 19-60) and 30.0 years (SD
= 11.5, range: 20-60), respectively. This closely mirrors the median age of food preparation
workers in the U.S. (31.5 years) (Data USA, 2016). There was no significant difference between
training groups in age [t(28) = .49, \( p = 0.62 \)], technology use [t(28) = .14, \( p = 0.89 \)], or
foodservice experience [\( \chi^2(1) = .13, p = 0.72 \)].

Data was analyzed using SPSS version 24.

**Results**

Average time to view and execute the sandwich and handwashing training for the Glass
and strictly video-based training group was 4 minutes 15 seconds (SD = 33 seconds) and 6
minutes 43 seconds (SD = 36 seconds), respectively. All participants in the Glass group made the
sandwich in the exact way informed by the training, receiving an average score of 10 out of a
possible 10. Average sandwich score in the strictly video-based group was 5.1 (SD = 2.3, range
= 2-10). All participants washed hands both times as designated in the training. Average
lathering time before making the sandwich for the Glass and strictly video-based training groups
was 24.5 seconds (SD = 7.2, range = 12-43) and 19.7 seconds (SD = 8.7, range = 3-37),
respectively. Average lathering time before handling vegetables after touching pre-cooked,
processed meat for the Glass and strictly video-based training groups was 19.8 seconds (SD =
8.8, range = 0-30) and 21.3 seconds (SD = 8.7, range = 3-45), respectively. There was no
significant difference between the training groups in lathering times for before making the sandwich \([t(28) = 1.63, p = 0.11]\) and before handling vegetables after touching pre-cooked, processed meat \([t(28) = -.48, p = 0.64]\).

**Discussion**

The purpose of the study was to explore the properties of wearable computers that included efficiency, hands free access to information, and freed up spaces in the work environment. The strictly video-based training group required over 50% more time to receive and execute the training compared to the Glass group [6 minutes 43 seconds (SD =36 seconds) compared to 4 minutes 15 seconds (SD = 33 seconds)]. Wearable computers such as smart glasses show potential to expedite and to impact food handler training positively. However, more research is needed that determines whether this potential is realized across a diverse workforce with different comfort levels in learning and using new technology (Ravichandran et al., 2015). Recent labor trends indicate more older workers are being employed in the foodservice industry (Patton, 2018). Older foodservice workers have expressed frustration with computer-based training and may require one-on-one assistance that increases the overall cost of training (Ravichandran et al., 2015).

Having hands free access to the training material through voice activation allowed participants in the Glass group to receive on-the-job training, while freeing up space in the work environment that would typically be required for viewing training manuals. Foodservice kitchens may face space limitations, as smaller work areas allow food handlers quick access to ingredients. Additionally, some tasks such as properly cleaning food equipment may require more than a poster on a wall to explain the procedure properly, rendering paper-based training manuals impractical. A study that assessed hygiene of food contact surfaces in a catering
establishment found 19.4% of surfaces that included cutting boards, meat slicers, and
countertops were considered dirty (>100 CFU/25 cm²) (Garayoa, Díez-Leturia, Bes-Rastrollo,
García-Jalón, & Vitas, 2014). Hands free access to training content through voice activation
could decrease the potential for cross contamination between food, food contact surfaces, and the
instructional media.

**Conclusions and Applications**

Foodservice owners and managers have a need to train employees quickly and
effectively, given high turnover and the resulting training costs. While the type of instructional
media may not have significant effects on learning outcomes, it does offer different properties,
uses, and conveniences. The present study examined three properties offered by wearable
computers in juxtaposing Glass and strictly video-based training. This information could benefit
foodservice stakeholders conducting cost-benefit analysis on whether to modernize training
programs by utilizing wearable computers.

The cost of wearable computers compared to more traditional forms of instructional
media should be considered in light of the possibility of time savings. While computer-based
training allows employers to save money through decreasing the need for paper manuals (Hall II,
2015) this must be weighed against the cost of using the technology. The smart glasses used in
the study cost between $1200-$1400 per pair, though renting the devices remains a potential
pricing option for foodservice entities. As with any piece of equipment, foodservice entities
would need to consider the device’s durability and maintenance needs balanced against the
possibility of it being damaged or stolen. One device has the capacity to train an unlimited
number of workers one at a time (limited by battery life). As implied, training multiple workers
simultaneously would necessitate multiple devices, which would also drive up training costs.
More research is needed that compares the time required to design and execute training with wearable computers compared to strictly video-based methods or paper-based training manuals. Creating a workflow and embedding video instructions in the smart glasses ranged from 2-3 hours. While the researchers did not time participants on how long it took them to learn how to operate the smart glasses, this time cost of computer-based training should also be examined.

The experiment had several limitations. The study was a laboratory experiment, and future research should assess wearable computer use in the context of an operational foodservice environment. Qualitative research with industry stakeholders on the advantages and disadvantages of using wearable technology to train workers would provide needed perspectives to supplement the present study’s findings. The study was limited to 15 participants per group, and future studies should compare trainings with a larger sample size.

The researchers were mindful of the impact an observer may have on an employee performing a behavior, commonly known as the Hawthorne effect (Latham, 2012). The researchers endeavored to minimize the impact of the Hawthorne effect by utilizing the same experimenter for both the wearable computer and strictly video-based training groups. In addition, the efficiency of both trainings was measured, rather than focusing solely on the compliance with handwashing behavior which has been shown to be inflated by the presence of an observer (Srigley et al., 2014). Time to become familiar with and learn how to operate the smart glasses was not recorded by the researchers and future studies should measure this input.

Acknowledgements

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Chapter 7: Perceptions of a Handwashing Video Game
Perceptions of a Video Game to Promote Handwashing Habits in Foodservice

1. Introduction

Foodborne disease is a pervasive problem with global impact. According to the World Health Organization, close to 1 in 10 people annually become ill due to foodborne disease, leading to 33 million healthy life years lost (World Health Organization, 2015). The Center for Disease Control and Prevention estimates 1 in 6 Americans on a yearly basis will be affected, leading to 128,000 hospitalizations and 3,000 deaths (Scallan, Hoekstra, et al., 2011; Scallan, Griffin, et al., 2011). Foodborne disease is largely a preventable mortality, and foodservice operators have a responsibility in protecting public health. In the U.S., restaurants, catering, and banquet facilities were responsible for 75% of foodborne disease outbreaks from 2009-2015 that reported a single location for the preparation of the implicated food (Dewey-Mattia, Manikonda, Hall, Wise, & Crowe, 2018). Of the outbreaks with a single confirmed etiology, Norovirus, prone to be spread through shortcomings in hygiene, comprised 41% of the outbreak-associated illnesses.

These findings highlight the importance of worker hygiene. Poor personal hygiene by food handling employees is one of the five principle risk factors in retail foodservice that contribute to foodborne disease occurrence (FDA, 2010), and poor hygiene was the second highest factor contributing to outbreaks in a 24 year period from the mid 1970’s to late 1990’s (Michaels et al., 2004). Hand hygiene deserves special attention due to the role of the hands as a causal agent in contributing to illnesses both historically and in the present day (Stewardson et al., 2011). Handwashing, through wetting the hands, application of soap, lathering for 20 seconds, and drying with a single-use paper towel, is a simple, yet effective procedure for removing
potential foodborne pathogens from employees’ hands (Todd, Greig, et al., 2010). A study of 308 foodborne disease outbreaks found 59% involved food contaminated after hand contact (Michaels et al., 2004). Despite the known risks, handwashing compliance in retail foodservice is typically low, ranging from 5-60% in several studies (Todd, Greig, et al., 2010).

To address this problem, food industry stakeholders have often relied on employee food safety training. Trainings frequently rely on educational materials that provide knowledge and seek to motivate employees in the hopes that this will lead to long-term behavior change (Zanin, da Cunha, de Rosso, Capriles, & Stedefeldt, 2017). However, there is sparse evidence of the long term impact food safety training has on improving worker behavior and mitigating the burden of disease (Egan et al., 2007; Viator et al., 2015). Empirical evidence suggests food safety training must target the consequences of behavior execution to be effective (Yu et al., 2017). Food safety training should be included with behavioral interventions in order to promote long term behavior changes (Jan Mei Soon et al., 2012). From a dual process model of self-regulation perspective (Friese, Hofmann, & Wiers, 2011), trainings and interventions often target reflective, deliberative processes such as an employees’ intentions, while ignoring automatic, reflexive processes (Pellegrino, Crandall, O’Bryan, et al., 2015). Handwashing is a behavior typically learned at a young age (Whitby & McLaws, 2007), and there is a strong association between automatic cognition associated with habits and handwashing execution (Sladek et al., 2008). Habit-based behaviors such as handwashing warrant habit-based interventions, yet evidence for trainings targeting habits based approaches in foodservice is limited (Wood & Neal, 2016).

Habits can be defined as an automatic response to a stimulus in a given context (Wood & Neal, 2007) and can make up 45% of the responses in our everyday lives (Wood, Quinn, & Kashy, 2002). Habit learning occurs through behavior repetition and rewarded actions in stable
contexts (Wood & Rünger, 2016). To promote habit formation, the target behavior must also be practiced through repetition and initiated with the aid of cues. These three components of rewards, repetition, and cues constitute the three pillars of promoting habit-based interventions (Wood & Neal, 2016). The present study focused on assessing perceptions of a handwashing video game as a reward system to be used alongside the other two components of habit-based interventions.

Rewards function as salient feedback that shift a learners’ attentional resources (B. A. Anderson et al., 2016). Incentives must be given consistently and systematically for a sustained change in behavior to occur (Wood & Rünger, 2016). This type of a reward system is extremely difficult for foodservice managers to consistently implement and maintain, given the frequent, sometimes sporadic circumstances that necessitate food safety practices such as handwashing. However, this reward system would be more feasible adapting automatic rewards using computer-based technology. A handwashing video game could serve as a tool that integrates the mechanics of habit formation. Gamification has been shown to increase intrinsic motivation of ordinary behaviors through fun and enjoyment (Z. H. Lewis, Swartz, & Lyons, 2016). The pleasure obtained from playing a video game while simultaneously engaging in a health-promoting behavior constitutes a reward system that may strengthen habit formation. Almost 60% of the studies reviewed that measured the effectiveness of gamification on health behaviors found a positive impact (Johnson et al., 2016).

Gamification has been incorporated in a system that educates health care workers on hand hygiene technique and handwashing compliance (Higgins & Hannan, 2013). Mixed results from two studies with this system support the role of persuasive technology as a supplementary tool, rather than the sole driver for promoting handwashing compliance and habits in the
foodservice industry (Higgins & Hannan, 2013; Kwok, Callard, & McLaws, 2015). One study found the automated training system improved handwashing techniques, while failing to change compliance rates (Kwok et al., 2015). Another study incorporated the game-reward system as part of a multi-modal intervention and observed significant improvements in hand hygiene compliance and technique ($p < 0.0001$) (Higgins & Hannan, 2013). While the system adds an element of novelty to an otherwise mundane public health obligation, it must be coupled with leadership oversight to effectively change behavior. The aforementioned studies were implemented in a hospital, and, to date, little is known of the potential impact gamification could have on handwashing practices in a foodservice environment.

