5-2015

Effect of Sensory Cues on Hand Hygiene Habits Among a Diverse Workforce in Food Service

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A thesis submitted in partial fulfillment
of the requirements for the degree of
Master of Science in Food Science

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May 2015
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Abstract

Poor hand hygiene is a leading cause of foodborne illnesses in the foodservice industry. A series of complex motivational interventions must be employed to permanently change the behavior of workers, to increase their compliance and sustain appropriate levels of proper hand hygiene. Unlike the healthcare industry, which uses large, costly multi-modal behavior modification strategies, the foodservice industry must deploy rapid, cost-efficient strategies that are focus on accommodating these goals with the constraints of high employee turnover rates and diverse demographics. This research was twofold, 1) examining differences in emotions and hand hygiene behavior among participants of two cultures when handling common foods and 2) comparing prospective memory reminders across three basic senses (sight, hearing and smell) for individuals of Hispanic / Latino descent. Results showed hand washing behavior was affected by the type of food being handled and the intensity of the emotion of disgust. Individuals washed their hands more frequently after handling foods they perceived as more hazardous, and their motives to wash varied among variables of gender (self-protection for men, carryover effects for women), culture (self-protection for Caucasians, texture for Hispanics) and the type of food (self-protection for chicken, smell for fish). Additionally, as the feeling of disgust increased among individuals their probability to wash their hands also increased. In our second study, we showed that common, non-provoking visual cues are not as effective at increasing hand hygiene compliance as disgust-induced sensory cues. Furthermore, olfactory disgust, which is an underutilized motivator in interventions, showed a significantly higher probability that individuals would engage in hand washing behaviors than all other stimuli. This knowledge is important for future behavioral interventions that may need to be modified by food type or diversity, and extends current intervention techniques by introducing and comparing disgust-

related sensory cues to decrease miscommunication and the intention-behavior gap associated with preforming required routine behaviors such as complying with proper hand hygiene.

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Pellegrino, R., Crandall, P. G., & Seo, H. S. (2015). Hand washing and disgust response to handling different food stimuli between two different cultures. Food Research International, In press.

Introduction

Preventing food borne illness by proper hand washing, is perhaps the single most important component to significantly reducing the transmission of infectious disease (Bloomfield, Cookson, Falkiner, Griffith, & Cleary, 2007; U.S. Food and Drug Administration, 2010). Unfortunately, lack of hand washing (Green et al., 2006; U.S. Food and Drug Administration, 2009) has been shown to be a major contributor to food borne illness outbreaks in the food service industry (Mead et al., 1999; Hillers, Medeiros, Kendall, Chen, & Dimascola, 2003; Lynch, Elledge, Charles, Griffith, & Boatright, 2003). For example, one study showed that less than 3 out of 10 of employees' self-reported hand hygiene behaviors complied with the FDA Model Food Code (Green et al., 2005). In another study by Green et al. (2006) basic hygienic practices with food workers were observed in 333 randomly selected restaurants across Colorado, Connecticut, Georgia, Minnesota, Oregon, and Tennessee. Results showed food service workers in these restaurants only attempted to wash their hands one-third of the times when their food contact activities required hand washing. Of these 1/3 attempts, only 27% washed their hands properly. So we are left with slightly more than 10% compliance of restaurant employees using proper hand washing when required. These studies and others beg the question, why after decades of employee personal hygiene training, untold millions of posters and talks by managers encouraging employees to properly wash their hands is the compliance so abysmal? Behavioral change is complex and multifaceted (Larson, Bryan, Adler & Blane, 1999; Larson, Early, Cloonan, Sugrue, & Parides, 2000; Pittet et al., 2000; Jumaa, 2005) and theories needs to consider education, culture, motivation and system change in order to create a sustainable effect (Pittet, 2004; Neal, Dawson, & Madera, 2012).

To date, most training models aim at improving hand hygiene in the food service industry by narrowly focusing just on hand hygiene as a behavior (Nieto-Montenegro, Brown, & LaBorde, 2008; York et al., 2009; Soon & Baines, 2012). This includes using behavioral models such as training and education, Theory of Planned Behavior (TPB) and Health Belief Model (HBM) (Roseman & Kurzynske, 2006; Milton & Mullan, 2012; Soon & Baines, 2012). However, hand hygiene in not just a behavior; it is a habitual, automatic practice that is influenced by past behavior and these past behavior influences probably have their roots in childhood (Whitby, McLaws, & Ross, 2006; Aunger, 2007; Whitby et al., 2007). This habit is also comprised of an inherent hand hygiene behavior which is associated with the emotion of "disgust" or an evolutionary response to environmental factors that would have minimized the risk of self-infection (Curtis & Biran, 2001; Whitby, McLaws, & Ross, 2006). In addition to habit-oriented requirements, successful interventions must also consider the individual receiving the training and the diversity of today's workforce in the food service industry.

Unlike the healthcare industry, which has significant resources to implement costly multi-modal behavior modification strategies, the foodservice industry must deploy rapid, highly cost-efficient strategies that accommodate its high employee turnover rates and diverse demographics (Fenton, LaBorde, Radhakrishna, Brown & Cutter, 2006; Pilling, Brannon, Shanklin, Howells & Roberts, 2008; Madera, Neal, & Dawson, 2010). The food service industry is the single largest employer of immigrants in the United States (Jackson, 2008). It is estimated that 1.4 million immigrants work in the food service industry, accounting for 10% of the entire labor force (Bendick, Rodriguez, & Jayaraman, 2010). For example, according to the United States Bureau of Labor Statistics (2012), Hispanics workers are employed in 1/3 of the animal slaughtering and processing industry and are heavily represented in the further processing industries. In addition to documented workers, an estimated 12% of all undocumented workers are employed in the food service and food preparation occupations (Passel, 2006), where 20% of these workers are employed as primary food handlers and in food preparation as chefs, head cook, and cooks (Kershaw, 2010). For this reason, hand hygiene intervention must consider cultural and religious learning differences (Po, Bourquin, Occena, & Po, 2011; Neal, Dawson, & Madera, 2012), as well as adapt learning techniques to employees whose primary language is not English (Fraser, 2000; Fraser & Alani, 2009).

The habit of washing your hands after using the bathroom is learned at a very young age and is commonly held among most cultures (Curtis, Danquah, & Aunger, 2009; Aunger et al., 2010). But little is known about the cultural component of hand hygiene habits during food preparation and food handling. The appearance and texture of food can modulate emotions and these emotions may influence behavior (Rousset, Deiss, Juillard, Schlich, & Droit-Volet, 2005; Gibson, 2006; Desmet & Schifferstein, 2008). To date, most evidence to changes in hand hygiene behavior only emphasize the emotion of disgust and does not take into account cultural differences (Judah et al., 2009; Porzig-Drummond, Stevenson, Case, & Oaten, 2009). For instance, do emotions provoked by different foods vary among diverse cultures? Additionally, can old habits be used to change existing habits, and can emotional components help segue this transformation? The experiments outlined in this paper are setup to determine these and similar questions and provide the food industry with more information to make appropriate hand washing interventions that are suitable for relevant cultures. It also examines hand hygiene as a habit and tests novel approaches to increasing compliance among diverse cultures.

Chapter 1: Literature Review

A review of motivational models for improving hand hygiene among an increasingly diverse food service workforce.

Introduction

At the 2011 Global Food Safety Conference in London, Frank Yiannas, Vice President of Food Safety for Walmart USA, ended his plenary remarks with, “That’s my personal take home message: food safety equals human behavior” (GFSI, 2011). Yiannas underlined the critical role of motivating and training employees in order to take the safety of our food supply to the next, higher level. It is estimated that companies in the United States annually spend about $62 billion on workforce training (Bersin, 2013), so the food industry already spends an enormous amount of resources on training their employees. The World Health Organization (WHO) has developed scientifically sound, simple health messages targeting food service employees and consumers in an effort to reduce the world-wide burden of food borne illnesses (WHO, 2012). Among the five key behaviors noted the number one message is to keep the food preparer and the food preparation area clean to minimize cross contamination by pathogens.

In 2011, the Centers for Disease Control and Prevention estimated that there are 9.4 million episodes of food borne illness, 55,961 hospitalizations, and 1,351 deaths in the United States each year (Scallan et al., 2011). Hand washing may be the single most important component to significantly reducing the transmission of food borne illnesses (Guzewich & Ross, 1999; Green et al., 2007; Lues & Van Tonder, 2007; Todd, Greig, Bartleson & Michaels, 2008; FDA, 2009). For example, Olsen, MacKinon, Goulding, Bean & Slutsker (2000) found that poor personal hygiene of food workers was a contributing factor in up to 38% of food borne illness outbreaks between 1993 and1997, and Guzewich and Ross (1999) found that pathogens were transferred to food by workers' hands in 89% of outbreaks caused by contaminated food. A study using self-reported hand hygiene behaviors of food service employees reported that less than 30% of employees complied with the recommendations in the FDA Model Food Code (Green et al., 2005). In another study by Green et al. (2006), basic hygienic practices among food workers were observed in more than 300 randomly selected restaurants across six states. Results showed foodservice workers in these restaurants only attempted to wash their hands one-third of the times when their food contact activities required hand washing. Of these 1/3 attempts, only 27% washed their hands properly. In the 2009 FDA report on the occurrence of foodborne illness risk factors in selected institutional, restaurant and retail store facility types, researchers found that employee noncompliance with proper and adequate hand washing regulations ranged from 27% for elementary school food service employees to 76% for employees at full-service restaurants (FDA, 2009). These studies and others beg the question of why, after decades of employee personal hygiene training, untold millions of posters and talks by managers encouraging employees to properly wash their hands is the compliance so abysmal? Proper hand hygiene must begin with properly motivated employees. Unmotivated employees who may possess the correct knowledge but are lax in their hand washing behavior are a major contributor to foodborne outbreaks that lead to making customers sick. Obviously, motivating employees to make long-term behavioral changes is complex. In this review we will briefly discuss the demographics of the retail food service work force. We will then discuss several strategies for implementing behavioral change, especially how habits are formed and what types of motivation produce changes in long term behavior of workers. This review also evaluates sensory cues and cognitive mechanisms that may lead to a development of good hand washing habits among workers with large demographic differences by using basic senses, relating inherent, congruent acts, and leveraging the cross-cultural emotion of disgust.

Demographics of the retail foodservice industry

The foodservice industry is the single largest employer of immigrants in the United States (Jackson, 2008). The Hispanic population remains the second largest ethnic group in the U. S., representing 17 percent of the country's population just behind African Americans (U. S. Census Bureau, 2013). Data from the U.S. Census Bureau also shows that Asians were the nation's fastest-growing ethnic group in 2012 (U.S. Census Bureau, 2013). These growing ethnic groups are becoming more and more prominent in the U. S. workforce, especially in the foodservice industry (Olsen, 2012). It is estimated that 1.4 million immigrants work in the foodservice industry, accounting for nearly 10% of the entire foodservice labor force (Bendick, 2010). For example, the U.S. Equal Opportunity Commission (2008) reported that 24% of all employees, 25% of service workers, and 13% of first- and midlevel managers for foodservice and drinking places were Hispanic. In addition to documented workers, an estimated 12% of all undocumented workers (a total of 7.2 million) are employed in the foodservice and food preparation occupations (Passel, 2006), where one out of five of these workers are employed as primary food handlers and in food preparation as chefs, head cook, and cooks (Kershaw, 2010).

Although the retail food industry has embraced these immigrant workers, language difficulties present a communication barrier for both employers and workers (Loosemore & Lee, 2001). In fact, U.S. census data show that approximately 46% of foreign-born workers have limited English proficiency and that nearly 73% of immigrant workers with limited English proficiency speak Spanish as a first language (Capps, Fix, Passel, Ost, & Perez-Lopez, 2003; Shin & Bruno, 2003). Larson et al. (2013) agreed that sustained motivation is the key to employees complying with proper hand hygiene requirements. Forming and maintaining an unwavering "habit" of proper hand hygiene could significantly reduce both the morbidity and mortality of foodservice and retail food consumers.

Strategies of behavioral change

With the emergence of *Staphylococcal* epidemics in health care settings in the 1950's, the effects of poor hand hygiene in the hospital environment became strikingly evident and started a national campaign to find ways to increase employee hygiene compliance (Mortimer, Wolinsky, Gonzaga, & Rammelkamp, 1966). Many of the early hospital based interventions relied on evidence-based education and repetitive training to increase the rates of hand washing. These types of approaches were shown to initially increase compliance, but were found to be non-sustainable (Boyce & Pittet, 2002; Gould et al., 2007). One study indicated that knowledge interventions that rely solely on knowledge sharing, such as traditional lectures that provided employees information, were ineffective in instituting or sustaining changes in behavior (Evans & McCormack, 2008). Learning behaviorists analyzed the results from many of these failed early training attempts and came to believe that most hand hygiene training failed to prepare employees for on-job barriers to hand washing and help them become active problem solvers (Gould, 2004).

Cognitive theories provided an understanding that employee behavioral change must begin with a consideration of the complexities of compliance, and intervention should focus on the educational, cognitive dimensions preparing the employees for the requirements of employment in the workforce (Larson, Bryan, Adler, & Blane, 1997). However, these techniques might actually discourage employees from washing their hands because a subset of employees viewed the goals of the cognitive training as impractical (O'Boyle, Henley & Larson, 2001). In light of these failed strategies, which resulted in low compliance rates and little behavioral change, many researchers started to look outside the realm of education, borrowing from other disciplines which incorporated individual, social, organization, and self-protection influences.

Training based on social strategies

Health care workers in the same ward have been shown to display significantly different hand hygiene behaviors, suggesting that individual hygiene compliance influences are both individual and community derived (Whitby et al., 2007). Taking similar findings into account, motivational models have been used to incorporate intrapersonal and social factors into intervention development and access its success. Two popular training models are the Health Belief Model (HBM) and Theory of Planned Behavior (TPB) (Ajzen, 1988; Kretzer & Larson, 1998). The HBM model asserts that four principles guide individuals' attitudes regarding health behavior: perceived susceptibility, perceived severity of a condition, perceived benefits of treatment, and perceived barriers to treatment. It also assesses individuals' belief in their ability to overcome perceived barriers to target behavior (Ajzen, 1991). According to TPB, intention is the main precursor to actual behavior, guided by an individual's perceived behavioral control, attitudes and subjective norms. While HBM and TPB interventions to promote hand hygiene have mainly been reported in the healthcare sector (Roseman & Kurzynske, 2006; Larson, 2009; Milton & Mullin, 2010), many foodservice trainers have also begun incorporating these theories into their hygiene campaigns (Nieto-Montenegro, Brown, & LaBorde, 2008; York, 2008; Soon & Baines, 2012). The principal weakness with TPB and similar models is their sole dependence on intention as a predictive means for making sustained changes in employee behavior. According to Ajzen (1991), intention is the mediator between attitudinal beliefs and actual behavior which depends on cognitive elements such as personal attitude, subjective norms, and perceived behavioral control.