The present study assessed perceptions of a video game designed to promote handwashing habits in foodservice. This technology is meant to be used alongside other techniques for habit formation including response repetition and stable cues. Cost of the video production, time savings during repeated trainings, management/stakeholder perceptions, and whether the technology would be continuously used by employees once installed are important things to consider when adopting new technology in foodservice. Measuring attitudes and perceptions provides valuable insight into whether the technology is a useful tool prior to installation in a foodservice environment, while directing game design for developers. The purpose of this study was to measure hospitality student perceptions to determine how likely a handwashing video game would be accepted as one of three components in a habit-focused intervention designed to promote handwashing practices. To the best of the researchers’ knowledge, no prior studies have tested perceptions of a handwashing video game designed to improve handwashing practices in foodservice.
2. Materials and Methods

2.1 Video Game Software

The handwashing video game was created in collaboration with a team of five undergraduates majoring in computer science and computer engineering as part of a required course for their degree. Well-established principles of persuasive technology design were incorporated as part of concept development, including the Principle of Conditioning (positive reinforcement) and the Principle of Ease of Use (Fogg, 2003). The authors of this manuscript served as the behavioral health specialists given their prior research with food safety behaviors, and the undergraduates developed the software and incorporated the hardware for the game. All game files were made in Android Studios using LibGDX, a free, open source application framework for game development that consists of a Java library. Java files were stored in GitHub for version control and source code management. Google Analytics for Firebase, a free analytics solution, was used for analytics purposes. This software logged each game play usage, including a timestamp of the duration, how well users performed, and total play time that all could be exported to an Excel spreadsheet. Data analytics were incorporated to determine trends in game play, useful for gauging interest and whether employees would repeatedly choose to play the game while washing their hands. The game was designed to include different background themes, characters, and difficulty levels every Nth time to maintain users’ interest.

2.2 Video Game Hardware & Gameplay

The hardware consisted of a tablet designed to be mounted above a sink in a theft-proof case. The tablet was connected to a USB foot pedal on the floor (iKKEGOL USB Single Foot Switch Control), which activated the game when depressed. Cost for the hardware, including
tablet and foot pedal was approximately $115. Video game hardware was funded by the course taken by the undergraduate computer engineering and computer science students.

The goal of the game was to reach the end of the level by causing a character to jump over pipes by pressing down on the foot pedal as the character approached the pipes (Fig. 1). The researchers hypothesized the enjoyment of playing the game and reaching the end of the level would function as the element of game design that would serve as an abstract reward. This hypothesis was based on neuroimaging studies which have shown abstract rewards such as money can elicit dopaminergic responses in the brain (O’Doherty, 2004). The reward would then change player’s beliefs to regard handwashing as a fun activity, which would then change handwashing behavior, leading to measurable increases in handwashing practices:

Game reward ➔ Change in players’ attitudes ➔ Increased handwashing ➔ Improved handwashing practices

The video gameplay lasts 30 seconds to encourage participants to wash hands for at least 20 seconds as mandated by the FDA Food Code (FDA, 2017).
2.3 Procedures

Prior to data collection, this study was approved by the Institutional Review Board for human subjects research for the two universities in the Midwest and Northeast that took part in the study. A convenience sample of hospitality students was selected from each university. All surveys were completed online through Qualtrics. Participants first watched a one-minute video showing the components of the handwashing video game and how to operate it. Participants then completed the survey containing the Technology Acceptance Model variables.

2.4 Survey Variables

All survey variables were measured on a seven-point Likert scale ranging from “1 = Strongly disagree” to “7 = Strongly agree” (Table 1). As the primary objective of the study was to determine perceptions as part of the pre-implementation phase, preference for using the game in a foodservice environment was chosen as the dependent variable as opposed to the users’
actual behavior. While intentions are often designated as the dependent variable of choice in the TAM (M. D. Williams, Rana, & Dwivedi, 2015), this construct may not be appropriate for foodservice workers since the decision to have access to the technology would ultimately lie with the manager or owner (Bourgonjon, Valcke, Soetaert, & Schellens, 2010). Preference can be defined as, “the degree of users’ positive feelings about participating” in a gaming experience (Hsu & Lu, 2007, p.1648). Preference for handwashing video game use consisted of three questions based off Bourgonjon et al. (Bourgonjon et al., 2010) and tailored for the context of the present study (Table 1). Perceived enjoyment, perceived ease of use, and perceived usefulness consisted of 3, 4, & 4 questions, respectively, and were adapted from Sun and Zhang (2006). Perceived usefulness was concerned with how motivating the game would be for fostering frequent and effective handwashing.
**Table 1.** Survey variables and questions pertaining to the handwashing video game.

<table>
<thead>
<tr>
<th>Preference</th>
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<tbody>
<tr>
<td>If I had the choice, I would choose to use the handwashing video game in food service.</td>
</tr>
<tr>
<td>If I had to vote, I would vote in favor of using the handwashing video game in food service.</td>
</tr>
<tr>
<td>If it were me, I would allow use of the handwashing video game in food service.</td>
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</table>

**Perceived ease of use**

Learning to operate the handwashing video game would be easy for me.
I would find it easy to get the handwashing video game to do what I want it to do.
It would be easy for me to become skillful at using the handwashing video game.
I would find the handwashing video game easy to use.

**Perceived enjoyment**

I would find using the handwashing video game to be enjoyable.
The actual process of using the handwashing video game would be pleasant.
I would have fun using the handwashing video game.

**Perceived usefulness**

Using the handwashing video game would motivate me to wash my hands more often in food service.
Using the handwashing video game would motivate me to wash my hands more effectively in food service.
I would find the handwashing video game useful for motivating me to do a better job of washing my hands in food service.
I would find the handwashing video game useful for motivating me to wash my hands more frequently in food service.

2.5 **Data Analysis**

Survey data was analyzed with IBM SPSS Version 24. The survey variables had good or excellent reliability, as evident by all Cronbach’s alpha values exceeding 0.8 (Devellis, 1991)(Table 2). A linear multiple regression model was used to find the amount of variance in preference explained by perceived usefulness, perceived ease of use, and perceived enjoyment of the handwashing video game. Multicollinearity between the dependent and independent variables was ruled out since all variance inflation factor values were less than 10. Separate scatterplots comparing the averages of the dependent variable to the averages of the independent variables confirmed linearity. Normality of the residuals was also confirmed after the P-P plot
showed the relationship between the observed and expected cumulative probability followed the normality line. Examination of a scatterplot of the residuals confirmed the homoscedasticity of the data.

**Table 2.** Survey variable averages and reliability.

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<thead>
<tr>
<th></th>
<th>Mean (SD)</th>
<th>Cronbach’s α</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preference</td>
<td>4.73 (1.55)</td>
<td>.91</td>
</tr>
<tr>
<td>Perceived ease of use</td>
<td>5.26 (1.31)</td>
<td>.90</td>
</tr>
<tr>
<td>Perceived enjoyment</td>
<td>4.98 (1.33)</td>
<td>.89</td>
</tr>
<tr>
<td>Perceived usefulness</td>
<td>4.64 (1.56)</td>
<td>.95</td>
</tr>
</tbody>
</table>

3. Results & Discussion

The purpose of the study was to measure student perceptions of a handwashing video to determine its likelihood of acceptance as part of a three-tiered, habit-based intervention to promote handwashing practices. A variation of the TAM was employed to determine the relation between preference, perceived usefulness, perceived ease of use, and perceived enjoyment. One hundred thirty-one hospitality students were administered the online questionnaire. Thirty-one surveys were found to be incomplete and removed from further analysis. Means of survey variables were between “Neither agree nor disagree” and “Agree” (Table 2). Thirty-three percent of respondents had an average preference of “Agree” or higher for handwashing video game usage in foodservice. For perceived ease of use, perceived enjoyment, and perceived usefulness, 31%, 34%, and 28% of respondents, respectively, had average scores of “Agree” or higher. All variables were significantly correlated at $p < .01$ (Table 3) and exhibited either moderate or strong positive relationships. Perceived usefulness had the highest correlation with preference ($r$...
The lowest observed correlation was between perceived ease of use and perceived usefulness ($r = .671, p < .01$).

**Table 3. Correlation matrix of survey variables.**

<table>
<thead>
<tr>
<th>Variable</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.) Preference</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.) Perceived ease of use</td>
<td>.680**</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.) Perceived enjoyment</td>
<td>.787**</td>
<td>.798**</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>4.) Perceived usefulness</td>
<td>.876**</td>
<td>.671**</td>
<td>.817**</td>
<td>1</td>
</tr>
</tbody>
</table>

**Correlation significant at $p < .01$ (two-tailed)

Multiple regression analysis indicated the three predictors of perceived ease of use, perceived enjoyment, and perceived usefulness explained 78.7% of the variance in preference for using the handwashing video game in foodservice (Adj. $R^2 = .78$, $F(3,96) = 118.09, p < .001$). Of the three predictors, only perceived usefulness contributed significantly to the model ($\beta = .694$, $t(96) = 8.48, p < .001$) (Table 4).

**Table 4. Regression analysis with Preference as the dependent variable.**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Standardized $\beta$ coefficients</th>
<th>t-value</th>
<th>VIF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived ease of use</td>
<td>.107</td>
<td>1.371</td>
<td>2.766</td>
</tr>
<tr>
<td>Perceived enjoyment</td>
<td>.134</td>
<td>1.326</td>
<td>4.580</td>
</tr>
<tr>
<td>Perceived usefulness</td>
<td>.694</td>
<td>8.477***</td>
<td>3.022</td>
</tr>
</tbody>
</table>

***$p < .001$

Results from the surveys indicated the participants had slightly positive attitudes towards using the handwashing video game in a foodservice environment. Nearly one out of every three...
students had an average preference rating of four ("Neither agree nor disagree") or less. Perceived usefulness was the predictor variable most highly correlated with preference for handwashing video game use in foodservice and the only significant variable in the multiple regression model. This information suggests that the current design of the handwashing video game may not be conducive for promoting handwashing behavior in foodservice. While it was the intention of the researchers that the game was easy and simple to operate, survey results were not strongly supportive of this. Playing the video game while washing hands could have been perceived as requiring significant multi-tasking, between pressing the foot pedal and simultaneously lathering with soap. A more simplistic reward system that requires less active decision making such as that necessitated by the video game may be more conducive for habit formation (Wood & Rünger, 2016). Future studies may consider comparing the reward saliency of an interactive video game to other tested methods in foodservice interventions that have involved humorous posters (B. Chapman, MacLaurin, & Powell, 2011), music played from a soap dispenser (Yu et al., 2017), and financial rewards (Nieto-Montenegro et al., 2008; York, Brannon, Shanklin, Roberts, Howells, et al., 2009). Another direction for future research would be to test whether the device would be better suited as an educational tool for younger children, rather than in foodservice. Proper hand hygiene is often learned at a young age (Whitby et al., 2007; Whitby, McLaws, & Ross, 2006), and the classroom could serve as a more favorable environment for fostering habits compared to a commercial kitchen.

This study was limited in not measuring perceptions after actual video game usage and prior experience of the surveyed individuals with video games. Experience with video games may also help explain why there was not strong agreement as to the acceptance of the video game. A prior study found a significant relationship between learners’ general video game
experience and preference for video game use in the classroom (Bourgonjon et al., 2010). Future research may consider determining whether experience with video games serves as a moderator in the relationship between preference for usage and other TAM variables such as perceived usefulness.