For hand hygiene, intentions are not a good predictor of sustained behavior change because only minimal, sporadic thought is required to initiate, implement, and then terminate actions that in the past have been repeated in stable contexts (Ouellette & Wood, 1998). This may result in the employee deciding to skip, "just this once", proper hand-hygiene to which they were faithfully adhering because he feels especially pressured or rushed. Additionally, 50% to 60% of the variance in human behavior is unexplained in longitudinal studies, which may account for the majority of the compliance failures in outcome assessment studies in foodservice (Orbell & Sheeran, 2000). Issues among standard predictive models of social psychology become even more apparent when you consider the habit forming nature of most foodservice jobs (Wood & Quinn, 2002). This being said, as the current behavior becomes increasingly habitual in nature, the reliance on intention as a predictor of behavior actually decreases (Aarts, Paulussen & Schaalma, 1997; Ouelette & Wood 1998). Additionally, a point that must be kept in mind, especially in training or re-training long-term employees, it is well known that as behaviors become habitual, their sensitivity to change decreases since the employee has already developed strong expectations for a particular outcome (Gersick & Hackman 1990; Betsch, Haberstroh, Glöckner, Haar & Fiedler, 2001). In other words, these predictive models of employee behavior become less-and-less effective when applied to routine tasks in foodservice like hand washing which is a highly repetitive behavior that is more automatic, than those behaviors that require employees to make decisions before initiation of an action. Lastly, many of these techniques tend to focus on initiation while ignoring maintenance to establish sustained, long-term changes in behavior. This leads to a decline in behavioral compliance rates soon after intervention ends (Jeffery et al., 2000).

Multi-model strategies

Making sustained changes in human behavior is complex and multifaceted (Larson et al., 1997; Larson, Early, Cloonan, Sugrue & Parides, 2000; Pittet et al., 2000; Jumaa, 2005). Thus, strategies need to consider education, motivation and system change in order to create a sustainable effect (Pittet, 2004). New, large-scale, employee training campaigns that have emerged in the healthcare industry revolve around ideas of positive deviance, role modeling, organizational influence and social marketing. Each strategy has showed some sustained hand hygiene compliance (Formoso, 2007; Pittet et al., 2000; Zaidi, Jaffery & Moin, 2010; Marra et al., 2011; Son et al. 2011). Larson et al. (2000) suggested that any intervention aimed at the individual, without considering the organization, would not produce cost-effective, sustainable results, even if well-grounded in behavioral science theory. One successful application of Organization Theory at Memorial Sloan-Kettering Cancer Center in New York City increased hand hygiene compliance from 60 to 70% to a "Gold-Standard" level of 97% compliance and has sustained numbers at that level (Son et al., 2011). In their approach, they established small teams that included representatives for quality assurance, an infection prevention specialist and staff representative from that individual unit. The teams identified barriers to hand hygiene success and created their own performance goal for that unit's hand hygiene compliance. Along with these rules, they also adopted the World Health Organization (WHO) hand hygiene guidelines and made flow diagrams for common tasks by employees to pinpoint critical points and areas of improvement. This initial process alone took 3 months, and afterwards personnel in individual units were trained to observe each other for proper adherence to the new guidelines and report their findings to the infection prevention and control departments. This process in hindsight was used to create traditions within hospital units that sustained habits. In 2000, the University of Geneva Hospitals improved hand hygiene compliance in health care workers to an average of 66% (improvement) over a four year period (Pittet et al., 2000). This 3-year hospital-wide program was multifaceted with a number of interventions designed to positively affect health care worker behaviors. A major component of the campaign was the use of role-modeling by senior management designating the program as a hospital-wide priority and senior management providing funding for this training.

These successful interventions demonstrate that in order to initiate and sustain a behavioral change in hand hygiene compliance, it takes a substantial amount of time and money. In addition to those costs, most foodservice areas would also need to consider secondary campaigns to cater to its large diversity of demographics (Neal, Dawson & Madera, 2012). The healthcare industry can manage such costs through private and public funding, but resources in foodservice are often far less and foodservice businesses must remain economically competitive in an ever-changing industry. This makes long, expensive hand hygiene campaigns inappropriate for the foodservice area. Other methods must be examined that take fewer resources to provide adequate, similar outcomes.

Self-protection

Whitby, McLaws & Ross (2006) identified that an individual's hand hygiene behavior is not homogeneous and can be classified into at least two types of practice, inherent and elective hand hygiene. In their study involving hospitals, schools and the community, hand washing practices discussed by all respondents involved a ritualized behavior performed mainly for self-protection against infection from harmful microorganisms, despite differences in age and employment experience and the potential influence of scientific training. In addition, it was found that most hand washing patterns were most likely to be established in the first 10 years of life, with mothers and nurses reiterating to the child the belief that toilets are “havens of germs” (Whitby et al., 2006; 2007). This “inherent” behavior towards hand hygiene is one that is repeated as a young adult and carries years of practice thus molding the hand washing habits of an individual (Wood & Quinn, 2002). Since hand washing is one of the “life-long” practiced habits, this may be a reason why hand hygiene is so difficult to change and why this issue needs to be looked at as habitual rather than a typical behavior. This view is supported by empirical findings in various fields that agree repeated behaviors in constant contexts are difficult to change (Heatherton & Nichols, 1994; Wood, Tam & Wit, 2005; Bamberg, 2006; Aunger, 2007), and interventions focusing on contextual disturbance have a greater probability of success. This action can be utilized by using stimulants as reminders of inherent behaviors, or habits, and associate them with more elective hand hygiene practices.

Habitual approach

Intents resemble plans about how to act when predetermined cues or conditions occur (Gollwitzer, 1999). Once formed, however, the intents no longer require much conscious thought. Instead, they are triggered as automatic or quasi-automatic operations (Heckhasusen & Beckmann, 1990). At this point, well-established behavior becomes a habit with past behavior as a significant determinant of future behavior (Oullette & Wood, 1998). Habits, by definition, are automatic responses to contextual cues, acquired through repetition of a behavior (Wood & Neal, 2007; 2009). Contextual cues for habits reflect features of performance environment in which the response typically occurs (Wood & Neal, 2007; 2009). Habits are activated directly by these context cues, with minimal influence by goals (Neal, Wood, Wu &

Kurlander, 2011). Context cues may include physical settings in which the habit is typically performed, completing the response that typically precedes it, or encountering a person who is typically present (Wood & Neal, 2007). Through repetition, actions become an automatic impulsive system initiated by these context cues after behaviors shift from a conscious reflective processing system initiated by intention (Gardner, 2012a). Development of an action is the aim of habit formation, and the discontinuation of automatic responding the aim of habit disruption (Gardner, 2012a).

Researchers have shown that habits play a significant role in everyday life, accounting for about 45% of our everyday behaviors (Wood & Quinn, 2002). Typical studies of habit have looked at obvious unhealthy cases such as smoking (Godin, Valois, Lepage & Desharnais, 1992) while emerging studies are beginning to explore its role in behaviors that have historically been explained by cognitive theories such as Health Belief Model or Theory of Planned Behavior (Nilsen, Bourne & Verplanken, 2008, McGowan et al., 2013). These studies point to the intention-behavior gap of cognitive theories and how changing beliefs and intentions may be insufficient to break health-compromising habits. It has been shown that where habit and intention conflict, behavior is more likely to proceed in line with habit than intention (Gardner & Bruijn 2011). Some of these new studies indicate the possible use of habit intervention for health-promoting behaviors and its associated benefits (Nilsen et al., 2008, Nilsen, Roback, Broström & Ellström, 2012; Judah, Gardner & Aunger, 2013). They point out that healthcare professionals, like all people with repetitive acts, are prone to developing efficient and automatically activated habits which may explain non-best-practice clinical behaviors. Moreover, habitual behaviors are less likely to be disrupted by losses in motivation (Gardner 2012a).

Surprisingly, little has been stated about the benefit of some habits being cross-cultural, particularly those more universal habits of human self-protection (Whitby et al., 2006). Hand hygiene is a habitual, unconscious practice that is influenced by past behavior that precedes adulthood (Whitby et al. 2006; Aunger 2007; Whitby et al. 2007). It is also considered a primarily inherent act used to protect one's self against disease. Additionally, no research has been stated about the potential of habit intervention to reach less educated sectors of the population outside the health care sector. Wood and Quinn (2002), state the most striking benefit of habits is the cognitive economy and performance efficiency of habits. Habits, such as hand washing, do not rely on the deliberate/rational thinking (Sladek, Bond & Phillips, 2008). This enables people to engage in more important thoughtful activities and keep hand hygiene from impeding job functions. In relation to the food sector, immigrants who speak little English may discover a decrease in the ability to engage in high-level reasoning with given tasks which may promote a greater reliance on previously formed and culturally influenced habits (Marchette, Bakker & Shelton, 2011). Initiation to change these habits or create new ones for some could be troublesome where miscommunication is possible during training. Additional reminders and reinforcement, in the form of external cues, could be used to reiterate basic concepts and emphasize desired behavior.

Motivational models used in the foodservice industry

Several behavior models have shown considerable improvement in proper hand hygiene compliance such as training and education, TPB, Organizational Theory, and HBM (Roseman & Kurzynske, 2006; Larson, 2009; Milton & Mullin, 2010). Although most of these models have been studied only in motivating and increasing the compliance of hand hygiene in the healthcare industry, new research is beginning examine their relevance of each of these theories in sustaining motivation for food service employees (Nieto-Montenegro et al., 2008; York, 2008; Soon & Baines, 2012). Applying some of these theoretical models resulted in sustained compliance, leading to documented changes in long term behavior, while others have shown no such evidence (Jeffery et al., 2000; Larson, 2009).

In a meta-analysis of food safety training on hand hygiene knowledge and attitudes among food handlers, authors found that the training effect was largest for participants that received a well-planned combination of both standard training and behavioral interventions (Soon, Baines & Seaman, 2012). In their review, 1592 studies were screened to meet an inclusion criterion with 9 studies qualifying to measure hand hygiene knowledge and 5 studies measuring hand hygiene attitudes. Out of the five studies, social cognitive intervention such as TPB and HBM, in combination with training, resulted in the highest shift of increased attitude toward hand hygiene. The authors believe this change is due to the interventions targeting the individuals' motivation system which considers the individuals behavior and how this behavior interacts with their beliefs and level of knowledge. For example, Soon and Baines (2012), which was reviewed in this study, enhanced the perception of risk by showing case studies of poisoned victims to incorporate the emotion of fear into individuals, especially those with children. In addition, the authors point out that successful interventions need to incorporate hand washing intervention into the environment, displaying posters and reminders (specific to the workers' native language) (York et al., 2009). The authors also concluded that more studies need to look at changes in attitudes and behaviors after intervention to measure the effects over time and that refresher training is often neither planned nor implemented (Worsfold & Griffith, 2003). This long term usage of hand hygiene, the study points out, may be difficult to measure due to high turnover rates in the food service industry.

Researchers randomly sampled 31 restaurants in three Midwestern states to measure the effects of training on knowledge and behavior. This assessment showed that training can improve knowledge and behavior, but knowledge alone does not always improve behavior (Roberts et al. 2008). A common theory to use for interventions aimed at targeting a change in behavior is TPB (Robert & Barret, 2008). This theory was used to significantly improve hand washing among fresh produce farm workers. Principles from this theory were able to explain approximately 57% of the variance of hand washing intentions and these findings were then used in conjunction with YouTube video training and cross-contamination demonstrations to improve behavior (York et al., 2009). In another standalone study using the National Restaurants' ServSafe training, an intervention based off TPB, and a combination of both training and theory-based intervention, were used to measure the effectiveness in changing food service behaviors toward hand hygiene compliance in employees. These researchers concluded that training or theory-based intervention alone is better than no treatment, but the combination of training and intervention was the most effective at improving compliance among employees and increased their perceptions of control at performing these behaviors (York, 2008). These approaches, that used a combination of education and theory-based motivation, were successful in short-term change, but long-term, sustainable change is needed.

Sustained motivation

What is the most appropriate behavioral theory for sustained motivation for food service employees? To answer this question we need to be reminded that the healthcare environment, in which many of these theories were used to promote sustained hygiene, has a drastically different work environment than food service. In the health industry, the annual income and education level of employees is significantly higher than the average food service worker (U.S. Census Bureau, 2008). Additionally the motivational hand hygiene models, designed around the healthcare industry, are not suitable for most areas of the food industry where a higher level of diversity and turnover must be taken into consideration (Fenton, LaBorde, Radhakrishna, Brown & Cutter, 2006; Pilling, Brannon, Shanklin, Howells & Roberts, 2008; Madera, Neal & Dawson, 2010).

The current behavioral models explored earlier in this paper do not account for cultural and religious learning differences (Neal et al., 2012; Po, Bourquin, Occena & Po, 2011), nor do they give us an understanding of motivating employees whose primary language is not English (Frazer, 2000; Frazer & Alani, 2009). The food industry has one of the most diverse employee demographics (Simonne, Nille, Evans & Marshall, 2004) where cultural and religious learning differences cannot be ignored (Jumaa, 2005). Research shows communication of concepts are dampened for employees who are non-English speaking or for whom English is not their first language (Wilcock, Ball & Fajumo, 2011). In the following sections of this paper, we will describe approaches to overcome these demographic differences. There is also a difference in employees' level of education and turnover rates in the food service sector. For example, Latina/o immigrants have less formal education (e.g. only 16.7% of the workforce is college graduates) and are more likely to work in minimal skilled jobs for lower pay than their native-born counterparts in the U. S. (U.S. Census Bureau, 2008; U.S. Department of Labor, 2012). The gap between employed Whites with a college education and employed Latinos with a college education actually grew from 17.6 to 20.1 percentage points between 2000 and 2011 (U.S. Department of Labor 2012). Additionally, due to the high turnover rates in the food industry (e.g. 25% of management quit within a year), investing lots of time and money into demographic-specific training programs has typically shown a lower return on their employers' investment (Ghiselli, La Lopa & Bai, 2001; Niode, Bruhn & Simmone, 2011).

On top of higher turnover rates, most food service establishments have among the lowest annual salaries with average wages roughly half the national mean wage (U.S. Bureau of Labor Statistics 2009; Bureau of Stats Employ 2012;). Sustainable approaches, used by healthcare organizations, are expensive and depend on a corporation-wide hand hygiene campaign due to several months of intervention by 3rd party consultants (Larson, 2013). In the food service industry, this expense and dedication to sustainable campaigns becomes an issue where job satisfaction and organizational commitment is low due to minimal wages, high turnover and occupational stress (Aghdasi, Kiamanesh & Ebrahim, 2011). Additionally, developing and applying culturally appropriate training can add significantly to the food industry's costs and preparation time (Po et al., 2011). In other words, motivational hand hygiene models, which were first created for the healthcare industry, are not suitable for most areas of the food service industry. Attention must be given to communication skills and education levels for all employees, and a better, cheaper cross-cultural motivational model is needed for the increasing diversity in the food service industry. In conclusion, a more universal approach needs to be considered that not only caters to these needs of the industry, but also provides sustained motivation for continual compliance in hand hygiene.

A new approach using habitual motivation

The food industry should consider alternative methods for increasing hand hygiene compliance based on habitual motivation rather than traditional methods rooted in common behavioral theories. Similar to thoughtful processing modes, studied in behavioral and cognitive science, automatic processes outside of conscious awareness have been shown to motivate behavior (Chartrand, 2005). Habits, which are automatic responses to a particular context, could play a critical role in increasing hand washing compliance (Wood & Neal 2007; 2009; Gardner, 2012b). A study in Kenya observed that habit was the single most powerful determinant of hand washing compliance followed by several motives including disgust (Aunger et al., 2010). Many of the habits pertaining to hand washing practice are learned as a child, including washing after going to the restroom and before eating. Additionally, unlike current cognitive theories, which rely on an intentional mental processing that are characterized as rational, deliberate, slow and rule-based, a focus to form habits allows for a cognitive shortcut in which an employee does not have to explicitly think about their response but will automatically respond to a predetermined sensory stimulus (Sloman, 1996; Gigerenzer. 2007; Wood & Neal, 2007). As repetition occurs and this behavior becomes more habitual, its response does not rely on a heightened level of training the employee has acquired and thus removes most of the training thresholds as a barrier to learning proper hand hygiene.

The support for this application is based on published studies which have looked at using habit intervention to modify or create a desired behavior (Gardner, 2012b; Judah et al., 2013; McGowan et al., 2013). These past approaches to habit intervention utilize existing routine cues to initiate or modify habits. However, the foodservice needs a rapid habit modification rate with a culturally neutral increase in proper hand hygiene compliance among different employee demographic. In light of this, we provide a review of reminders that have been used in multiple food service hand washing campaigns in the past and may provide additional support for habit interventions. These cues include three of the five basic human senses (sight, hearing and smell) and provide the stimulus to initiate a conditioned behavior. Furthermore, we evaluate two mechanisms for increasing the effectiveness of these cues: context-bridging and the emotion of disgust. These mechanisms are supported by their ability to promote hand washing and established educational methods such as multilingualism which has demonstrated the ability to overcome language barriers in the workplace (Freely & Harzing, 2003). For instance, the habit of washing your hands after going to the bathroom is learned at a very young age and is commonly held among most cultures (Curtis, Danquah & Aunger, 2009; Aunger et al., 2010). Part of the foundational reinforcement of this habit is to avoid making oneself or member of your immediate family sick. Accordingly, this action is comprised of an inherent hand hygiene behavior which is associated with emotional “disgust” or an evolutionary response to environmental factors that might pose a risk of self-infection (Curtis & Biran 2001; Whitby et al., 2006).

Context-bridging

Before habits can be formed, individuals must overcome the ‘intention-behavior gap’ and actively initiate a new behavior. One reason people fail to act on their intentions relates to their inability to remember their intended action when the opportunity to act presents itself (Lally & Gardner, 2013). Several methods to decrease this gap exist, most depend on the premise that planning increases the chances of performance of the intended action. However, smart cues that bridge two contexts may need to be developed to remind and reinforce actions. “Context-bridging” is defined as a cognitive mechanism to associate one context to another as a way to decrease the perceived difference between two habits. Creating new habits depends on initiation of new behaviors and continued context-dependent repetition (Lally & Gardner, 2013). By applying this technique and creating the sense that two contexts are similar, new habits are more likely to become instinctive. In addition, when ongoing tasks focus attention on aspects of the context that are relevant for performance of the intended action, people are more likely to enact their plan (Marsh, Hicks & Hancock, 2000; Meier & Graf, 2000). Further support is shown in prospective memory studies demonstrating that reminders can be useful depending on the appropriateness to the prospective memory task (Guynn, Mcdaniel & Einstein, 1998; Nowinski & Dismukes, 2005). For example, Guynn et al. (1998) found that reminders that referred to both the prospective memory target event and to the intended activity were effective at increasing response to the task. Furthermore, other studies suggest the activation of an encoded associative link between the target events and the intentional response is important for prospective memory tasks to be initiated (Nowinski & Dismukes, 2005; McDaniel & Einstein. 1993). Therefore, associating existing context-action sequences with the desired action of the current context may lessen the gap between intention and behavior.

Sensory cues

To date, most habit interventions have used internal cues present in existing routines to modify an established habit or create a new one (Lally, Wardle & Gardner, 2011; Judah et al., 2013). This approach is based on prospective memory situations which involve forming intentions and then realizing those intentions at some appropriate time in the future (McDaniel & Einstein, 2000). For example, Judah et al. (2013) used intervention to create a flossing habit by using cues within the existing 'dental care' routine of individuals. This study demonstrated that integrating a new action of flossing after brushing teeth was more effective than encouraging participants to floss after showering. In this sense, the study showed that internal cues to an existing routine can help associate new actions as long as they are present in short term memory (brushing teeth) rather than long term memory (after showering). In addition, this study supports prior research which shows that planned intentions associated with a cue have a potential to override existing habits with new responses (Adriaanse, de Riddler & Wit, 2009). We suggest that a similar approach, educating participants to wash their hands based on internal cues associated with food safety cues, such as after exposure to areas with a high risk of contamination (Caswell & Hooker, 1996). In addition to internal cues, external cues are proposed to reinforce and aid initiation of behavior change (Neal, Wood & Quinn, 2006). External cues, such as text messaging, have been shown to help individuals remember their plan to execute an intended action by providing them with reminders (Guynn, Mcdaniel & Einstein, 1998; Prestwich, Perugini & Hurling, 2009). In this effect, they act as self-regulators, such as planning, which has been used to help overcome the 'intention-behavior gap' and motivate repetition (Michie, Abraham, Whittington, McAteer & Gupta, 2009). External cues will use three of the five senses common to all humans (Geldard, 1953) to elicit disgust and help bridge two contexts. Two senses described in this paper are sight and sound which have been shown to increase hand hygiene (McGuckin et al. 2006; Filion, KuKanich, Chapman, Hardigree & Powell, 2011). The third sense we suggest is smell which shows potential to influence habits related to self-protection (Croy, Maboshe & Hummel, 2013). We theorize external cues can lead to quicker memory associations with internal cues and also provide a mechanism for associating a past habit with a current habit. For cue placement, Event Segmentation Theory has shown to be effective in habit intervention (Judah et al., 2013). This theory suggests that certain points within existing routines may be optimal for initiation of new behaviors (Zacks & Swallow, 2007). For example, with deli workers handling raw meat, cues should be placed or activated near or during the act of preparing meat. Cue placements should also be in line with FDA Model Food Code hand hygiene guidelines and procedures.

Sight. Visual prompts are reminders of stored information and are an effective and recommended intervention to improve hand hygiene (Filion et al., 2011; Soon et al., 2012). In early interventions based on posters, prompts were focused as an educational tool rather than a motivational one. However, recent research shows education alone does a poor job of increasing employee compliance rates (Gould et al. 2007; Mackert, Liang & Champlin, 2013). Consequently, more sophisticated posters are being developed that take behavioral theories into consideration (Aunger et al., 2010; Chapman, Eversley, Fillion, MacLaurin & Powell, 2010; Soon and Baines 2012; Mackert et al., 2013). These posters are designed to incorporate theoretical elements like peer pressure, focusing on consumers' health, and reinforcing an individual's need for self-protection. Posters of this nature not only act as reminders, but are solidly based on incorporating cognitive theories to influence hand hygiene.

However, the visuals incorporated into poster designs must be cross cultural and prompts must be multilingual in order to be effective with the diverse workforce in modern food service operations (York et al. 2009; Po et al., 2011). In light of this need, videos that are ethnically appropriate have become a popular visual aid, but have been limited to initial training rather than use as a continual intervention tool (Nieto-Montenegro et al., 2008; Soon & Baines, 2012). It has been suggested that posters or videos that use cross-referential images of disgust to express a message of handwashing and its importance would be an effective tool. Porzig-Drummond, Stevenson, Case & Oaten (2009) used visual aids of disgust to effectively provoke handwashing. Porzig-Drummond, et al. (2009) developed a brief (3-min) video using disgust/education and found that the video improved hand hygiene relative to education alone or no intervention. They subsequently placed disgust/education-based posters in two bathrooms and educational posters in two other bathrooms, exhorting participants to wash their hands, and found that the disgust-based intervention was significantly better at promoting hand hygiene (Porzig-Drummond et al., 2009). Although posters can be strategically placed, they cannot remind people of an intention at a specific time. This may be one advantage of using video as a visual aid since they can flash colors or similar actions to attract attention. The use of videos may be a disadvantage if triggered sporadically because they may distract users from an active task and cause them to waste time. Another issue with posters is their tendency to be overlooked or ignored which subtracts from their potency as external cues (Woolsey, 1989). Videos may prove to be similarly ignored, but more research is needed.

Hearing. The use of vocal stimulus to influence health-related behaviors is a recent area of exploration (McGuckin et al., 2006; Swoboda, Earsing, Strauss, Lane & Lipsett, 2007). These preliminary studies, for the most part, rely on formal language understood by the receiver to communicate a message, using such cognitive theories as role-modeling to increase compliance. For example, McGuckin et al. (2006) used voice prompts recorded by different authoritative figures from persons who were known to the receiver. These voice recordings were from supervisors who were responsible for overseeing staff in the intensive care unit (ICU), and were meant to be staff hand hygiene reminders. Twelve different messages were delivered at random intervals to the staff and included such sayings as ''hand hygiene should occur before and after patient contact." Collecting pre and post intervention observations using this authority role-modeling approach, the hospital saw a 60% overall improvement for soap and sanitizer usage with sanitizer usage increased by 25%.

However, recorded statements are time-consuming and reach their full potential only when completely understood. This brings up two caveats in the use of recorded supervisor's voice to promote hygiene in the food industry. Repeated messages where language barriers exist can lead to mixed messages or confusion on the part of employees with limited language abilities which may in fact lead to poorer hygiene or lowered employee output. Overcoming language barriers can be accomplished by repeating the message in several native tongues, but this would increase the length of the message leading to the possibility of even more production delays. Additionally, motivational components may be lost such as role-modeling if the authority figure, the employees' immediate supervisor, cannot record themselves using foreign languages properly. Additionally, experimental research into the nature of attention and vigilance indicate that such messages when repeated many times tend to be ignored (Vedantam, 2006).

One possible solution is the use of auditory cues, such as common sounds, to increase awareness of disgust and promote hand hygiene. Non-speech sounds have been studied in multiple ways, but little research has focused on their ability to motivate (McGee-Lennon, Wolters & McBryan, 2007). Based on prior research, sounds have a disruptive effect on the performance of a cognitive task (Furnham & Strbac 2002; Trimmel & Poelzl 2006). This negative effect may play as a benefit in habit formation by creating contextual changes to disrupt a current badly practiced habit (Wood et al., 2005). Additionally, sounds have been successful reminders to prompt behaviors in individuals with prospective memory problems such as the elderly (Inglis et al., 2003; Caprani, Greaney & Porter, 2006).

Smell. Human perception of hearing, sight, touch and smell are not simple responses to a single stimulus, but are manifested through a complex chain of events (Schiffman, 1996). As an aroma is perceived by the sense organs, in the epithelium of the nose, the stimulus is converted to nerve signals that travel to the brain. The brain upon receiving the signals uses stored past memories to interpret, organize and integrate the signal then produces an integrated response based on the brain's combined perceptions. Unlike other senses of sight and sound (which are limited by wavelengths and oscillation of air pressure), the sense of smell can distinguish stimulus across a wide range of concentrations of a trillion, 10^{12}, chemicals and compounds (Harper, 1972; Meilgaard, 1975). However, it is important to note that odor thresholds and sensitivity to odors among individuals can vary greatly depending on the characteristics of the aroma compound itself (Maruniak, 1988). Furthermore, odor identification based on an individuals' past experience may also be influenced by culture and age (Doty, Applebaum, Zusho & Settle, 1985; Hummel, Kobal, Gudziol & Mackay-Sim, 2007). This enormous diversity of perceptions of aroma stimuli leads to individual perception of smells which may lead to different responses in behavior.

Because the brain integrates aroma stimuli with past experiences, an individuals' memory plays an important role in odor perception. Research has shown that an individuals' first encounter with an odor is remembered over a long time (Koster, Degel & Piper, 2002). Many of these memory-odor associations are formed as adolescents (Chu & Downes, 2000; Herz, 2004), and are often linked in the brain with a basic emotion (Alaoui-Ismaili, Robin, Rada, Dittmar & Vernet-Maury, 1997b; Croy, Olgun & Joraschky, 2011). Odors have been shown to have strong linkage to the basic emotions of happiness and disgust but linkages to fear, anger and sadness show less correlation (Alaoui-Ismaili et al. 1997b; Bensafi et al., 2002; Desmet, 2006). Additionally, odor stimulus has been shown to produce larger, more startled emotional responses than visual or auditory presentations (Adolph & Pause, 2012; Hertz, 2004). Sensitivity to disgusting or irritating odor associations are common in at least seven geographic areas (Ferdenzi et al., 2013), especially Hispanics who appear to be more attentive to odors than other cultural populations (Seo et al., 2011). According to Stevenson (2010), odor-related feelings, such as disgust, may play an evolutionary role in humans to avoid environmental hazards such as food that if consumed would be harmful. Similarly, the olfactory system may be predisposed to warn about microbial threats by evoking avoidance (Stevenson, 2010; Croy et al. 2011; 2013).

Interestingly, this emotional response of disgust-avoidance is not just a response to the presence of the odor, and can be triggered by just imagining the odor (Bensafi, Sobel & Khan, 2007).

Although the correlation of odor and emotion has been well investigated, there has been little research evaluating the odor trigger of emotion with associated habits or with the use of odor to stimulate a learned behavior like proper hand washing. To date, most odor research has focused on aromas use as an alternative medicine rather than a behavior motivational tool (Lee, Choi, Posadzki & Ernst, 2012). Setting aside the low degree of rigor in many of the alternative medicine research articles, the base assertion may be valid—the possibility of odor chemosensory properties to alter moods for low-risk cognitive disabilities such as anxiety (Perry & Perry 2006; Lee, Wu, Tsang, Leung & Cheung, 2011). One recent study, looking at the long-term effects of odors, found that an increase repetition of an unpleasant stimulus (H_2S) lead to an increase in its pleasantness and a decrease in neuronal activation in subjects. However, the unpleasant odor was still rated significantly below neutral even after the third consecutive presentation (Croy et al., 2013). This evidence should be considered when forming habits with odors since repetition is a main component to its intervention. Additionally, Croy et al. (2013) study demonstrated a similar conclusion to other papers that unpleasant odors produce quicker, more automatic response than pleasant odors (Alaoui-Ismaili et al., 1997a; Jacob & Wang 2006).