4. Conclusion

The present work involved the design and creation of a video game for use in a foodservice environment to improve handwashing practices. The game is purposed for use as a reward in conjunction with practiced repetition and cues as part of a habit-focused behavioral intervention. Gameplay involved pressing a foot pedal on the floor to cause a character to jump over pipes to reach the end of a level, while the user simultaneously washed hands. The perceptions of one hundred hospitality students indicated the video game, in its present state, may not serve as a beneficial tool for promoting handwashing practices. Results also showed the need to either improve game design or consider alternative reward mechanisms to promote handwashing habits. Information from this study could help explain what facets of game design explain the variation in preference for video game usage, while guiding future efforts to incorporate technology in the foodservice environment that promotes handwashing practices with other food safety behaviors.

Funding

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Acknowledgements:

The authors would like to personally thank the team of computer science and computer engineering undergraduate students for their hard work in making the handwashing video game.

References


Chapter 8: Job Security, Automation, and Emotional Intelligence

Hospitality Undergraduate Perceptions of Their Future Job Security as Affected by Increased Automation and the Relation to Emotional Intelligence

Introduction

The world is rapidly changing due to advances in technology centered around computer-based systems. The foodservice industry has responded to these changes through implementing automation in a variety of tasks, driven by higher labor costs coupled simultaneously with decreased technology costs (Tanyeri, 2018). It is projected that compared to 2015, by the year 2030 the foodservice industry could use automation technology to decrease operating costs by as much as 15% (Harris, Kimson, & Scwedel, 2018). Advances in artificial intelligence have enabled robots to flip burgers, make pizzas, and brew coffee, among other tasks (Tanyeri, 2018). Self-service kiosks and mobile app ordering have been implemented in major restaurant chains, automating a portion of jobs once held by traditional cashiers (Dunn, 2017).

There is very little research on the impact of automation on foodservice jobs, with much of what is known coming from industry sources. Based on a report out of the McKinsey Global Institute, 73% of tasks performed by foodservice and accommodation workers could be automated (Chui, Manyika, & Miremadi, 2016). Research out of the University of Oxford suggests waiters, cashiers, and food preparation employees rank among the professions with the highest probability of being replaced by automation (Whitehouse & Gambrell, 2017). Job replacement would not take place overnight, but rather steadily, and by the year 2030, 35% of all of food preparation jobs and 5-14% of foodservice host jobs could be replaced by automation (Manyika et al., 2017). Greg Creed, CEO of Yum! Brands, predicts fast food workers will be replaced by automation within the next ten years (Dunn, 2017). Another study suggested fast
food workers have a 92% chance of their jobs being replaced by automation (Frey & Osborne, 2017). This raises questions as to what kind of psychological impact these changes will have on foodservice workers.

Anecdotal reports indicate greater use of robotics can raise employee concerns over their own job security (Chao & Kozlowski, 1986). While lower skilled workers tend to exhibit greater concerns over job loss (Chao & Kozlowski, 1986; Vieitez, Carcia, & Rodriguez, 2001), this anxiety could likely spread to more high-skilled employees with managerial responsibilities given recent advances in technology (Huang & Rust, 2018). Job insecurity plays an important role in occupational health across a broad range of professions. A meta-analytic review on job insecurity that included over 54,000 employees of varying skill levels from varying industries suggests this barometer of mental health is related to depression, anxiety, and low satisfaction in life (Llosa, Menéndez-Espina, Agulló-Tomás, & Rodríguez-Suárez, 2018). One study of 148 automobile workers found a significant relation between employees’ perceptions of how secure their jobs were as affected by technological change and their psychological well-being, including anxiety and depression (Vieitez et al., 2001).

While some scenarios reflect a future with massive foodservice worker unemployment, both history and empirical evidence point to the contrary. According to David H. Autor, Professor of Economics at MIT, the employment to population ratio increased in the 20th century despite more ubiquitous automation (2015). This mirrors a report put out over 50 years ago by the Lyndon B. Johnson Administration which reached the conclusion that, rather than threatening employment, “technology eliminates jobs, not work” (Bowen, 1966). Advanced technology can affect labor dynamics to where humans complement the technology or complete tasks less conducive to automation. For example, “cobots” are a type of helper robot that work alongside
humans in manufacturing to increase labor productivity (Harris et al., 2018). One restaurant chain that utilized mobile phone apps and kiosks for digital ordering witnessed increased sales growth by multiple percentage points and a more efficient process, leading to higher volume orders and, ultimately, net job creation (Dunn, 2017). More human labor was reallocated to table service and deliveries. The bigger problem facing foodservice workers may not be job replacement, but rather displacing of lower skilled occupations to those requiring abilities more difficult to automate.

Conservative estimates indicate 15% of all work activities across all industries worldwide could be displaced by 2030 as a result of automation (Manyika et al., 2017). Food preparation tasks in particular are routine and predictable, making them highly susceptible to automation (Brynjolfsson & McAfee, 2014); foodservice workers spend close to 50% of their time doing food preparation tasks that can be automated (Chui, Manyika, & Miremadi, 2016). While foodservice hosts and prep cooks are likely to experience a net decrease in employment opportunities, combination food preparation and service worker jobs are expected to increase by nearly 550,000 by 2030 (Manyika et al., 2017). The work environment at a popular fast casual restaurant chain lends support to this forecast, as workers were diverted to less computer friendly tasks such as personal interactions with customers, assembling orders, and checking orders before delivery (Dunn, 2017). In-person interactions are some of the most difficult processes to computerize (Huang & Rust, 2018). For example, the job of foodservice general managers, which entails motivating and interacting with a myriad of personality types, has a low probability of being automated (Whitehouse & Gambrell, 2017).

Generally speaking, computers are very proficient in performing predictable, rule-based tasks such as solving math problems or producing the same product over and over (Brynjolfsson...
By contrast, human interactions involve unpredictability and randomness given the wide spectrum of emotions and scenarios involved. Research on artificial intelligence by Huang and Rust (2018) suggests jobs that involve empathetic intelligence associated with emotion recognition and regulation are least susceptible to automation. As the workplace becomes more digitized, “Intuitive and empathetic skills will be the most lasting comparative advantages of human service” (Huang and Rust, 2018, p. 167). Alongside large frame pattern recognition and the ability to ideate, humans have greater complex communication skills than computers (Brynjolfsson & McAfee, 2014).

Despite rapid increases in technological innovation, humans are likely to still have the upper hand in this area of social skills for some time in the future (Brynjolfsson & McAfee, 2014). By 2030, workers will spend an estimated 34-38% additional hours devoted to activities that entail social and emotional aptitudes compared to their current position descriptions (Manyika et al., 2017). Social skills are a key factor in employability, and increased automation means employers can afford to be more selective in the hiring process (Hogan, Chamorro-Premuzic, & Kaiser, 2013). Both high and low skilled workers must improve their emotional intelligence (EI) to maintain their job security in foodservice while avoiding job displacement.

EI has been identified as “a set of interrelated abilities possessed by individuals to deal with emotions” (Wong & Law, 2002, p. 435). This skillset encompasses “the ability to perceive accurately, appraise, and express emotion; the ability to access and/or generate feelings when they facilitate thought; the ability to understand emotion and emotional knowledge; and the ability to regulate emotions to promote emotional and intellectual growth” (Mayer & Salovey, 1997, p.10). A study of 187 foodservice workers found a positive relation between EI, job satisfaction, and job performance (Thomas, Tram, & O’Hara, 2006). Executives in the automated
foodservice industry who had higher EI had significantly higher stress management skills and coping abilities compared to those with lower EI (Cha, Cichy, & Kim, 2009). Work incivility can lead to emotional exhaustion, but a study of restaurant frontline service found the extent of this exhaustion was moderated by an employee’s ability to regulate their emotions (Cho, Bonn, Han, & Lee, 2016). EI carries ramifications for both the mental health of employees and the fiscal health of restaurants; in another study, higher profit performance, customer satisfaction, and employee satisfaction were associated with greater EI of general managers (Langhorn, 2004).

The components of EI, including self-emotion appraisal, others’ emotional appraisal, use of emotion, and regulation of emotion, benefit workers by serving as a personal resource for coping with stressful situations (Cheng, Huang, Lee, & Ren, 2012). Low EI is associated with negative reactions to job insecurity (Jordan, Ashkanasy, & Hartel, 2002). Two studies involving nurses and real estate agents found negative correlations between job insecurity and EI (Cheng et al., 2012; Cheung, Gong, & Huang, 2016).

Within foodservice there is variation in the amount of customer interaction that would demand higher EI and skillsets less prone to automation. For example, a server may need to effectively regulate their emotions when conversing with unhappy customers. By contrast, a prep cook who spends their time relatively isolated in the kitchen, divorced from customer interaction, may not have these same demands for strong EI skills. This discrepancy in job requirements can be conceptualized as emotional labor, or “the extent to which the job requires the management of emotions to achieve positive job outcomes” (Wong & Law, 2002, p. 248). Front of the house positions such as servers, hosts, and cashiers are considered high emotional labor jobs, while back of the house positions, such as cooks and dishwashers, are classified as low emotional labor jobs (Adelman, 1989). Emotional labor can moderate the effect EI has on employee attitudes, as
high emotional labor jobs are associated with greater turnover intention and organizational commitment when EI is high (Wong & Law, 2002). Workers exposed to more emotionally demanding jobs may thus be able to cope more effectively with negative emotions.

The information from this study may shed light on the role of EI as a competitive advantage for students entering the foodservice industry, especially as society becomes more digitized. EI skills are often lacking in school curriculum (Manyika et al., 2017), despite the fact that EI can be improved through training (Mattingly & Kraiger, 2018). One study found hospitality students were able to improve their EI over time when lessons with EI were incorporated as part of the instructional materials (Wolfe, 2017). Many education systems are, in some regards, outdated and based around teaching students skills required to excel in the economy of 19th century England (Brynjolfsson & McAfee, 2014). While these skills, which include arithmetic, reading, writing, and memorizing facts, are fundamentally important, forward planning school curriculums must emphasize social skills and EI to equip students for the workforce as projected automation usage increases. Several studies suggest EI training should be integrated in the curriculum for hospitality students in higher education (Scott-Halsell, Shumate, & Blum, 2007; Wolfe, Phillips, & Asperin, 2014).

The purpose of this study was to investigate hospitality management undergraduate perceptions of job stability as affected by the increasing prevalence of robotics and automation, along with indicators of emotional intelligence. Four study objectives were identified: 1.) Determine the extent current and future foodservice workers perceive their jobs threatened by greater utilization of robotics and automation in the hospitality industry 2.) Determine the relation between EI indicators and perceptions of job insecurity as affected by increased robotics and automation in the hospitality industry for hospitality students 3.) Determine the relationship
between EI indicators and type of foodservice experience whether front of the house, back of the house, or both. 4.) Provide more support for the need for greater skill development in EI in hospitality management curriculum.

**Materials and Methods**

**Materials**

A seven-point Likert scale ranging from “1 = Strongly disagree” to “7 = Strongly agree” was used to measure all survey items. Perceptions of job insecurity rendered by increased robotics and automation in the hospitality industry consisted of ten questions adapted from Chao and Kozlowski (1986). This scale has been used previously to assess employees of varying skill levels in a large-batch manufacturing plant (Chao & Kozlowski, 1986) and a factory that manufactured car components (Vieitez et al., 2001). To the best of the researchers’ knowledge, hospitality student perceptions of job insecurity rendered by increased robotics and automation in the hospitality industry have yet to be evaluated. For the sake of brevity, this variable will be referred to as simply “perceptions of job insecurity.”