Disgust

Disgust elicitors, as reviewed by Rozin, Haidt & McCauley (1993), can be generalized into two groups: core and animal domains. Core disgust is based on the threat of personal contamination such as rotting foods, waste products, and small animals (rodents) that are associated with dirt and disease characteristics. Animal reminder disgust is stimulated by reminders of the animal origins of humans, such as blood, veins, tissue and death (Rozin et al., 1993; Haidt, McCauley & Rozin, 1994). Hygienic concerns represent core disgust because of its association with infectious diseases and people's fear of contamination rather than animal domain disgust, and this has been shown across a range of ethnicities (Sawchuk, Lohr, Tolin, Lee & Kleinknecht, 2000; Olatunji, Sawchuk, Lohr & de Jong, 2004; Curtis, Aunger, & Rabie, 2004; George, 2012). Disgust has also been shown to significantly increase hand washing among different ethnic groups (Aunger et al., 2010; Porzig-Drummond, Stevenso, Case & Oaten, 2009; Scott, Curtis, Rabie & Garbrah-Aidoo, 2007). As an example, a national hand washing program in Ghana that used disgust to motivate hand washing after changing a diaper or going to the bathroom increased self-reported hand washing using both soap and water before eating by 30% (Scott, Schmidt, Aunger, Garbrah-Aidoo & Animashaun, 2008). Although most studies relate to third-world cultures, it seems logical to assume hand hygiene could be promoted across all major U.S. demographics since disgust has been shown to be an evolved response to objects in the environment that represent threats of an infective disease (Curtis et al., 2004). Furthermore, it is suggested that this emotion of disgust may initiate the act of hand hygiene among individuals (Curtis et al. 1999; 2007; Curtis, Danquah, & Aunger, 2009). Objects, such as food, may also acquire disgust-evoking qualities from disgust elicitors (Curtis & Biran, 2001). To date, several studies have evaluated the effects of disgust on hand hygiene behavior, including one study that showed initiation of hand washing with objects that are not visibly dirty (Judah et al, 2009; Curtis et al., 2007; Porzig-Drummond et al., 2009).

In one study, two experiments were performed to show that disgust-evoking qualities of contaminated objects can trigger hand hygiene behavior (Porzig-Drummond et al., 2009). In the first experiment, subjects were shown three intervention videos (disgust video, education video, control video). A week later, participants were asked to handle different items and then eat a cracker; the number of hand washing attempts was recorded for each individual. The results showed a significant difference in hand washing compliance among interventions, with the disgust intervention being superior to education, which in turn was superior to the control. In the second part of the study, posters were used to instill hand-hygiene knowledge and to induce the emotion of disgust. This intervention also showed an effect on hand hygiene adherence, and supports the idea that distinctive, novel cues can be more effective at initiating planned behavior (McDaniel & Einstein, 1993).

Disgust is a universal emotion that drives the behavioral avoidance of infectious diseases (Curtis & Biran, 2001; Smith, 2007). These include bodily, domestic and communal cleansing, avoidance of close contact or exchange of bodily fluids with others, and the avoidance of foods that are spoiled, contaminated or unfamiliar (Curtis et al., 2011). This perception of self-risk is thought to be multicultural and highly influential in hand hygiene behavior (Harris et al., 2000; Curtis et al., 2009). Additionally, autobiographical recall of disgusting episodes activates the insular cortex and the basal ganglia (Fitzgerald et al., 2004), as does exposure to disgusting smells (Wicker et al., 2003). This area is associated with the initiation of starting a new habit thus may provide additional reinforcement in the intention phase of habit formation.

Conclusion

To make additional, substantial reductions in the risk of food borne illness from cross-contamination, new approaches to improve hand hygiene must be evaluated under “real-world” conditions. The number of food-borne outbreaks in the United States must be reduced and hand hygiene compliance plays a critical role that must be increased not only through education and training, but with sustained food handler behavioral change. Unlike the health industry, employee behavioral change interventions must take into account the educational level and breadth of demographic differences among employees in the food industry. Effective motivational training also needs to be cost efficient and judicious with the supervisor's time. Additionally, intervention must consider the habitual nature of the foodservice jobs and carefully select the target behavior to be changed. For hand hygiene, the act of washing your hands is habitual. This behavior is created beginning with childhood lessons of self-protection and becomes habitual through years of repetition in response to certain clues like going to the bathroom. Thus, to change the behavior of hand hygiene, habit interventions should be employed as an alternative approach to sustaining long-term behavioral changes in employees.

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Chapter 2: Emotional and behavioral responses to handling foods

Hand washing and disgust response to handling different food stimuli between two different cultures

Introduction

During food handling and preparation, bacteria on raw foods may cross-contaminate the hands of foodservice workers or consumer, food-contact surfaces, and other foods that are later handled with contaminated hands. Hand washing has been shown to significantly reduce levels of contamination in homes and work places, and minimize the transmission of food borne illness (U.S. FDA, 2010; Hillers, Medeiros, Kendall, Chen, & Dimascola, 2002). Compliance with good hand hygiene practices has increased from 45.5% in 1998 to 61.2% in 2008 in fast food restaurants; however, it was also reported that 76% of restaurants and approximately 50% of delicatessens did not practice proper hand washing (Pragle, Harding, & Mack, 2007; U.S. FDA 2009). Green, Selman, Radke, Ripley, Mack, Reimann, Stigger, Motsinger, & Bushnell (2006) observed food handlers preparing food in 333 restaurants in six states. In this study, they found that food handlers attempted hand washing during 33% of the specific work activities that should have required hand washing (e.g., food preparation, handling dirty equipment) and only 27% of those attempts could employees' hands be considered appropriately washed. Adding the low attempt rate with the success rate results in roughly only 1 in 10 times where employees washed their hands properly when required (Green et al., 2006). This lack of hand washing has been shown to be a major contributor to food borne illness outbreaks attributed to the foodservice industry (Pragle, Harding, & Mack, 2007).

The foodservice industry is the single largest employer of immigrants in the United States (Jackson, 2008). A large, increasingly growing group of workers in U.S. population and foodservice are from Hispanic descent (U.S Census Bureau, 2013). According to the U.S. Bureau of Labor Statistics (2014a) 1/4 of the employees in foodservice and drinking locations are Hispanics. For instance, Hispanic foodservice workers make up 24.4% of the food preparation and serving related occupations and 18.5% of first- and midlevel managers for these foodservice and drinking establishments. Hispanic employees also hold 37.9% of the dishwasher positions, 34% of the cooks' positions, 29.3% of the food preparation positions, 22% of chef and head cook positions and account for 19.4% of the wait staff (U.S. Bureau of Labor Statistics, 2014b). As mentioned earlier, differences in employee knowledge and their compliance with safe food handling may play a role in the workplace. One of the questions that we don't know is, "do persons from some ethnic populations handle food less safely than others?" Based on prior reporting, there might be differences in complying with good food safety practices due to ethnicity (Li-Cohen & Bruhn, 2002; Patil, Cates, & Morales, 2005), but these studies are hard to validate since large discrepancies exist between self-reported and observed behaviors dealing with food handling and sanitation. This has been shown in prior studies where the vast-majority of the participants who self-reported proper hand washing behaviors were not observed doing so (Dharod, Perez-Escamilla, Paciello, Bermudez-Millan, Venkitanarayanan, & Damio, 2007).

In the workplace and home environment, there are many contributing factors and barriers that lead to low compliance rates of proper hand hygiene (Byrd-Bredbenner, Maurer, Wheatley, Schaffner, Bruhn, & Blalock, 2007; Todd, Greig, Michaels, Bartleson, Smith, & Holah, 2010). One contributing factor for consumers is a knowledge-compliance gap. For instance, one study showed that 97% of young adults rated their own food safety knowledge as at least fair, however, 60% did not wash their hands with soap and water, after touching raw poultry (Byrd-Bredbenner et al., 2007). Likewise, some important barriers in restaurants have been shown to be the lack of time during busy routines, inadequate hand washing facilities and supplies, lack of accountability, lack of involvement by management and coworkers, and working in organizations where proper hand hygiene is not seen as a priority (Green, Radke, Mason, Bushnell, Reimann, Mack, Motsinger, Stigger, & Selman, 2007). For instance, hand hygiene is more likely to occur in restaurants with more than one hand washing station and when workers had received specific training in their work environment on proper hand washing techniques (Pragle et al., 2007). Workers were also less likely to wash their hands when they wore gloves. The physical barrier provided by gloves may create a disconnection from disgust that has more recently been shown to be contributing factors to hand washing behavior (Curtis, Danquah, & Aunger, 2009). Disgust has also been shown to be a primary factor in determining hand hygiene behavior and a motivational tool to increase compliance (Curtis, Danquah, & Aunger, 2009).

Disgust is a universal emotion that is associated with characteristic facial expressions, a specific physiological state, a characteristic feeling state, and a behavioral component that motivates people to avoid situations or to refrain from touching objects that are perceived to be a potential risk for infectious diseases (Rozin, Haidt, & McCauley, 1993). People in most cultures engage in activities to avoid objects that are perceived to be disgusting which can be termed "disgust elicitors". For example, individuals bathe when they feel unclean and foods perceived as spoiled, rotten, or unfamiliar are typically thrown away or avoided (Curtis, de Barra, & Aunger, 2011).

These disgust elicitors, from an evolutionary perspective, may be associated with avoidance behaviors that can be viewed as an adaptive emotional response to protect people from diseases (Oaten, Stevenson, & Case, 2009). Additionally, disgust is considered to be multicultural (Curtis, de Barra, & Aunger, 2011). However, levels of disgust have been shown to vary among individuals and within their cultures (Rozin, Haidt, McCauley, Dunlop, & Ashmore, 1999). For example, a national hand washing program in Ghana used disgust and nurture (e.g. the desire for a happy, thriving child) to motivate hand washing, increased self-reported hand washing before eating by 41% (Scott, Schmidt, Aunger, Garbrah-Aidoo, & Animashaun, 2008). However, these acts of hand washing after going to the bathroom or before eating are inherent in nature, which were learned at an early age, and may not totally transfer as motivation for adult hand washing after handling common objects or foods (Whitby, McLawas, & Ross, 2006).

Studies have demonstrated objects with a perceived disgusting property can motivate hand washing even when no traces of filth are visible (Curtis & Biran, 2001; Porzig-Drummond, Stevenson, Case, & Oaten, 2009); however, little is known about the emotional response of disgust and its interaction with hand hygiene behavior towards common foods handled in the foodservice industry. To date, most studies have focused on foods that appear disgusting such as rotten food, foods that appeared dirty or other factors that illicit self-protection and thus an instinctual level of avoidance, rejection or eating these foods. (Martins & Pliner, 2006; Piqueras-Fiszman, Draus, & Spence, 2014). Yet, none of these previous studies measure the level of disgust (or other emotions) experienced by physically handling the foods, nor did they discuss behaviors relating disgust to hand hygiene. There is also a lack of previously published information showing the impact of cultural differences to these responses. This information is important in a highly diverse workplace, such as the foodservice industry, where cultural differences should be considered in food safety training (Po, Bourquin, Occena, & Po, 2011).

This current study is designed to determine the relationships among disgust, hand hygiene, their interactions, and how stimulus/reactions may differ between persons of two different cultures in the handling of foods commonly handled by persons in the foodservice industry or at home. The two cultures were Caucasian, which make up a majority of the industry's employees, and Hispanic for reasons stated earlier. It is our intent to further the understanding of the emotional motivators for behavior in the two largest ethnic groups working in foodservice today and document differences in the motivation for hand washing following handling common foods.

Preliminary Study

A preliminary survey was used to gauge the impact of proposed variables that affect the perceived disgust levels among individuals. The variables were later used to create a balanced design for the primary study.

Materials and Methods

Participants. A total of 557 volunteers (141 men and 416 woman; 505 Caucasians, 9 Latinos, 19 Asians, 16 African-American, 4 Native Asians, and 4 other) with ages ranging from 20 to 82 years [Mean age ± standard deviation (SD) = 47 ± 14] completed our preliminary survey. All participants were recruited from Northwest Arkansas, and only those reporting no sensory impairments were considered for analysis.

Survey. A six question survey was created with an on-line survey tool (http://www.surveymonkey.com) to determine how a diverse group of individuals perceive disgust after handling foods commonly handled in the foodservice and record factors that influenced their perception. The main question of interest looked at the intensity of disgust people perceived when they are handling 21 common foods. The selection of these foods was based on food safety information given to individuals about foodborne illness and their associated foods (USDA, 2011). Perceived disgust level among these foods was determined by asking surveyors for their degree of agreement with the statement ("*When handling this food, I feel disgusted*.") that was rated on a 7-point Likert scale ranging from 1 ("strongly disagree") to 7 ("strongly agree"). The foods for this question were randomly sorted per survey filled out, and participants were not asked to physically handle the food during this preliminary evaluation. This survey also asked participants for demographic information: age, gender and race. Additionally, it asked respondents two yes or no questions: 1) *Do you have an abnormal fear of being contaminated by germs or dirt or contaminating others?*, 2) *Are you currently or have you in the past worked a foodservice job (e.g. restaurant, meat processing facility)?*.

Statistical Analysis. Data was analyzed using JMP (version 11.2, SAS Institute, Inc., Cary, NC, USA). In a three-way analysis of variance (ANOVA), the level of disgust was compared as a function of type of food, to the respondents' work experience, and their personal fear of contamination. If a significant difference of means was indicated by the ANOVA, post hoc comparisons were conducted using Tukey's honest significant difference (HSD) tests. A statistically significant difference was defined as $P < 0.05$.

Results

There was a significant effect among the types of food, work experience, and fear of contamination [$F(20, 11{,}612) = 142.33$, $P < .0001$; $F(1, 11{,}612) = 5.50$, $P = .019$; $F(1, 11{,}612) = 749.12$, $P < 0.0001$ respectively]. However, there was also a significant interaction between type of food and fear of contamination [$F(20, 11{,}612) = 5.97$, $P < .0001$]. Our data showed that people who reported an abnormal fear of contamination of germs, dirt, or contaminating others rated food items as being more disgusting than individuals reporting no such fear. Furthermore, individuals reporting fear of contamination reported less differences of disgust among foods than individuals reporting no fear of contamination. These trends can be seen in Table 1 which shows differences in the means of disgust intensities per food within each contamination group.

Individuals who had past work experience in the foodservice industry also showed significantly higher levels of disgust (mean ± SD = 2.26 ± 0.03) than individuals who had not worked in such environment in the past (2.16 ± 0.03).

Table 1. Results of preliminary experiment where the intensity (mean ± SD) of disgust for different foods between groups self-reporting existence (n = 49) or non-existence (n = 508) of abnormal fear of contamination of germs, dirt, or contaminating others.

Food (in higher disgust order)	**Fear of contamination** Mean (± SD)		**No fear of contamination** Mean (± SD)	
Raw chicken	6.12 (± 1.25)	a	4 ± 2.03	b
Moldy Bread	6 ± 1.29	ab	4.48 ± 1.91	a
Raw Beef	5.73 ± 1.56	ab	3.62 ± 2.01	c
Fish	5.29 ± 1.65	ab	3.69 ± 2.01	c
Dirty Mushrooms	4.39 ± 2.02	bc	2.73 ± 1.73	d
Eggs	4.12 ± 1.9	c	2.15 ± 1.46	e
Luncheon Meats	4.08 ± 1.9	cd	2.41 ± 1.58	e
Onions	2.96 ± 1.8	de	1.84 ± 1.34	f
Cheeses	2.67 ± 1.52	e	1.55 ± 1.03	fg
Head of lettuce	2.63 ± 1.74	e	1.51 ± 0.93	g
Potatoes	2.61 ± 1.68	e	1.5 ± 0.93	g
Head of cabbage	2.49 ± 1.65	e	1.54 ± 0.96	g
Asparagus	2.49 ± 1.49	e	1.56 ± 1.03	fg
Broccoli	2.39 ± 1.5	e	1.47 ± 0.91	g
Dry Beans	2.27 ± 1.43	e	1.42 ± 0.92	g
Bread	2.22 ± 1.45	e	1.36 ± 0.79	g
Strawberries	2.22 ± 1.45	e	1.41 ± 0.82	g
Bundle of Bananas	2.22 ± 1.4	e	1.41 ± 0.81	g
Apples	2.16 ± 1.37	e	1.38 ± 0.79	g
Tomatoes	2.12 ± 1.17	e	1.59 ± 1.07	fg
Kiwis	2.1 ± 1.31	e	1.56 ± 0.98	fg

Numbers with different letters indicate a significant difference at $P < 0.05$ within each column.

Intensity of disgust rated on a 7-point Likert scale ranging from 1 (“strongly disagree”) to 7 (“strongly agree”).

Discussion

Disgust levels have been shown to vary among different foods (Rozin & Fallon, 1986; Rousset, Deiss, Juillard, Schlich, & Droit-Volet, 2005). Studies have found that differences may come from appearance attributes (e.g. rot, dirtiness), familiarity (e.g. common to culture), texture (e.g. slimy, mushy), and perceived danger (Rozin & Fallon, 1987; Martin & Pliner, 2006). However, most of these previously published studies did not capture individuals' perceived disgust when handling foods, but rather recorded areas of consumption and avoidance. Our survey adds to these previously published findings, providing differences in disgust levels for various foods handled by the individual and contributing factors among individuals.

Individuals not reporting a fear of contamination perceived foods (overall) at a lower disgust level than people who reported such fears. Disgust has been increasingly implicated in the development and maintenance of a contamination fear, a common indicator of obsessive-compulsive disorder (OCD) (Schienle, Stark, Walter & Vaitl, 2003). Individuals with this disorder typically have symptoms of excessive concern in two categories: washing and checking. In one study, three groups of people (classified as checkers, washers, and normal) were scanned using functional magnetic resonance imaging (fMRI) while observing normally disgusting, washer-relevant disgusting, and neutral pictures. Individual with washing OCD's activated the visual regions of their brain which are implicated in perception of aversive stimuli and the insular (important in disgust perception) significantly more often than the other groups (Phillips, Marks, Senior, Lythgoe, O'Dwyer, Meehan, Williams, Brammer, Bullmore, & McGuire, 2000). Similarly, individuals indicating abnormal fears of contamination, from our study, may act in accordance with washer behaviors more often than persons described as OCD checkers. Our survey also indicates the intensity of disgust varies when participants thought about handling different foods. However, individuals reporting a fear of contamination rated hazardous food items in fewer categories than others. For instance, raw chicken, moldy bread, raw beef and fish were perceived with similar intensities of disgust for individuals with a heightened fear of contamination while these four foods were separated into three categories for the normal individuals. This may be due to individuals compartmentalizing disgust cues or seeing fewer differences between known disgust factors.

Our survey also showed that individuals with foodservice experience perceived a higher level of disgust for foods handled than individuals that have no such work experience. These findings are reassuring and may be an effect from their previous food safety training within foodservice organizations. For instance, multiple studies have shown that food safety interventions have a positive effect at increasing employees' awareness of risks associated with food borne illness (Soon, Baines, & Seaman, 2012). Furthermore, individuals having experienced foodservice environments where these behaviors are at low compliance might heighten their sense of disgust for foods. The disgust difference between foodservice employment and non-employment shown in our survey may also be interpreted as a lack in consumer education on proper food handling practices. For example, one study investigating consumer perception of food safety issues demonstrated some consumers have notions of perceived invulnerability to food poisoning from foods they prepared for themselves, as well as notions of an `optimistic-bias' and the `illusion of control' with their own food handling practices (Redmond & Griffith, 2004). Furthermore, other studies have shown that only a few consumers consider improper handling for food at home as a common cause of illness or perceive home food preparation as a serious threat to their health (Cody & Hogue, 2003; Redmond & Griffith, 2004).

Primary study

The results from the preliminary study were used to focus the next study on either tail of the distribution—those foods a majority of persons (all ethnicities) found disgusting and those foods that were not perceived as eliciting a feeling of disgust.

Materials and Methods

Participants. Sixty-six volunteers (32 men and 34 women), ages ranging from 18 to 46 years [M ± SD = 32 ± 7 years] were recruited to participate in this study. Around half the participants were of Hispanic descent (16 men and 18 women; 33 ± 8 years of age), while the others were Caucasian (16 men and 16 women; 32 ± 6 years of age). The two ethnicity groups were not significantly different in gender ratio and mean age ($P > 0.05$). All participants reported that they had no history of major diseases, and no sensory or cognitive impairments. A prescreening survey, using the same questions from the preliminary survey, was used to identify individuals' past foodservice experience and exclude individuals with unusual sensitivity disorders to disgust. Participants were informed that the study concerned emotion and behavior, but no further details were provided. Additionally, a written informed was obtained from each subject which prior to participation. This consent form described foods that would be handled in the study, gathered information on allergies and/or intolerances and informed participants about availability of hand washing materials. The survey questions and study protocol received a full IRB review and was approved prior to initiating the study by the University's Human Subjects Review Committee.

Food samples and preparation. Four common raw foods were selected to represent differences in expected response based on the results from our preliminary study. These were apple, bread, raw fish, and raw chicken. Each food was stored at similar handling temperatures (approximately 4 °C for raw fish and chicken and 25 °C for other foods) as used in the foodservice industry. These foods were properly washed prior to initiating this study and in between individuals' handling of these foods.

Measurements of facial expression-based emotions were obtained by Facial Action Coding System (FACS)-based facial expression recognition software (FACET, Emotient, Inc., San Diego, CA, USA) and an external webcam (Logitech X898, Newark, CA, USA) positioned in front of the participant at a 30 degree perpendicular angle to their face. The camera and software were calibrated prior to the study using 3 volunteers, and adjustments to lighting and seat position relative to background light were standardized. Additionally, participants were discouraged from wearing hats or eyewear to minimize shadows and requested to keep an upright posture and minimize head movements (even while examining food) to reduce interference with facial readings. Measurements with camera were taken during the entire time the participant handled the foods, but only frames during the ten seconds of actual contact with the food were processed for analysis. Two hot keys within the software were used by the Test Administrator seated perpendicular to the participant to start and stop these actual 10 second handling periods. Video was captured at 30 frames per second (FPS) and an Emotient FACET algorithm was used to determine evidence number for each emotion, for every frame where the face was at least 20% of the capture resolution size.

Procedure. Participants were evaluated one at a time in a small white class room with all furniture removed except a long wooden table where the study took place. On arrival, each participant sat perpendicular from the test administrator at the 9 o'clock position from a laptop (that the screen of the laptop could only be seen by the administrator) looking directly in front of the webcam. Hand sanitizer and wet wipes were placed within easy reach, but unobtrusively on the left side of the participant, in order to not cue participants to wash their hands after handling each food sample. A handwashing sink with water, soap and paper towels was located just outside the room. Participants were casually told where the hand sanitizer, wet wipes and the sink were located. The positioning of study elements and test protocol were similar to a published study that developed a behavioral hand-hygiene measure to test whether participants would engage in hand hygiene before eating food (Porzig-Drummond et al., 2009) and the measurements were based on a technique developed to validate the Disgust Scale (Rozin et al, 1999). Participants were next briefed about the procedure of handling the foods.

Each individual's face can have a default appearance that resembles any of the emotional categories even though he or she may be in a neutral state (e.g. a "neutral frown"). In order to remove this bias, a baseline recording was taken to measure each subjects' default appearance. Measurements on the subsequent stimuli were processed by a simple subtraction from the values obtained during the baseline stimulus. Next, each participant was given a rectangular white tray (34 cm x 26 cm) with a dark cover over one of the four foods. They then were asked to uncover the tray and pick up the food, examine it for 10 s with both hands, and place it back on the tray. After the item was put back on the tray, subjects were offered a cracker (Premium Saltine Crackers, Mondelez Global LLC, USA) and asked to pick it up from the plate and eat it. This same procedure was performed for each of the four foods for each subject with the each food being presented in a random order. Participants were allowed to clean their hands at any time during the experiment, but were never prompted to do so. Each use of sanitizer, wet wipes or sink use (with or without soap) was recorded for each food and totaled for a session hand washing count. After all foods had been evaluated, the procedure was repeated without the emotion recording equipment or the task of eating a cracker. For this second part of the study, the participants were shown each food and asked to fill out an emotional scale for it. Six emotions (joyful, disgust, fearful, anger, sadness, and surprised) were rated on a 7-point Likert scale ranging from 1 (“strongly disagree”) to 7 (“strongly agree”) to a statement about handling food (e.g. “When handling this food, I feel joyful.”). Additionally, any foods that initiated a hand washing behavior in the first part of the study were further investigated by asked an open-ended follow-up question pertaining to the motivation for their actions (e.g. “After handling this food you washed your hands, why did you wash your hands?”). This question was used to determine the motivational reason why the hand washing act was initiated. Lastly, the subjects were asked to fill out an 11-item washing subscale of the Maudsley obsessive–compulsive inventory (MOCI) to assess their level of contamination fear (Foa, Kozak, Salkovskis, Coles, & Amir, 1998). Questions on this scale are true or false and approximate scores can be derived by totaling the number of questions which are answered in the obsessional direction.

Statistical Analysis. A participant with a MOCI score of seven or above in the washing subscale was a classified as having moderately compulsive hand washing practices and were excluded from further data analysis. This exclusion removed seven participants (2 Hispanic men, 3 Hispanic women, 1 Caucasian man, and 1 Caucasian woman), resulting in fifty-nine remaining participants (14 Hispanic men, 15 Hispanic women, 15 Caucasian men, and 15 Caucasian women), with ages ranging from 18 to 46 years [M ± SD = 32 ± 7 years]. Table 2 shows the participants that were used for data analysis. Among these participants, there was a significant difference among cultures with Hispanic men having a larger MOCI score than Caucasians men (P = 0.03).

Table 2. Maudsley obsessive-compulsive inventory (MOCI) washing subscale scores, age and past foodservice employment by gender and ethnicity of participants (n = 59).

	Men		**Women**	
	Caucasian	**Latino**	**Caucasian**	**Latino**
MOCI	**2.6 ± 2.14 ***	**3.36 ± 1.69 ***	**3 ± 1.73**	**3.2 ± 1.73**

(Mean ± SD)				
Age (Mean ± SD)	**31.2 ± 4.83**	**34.71 ± 7.53**	**32.4 ± 5.91**	**31.27 ± 8.47**
Past foodservice employment (Sum)	**Yes (8) No (7)**	**Yes (9) No (5)**	**Yes (7) No (8)**	**Yes (6) No (9)**

*indicates a significant difference at P < .05. Standard deviation (SD) assessed variation among participants.
Maudsley obsessive–compulsive inventory (MOCI) was used to assess levels of contamination fear through its 11-item washing subscale. Questions on this scale are in true or false form and approximate scores can be derived by totaling the number of questions which are answered in the obsessional direction.

A mixed binary logistic regression model was built to determine the factors that influence hand washing and to be able to predict the likelihood of a participant washing their hands after handing a particular food item. The response was if the individual washed their hands (yes or no) while the initial fixed predictors were gender (men, women), ethnicity (Caucasians, Hispanics), experience (yes, no), disgust (1-7), and the four different foods (apple, bread, chicken and fish). Participants were set as a random variable. Looking at the main effects of these initial factors there was no evidence that work experience ($\chi2 = 0.35$, $P = 0.55$) and gender ratio ($\chi2 = 1.03$, $P = 0.31$) had an effect on hand washing, so they were excluded from additional analysis. Because the four different foods also clearly fell into two distinct groups with no differences either between apple and bread ($P = 0.73$) or between chicken and fish ($P = 0.57$), the two similar items were pooled and the food term was simplified into the difference between the two groups.

To examine the negative (disgust, fear, anger, and sadness) and disgust emotions recorded with the FACET software, one-way ANOVAs were performed between the means of those that had washed their hands and those that had not. These means were an average of FACET evidence numbers for the emotion minus the baseline of the same emotion. Evidence numbers, defined by FACET, represent the odds, in logarithmic (base 10) scale, of a target expression being present. For example, using disgust, an evidence number of 1 means the observed expression was 10 times more likely to be categorized by an expert human coder as disgust rather than not disgust. According to FACET, positive values larger than 3 indicates evidence for a strong positive effect in the emotion of interest while negative values smaller than -3 indicates evidence for a strong negative effect in the emotion of interest. Additionally, no video captures other than the one explained were excluded from analysis.

To further examine the motivational reasons for someone washing their hands the answers from the open-ended question were evaluated. Answers were first evaluated and placed into the seven categories displayed in Table 3. A chi-square comparison test was then performed between these categories to determine differences among race, gender and food.

Table 3. Compiled categories of motives for people washing hands and their description based on their response to open-ended questions.

Categories (n)	**Examples of descriptions**
Texture (38)	Slimy, wetness
Smell (22)	Odor of the product
Disgust (8)	Gross, dirtiness, cleanliness, unsanitary
Habit (38)	Reaction with raw meat or fresh produce
Carryover (5)	Lingering effect from previously handled foods
Foreign (8)	Never handled before, unfamiliar with food
Self-protection (45)	Bacteria, germs, pathogens, *Salmonella*, cross-contamination

To determine the influencing variables of disgust a four-way ANOVA was performed. The level of disgust was compared as a function of type of food, gender, work experience, and ethnicity. Participants were set as a random variable. However, using Tukey HSD comparisons there was no difference between apple and bread ($P = 0.19$) or chicken and fish ($P = 0.15$) thus the food term was simplified into the difference between the two groups.

A statistically significant difference for all tests was defined as $p < 0.05$ at an alpha of .05.