EI was assessed with the scale developed by Wong and Law (2002), previously validated as a psychologically sound tool for measuring EI. This scale included self-emotion appraisal, others’ emotion appraisal, use of emotion, and regulation of emotion, each of which consisted of four items each. Cronbach’s alpha for this scale was .90 for the study sample of undergraduates. Additionally, demographic variables were collected that included age, gender, years of experience in hotels and foodservice, whether students anticipated working in the hospitality industry after graduation, and type of foodservice experience. Type of foodservice experience was categorized using common terminology used in foodservice operations and familiar to participants, including
“Back of the house”, “Front of the house”, “Both”, and “I don’t have foodservice experience”. Specific examples of front and back of the house jobs were given to participants: (a) Back of the house (i.e. chef, line cook, prep cook, preparing food); (b) Front of the house (i.e. waiting tables, serving food, cashier, host/hostess, busser).

Sample and Procedures

A convenience sample of hospitality management students were surveyed from two universities, one in the Northeast and one in the Midwest. Before data collection began, the Institutional Review Board from each university approved the study. An online survey platform was used to collect data.

Data Analysis

Data was analyzed with IBM SPSS Version 24. Descriptive statistics of the survey were calculated that included variable averages and standard deviations. Cronbach’s alpha was used to determine the reliability of all survey variables. Mean job insecurity perceptions were compared to determine differences between students who did and did not anticipate working in hospitality after graduation. The normality assumption was confirmed by the Shapiro Wilk’s test, but the Levene’s test showed a lack of homogeneity of variance. Therefore, a Welch’s F test was used (Jan & Shieh, 2014).

Correlation coefficients were calculated to determine the relationship between average perceptions of job insecurity and averages of the EI indicators. Because Shapiro-Wilk tests showed all EI variables violated the required assumption of normality, the correlation between survey variables was calculated using Spearman’s rho.
To determine the effect of type of foodservice experience (excluding students without experience) on EI variables, a Welch’s F test was used for self-emotion emotion appraisal, since this variable showed a lack of normality. Others’ emotional appraisal showed normality and homogeneity of variances, and a traditional one-way ANOVA was conducted. For use of emotion and regulation of emotion, a Welch’s F test was used since our preliminary analysis showed a lack of normality and homogeneity of variances. Post-hoc tests used included Tukey’s HSD for others’ emotional appraisal and the Games Howell test for the remaining EI variables.

Results

Of the 131 student surveys completed, 31 were largely incomplete and excluded from further analysis, rendering 100 usable surveys. Demographic information can be found in Table 1. The proportion of male to female students reflects trends in higher education where the majority of students, as of the fall of 2018, are female (National Center for Education Statistics, n.d.). Close to three-fourths of the students surveyed had some level of foodservice experience. Slightly more than one third of respondents did not anticipate working in hospitality after graduation.
Table 1. Demographics of hospitality students surveyed (n =100)

<table>
<thead>
<tr>
<th></th>
<th>Mean (SD)</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>20 (2.09)</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>Female</td>
<td></td>
<td>70</td>
</tr>
<tr>
<td>Years of experience working in hotels</td>
<td>.5 (.99)</td>
<td></td>
</tr>
<tr>
<td>Years of experience working in foodservice</td>
<td>2.2 (2.1)</td>
<td></td>
</tr>
<tr>
<td>Type of foodservice experience</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Back of the house</td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>Front of the house</td>
<td></td>
<td>36</td>
</tr>
<tr>
<td>Both back and front of the house</td>
<td></td>
<td>29</td>
</tr>
<tr>
<td>I don't have foodservice experience</td>
<td></td>
<td>28</td>
</tr>
<tr>
<td>Anticipated sector working in after graduation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foodservice</td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>Hotels</td>
<td></td>
<td>29</td>
</tr>
<tr>
<td>Hotels and foodservice</td>
<td></td>
<td>15</td>
</tr>
<tr>
<td>I don’t anticipate working in</td>
<td></td>
<td>36</td>
</tr>
<tr>
<td>either foodservice or hotels</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2 contains descriptive information for job insecurity survey items. On average, students had slightly less than neutral perceptions (M = 3.94, SD = 1.31) on the seven-point Likert scale of how robotics and automation would impact their job security in the hospitality industry (Table 3). Average perceptions of job insecurity based on where these students anticipated working after graduation were as follows: (a) foodservice: M = 4.26, SD = 1.54; (b) hotels: M = 3.77, SD = .88; (c) both hotels and foodservice: M = 4.63, SD = 1.52; (d) neither hotels or foodservice: M = 3.63, SD = 1.27. There were no significant differences among the four groups, (Welch’s F[3,40.36] = 2.15, p = .109). On average, students “Somewhat agree[d]” or “Agree[d]” they possessed EI as shown by the four indicators.
Table 2. Descriptive statistics of perceptions of job insecurity* as affected by robotics and automation in hospitality

<table>
<thead>
<tr>
<th>Statement</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.) With more and more robots and automation everywhere, my chances of finding another job in the hospitality industry are small.</td>
<td>3.75</td>
<td>1.67</td>
</tr>
<tr>
<td>2.) Robots and other new forms of automation reduce my job security in the hospitality industry.</td>
<td>3.97</td>
<td>1.65</td>
</tr>
<tr>
<td>3.) My job skills in the hospitality industry are rapidly becoming obsolete.</td>
<td>3.91</td>
<td>1.44</td>
</tr>
<tr>
<td>4.) Robots &amp; automation seriously threaten my future in the hospitality industry.</td>
<td>3.87</td>
<td>1.66</td>
</tr>
<tr>
<td>5.) The introduction of robots &amp; automation will slowly displace jobs in the hospitality industry.</td>
<td>4.35</td>
<td>1.57</td>
</tr>
<tr>
<td>6.) I have only a small chance of keeping my job in the hospitality industry as technological advances increase.</td>
<td>3.63</td>
<td>1.60</td>
</tr>
<tr>
<td>7.) I fear that someday I will lose my job in the hospitality industry to robots &amp; automation.</td>
<td>3.75</td>
<td>1.59</td>
</tr>
<tr>
<td>8.) Robots &amp; automation will make me less useful as a worker in the hospitality industry.</td>
<td>3.93</td>
<td>1.71</td>
</tr>
<tr>
<td>9.) Increased automation and robots will mean less and less work for people in the hospitality industry.</td>
<td>4.34</td>
<td>1.55</td>
</tr>
<tr>
<td>10.) As a result of robots &amp; automation in the workforce, I will have a smaller and smaller part in the hospitality industry.</td>
<td>3.94</td>
<td>1.55</td>
</tr>
</tbody>
</table>

*Perceptions of job insecurity were measured on a 7-point Likert scale ranging from “1 = Strongly disagree” to “7 = Strongly agree”.
There was no correlation between student’s perceptions of job insecurity and any of the EI indicators (Table 4). However, all EI indicators were significantly correlated with one another at p < .001. The greatest correlation observed was between self-emotion appraisal and regulation of emotion, (rs[98] = .71, p < .001). The weakest correlation observed was between perceptions of job insecurity and regulation of emotion, (rs[100] = .003, p = .98).

| Table 3. Descriptive statistics and reliability of survey variables |
|------------------|------------------|------------------|
|                  | Mean  | SD  | Cronbach’s α |
| Perception of job insecurity | 3.94  | 1.31 | .944           |
| Self-emotion appraisal        | 5.66  | .821 | .771           |
| Others’ emotion appraisal     | 5.62  | .753 | .667           |
| Use of emotion                | 5.85  | .841 | .783           |
| Regulation of emotion         | 5.56  | .893 | .752           |

Main effects for type of foodservice experience were found with self-emotion appraisal (Welch’s F[2, 15.9] = 3.66, p = .049), use of emotion (Welch’s F[2, 15.18] = 7.06, p = .007), and regulation of emotion (Welch’s F[2, 16.06] = 4.41, p = .03). There was no main effect of type of foodservice experience on others’ emotion appraisal, (F[2, 69] = .701, p = .50).

| Table 4. Correlation matrix of survey variables |
|------------------|------------------|------------------|------------------|------------------|
|                  | 1  | 2             | 3             | 4             |
| 1.) Perception of job insecurity     | -  |               |               |               |
| 2.) Self-emotion appraisal           | .059 | -             |               |               |
| 3.) Others’ emotion appraisal        | .189 | .634*        | -             |               |
| 4.) Use of emotion                   | .066 | .59*         | .551*         | -             |
| 5.) Regulation of emotion            | .003 | .71*         | .506*         | .632*        |
Self-emotion appraisal was higher for students who had both front and back of the house experience in foodservice (M = 5.97, SD = .67) than only front of the house experience (M = 5.47, SD = .79) (Table 5). Use of emotion was higher for students with both front and back of the house experience in foodservice (M = 6.24, SD = .47) than only front of the house experience (M = 5.69, SD = .87) (Table 6). Regulation of emotion was higher for students with both front and back of the house experience in foodservice (M = 5.89, SD = .57) than only front of the house experience (M = 5.39, SD = 1.05) (Table 7).

Table 5. Post hoc results for self-emotion appraisal by type of foodservice experience

<table>
<thead>
<tr>
<th>Foodservice Experience Type</th>
<th>Mean</th>
<th>Mean Differences (Xi − Xj) (Effect Sizes are indicated in parentheses)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>1. Back of the house</td>
<td>5.54</td>
<td>--</td>
</tr>
<tr>
<td>2. Front of the house</td>
<td>5.47</td>
<td>.063(.069)</td>
</tr>
<tr>
<td>3. Both back and front of the house</td>
<td>5.97</td>
<td>-.43(-.493)</td>
</tr>
</tbody>
</table>

*p < .05

Table 6. Post hoc results for use of emotion by type of foodservice experience

<table>
<thead>
<tr>
<th>Foodservice Experience Type</th>
<th>Mean</th>
<th>Mean Differences (Xi − Xj) (Effect Sizes are indicated in parentheses)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>1. Back of the house</td>
<td>5.18</td>
<td>--</td>
</tr>
<tr>
<td>2. Front of the house</td>
<td>5.69</td>
<td>-.516(-.506)</td>
</tr>
<tr>
<td>3. Both back and front of the house</td>
<td>6.24</td>
<td>-1.06(-1.21)</td>
</tr>
</tbody>
</table>

**p < .01
Table 7. Post hoc results for regulation of emotion by type of foodservice experience

<table>
<thead>
<tr>
<th>Foodservice Experience Type</th>
<th>Mean</th>
<th>Mean Differences (Xi − Xj)</th>
<th>(Effect Sizes are indicated in parentheses)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Back of the house</td>
<td>5.11</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>2. Front of the house</td>
<td>5.39</td>
<td>-.281(-.788)</td>
<td>--</td>
</tr>
<tr>
<td>3. Both back and front of the house</td>
<td>5.89</td>
<td>-.781(-1.02)</td>
<td>-.499(-.59)*</td>
</tr>
</tbody>
</table>

*p < .05

Discussion

The present study was designed to gage current perceptions of job insecurity rendered by greater automation and robotics in hospitality along with emotional intelligence indicators. Based on perceptions of job insecurity, students had mixed reactions as to whether their jobs in hospitality would be affected by more robotics and automation. Students, on average, had slightly less than neutral perceptions. Perceptions had no relation to what type of jobs they planned to pursue upon completion of their undergraduate degree. Prior research in a manufacturing plant has shown perceptions of job insecurity differ between high and low skill workers, with higher skill workers perceiving robots as having a positive impact on their jobs (Chao & Kozlowski, 1986). Another study of employees in a car component factory found similar results, employees with a higher level of job qualification and greater levels of education had main effects on perceptions of job security (Vieitez et al., 2001). The present study did not assess students using any metric involving skill level and including this may have shed additional insight on perceptions.

The overall neutral perceptions of job insecurity, even among students who intended to work in foodservice after completing their degree, stand in contrast to estimates of how likely hospitality jobs will be automated in the coming years (Chui et al., 2016; Frey & Osborne, 2017;
Manyika et al., 2017; Whitehouse & Gambrell, 2017). Chefs and general managers, professions that generally involve high levels of creativity and EI, have a low probability of being replaced by automation (Whitehouse & Gambrell, 2017). Among jobs unique to foodservice not yet mentioned, bartenders, dishwashers, and housekeeping workers have a very high chance of being automated (Whitehouse & Gambrell, 2017). Given how the students surveyed were part of hospitality programs, it is likely some will pursue management positions. Neutral perceptions of job insecurity towards a profession with a small probability of being automated may indicate a lack of awareness or uncertainty of how technology could impact the hospitality industry. This was a base-line study where the students expressed their current understanding without the benefit of reading current literature detailing the waves of automation sweeping the industry. Future studies should determine whether perceptions of job insecurity are affected by exposure to foodservice industry trends in automation use.

In contrast to prior research, the present study found no negative correlation between perceptions of job insecurity and EI indicators. Students reported, on average, greater EI compared to perceptions of job insecurity. EI can reflect an individual’s ability to cope with stressful circumstances and is negatively correlated with psychological strain (Cheung et al., 2016). The slightly higher EI observed in the students and increased capacity to manage undesirable perceptions of job insecurity may therefore explain why no negative correlations were found.

There was a main effect of type of foodservice experience on EI indicators that included self-emotion appraisal, use of emotion, and regulation of emotion. These three variables were significantly higher for students who had both back and front of the house experience compared to just front of the house experience. This could be attributed to several factors. Students who have worked as both a line cook (back of the house) and a server (front of the house), for example, may
have been exposed to more diverse situations that led to greater increases in their abilities to identify emotions within themselves, use emotions to their advantage, and cope with negative emotions. Higher EI is associated with greater adaptability to situational demands (Salovey, Mayer, Goldman, Turvey, & Palfai, 1995). Alternatively, as opposed to more diverse work experiences leading to higher EI, students with already high EI may be more likely to seek out and engage in a broader range of foodservice jobs.

A post-hoc analysis was conducted to determine if EI was related to years of foodservice experience. No significant correlations were found between years of foodservice experience and self-emotion appraisal (rs[70] = .056, p = .641), use of emotion (rs[70] = .222, p = .06), and regulation of emotion (rs[70] = .177, p = .137). This suggests that type of foodservice experience may explain EI better than time spent working in the industry.

**Conclusions and Applications**

The findings support the need to encourage hospitality students to work in different foodservice jobs that necessitate varying degrees of emotional labor and that this may be independent of time spent working in foodservice. Diverse working environments also give students the opportunity to practice complex communication skills, an important asset for maintaining job security and potentially minimizing job displacement as automation becomes more prevalent in the years to come (Brynjolfsson & McAfee, 2014).

Prior research has shown hospitality professionals score higher than hospitality undergraduates on EI indicators pertaining to problem solving (Wolfe et al., 2014). This evidence, in combination with the present study, highlights how real-world experiences in foodservice could provide opportunities to develop EI outside of the classroom. EI training incorporated in higher
education curriculum could be complemented by giving students the opportunity to apply that information through internships or work-study programs in foodservice.

This study had several limitations. Whether the undergraduates had experience with EI training as part of their schooling was not measured, and this variable may have shed more insight on the EI values observed. Others’ emotion appraisal had a Cronbach’s alpha value of .667 that is only slightly below what is considered satisfactory for a subscale (Nunnally, 1978). Deleting items from this subscale would have resulted in no improvements in reliability. Results that relate to this variable should be interpreted with caution, as this sample may not have a complete understanding of this concept. However, the EI scale with its four variables was reliable overall with a Cronbach’s alpha value of .90.

Concerning the sample of students, seven undergraduates had only back of the house experience, and surveying more students that fit this category would aid in substantiating the study findings that relate to the effect of type of foodservice experience on EI indicators. Nevertheless, the validity of the results was supported in that homogeneity of variance was tested, and either a classic one-way ANOVA or a Welch’s F test was used based on whether this assumption was violated.

The study was cross-sectional in design. Future work could utilize a longitudinal study to address how student perceptions of job insecurity change over the duration of their schooling. A portion of the students surveyed are likely to enter management positions in foodservice, which have a low forecasted probability of being automated. Future research should study perceptions of job insecurity of workers who have a higher probability of having their jobs displaced by automation and robotics, such as prep cooks and cashiers. This would be useful from an
occupational health standpoint to gauge the psychological well-being of employees and provide EI training to help cope with potential changes in labor dynamics.

Lastly, this study relied on self-reports of EI, as opposed to assessments from other people and ability-based measures. Self-reported measures of EI can be prone to response bias, which can inflate scores compared to peer reports of EI (Keefer, 2015; Lievens, Klehe, & Libbrecht, 2011). This does not, however, undermine the role that personal beliefs play in influencing behavior. Self-reports of EI provide insight into how individuals adapt and cope with adverse circumstances or perceptions, which can then shape observable behavior (Keefer, 2015). It should be noted how self-report measures of EI may measure a distinct set of abilities and are thus not a direct replacement for other forms of EI assessment (Keefer, 2015). Future research should explore other-reports and ability-based measures of EI to expand our understanding of how EI relates to perceptions of job insecurity and type of foodservice experience.

**References**


Chapter 9: Risk Classification and Health Inspections

Validating Food Establishment Risk Classification by Analyzing Health Inspections

Introduction

While necessary for life, eating poses a risk for public health given the potential for foodborne disease. In the U.S. alone, approximately 48 million illnesses annually are attributed to foodborne disease (Scallan, Hoekstra, et al., 2011; Scallan, Griffin, et al., 2011). Understanding and identifying the factors in the farm to fork continuum that contribute to foodborne illness occurrence is instrumental for preserving public health. The present study focuses on the role of state health departments’ inspection of foodservice establishments in mitigating foodborne illness.

From 1998-2008, over 75% of foodborne illness outbreaks were attributed to a single foodservice location (Centers for Disease Control and Prevention, 2013). Investigating these outbreaks provides new insight in conducting effective prevention efforts. Summarizing restaurant associated foodborne illness outbreaks from 1998-2013 linked to a single contributing factor, the most common factor was employees’ poor food handling and preparation practices, followed by poor worker health and hygiene (Angelo, Nisler, Hall, Brown, & Gould, 2017). State and local health departments enforce food safety practices through routine inspections as a countermeasure to decrease the risk of foodborne illness transmission. Foodservice workers are educated in food safety best practices and are held accountable for upholding health standards for the benefit of both the consumer and fellow employees. However, there is conflicting evidence as to whether routine inspections actually help decrease the risk of outbreaks and foodborne
illness (Buchholz, Run, Kool, Fielding, & Mascola, 2002; Cruz, Katz, & Suarez, 2001; Jones, Pavlin, LaFleur, Ingram, & Schaffner, 2004; Lee & Hedberg, 2016). These findings raise questions about the optimal inspection rate and how often inspections should take place. Providing answers could have important policy implications on how state funding is allocated for public health purposes.

Previous research has sought to determine whether frequency of inspection and risk classification schemes reflect a food establishment’s likelihood of incurring food safety violations. While there is some evidence that supports the premise that greater frequency of inspections are associated with higher inspection scores, i.e. more favorable food safety practices, (Allwood, Lee, & Borden-Glass, 1999; Leinwand, Glanz, Keenan, & Branas, 2017), several studies found no relation between frequency of inspection and food safety compliance measures (Medu et al., 2016; Newbold, McKeary, Hart, & Hall, 2008).

Health authorities may determine the frequency of inspections by the level of risk reflected in a food facility’s food handling practices. In general, foodservice establishments with a greater potential risk are inspected more often over a set timeframe. Given limits on state spending for public health, this methodology of spending a greater amount of resources on perceived higher risk establishments also makes fiscal sense. A study from Oklahoma found critical violation rates were significantly higher for “high risk” than “medium risk” establishments (Phillips, Elledge, Basara, Lynch, & Boatright, 2006). Public workforce cuts necessitated decreases in health inspection frequency in Louisiana in the early to mid 2000’s; establishments designated as risk category 4 (higher risk) had a greater proportion of critical violations compared to establishments of risk category 3 over the study period (lower risk) (Realmuto, Hunting, & Parkin, 2013). Chang, Rochani, Mase, & Aslan (2018) used longitudinal
data analysis to determine that foodservice operations in risk class IV (higher risk), compared to risk class III (lower risk), had higher odds of incurring food safety violations.

The present study sought to contribute to a better understanding of how risk classification schemes and frequency of health inspections correspond with food safety violations. Prior studies, however, have not addressed several nuances of health inspections which show a gap in the present knowledge. How the dependent variable is calculated varies across studies, but most commonly involves some quantification of health inspection violations (Table 1). There are a set number of food safety practices health inspectors check for as part of the food establishment assessment report. However, some food safety practices may not be applicable to the facility or may not be observed by the health inspector at the time of inspection. For example, in a facility that does not cook foods, “Proper cooking time and temperatures” would not be applicable. If an inspector comes during a serving period, he/she may not observe “Proper date marking and disposition” if this is normally done by employees at the end of the day during closing.
Table 1. Published studies on the relationship between health inspection violations, risk classification, and/or inspection frequency

<table>
<thead>
<tr>
<th>Author</th>
<th>Dependent Variable</th>
<th>Independent Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chang et al. 2018</td>
<td>Whether facility incurred violation that year (no violation or ≥ 1 violation)</td>
<td>Risk: Class I-IV (low to high)</td>
</tr>
<tr>
<td>Phillips et al. 2006</td>
<td>Violations per inspection</td>
<td>Risk: Medium or high</td>
</tr>
<tr>
<td>Realmuto et al. 2013</td>
<td>Whether facility incurred critical violation (yes or no)</td>
<td>Year of inspection</td>
</tr>
<tr>
<td>Realmuto et al. 2013</td>
<td>Average days between inspections</td>
<td>Facility incurred a violation: Yes or no</td>
</tr>
<tr>
<td>Medu et al. 2016</td>
<td>Violations per inspection</td>
<td>Inspections per year</td>
</tr>
<tr>
<td>Newbold et al. 2008</td>
<td>Violations per inspection</td>
<td>Inspections per year</td>
</tr>
<tr>
<td>Allwood et al. 1999</td>
<td>Inspection score</td>
<td>Inspections per year</td>
</tr>
<tr>
<td>Leinwand et al. 2017</td>
<td>Violations per inspection</td>
<td>Inspection frequency</td>
</tr>
</tbody>
</table>

Inevitably, there is variation among inspections across foodservice establishments in the quantity of applicable and not observed food safety practices. A more appropriate metric would be to control for this by calculating the number of violations observed in proportion to the total applicable and observed food safety practices an inspector noted. This would improve on studies that only measured total violations, whether a facility incurred a violation, or violations per inspection that did not account for total observed and applicable food safety practices, see Allwood et al. (1999), Chang et al. (2018), Newbold et al. (2008), Phillips et al. (2006) for examples of this approach. The next logical point of inquiry would be whether foodservice
establishments classified as high risk show more opportunities for food safety infractions through greater total observed and applicable food safety practices. For example, are there significant differences in potential food safety violations for a facility that only serves pre-packaged foods compared to a facility that prepares raw ingredients and cooks meals on site? If so, this would provide further justification for how often foodservice establishments are inspected and how they are classified based on risk.