Results

Predictors of hand washing. The logistic regression analysis showed a significant difference on hand washing probability between the two food groups ($P < 0.001$). Participants were 10 times more likely to wash their hands after handling chicken or fish as compared to handling apple or bread. There was also a significant effect of disgust level in the probability of washing hands ($P = 0.04$). As disgust increased, there was a higher probability that the individual would wash their hands. Specifically, when each unit of disgust (on a 7-point Likert scale) increased, the probability of washing hands, following handling the food, increased 1.3 times. However, the predictive effect of disgust level on the probability of washing hands was more obvious in the group of bread and apple than within that of chicken and fish. A visual representation of these results can be seen in Figure 1. Additionally, there was no significant difference between Caucasians and Hispanics in the probability of washing hands ($P = 0.15$), nor a significant interaction effect between food type and disgust ($P = .13$).

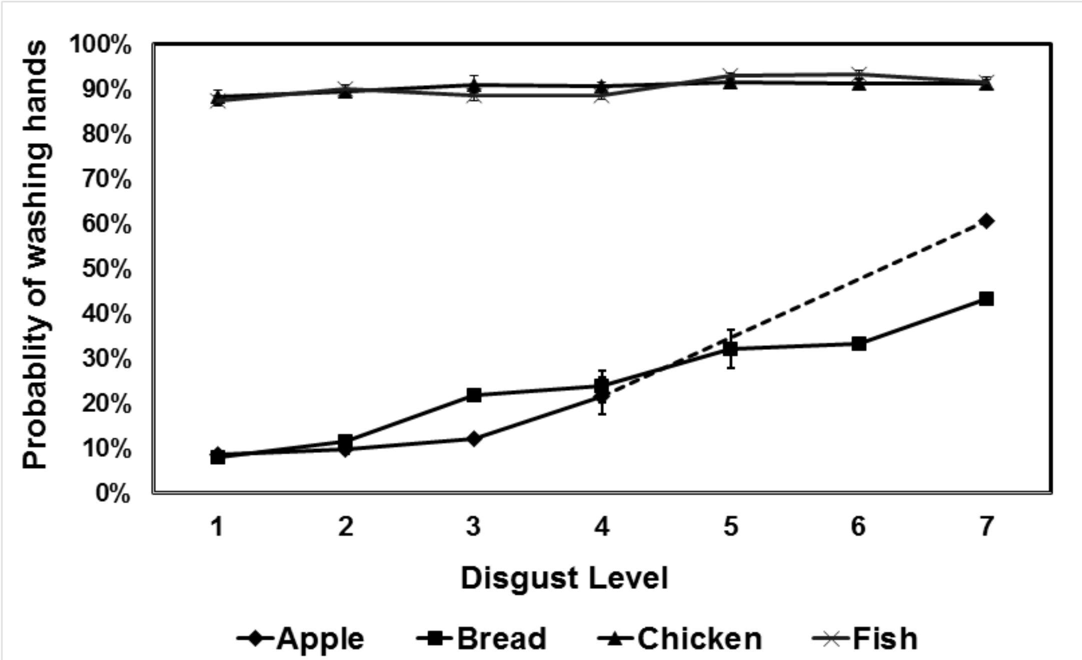

Figure 1. Logistic regression analysis showed the probability for individuals to wash their hands was influenced by the disgust level perceived (*P* < .05) and the type of food (*P* < .001); however, larger effects of disgust influence were seen in less hazardous foods (apple and bread) than more hazardous food (chicken and fish). Additionally, no participants rated apple at a disgust level of 5 or 6 and thus these points are represented with a dotted line.

With regard to facial expression, there was a significant difference in negative emotions [F (1, 234) = 7.13, P < 0.01]. Participants who washed their hands (mean ± SD = 0.22 ± 1.08) showed higher negative emotions than those who did not wash (-0.14 ± 0.98). Similarly, the participants who washed hands produced higher disgust emotions (0.22 ± 0.61), based on their facial expression, than those who did not wash their hands (0.08 ± 0.54), although there was a lack of significance (P = 0.07). However, it is important to note that according to FACET manufacturers an evidence number between 3 and -3 may not be totally representative of an emotion being present. Because these differences did not reach these predetermined thresholds, no further analysis of the FACET data was performed.

Reasons to wash hands. A significant difference in the reasons why participants washed their hands was shown between the Caucasian and Hispanic populations [Figure 2 (a)]. The frequency of self-protection response was significantly higher in Caucasian participants than their Hispanic counterparts (P = 0.04). By contrast, the frequency of texture response was significantly higher in Hispanic participants than Caucasians (P = 0.047).

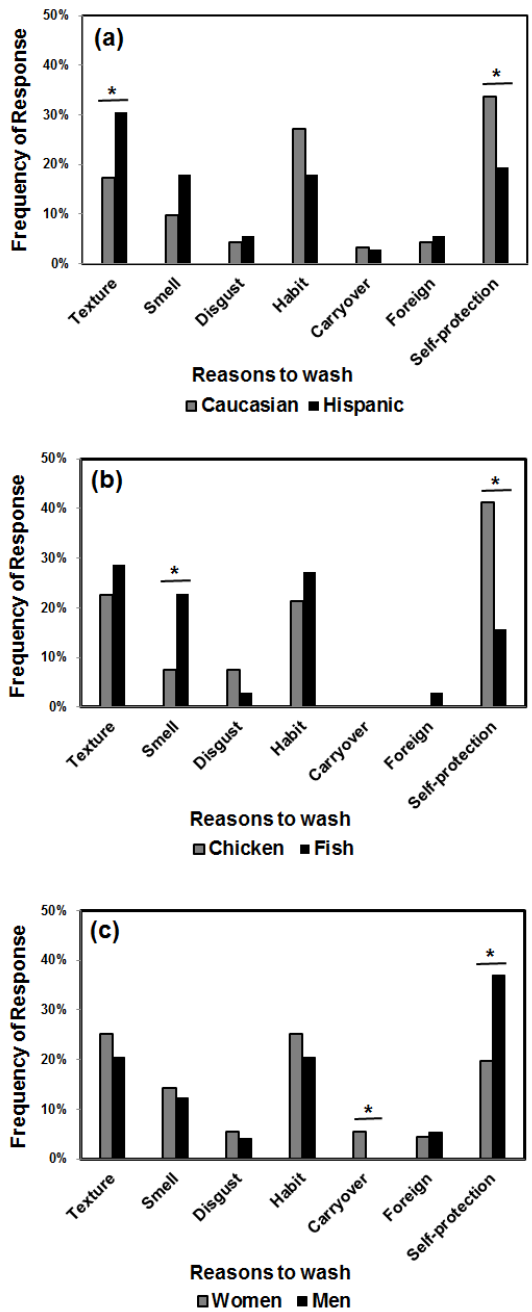

Figure 2. The frequency that people chose reasons to wash their hands depended on ethnicity, gender, and food. (a) *Caucasians washed their hands for self-protection significantly more than Hispanics while Hispanics washed their hands for texture reasons significantly more than Caucasians ($P < .05$). (b) *Self-protection was significantly more frequent reason for individuals to wash than hands while handling chicken compared to fish, and smell was significantly more frequent reason for people to wash their hand when handling fish compared to chicken ($P < .05$). (c) *Men were significantly more concerned with self-protection than woman, and woman were the only individuals to experience a carryover effect when handling food ($P < .05$).

Figure 2 (b) demonstrates the differences in motivational reasons depended on the type of food that was being handled. Since the frequency of washing the hands were very low in both apple and bread (also, no significant difference between the two foods), only chicken and fish were highlighted in Figure 2 (b). The frequency of self-protection response was significantly higher when the participants handled chicken than when handled fish (P = 0.001). However, the smell of fish played a significantly larger role than chicken as being a reason given to motivate people to wash their hands (P = 0.008).

Figure 2 (c) shows that the motivational reason to wash the hands is significantly different between men and women. Men were significantly higher than women at reporting self-protection as a reason to wash their hands (P = 0.01). As opposed to men, women were significantly higher at reporting “carryover effect” as a reason to wash their hands (P = 0.04). That is, women were more influenced by the remnant of foods previously handled during the study compared to men.

Level of disgust. There was a significant interaction between type of food and gender in the level of disgust based on the emotional scale [P = 0.02]. Women showed higher mean ratings of disgust in all types of food except bread. Overall, the mean ratings of disgust were significantly higher in women (mean ± SD = 3.18 ± 2.14) than in men (2.68 ± 1.85) (P = 0.04).

In addition, mean ratings of disgust for chicken and fish were significantly higher than apple and bread (P < 0.001). A representation of these results can be seen in Figure 3.

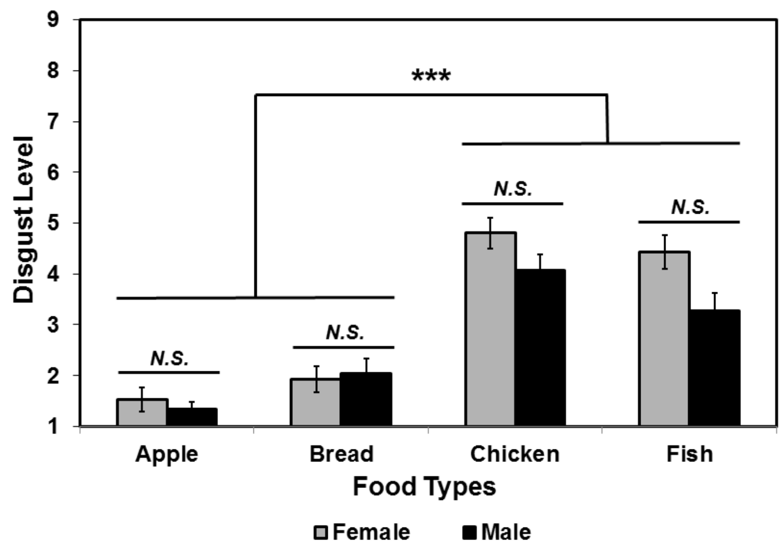

Figure 3. Based off the paper emotional scale, disgust levels (1-7) among genders (Men and Women) varied for food handled in the study (apple, bread, chicken, and fish). Woman rated all foods except bread as more disgusting, however there were no significant difference in gender disgust ratings within each food (P > .05). ***However, men and women significantly rated chicken and fish as more disgusting than apple and bread ($P < .001$).

Discussion

The interaction of many contributing factors and barriers such as inadequate hand washing facilities, number of sinks and their placement, requirement to wear gloves, lack of accountability or minimal management involvement has been shown as direct or indirect reasons for low employee compliance rate of proper hand hygiene in foodservice (Todd et al., 2010; Green et al., 2007; Pragle et al., 2007). Additionally, researchers have begun to emphasize the importance of internal motivational factors such as the emotion of disgust and how it affects hygiene behaviors (Curtis et al., 2009; Porzig-Drummond et al. 2009; Scott et al., 2008). Our study adds to these findings, demonstrating the difference of disgust between foods and the effect these foods have on the behavior of hand hygiene.

Relationships between type of food being handled and hand hygiene. Our results showed that type of food being handled affects hand hygiene. Chicken and fish had a much higher probability to stimulate the participant in the behavior of hand washing than did bread or an apple. This may be due to differences in the level of perceived danger among raw meat types of foods with one group of foods perceived as being more hazard than the other. For instance, individuals may pay more attention to food safety information that pertains to raw meat because they perceive it to be more of a hazard when handling (Kornelis, De Jonge, Frewer & Dagevos, 2007). Similarly, self-protection and maintenance of cleanliness, habit, were high motives for individuals to wash their hands after handling chicken and fish (63% and 43% of total motives, respectively). These findings may provide an opportunity for food safety improvement by educating individuals on lesser known risks of contamination where Escherichia coli, Salmonella, Shigella, and Norovirus has been shown responsible for outbreaks using previously unsuspected vehicles, like fresh produce (Newell, Koopmans, Verhoef, Duizer, Aidara-Kane, Sprong, Opsteegh, Langelaar, Thresfall, Scheutz, van der Giessen, & Kruse, 2010); for an extensive review on microbial safety of fresh produce, see Olaimat & Holley (2012). However, between chicken and fish, different reasons were suggested to why individuals may be motivated to wash their hands. For chicken, individuals responded that self-protection was a driving motivator for their behavior. This may be due to the well-established connection of raw chicken with Salmonella (Kennedy, Stewart-Knox, Mitchell, & Thurnham, 2004). For instance, Alekruse et al.(1996) showed that out of 1,620 respondents interviewed about food handling practice, those who identified a food association with Salmonella spp. were more likely to report washing their hands and cleaning cutting boards after preparing raw meat and poultry. Texture, habit, and smell were the dominant reasons for individuals to wash their hands after handling fish. Furthermore, smell was a much larger influence in fish than chicken. This result is supported by the facial expression data, which showed a negative correlation with fish where olfactory response would have been provoked before handling the fish (data was not shown). This ability of the olfactory system to have a predisposed ability to warn about microbial threats has been shown in other studies (Stevenson, 2010; Croy, Maboshe, & Hummel, 2013).

Relationships between disgust level and hand hygiene. Disgust also plays an influencing role in hand washing when handling food. For instance, as disgust increased when handling food, the probability that an individual would wash their hands also increased. This disgust-hygiene relationship is similar to other studies that show hand washing increasing with disgust (Porzig-Drummon 2009, Curtis & Biran, 2001; Scott et al., 2008). For instance, Porzig-Drummond et al. (2009) performed an experiment to show that disgust-evoking qualities of contaminated objects can trigger hand hygiene behavior. In that experiment, participants were shown three intervention videos (e.g., a disgust video, an education video, a control video). A week later, participants were asked to handle different items and the number of hand washing attempts was recorded for each individual. The results showed a significant difference in hand washing compliance among the three interventions, with the disgust video intervention being superior to education, which in turn was superior to the control. It also showed a linear trend where items rated more disgusting initiated more acts of hand washing. However, our study further showed that many other motives, including disgust, may be in play when individuals are handling food. Among foods perceived as riskier (e.g., raw chicken and raw fish), disgust levels were the highest, but their action to engage in hand washing was also driven by other reasons mentioned earlier. This perceived disgust may be due to previous knowledge, preference, and domains of disgust related to death of an animal, which has been characterized as a disgust eliciting property of certain food (Rozin & Fallon, 1987). A similar conclusion was drawn from one study showing some foods, such as fresh red meat, that does not look to be rotting or dirty in appearance, still evoked disgust in certain individuals (Rousset et al., 2005). However, the effect of disgust on hand hygiene was larger with foods considered non-hazardous (e.g. apple and bread). These items may also have been influenced more by other reasons such as carryover effect from more hazardous foods and unknown handling from prior participants.

Relationships of hand hygiene with demographics and past experience of foodservice work. Our findings demonstrated no significant effects of gender, culture, and past experience of foodservice work on hand washing. These results were not expected, based on prior research findings. Several studies have shown that increasing education through food safety training increases hand washing compliance (Soon et al., 2012). However, there were no differences between individuals with or without foodservice work experience, meaning food safety training was not effective or both parties show an inclination to wash after handling certain foods. Previous research also shows that women tend to have less confidence in the safety of food compared to men (Berg, 2004). Additionally, in many studies woman have shown better hand hygiene practices to prevent cross-contamination than men, even when visual cues were used to increase compliance (Patil et al., 2005; Anderson, Warren, Perez, Louis, Phillips, Wheeler, Cole, & Misra, 2008). In one observational study by Anderson et al. (2008), men washed their hands only half as many times as women washed their hands in pre interventions, 31.5% and 62.8% respectively, and this difference between the two did not decrease much with visual prompts. However, in our study no difference in hand washing rates were observed between men and women. Similarly, no significant differences in hand hygiene practices between Hispanics and Caucasians were observed. Lack of differences between gender and cultures observed may be due to each individual having diverse motives to wash. For instance, men were more likely to wash their hands than women for self-protection where woman relied heavily on habit and texture. This effect was surprising since studies have shown that fear of contamination was higher among woman than men (Patil et al., 2005; Haidt, McCauley & Rozin, 1994), but this fear and repetition of sanitation practices may have led to a hand hygiene habit among women (Whitby et al., 2006). Additionally, women were affected by more of a carryover effect from more hazardous foods. This effect may explain why gender differences with hand washing was most prominent with food perceived as less hazardous, and also supports our results that women found hazardous foods more disgusting than men. For example, Haidt et al. (1994) found gender as one of the most powerful predictors of disgust sensitivity with women scoring as much as one standard deviation higher on disgust sensitivity than men. Secondly, Caucasians were motivated more by self-protection than Hispanics, while the texture of the food was the initiating factor for Hispanics to wash their hands. This shows that unlike Caucasians who worried about bacterial contamination and disease, Hispanics simply did not like the feel (texture) of the food. This difference in food safety concerns between Caucasians and Hispanics may be due to basic education differences or a misunderstanding of food safety material available. For example, Hispanic immigrants typically have less formal education (e.g. only 16.7% of the current foodservice workforce are college graduates), and food safety materials effectiveness is highest when modified to the intended audience's culture (Po et al., 2011; U.S. Department of Labor, 2012). It is also important to note that other factors not controlled in the study that have been shown to influence hand hygiene behaviors, such as education and income, may also have an effect (Patil et al., 2005).

Conclusion

Hand hygiene plays a large role in controlling the spread of bacteria and disease at home and to customers throughout the foodservice environment. Several factors influence the rate of hand washing compliance among employees and acknowledging each is important to maximize intervention strategies designed to increase compliance. Our findings show that hand washing behavior is modulated by the type of food being handled and the emotion of disgust. Individuals tend to wash their hands more frequently after handling foods perceived as more hazardous, and their reasons to wash varies on demographic factors (e.g. culture and gender) and food type. In addition, as the feeling of disgust increases among individuals their probability to wash their hands also increases. This information concerning perceived levels of threat and disgust among foods should be considered when designing strategies to increase consumer or foodservice employee hand washing behaviors.

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Chapter 3: Effectiveness of sensory cues as prospective memory reminders

Disgust and odor: Reducing the intention-behavior gap for hand washing behaviors

Introduction

Food borne diseases are a serious public health concern in the United States and worldwide. For instance, two-thirds of the people, 68%, who became ill, became ill from eating food prepared in a restaurant or deli (Gould et al., 2013), and researchers even believe that the number of foodborne diseases are underreported where food-borne disease outbreaks that don't cause serious illness, hospitalization, or death are often overlooked (Lynch, Painter, Woodruff, & Braden, 2006). The Centers of Disease Control and Prevention estimates 9.4 million Americans become ill from food borne pathogens, nearly 56,000 are hospitalized and more than 1,300 deaths annually in the United States (Scallion et al., 2011).

What can be done to minimize the risk of someone becoming ill when they go out to eat? Numerous risk assessments point to proper hand hygiene as an effective way of eliminating food borne pathogens in the food supply chain and reducing its dispersion in the food service industry (Todd, Greig, Bartleson, & Michaels 2008; FDA, 2009). Consequently, employers all along the food chain from farms, food processing facilities to wholesale and retail food service establishments have focused on increasing employees' hand hygiene compliance (Soon et al, 2012; Viator, Blitstein, Brophy, & Fraser, 2015). Understanding better ways to motivate employees through the use of behavior models has shown considerable improvement in proper hand hygiene compliance by providing a motivational framework to employee training and education. Popular and effective methods of training include basic food safety education, Theory of Planned Behavior (TPB; Roseman & Kurzynske, 2006), Organizational Theory (Larson, 2009), and Health Behavior Model (HBM; Milton & Mullin, 2012). A meta-analysis of food safety training on hand hygiene knowledge and attitudes among food handlers found that a well-planned combination of both standard training and behavioral interventions were the most effective at improving hand hygiene engagement (Soon, Baines & Seaman, 2012). For instance, out of the five studies measuring hand hygiene attitudes, social cognitive intervention such as TPB and HBM, in combination with training, resulted in the highest shift of increased attitude toward hand hygiene.

However, seldom do intervention studies measure the effectiveness of increasing hand washing performance (e.g. how well did they wash their hands?) rather than just an observation of did they wash. For example, Green et al. (2006), monitoring, hand washing practices in 300 restaurants across six states, noticed that only 1/3 of employees washed their hands after food contact activities requiring hand washing, and only 27% washed their hands properly. Additionally, depending on the type of food facility, 33% to 73% of the facilities were out of compliance with proper hand washing procedures (Palumbo et al., 2007). According the FDA (2003), proper hand washing, as described in the Food Code is a vital and necessary public health practice in retail and food service, and deviations from these practices do not adequately reduce important foodborne pathogens on foodworkers' hands. This means, increased hand washing performance in parallel with compliance should be the driving force in hand washing interventions to decreasing the spread of disease. Additionally, York et al. (2009) points out that long-term success in something as monotonous as hand washing requires multiple interventions in which hand washing components are incorporated into the environment, displaying posters and reminders (in the workers' native language). These reminders reinforce basic concepts and emphasize desired behavior thus reducing the intention-behavior gap encountered during behavioral change, and help lead an employee to the ultimate goal of having the habit of proper hand hygiene (Michie, Abraham, Whittington, McAteer & Gupta, 2009; Pellegrino, Crandall, O'Bryan, & Seo, 2015).

Typical hand washing reminders used during or after training have concentrated on two senses, sight and sound, both of which have been shown to increase hand hygiene (McGuckin et al., 2006; Judah, et al., 2009; Filion KuKanich, Chapman, Hardigree, & Powell, 2011). Early reminders were fashioned as educational tools; however, recent research shows more sophisticated reminders that are based on behavioral theories and targeting the employees' emotions can be more effective (McGucken et al., 2006; Judah et al., 2009; Mackert, Liang, & Champlin 2013). For instance, in a hospital environment McGuckin et al. (2006) used role-modeling by using voice prompts recorded by different authoritative figures (e.g. shift managers) as hand hygiene reminders. Through this approach, the hospital saw a 60% overall increase in hand soap and sanitizer usage. Similarly, roles of disgust have been used to influence individuals through visual prompts (Judah et al., 2009). Judah et al. 2009 placed electronic screens above the entry of 200,000 highway service station restrooms and demonstrated that disgusting text prompts compared to the control condition, significantly increased soap usage by 9.8% for men. Additionally, other studies have shown that a heightened level of disgust in objects or food can increase hand washing compliance (Porzig-Drummond, Stevenson, Case, & Oaten, 2009; Pellegrino, Crandall, & Seo, 2015). Pellegrino et al. (2015) showed that individuals, both Caucasian and Hispanic, were more likely to wash their hands after handling a food they perceived being disgusting, and this effect was larger for less hazardous foods (fresh produce), which are common carriers of food borne pathogens.

However, it is unknown whether using disgust as a motivator can be levered to influence hand hygiene behaviors through simple reminders. Similarly, there has been limited research focusing on the sense of smell which shows potential to influence behaviors related to self-protection. Unlike other senses of sight and sound (which are limited by wavelengths and oscillation of air pressure), the sense of smell can distinguish stimulus across a wide range of concentrations of a trillion chemicals and compounds, has long been tied to memory association, and represents a first-line of defense for encountering danger (Harper, 1972; Maruniak, 1988; Koster, Degel, & Piper, 2002; Stevenson, 2010).

This study was designed to give a cross-comparison of these three sense stimulators and their potency to not only influence hand washing behavior, but increase performance through the development of a hand washing performance model and a real-time prospective memory scenario. In the first part of the study, six participants' hands were inoculated with GermGlo (a florescent micro-particle) and asked to wash their hands at different levels of time (5, 10 and 15 seconds) and intensities as monitored by an electronic hand hygiene verification (HHV) machine to obtain an accurate hand washing performance model. Next, eighty individuals of Hispanic / Latino participants performed a real-time prospective memory scenario under four different treatment conditions (visual control, visual disgust, auditory disgust, and odor disgust) while the HHV recorded their real-time hand washing performance. Prior prospective memory studies have shown that reminders can be useful depending on the appropriateness to the prospective memory task (Guynn, Mcdaniel, & Einstein, 1998; Nowinski & Dismukes, 2005); however, these studies have been limited to simple text reminders and event actions within a computer-based environment. This study provides new insight into the effectiveness of different senses and emotion to influence hand washing behavior and performance, and broadens current prospective memory research to a real-time application that may reduce the risk to consumers of food borne illness.

Experiment 1

This preliminary experiment was performed to create a statistical model for determining hand washing performance by recording the variance of the measurements taken by the HHV that will later be used in Experiment 2.

Materials and Methods

Physical surrogate. GGP (Glo Germ™, Inc., Moab, UT) was chosen as a physical surrogate for food borne pathogen contamination. GGP is a non-toxic agent which has been previously shown to simulate *L. monocytogenes* cross-contamination in a food service environment, due to its small particle size (5 µm, compared to 1-2 µm for *L. monocytogenes*). Additionally, GGP fluoresces under ultraviolet lighting which permits quantification of very low concentrations perhaps as low as 1/10 the levels of a non-fluorescent surrogate and the ability to rapidly quantify amounts transferred among surfaces (Benoit, Marks, Ryser, Jeong, & Crandall, 2015).

A 1:10 w/v suspension of the physical surrogate Glo Germ™ polymer powder (GGP) was prepared by adding 1 g of GGP to 10 ml of 70% ethanol, followed by vortexing for 1 min.

Electric Hand Hygiene Verification (HHV) Machine. To measure variables related to hand hygiene performance, an electronic hand hygiene (HHV) machine constructed with researchers at Oklahoma State University was setup in our lab (Wan, 2014). Using the HHV, allowed us to assess real-time metrics for analysis. The overall design of the HHV monitoring system was divided into three parts: a multiple-input sensing unit, a hand-motion detection unit, and a sensor fusion and data management unit. The sensing unit collects data measuring the volume and temperature of water, automated soap/sanitizer volumetric dispenser, and automated paper towel dispenser. Wi-Fi modules were put into both the automated paper dispenser and automated soap dispenser and usage was monitored by a wireless microcontroller (Wifly GSX Wireless Module, Microchip Technology Inc., Chandler, Arizona) using General Purpose Input Output (GPIO) pins. Similarly, water flow and temperature were monitored directly by the main microcontroller (Micro-programmed Control Unit, MCU; v1.22, Seeeduino Mega, Seeed Studio, Shenzhen, China) through Hall Effect flow sensors (in both hot and cold water pipe lines) and analog input respectively. The hands motion detection unit monitored the movements of hands in a 3D space and measured the real-time hand washing actions (hand washing and lathering duration) of a human subject. A Microsoft Kinect Sensor was used for hand motion detection because it provides two cameras and is able to measure hand motion in a 3D space. The motion sensor was mounted 1.2 meters above the sink facing the hand washing station and connected to a computer directly via a USB port. A sensing system was used for data integration from different sensing sources to interpret and recorded hand washing events for later analysis. The sensing system for data collection had two sections, a data collection section with a microcontroller unit and an image and data processing section with a PC/Server. Since the system server processed the video stream from the 3D camera sensor, a PC with a relative high computation power was required (Optiplex 3010 Desktop, Dell Inc., Roun Rock, Texas, United States). A visual arrangement of components can be seen in Figure 1. Hand washing event variables gathered from the HHV were based off the WHO hand-hygiene guidelines of critical parameters that need to be measured and monitored closely to determine overall hand washing performance. For more information on each variables collected, refer to Table 1.

Figure 1. Hardware configuration of the electronic hand hygiene machine.

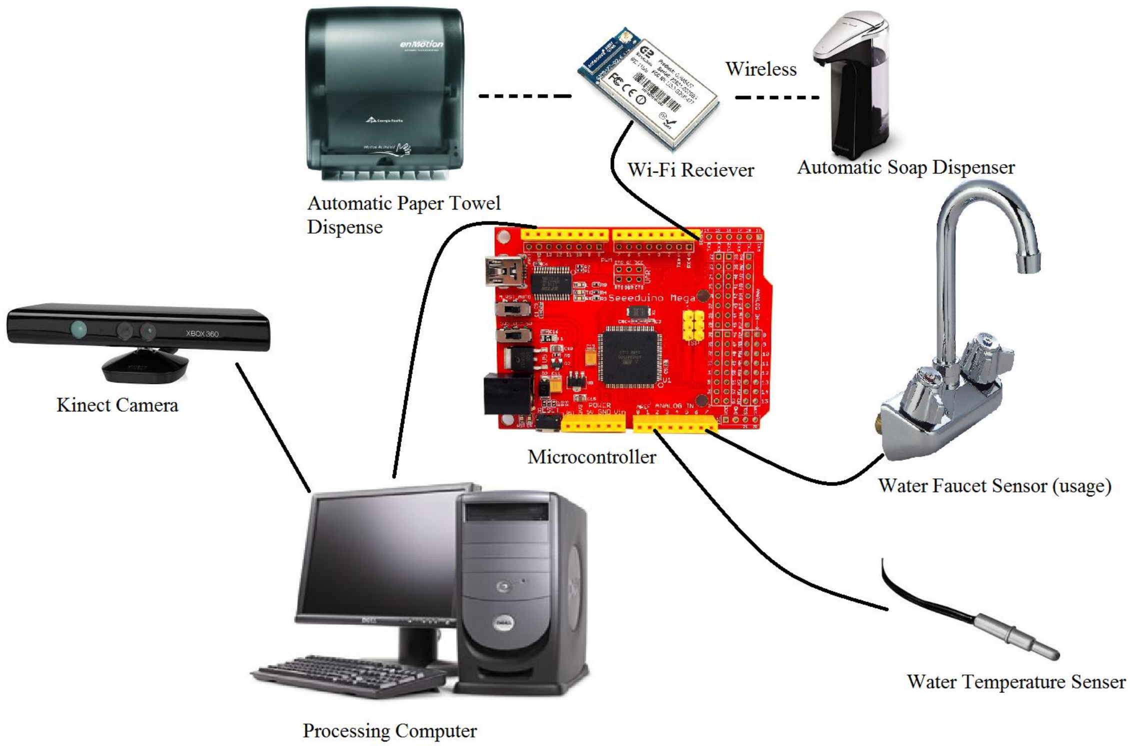


Table 1. Variables monitored and recorded by the electronic hand washing machine.