To the best of the authors’ knowledge, no prior studies have taken these confounding variables into consideration and doing so may help further refine the connection between health department risk classification schemes and food safety violations. The objectives of the study were: 1.) determine if risk classification has a main effect on proportion of food safety violations, controlling for total number of applicable and observed food safety practices; 2.) determine if risk classification has a main effect on total applicable and observed food safety practices.

Methods

Data Source

The study did not classify as research involving human subjects and therefore IRB approval was not needed. Four thousand, two routine, unannounced health inspections from a 23-month period (2015-2017) for a single county in Arkansas were obtained from the Arkansas Department of Health. Food establishments were made anonymous by using an internal vendor ID prior to the data being given to the researchers. The Arkansas Department of Health uses a risk classification scheme for food establishments corresponding with high, medium, or low priority (Table 2), a slightly different taxonomy from that observed in previous studies (Chang et al., 2018; Phillips et al., 2006). Priority corresponds with the number of times per year a food
establishment gets inspected. High, medium, and low priority establishments are inspected thrice, twice, and once per year, respectively. Priority also takes into consideration how long a facility stays open during the year. For example, a facility that engages in high risk food preparation activities such as raw food preparation, cooking, cooling, and re-heating but operates for only three months out of the year would be classified as low priority. A facility open year-round that only sells pre-packaged, temperature controlled foods would also be considered low priority, but for other reasons (Table 2). The taxonomy to classify the relative risk may be conceptualized as a hybrid compared to what has been observed in prior studies (see Table 1).

The data set included 1316 different food establishments that were represented across the health inspections. The type of food establishment varied between retail, food mobiles, and schools among others (Table 3)
**Table 2.** Criteria of how food establishments are prioritized for health inspection frequency.

**Low Priority**  
A facility that:
- Prepares limited amounts of non-potentially hazardous foods.
- Sells prepackaged food.
- May have soft drink dispensing.
- Microwaves commercially prepackaged foods.
- May meet high or medium priority criteria, but establishment is only open for three months or less per year.
- Does not meet the high or medium priority criteria.

**Medium Priority**  
A facility that:
- Cooks and serves potentially hazardous foods.
- Holds hot foods for less than four hours.
- Discards all food that has been in hot holding.
- Is a retail grocery establishment with a meat market.
- Meets high priority criteria, but actively uses an HACCP plan.

**High Priority**  
A facility that requests a variance or meets any two of the following criteria:
- Prepares, cooks and serves potentially hazardous foods for later service.
- Holds multiple quantities/items (> 2 gallons) of hot food for four or more hours.
- Reheats multiple quantities/items (> 2 gallons) of leftover foods from previous servings or preparations.
- Serves to a highly susceptible population (schools, childcare, nursing home, hospital).

Arkansas Department of Health (2008)
<table>
<thead>
<tr>
<th>Priority</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retail</td>
<td>219</td>
<td>1968</td>
<td>665</td>
</tr>
<tr>
<td>Food mobile</td>
<td>112</td>
<td>31</td>
<td>0</td>
</tr>
<tr>
<td>Daycare</td>
<td>6</td>
<td>202</td>
<td>0</td>
</tr>
<tr>
<td>Food store</td>
<td>152</td>
<td>173</td>
<td>17</td>
</tr>
<tr>
<td>Public school</td>
<td>28</td>
<td>228</td>
<td>0</td>
</tr>
<tr>
<td>Private School</td>
<td>5</td>
<td>31</td>
<td>0</td>
</tr>
<tr>
<td>Deli/Bakery</td>
<td>0</td>
<td>114</td>
<td>6</td>
</tr>
<tr>
<td>Seasonal/kiosk</td>
<td>9</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Very small food</td>
<td>5</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Public school food</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>warehouse</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total number</td>
<td>539</td>
<td>2753</td>
<td>688</td>
</tr>
</tbody>
</table>

Food safety infractions are commonly classified as critical/priority or non-critical/core item violations, corresponding with activities that are more and less likely, respectively, to present a public health hazard. More specifically, the Arkansas Department of Health, from which data was sourced for this study, defined critical/priority items as quantifiable food safety practices that directly eliminate, prevent, or reduce hazards associated with foodborne illness or injury (Arkansas Department of Health, 2012). The permit holder of the food establishment is required to correct critical item violations at the time of inspection or within 10 days, depending on the nature of the violation. There were 27 critical items a health inspector could check for. Non-critical items are defined as good retail practices to control pathogens, chemicals, and physical hazards from contaminating foods and consisted of 28 more items. Violations with non-critical items require correction within 90 days.
Data Analysis

Violation rates for critical and non-critical items were calculated as follows:

\[
\text{Item violations} = \frac{\text{Total items} - (\text{items not applicable} + \text{items not observed})}{\text{Total items}}
\]

Mean violation rates and 95% confidence intervals about the mean were calculated for each food establishment priority. In addition to violation rates, differences in total applicable and observed items between food establishments were calculated. IBM SPPS Version 24 was used to analyze the data.

The histogram of frequency of violation rates showed a lack of normality with a heavy skew to the right for all food establishment classifications for both critical and non-critical violations. The lack of normality was confirmed by the Shapiro Wilk’s tests. The Levene’s Test showed the data violated the assumption of homogeneity of variance for both the critical \( F[2, 3999] = 96.386, p < .001 \) and non-critical violations \( F[2, 3999] = 191.74, p < .001 \). Because two of the three assumptions for using an ANOVA test were not met, Welch’s F test was chosen as the test statistic with an alpha level set at .05. Because the assumption of homogeneity of variance was not met, the Games-Howell post hoc procedure was used to determine which types of food establishments differed significantly.

For both total applicable and observed critical and non-critical items, the histograms that showed the frequency distributions was skewed slightly to the left, and the Shapiro Wilk’s test showed a lack of normality. The assumption of homogeneity of variances for total applicable and observed critical and non-critical items was not met, as confirmed by the Levene’s tests (critical violations: \( F[2, 3999] = 7532, p < .001 \); non-critical violations: \( F[2, 3999] = 10.64, p < .001 \)).
Like with the violation rates, Welch’s F test with an alpha level set at .05 was used as the test statistic given violations in key assumptions underlying the use of an ANOVA test, and the Games Howell procedure was used for the post-hoc tests. Adjusted omega squared was used to calculate effect sizes for the Welch’s F test and Glass’s delta was used to calculate post-hoc effect sizes, given unequal sample sizes in the independent variable (Ialongo 2016).

**Results**

**Violation Rates**

Descriptive statistics for critical and non-critical violation rates can be found in Tables 4 and 5, respectively. Mean critical violation rates for low, medium, and high priority facilities were .039, .053, and .105, respectively. Average critical violations per inspection were .65, 1.01, and 2.07 for low, medium, high priority establishments, respectively. Mean non-critical violation rates for low, medium, and high priority facilities were .024, .036, and .082 respectively. Average non-critical violations per inspection were .46, .73, and 1.73 for low, medium, high priority establishments, respectively. The high priority facilities had the highest critical and non-critical violation rates, followed by medium and low priority facilities. The data showed a significant main effect of food establishment risk classification for critical (Welch’s F[2, 1074.41] = 100.32, p < .001) and non-critical violation rates (Welch’s F[2, 1073.78] = 95.41, p < .001). The adjusted omega squared value for critical violation rates (ω² = .047) indicated approximately 4.7% of the variance is attributed to risk classification. The adjusted omega squared value for non-critical violation rate (ω² = .045) indicated approximately 4.5% of the variance is attributed to risk classification.
Table 4. Characteristics of critical violation rates of food establishments grouped by priority.

<table>
<thead>
<tr>
<th>Priority</th>
<th>Mean</th>
<th>SD</th>
<th>95% Confidence Interval for Mean</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>.039</td>
<td>.065</td>
<td>.033 - .045</td>
<td>0</td>
<td>.429</td>
</tr>
<tr>
<td>Medium</td>
<td>.053</td>
<td>.07</td>
<td>.05 - .055</td>
<td>0</td>
<td>.529</td>
</tr>
<tr>
<td>High</td>
<td>.105</td>
<td>.103</td>
<td>.097 - .112</td>
<td>0</td>
<td>.556</td>
</tr>
<tr>
<td>Total</td>
<td>.060</td>
<td>.079</td>
<td>.058 - .063</td>
<td>0</td>
<td>.556</td>
</tr>
</tbody>
</table>

Low priority food establishments ($M = .039, SD = .065$) had significantly lower critical violation rates than medium priority food establishments ($M = .053, SD = .07$) and high priority food establishments ($M = .105, SD = .103$) (Table 6). Medium priority food establishments had significantly lower critical violation rates than high priority food establishments. Concerning non-critical violations, low priority food establishments ($M = .024, SD = .051$) had significantly lower violation rates than medium priority food establishments ($M = .036, SD = .057$) (Table 7). Medium priority food establishments had significantly lower non-critical violation rates than high priority food establishments.

Table 5. Characteristics of non-critical violation rates of food establishments grouped by priority.

<table>
<thead>
<tr>
<th>Priority</th>
<th>Mean</th>
<th>SD</th>
<th>95% Confidence Interval for Mean</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>.024</td>
<td>.051</td>
<td>.02 - .028</td>
<td>0</td>
<td>.520</td>
</tr>
<tr>
<td>Medium</td>
<td>.036</td>
<td>.057</td>
<td>.034 - .038</td>
<td>0</td>
<td>.412</td>
</tr>
<tr>
<td>High</td>
<td>.082</td>
<td>.096</td>
<td>.075 - .089</td>
<td>0</td>
<td>.550</td>
</tr>
<tr>
<td>Total</td>
<td>.043</td>
<td>.068</td>
<td>.041 - .045</td>
<td>0</td>
<td>.550</td>
</tr>
</tbody>
</table>
Table 6. Post-hoc results for critical violation rates. Effect sizes calculated with Glass’s Δ.

<table>
<thead>
<tr>
<th>Priority</th>
<th>Mean</th>
<th>Mean Differences</th>
<th>(Effect Sizes are indicated in parentheses)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Low</td>
<td>.039</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td>.053</td>
<td>.014* (.2)</td>
<td>--</td>
</tr>
<tr>
<td>High</td>
<td>.105</td>
<td>.066* (.64)</td>
<td>.052* (.5)</td>
</tr>
</tbody>
</table>

*p < .001

Table 7. Post-hoc results for non-critical violation rates. Effect sizes calculated with Glass’s Δ.

<table>
<thead>
<tr>
<th>Priority</th>
<th>Mean</th>
<th>Mean Differences</th>
<th>(Effect Sizes are indicated in parentheses)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Low</td>
<td>.024</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td>.036</td>
<td>.012* (.21)</td>
<td>--</td>
</tr>
<tr>
<td>High</td>
<td>.082</td>
<td>.058* (.6)</td>
<td>.046* (.48)</td>
</tr>
</tbody>
</table>

*p < .001

Total Applicable and Observed Items

Descriptive statistics for total applicable and observed critical and non-critical violations can be found in tables 6 and 7, respectively. There was a main effect of food establishment risk classification on total applicable and observed critical and non-critical items, *Welch’s F*(2, 1081.16) = 242.1, *p* < .001 and *Welch’s F*(2, 1118.97) = 139.58, *p* < .001, respectively. The adjusted omega squared value for total applicable and observed critical items (ω²=.108) indicated approximately 10.8% of the variance is attributed to risk classification. The adjusted omega squared value for total applicable and observed non-critical items (ω²=.065) indicated approximately 6.5% of the variance is attributed to risk classification.
Table 8. Characteristics of total applicable and observed critical items for food establishments grouped by priority.

<table>
<thead>
<tr>
<th>Priority</th>
<th>Mean</th>
<th>SD</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>16.17</td>
<td>3.03</td>
<td>15.91</td>
<td>16.42</td>
<td>6</td>
<td>25</td>
</tr>
<tr>
<td>Medium</td>
<td>18.88</td>
<td>2.53</td>
<td>18.79</td>
<td>18.98</td>
<td>7</td>
<td>26</td>
</tr>
<tr>
<td>High</td>
<td>19.6</td>
<td>2.47</td>
<td>19.42</td>
<td>19.78</td>
<td>11</td>
<td>26</td>
</tr>
<tr>
<td>Total</td>
<td>18.65</td>
<td>2.78</td>
<td>18.56</td>
<td>18.73</td>
<td>6</td>
<td>26</td>
</tr>
</tbody>
</table>

The post hoc test showed significantly lower total applicable and observed critical items with low priority food establishments ($M = 16.17$, $SD = 3.03$) than medium ($M = 18.88$, $SD = 2.53$) and high priority food establishments ($M = 19.60$, $SD = 2.78$) (Table 10). Medium priority food establishments had significantly lower total applicable and observed critical items than high priority food establishments. Low priority food establishments ($M = 18.43$, $SD = 2.85$) also had significantly lower total applicable and observed non-critical violations than medium ($M = 20.23$, $SD = 2.63$) and high priority food establishments ($M = 20.96$, $SD = 2.41$) (Table 11). Medium priority food establishments had significantly lower total applicable and observed non-critical items than high priority food establishments.

Table 9. Characteristics of total applicable and observed non-critical items for food establishments grouped by priority.

<table>
<thead>
<tr>
<th>Priority</th>
<th>Mean</th>
<th>SD</th>
<th>Lower Bound</th>
<th>Upper Bound</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>18.43</td>
<td>2.85</td>
<td>18.19</td>
<td>18.67</td>
<td>8</td>
<td>25</td>
</tr>
<tr>
<td>Medium</td>
<td>20.23</td>
<td>2.63</td>
<td>20.13</td>
<td>20.33</td>
<td>8</td>
<td>28</td>
</tr>
<tr>
<td>High</td>
<td>20.96</td>
<td>2.41</td>
<td>20.78</td>
<td>21.14</td>
<td>12</td>
<td>27</td>
</tr>
<tr>
<td>Total</td>
<td>20.12</td>
<td>2.72</td>
<td>20.03</td>
<td>20.2</td>
<td>8</td>
<td>28</td>
</tr>
</tbody>
</table>
Foodborne illness is costly from a human health and economic standpoint. An estimated 3,000 fatalities annually result from foodborne disease in the U.S. (Scallan, Hoekstra, et al., 2011; Scallan, Griffin, et al., 2011), costing approximately $15.6 billion annually, taking into account medical expenses and lost income (USDA ERS, 2014). Federal, state, and local health authorities play a role in foodborne illness prevention across the entire supply chain spanning from the farm to the point of purchase. State health departments are responsible for inspecting foodservice establishments to determine adherence to appropriate food safety practices. Analyzing health inspections can help provide justification for inspection frequencies and risk classification schemes. The objective of the present study was to address a gap in the literature.
by accounting for variations in health inspections in validating whether foodservice establishments labeled as higher risk are more likely to incur food safety violations.

The results of this limited analysis support the current system used by the state department to categorize food facilities and prior work on risk classification schemes (Chang et al., 2018; Phillips et al., 2006; Realmuto et al., 2013). The present research supports government spending on health inspections as a function of the classified risk of the foodservice establishment. Food facilities deemed a high priority and thus inspected three times per year had significantly higher critical and non-critical violation rates compared to medium and low priority facilities inspected twice and once per year, respectively. Food safety practices associated with high priority facilities are difficult to adhere to and are linked with restaurant associated foodborne illness outbreaks attributed to food handler practices (Angelo et al., 2017).

The total applicable and observed items for each priority classification further justify how food facilities are grouped. High priority foodservice establishments had significantly higher total applicable and observed items than medium and low establishments. High priority facilities are responsible for adhering to a greater number of food safety practices, and in some cases, serving immunocompromised populations such as children and the elderly. This translates to more opportunities for food safety infractions and a potential increased risk of foodborne illness transmission. The results are notable given how some facilities that engage in high risk food preparation practices but are only open a fraction of the year may be classified as medium or low priority. Facilities that meet these criteria may have thus inflated the average total and observable items for medium and priority facilities. Even taking this into consideration, there were still significant differences between all three categories, providing further substantiation to the risk classification scheme.
The results reflect how risk classification contributes a small portion of the variance in observed critical and non-critical violation rates, and that risk classification has a small to medium effect size on violation rates. This supports prior research which has shown the myriad of factors that influence food safety outcomes determined via health inspections, some of which reach well beyond the scope of this study. Aside from risk classification schemes, prior research has shown health inspection scores can vary by year, the health inspector, type of restaurant, and level of service (Burkink, Hughner, & Marquardt, 2004; Harris, DiPietro, Murphy, & Rivera, 2014; Kwon, Roberts, Shanklin, Liu, & Yen, 2010; Lee, Nelson, & Almanza, 2010, 2012). One variable worth noting is facility type, specifically with regards to public schools.

Most public school cafeterias represented in this study’s data set are classified as medium priority foodservice establishments. Public school cafeterias are typically open two-thirds of the year and must have and use a HACCP plan as a requirement to participate in the USDA commodity food program. Furthermore, the Arkansas Department of Education mandates that cafeteria managers attend annual food safety training. Purely from a descriptive statistics standpoint, of all facility types public schools had the lowest average critical violation rates, $M = .018; SD = .036$, despite also having the highest average total applicable and observed critical food safety items, $M = 19.67; SD = 2.49$. HACCP plans constitute food safety management systems which contribute to the food safety culture of a food establishment that can influence food handling behaviors (Clark, Crandall, & Reynolds, 2018). Additionally, mandatory certification of cafeteria managers may also have contributed to the lower violation rates, given evidence from prior research (Cates et al., 2009). Policy makers should carefully consider requiring HACCP plans and/or mandatory manager food safety training to reduce the number of required annual health inspections under the current system. This might be one solution that
could have a positive impact on public health, while decreasing state environmental health expenses and lowering the workload of health inspectors. The potential positive benefits of these changes should be weighed against the potential negative effects of reducing health inspection frequencies, as observed in prior research (Realmuto et al. 2013).

**Limitations**

Causality has been referred to as, “the cinnamon bun of social science…a sticky concept” that is often difficult to establish (Hayes, p. 17, 2013). Prior research has shown health inspections are not an infallible reflection of foodborne disease outbreak risk (Cruz et al., 2001; Jones et al., 2004; Lee & Hedberg, 2016). As mentioned previously, food safety practices documented through health inspections are influenced by many variables, risk classification being just one of them.

This study only focused on routine health inspections, and complaint inspections may have provided more insight into the relationship between risk classification and violation rates. The study covered a two year time span and data from a longer period may have revealed additional findings. Some of the health inspections were from the same food establishment; hierarchical linear modeling would therefore be an appropriate statistical method for the data set that future research should consider employing, also given how the data was longitudinal in nature. Lastly, more research could determine the relation between risk classification and violations in specific food safety practices, rather than critical and non-critical violation rates as a whole.
Conclusion

Economic difficulties can put pressure on state health departments to make budgets cuts which can result in fewer routine health inspections. Before making major policy decisions, health authorities should carefully assess the current body of literature on the association between risk and health inspection frequency. The results in this study show the risk classification scheme used by the state health department coincides with health inspection violation rates and total applicable and observed food safety items. As prior research has indicated, the relationship between health inspection scores and foodborne illness transmission risk may be moderated by variables such as facility type among others. Policy makers should explore ways to reduce the risk of foodborne illness in a cost-efficient way, which, based upon the results of this study, might include mandating HACCP plans to cut down on required health inspections. Future research should continue to test statistical models that account for the numerous variables to further elucidate the relation between health inspection scores and risk.

Conflict of Interest

The authors declare no conflict of interest, financial or otherwise, related to the subject of the manuscript.

Disclaimer

The Arkansas Department of Health does not guarantee the accuracy of the information, and the views expressed in this paper are not necessarily those of the Arkansas Department of Health.
References


Overall Conclusions

The foodservice industry continues to expand, warranting careful consideration of the food safety practices of food handlers that play a role in decreasing the risk of foodborne illness transmission. This dissertation focused predominantly on handwashing practices, given the causal link between hand hygiene and disease transmission, as well as the low compliance rates observed in the food industry. Poor compliance with handwashing is a multi-faceted problem demanding a multi-faceted solution. I approached the issue of compliance in chapter one through conducting an extensive review of the literature. A theoretical framework was presented through the Intervention Ladder that focused on the psychological implications of different strategies to promote handwashing compliance.

Chapter two sought to understand handwashing at the fundamental level by observing behavior of food handlers in an early childhood center. This study revealed an average compliance rate of 22%. These results do not reflect negligent child care personnel, but instead denote how information obtained from viewing human behavior under a microscope should be interpreted cautiously. This study ultimately highlights the sheer impracticality of full handwashing compliance in foodservice and raises questions of how best to quantify risk. Full handwashing compliance would require child care personnel devote 12 minutes/hour or 20% of their time, far from practical. Our data aligns with a review which calculated 6-24 minutes/hour would need to be devoted to handwashing across the eight foodservice studies included as part of the analysis (Fraser et al. 2012). These numbers raise several questions: 1.) Were the handwashing guidelines designed for full compliance? 2.) Are the guidelines more of an impossible goal to strive for in the hopes that simply aiming high will result in favorable outcomes?
Data collection required an objective approach for the sake of consistency that may not reflect the risk of each handwashing infraction. In other words, not all handwashing infractions carry the same level of risk. As Fraser et al. (2012, p. 757) alludes to, “It is not logical to treat all actions as equally risky and prescribe the same degree of rigor in hand hygiene across all tasks when some are clearly more risky than others.” Thus, it could be said that the prescribed handwashing guidelines are behavior based, rather than risk based. This raises additional questions about the claim that poor handwashing compliance among food handlers is a serious issue in foodservice to begin with, especially considering some of the most recent data on the link between food handler practices and restaurant associated outbreaks.

According to Angelo et al. (2017), a significant percentage of restaurant associated outbreaks from 1998-2013 linked with at least one contributing factor are from cross contamination by infectious, non-food handers rather than the food handlers themselves. Contributing factors due to poor foodservice worker hygiene are associated with contamination due to working while sick. Based on this information, a more accurate claim might be poor handwashing compliance of both foodservice workers and restaurant patrons thought to be sick is a serious issue.

In making these claims I am by no means saying handwashing compliance should not be enforced; any level of handwashing compliance above zero contributes to decreasing the risk of foodborne illness, however minute that risk might be. Rather, my hope is that this information would help direct and funnel resources and research to where it is needed to ultimately decrease the number of people affected each year by foodborne illness.

Future research might investigate the role of paid sick leave in mitigating foodborne illness and determining how common paid sick is in the food industry. Anecdotal evidence
suggests this practice is more the exception rather than the rule. Another line of research might be to investigate how government and businesses could collaborate to take a more pro-active approach in facilitating that sick employees can stay home without fear of losing their jobs.

Chapter three focused on the food safety climate factors that may influence handwashing practices, which involved measuring food handler attitudes towards handwashing. Perceived managerial commitment to handwashing was the only variable that contributed to a significant portion of the variance in handwashing indicators, highlighting the important role of managers in promoting food safety practices.

Three chapters took a more technologically advanced approached to understanding the effects of foodservice training design on measurable outcomes. Chapter four found handwashing training filmed from the first-person perspective using an action camera was preferred by almost twice as many food handlers compared to an analogous video filmed using the third person perspective. This study showed the potential for novel media presentations to better engage employees and promote motivation to wash hands. The big question is whether training design can have a noticeable and significant enough effect to change employee behavior. The results also raise questions of how much should be invested in food safety training design if food safety behavior compliance can be readily undermined by a host of other factors including management, work environment, and other employees.

Food safety and food handler trainings were developed for smart glasses and tested in chapters five and six. Chapter five revealed how participants in the strictly video-based group were four times more likely to wash hands compared to the smart glasses group. These results were attributed to two factors that may have undermined remembering to wash hands at the prescribed moments in the future, 1.) participants in the smart glasses group washed hands while
viewing the training, resulting in embodied cleansing, or a decreased desire to wash hands, and 2.) positive effects of embodied learning may be contingent upon the type of learning involved. Future research should account for these variables to determine the optimal design factors with smart glasses that maximize training transfer.

Chapter six assessed the educational properties of smart glasses-based foodservice training in comparison to strictly video-based training. The findings revealed that smart glasses were a more efficient training modality, in that participants completed the training at the workstation. Participants in the strictly video-based group watched the training in a separate room and then executed the training material at the workstation. The efficiency of smart glasses may be contingent upon how quickly users are able to learn the technology. In our study, most users were able to adapt quickly, but a more focused sample of food handlers would help determine whether this holds true. Those considering using smart glasses in foodservice should carefully weigh their costs and benefits; history has shown people learn regardless of the training medium used (Resier 2001).

In chapter seven a handwashing video game was developed. Perceptions were assessed of its potential acceptance in a food handling environment and whether it would be a useful tool for promoting handwashing compliance. Perceptions of the device were only slightly positive, indicating the need to either design a better device or to utilize alternative, more cost-effective methods for motivating handwashing.

Handwashing practices of food handlers comprised the bulk focus of this dissertation. Two chapters deviated from this emphasis on handwashing to address other issues in the food industry. Chapter eight assessed the relationship between perceptions of job insecurity rendered by robotics and automation in the hospitality industry and self-reported emotional intelligence.
There were no significant correlations observed between job insecurity and self-reported emotional intelligence. However, students with both front and back of the house experience showed greater self-reported emotional intelligence across three subscales in comparison to students with work experience in only the front of the house or the back of the house. These findings may indicate that students could be better prepared for foodservice careers through employment in roles that necessitate varying degrees of emotional labor.

The last study in this dissertation sought to understand the relationship between foodservice establishment risk classification and food safety practices by taking into consideration the nuances of health inspections in measuring violation rates. Violation rates were a function of food safety practices that accounted for both non-applicable and non-observed items. Main effects were found for risk classification on violation rates for both critical and non-critical violations. These results validated the current risk classification scheme employed by the Arkansas Department of Health. The study highlighted the possible positive influence of mandatory food safety training of public school kitchen managers and food safety management systems in public schools. The results raise questions of whether food safety management plans like HACCP should be required for all permit holding foodservice establishments. Mandating HACCP plans could, in theory, decrease the amount of yearly health inspections required by the state. This could result in costs savings and greater compliance with food safety practices.
Appendix
Research Compliance Protocol Letters

IRB # 15-07-027

MEMORANDUM

TO: Jeffrey Clark
Jennifer Hank
Corlisa O'Bryan
Mardi Crandall
Philip Crandall

FROM: Ru Windwalker
IRB Coordinator

RE: New Protocol Approval

IRB Protocol #: 15-07-027

Protocol Title: Reducing the Risk: Understanding and Promoting Hand Washing among Parents and Teachers of Young Children

Review Type: ☒ EXEMPT ☐ EXPEDITED ☐ FULL IRB

Approved Project Period: Start Date: 08/03/2015 Expiration Date: 08/02/2016

Your protocol has been approved by the IRB. Protocols are approved for a maximum period of one year. If you wish to continue the project past the approved project period (see above), you must submit a request, using the form Continuing Review for IRB Approved Projects, prior to the expiration date. This form is available from the IRB Coordinator or on the Research Compliance website (https://vpred.uark.edu/unlisa/sup/index.php). As a courtesy, you will be sent a reminder two months in advance of that date. However, failure to receive a reminder does not negate your obligation to make the request in sufficient time for review and approval. Federal regulations prohibit retroactive approval of continuation. Failure to receive approval to continue the project prior to the expiration date will result in Termination of the protocol approval. The IRB Coordinator can give you guidance on submission times.

This protocol has been approved for 15 participants. If you wish to make any modifications in the approved protocol, including enrolling more than this number, you must seek approval prior to implementing those changes. All modifications should be requested in writing (email is acceptable) and must provide sufficient detail to assess the impact of the change.

If you have questions or need any assistance from the IRB, please contact me at 109 MLKG Building, S-2208, or irb@uark.edu.
MEMORANDUM

TO: Jeffrey Clark
    Amandeep Singh
    Phil Crandall

FROM: Ro Windwalker
      IRB Coordinator

RE: PROJECT MODIFICATION

IRB Protocol #: 17-04-626

Protocol Title: Exploring Food Handler Practices, Attitudes, Working Conditions, and Training Reactions

Review Type: ☑ EXEMPT ☐ EXPEDITED ☐ FULL IRB

Approved Project Period: Start Date: 06/22/2017 Expiration Date: 04/26/2018

Your request to modify the referenced protocol has been approved by the IRB. This protocol is currently approved for 150 total participants. If you wish to make any further modifications in the approved protocol, including enrolling more than this number, you must seek approval prior to implementing those changes. All modifications should be requested in writing (email is acceptable) and must provide sufficient detail to assess the impact of the change.

Please note that this approval does not extend the Approved Project Period. Should you wish to extend your project beyond the current expiration date, you must submit a request for continuation using the UAF IRB form “Continuing Review for IRB Approved Projects.” The request should be sent to the IRB Coordinator, 109 MLKG Building.

For protocols requiring FULL IRB review, please submit your request at least one month prior to the current expiration date. (High-risk protocols may require even more time for approval.) For protocols requiring an EXPEDITED or EXEMPT review, submit your request at least two weeks prior to the current expiration date. Failure to obtain approval for a continuation on or prior to the currently approved expiration date will result in termination of the protocol and you will be required to submit a new protocol to the IRB before continuing the project. Data collected past the protocol expiration date may need to be eliminated from the dataset should you wish to publish. Only data collected under a currently approved protocol can be certified by the IRB for any purpose.

If you have questions or need any assistance from the IRB, please contact me at 109 MLKG Building, 5-2208, or irb@uark.edu.

109 MLKG • 1 University of Arkansas • Fayetteville, AR 72701-1201 • (479) 575-2208 • Fax (479) 575-6527 • Email irb@uark.edu

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IRB # 1710074661

To: Jeffrey Allan Clark
    BELL 4188
From: Chair, Douglas James Adams
      IRB Committee
Date: 11/16/2017
Action: Specific Minor Revisions Required
Action Date: 11/16/2017
Protocol #: 1710074661
Study Title: Assessing the Efficacy of Wearable Technology to Improve Food Handler Training Outcomes

The IRB Committee that oversees research with human subjects reviewed the above mentioned protocol and determined that specific minor revisions are required. These revisions are noted below. If you agree with all of the committee’s revisions, incorporate them in a revised protocol and/or consent form and submit it to the IRB Committee for expedited review. If you disagree with the committee’s recommendations, you may do the following: Please justify to the IRB Committee why the revisions should not be incorporated.

Correspondence Notes:
- Please add a statement to the Questionnaire section of the Protocol and the Screening Recruitment Materials about what will happen to pre-screening data if participants are ineligible for the study (e.g., data will be destroyed).

cc: Philip G Crandall, Investigator
    Seth W Ellisworth, Investigator
To: Jeffrey Allen Clark
    BELL 4188
From: Douglas James Adams, Chair
      IRB Committee
Date: 12/04/2017
Action: Expedited Approval
Action Date: 12/04/2017
Protocol #: 1710074661
Study Title: Assessing the Efficacy of Wearable Technology to Improve Food Handler Training Outcomes
Expiration Date: 11/15/2018
Last Approval Date:

The above-referenced protocol has been approved following expedited review by the IRB Committee that oversees research with human subjects.

If the research involves collaboration with another institution then the research cannot commence until the Committee receives written notification of approval from the collaborating institution's IRB.

It is the Principal Investigator's responsibility to obtain review and continued approval before the expiration date.

Protocols are approved for a maximum period of one year. You may not continue any research activity beyond the expiration date without Committee approval. Please submit continuation requests early enough to allow sufficient time for review. Failure to receive approval for continuation before the expiration date will result in the automatic suspension of the approval of this protocol. Information collected following suspension is unapproved research and cannot be reported or published as research data. If you do not wish continued approval, please notify the Committee of the study closure.

Adverse Events: Any serious or unexpected adverse event must be reported to the IRB Committee within 48 hours. All other adverse events should be reported within 10 working days.

Amendments: If you wish to change any aspect of this study, such as the procedures, the consent forms, study personnel, or number of participants, please submit an amendment to the IRB. All changes must be approved by the IRB Committee before they can be initiated.

You must maintain a research file for at least 3 years after completion of the study. This file should include all correspondence with the IRB Committee, original signed consent forms, and study data.

cc: Philip G Grandall, Investigator
    Seth W Ellsworth, Investigator
To: Philip G Crandall  
FDSC N-213

From: Douglas James Adams, Chair  
IRB Committee

Date: 08/22/2018

Action: Exemption Granted

Action Date: 08/22/2018

Protocol #: 1807130262

Study Title: Assessing Perceptions of Job Security and Motivational Influencers of a Handwashing Video Game

The above-referenced protocol has been determined to be exempt.

If you wish to make any modifications in the approved protocol that may affect the level of risk to your participants, you must seek approval prior to implementing those changes. All modifications must provide sufficient detail to assess the impact of the change.

If you have any questions or need any assistance from the IRB, please contact the IRB Coordinator at 109 MLKG Building, 5-2208, or irb@uark.edu.

cc: Jeffrey Allen Clark, Investigator