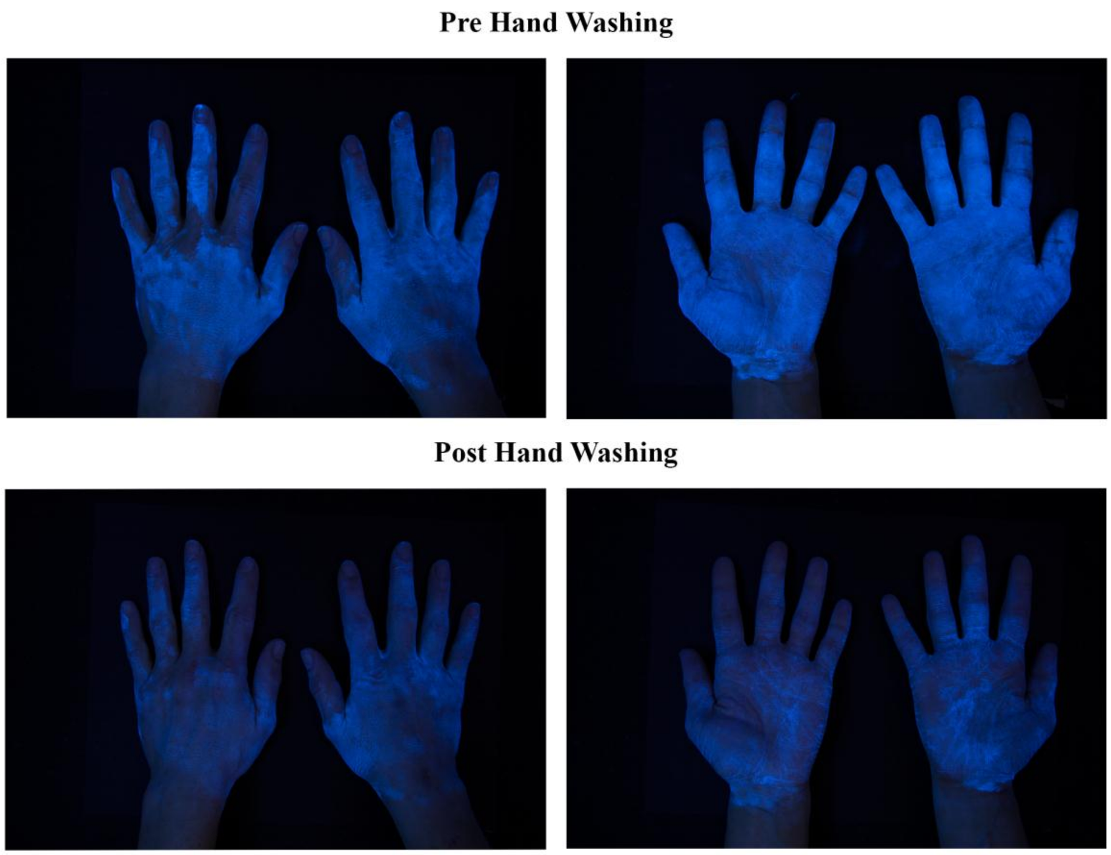
Parameter(unit)	Definition	Calculation Criteria
Start Time (MM/DD/YYYY H:M:S AM/PM)	Hand washing start time	The system software monitors the water flow and soap dispenser status. If water being turned on or soap dispenser being activated, the current computer system time was recorded as hand washing start time.
Soap Time (MM/DD/YYYY H:M:S AM/PM)	Time of soap being used	Current computer system time, when the server program detects the soap dispenser being activated
Soap Usage (drops)	The drops of soap used for current hand washing event	The server program monitors the serial communication data from MCU for message

Lathering Time (second)	Soap lathering time	Once system software detects the soap dispenser being activated, it will start a timer for this parameter. This timer adds an average frame time (1second/frame rate) for every processed frame, if only one hand was detected (lathering) and the system software detects hand under water running faucet over one second, the lathering timer will be stopped.
Paper Time (MM/DD/YYYY H:M:S AM/PM)	Time of paper towel being used	Current computer system time, when the server program detects the paper towel dispenser being activated
Paper Towel Usage (piece)	The weight of the used paper towel (s).	A scale placed under the waste receptacle measuring the weight of a used paper towel
Water Temperature (°F)	Water temperature	The MCU reads the temperature sensor once per iteration and stores the reading in to a 128 elements temperature buffer. If water being turned on, MCU will send an averaged buffer temperature reading once every two seconds. The server program monitors the serial communication data from MCU for message that contains “TEMP”, and extracts the water temperature data and put it in to another buffer. One averaged temperature data from this buffer was recorded into the log file for one hand washing event.
Water Usage (liter)	The volume of water used during hand washing event	The MCU monitors Hall Effect flow sensors (in both hot and cold water pipe lines) and reads the final volume at the end of a hand washing event
Hand Washing Duration (second)	Hand washing time including wetting time and rinsing time	The system software monitors the hand location. Once it detects the hand under a water running faucet, it will start a timer for this parameter. This timer will add an average frame time (1second/frame rate) for every processed frame.

Procedure. Six volunteers (3 men and 3 women), ages ranging from 23 and 43 years [M ± SD = 29 ± 8 years] participated in the preliminary study. Participants were asked to wash their hands as they normally did where their hand washing variables were tracked using the HHV for a specified period of time with different conditions. Three times (5 seconds, 10 seconds, 15 seconds) and four conditions (no soap + no paper towel, paper towel + no soap, soap + no paper towel, soap + paper towel) were used in this initial study. In total, the six participants completed 12 washing trials with each condition being partitioned randomly across three separate days. Prior to washing for each combination of time and condition, both hands of the participants were scrubbed clean with an alcoholic wet wipe and allowed to air dry. Afterwards, 300 µl of the concentrated GGP suspension was spread evenly over the surface of each hand and participants were asked to rotationally rub their hands in a figure eight pattern (covering both the front and back of their hands) until the solution dried. Participants were not informed of other variables being recorded by the HHV. The preliminary study protocol were approved prior to initiating the study by the University's Human Subjects Review Committee.

A baseline picture of both the front and back of the participants' hands were taken prior to any of the trials. Additionally, after the GGP suspension was applied pre and post each hand washing trial, the front and back of both hands of the participant were photographed. Photographs were taken in a darkened room using a digital SLR camera positioned 31 cm above the hand, and set to manual settings (Canon EOS 5D Mark II Full Frame DSLR Camera, EF 24-105mm f/4 L IS USM Lens, focal length = 35 mm, shutter speed = 1/30 s, aperture = f-stop 5.6, ISO = 400). The only light source were 4 ultraviolent spiral-shaped bulbs (PLT Inc., 13W bulb) on each corner (at a 20 cm distance and 30º degree angle from the hands) of a table top camera stand with a parallel tripod (holding the camera). Camera setting and positioning were selected based from a previous study quantifying GGP (Benoit, Marks, Ryser, Jeong, & Crandall, 2015). For an example of before and after picture of hands with this procedure, see Figure 2 (Pellegrino, 2015).

Figure 2. Hand contaminated with GermGlo pre and post hand washing



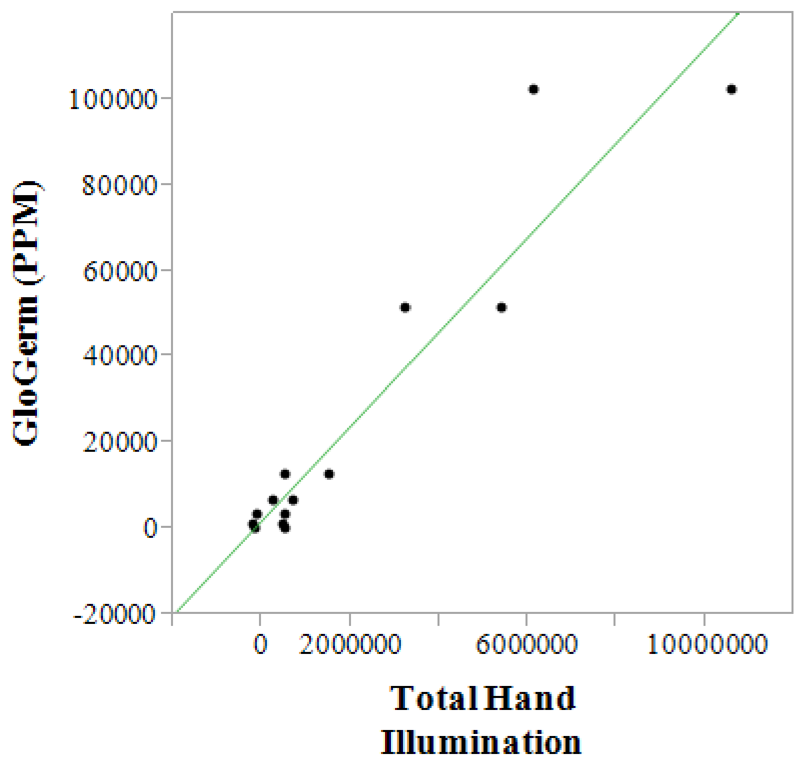
Analysis and Discussion

Processing Images to Determine Amount of GGP on Hands. Image processing tools in MATLAB® (v8.3.0532, The MathWorks R2014a, Natick, Mass.) were used to quantify the amount of GGP (ppm) on each hand (including baseline reflectance). The amount of GGP transfer was quantified by an algorithm that determined specific thresholds for each hand (changing the image to binary) to filter out background noise, followed by multiplying the binary image pixel values by the original image pixel values and summing the pixel intensities in the sample area (Gonzalez et al., 2004). This quantification method is based on prior studies that showed this method yielded the most accurate pixel count and a useful sum of the intensity values that included only those pixels encompassing the GGP visible in the image (Benoit, Marks, Ryser, Jeong, & Crandall, 2015).

The images first were read and imported into the program and cropped to the size of the hand surface. To correct for background noise in the images, red, blue, and green components were all evaluated. The red component was used to identify the GGP area, the blue component was used to distinguish the background noise, and the green component was used to determine the concentration of GGP on the hands. To distinguish the background from the GGP, the blue component was converted into a binary form. The area of background illumination, sum of the pixels in the red component image, and threshold to identify the effective green image were then determined. By using the red component to identify the area containing GGP, the green component could be isolated from the background surface. Doing so changed the image into a binary form. By blurring the green component image, the background noise was removed without compromising the GGP affected area. To calculate total hand illumination, the base line binary green component (of the back and front of the hands) were subtracted from the pre and post hand washing binary green component (of the back and front of the hands) and the difference between corrected pre and post hand washing components were recorded.

The total hand illumination was related to the concentration of GGP by creating a calibration curve for a set of hands. This was done by spreading a known serially diluted GGP concentrations ranging from 200 to 102,400 ppm of GGP on the front and back of a volunteer hand. The computed intensities were plotted against concentration, and a second-order calibration equation was chosen based off observations and the application of the equation (see Figure 3).

Figure 3. Quadratic calibration curve for total hand illumination vs. concentration of GGP.



Statistical Analysis and Model Development. Data was analyzed using JMP (version 11.2, SAS Institute, Inc., Cary, NC, USA). For the calibration equation, a female (age 23) and male (age 24) volunteer was used. The resulting second-order calibration equation accurately predicted the GGP concentration by total hand illumination (R^2 = 0.92, AICc = 309.68) and was used to define the performance of hand washing in the model described below.

No observations had a Cook's D influence (Cook, 1986) larger than 1 thus no outliers were excluded from the analysis. Looking at the correlations between GGP concentration (based on the equation mentioned above) and the continuous variables recorded by the machine (lathering time [seconds], water temperature [Celsius], water usage [liters], hand washing time [seconds], and paper towel weight [grams]), there was no correlations for water usage (-0.16), temperature (-0.009), and paper weight (.05) and thus were removed from the model. Next, a mixed model with GGP concentration (based on the equation mentioned above) was set as the dependent variable, and the remaining continuous variables with recorded by the machine and their interaction were set as its predictors, and individual subjects as a random predictor. A two-way predictive model with lathering time [$F(3, 68) = 11.22$, $p < .0001$] and hand washing [$F(3, 68) = 5.64$, $p < .0001$] along with the model intercept showed significance [Adj $R^2 = 0.73$, AICc = 1500.61]. Furthermore, residuals were checked and looked appropriate, including any issues with multicollinearty among predictors (VIF < 2). The resulting model for hand washing performance based off variables of our electronic hand hygiene machine is shown below:

Hand washing performance (GGP removed in ppm) =

81604.84 pp + (2817.81 ppm * lathering time) + (1682.38 ppm * hand washing time)

Discussion. Our model shows that only two important factors measured by HHV are effective at measuring hand washing performance: lathering time and hand washing time. Hand washing time and lathering time were positively linear with hand washing performance. Interestingly, these variables have often been lumped together for an overall hand washing time, but our model shows both have different levels of effectiveness where lathering time shows a larger impact on germ removal than simply washing hands under running water.

Our model also implies that factors such as paper towels, water usage, and temperature are not significantly responsible for the removal of bacteria from the hands in the event of a hand washing action. This conclusion was confirmed by looking at simple comparisons of the nominal variables (data not shown). However, it is important to note that this model simply looked at the removal of germs rather than the actual elimination (e.g. killing) of germs. For instance, it has been shown that washing in warm water (120 °F) removes more microorganisms than washing in cool water (70 °F) (Guzewich & Ross. 1999). Similarly, the use of single-use paper towels and clean single-use cloth towels has been shown to aid in the reduction of bacteria, and complete hand drying is critical to reduce recontamination (Patrick, Findon & Miller, 1997). Therefore, these variables in hand washing performance in other interventions should also be considered when measuring how well an employee washed their hands.

Experiment 2

Using a real-time prospective memory scenario, Experiment 2 compared hand washing behaviors and performance across sensory reminders and a control with the HHV machine model developed in Experiment 1.

Materials and Methods

Participants. Eighty-three volunteers (26 men and 57 women) with an age range age range from 18 and 44 years [mean age ± standard deviation (SD)] = 24.80 ± 5.21 years] participated in the study. All participants were of Hispanic / Latino descent and reported that they had no history of major diseases, and no sensory or cognitive impairments. Additionally, a prescreening survey was used to exclude individuals with unusual sensitivity disorders such as obsessive-compulsive disorder towards washing and to measure individual differences in odor perceptions. This survey included an 11-item washing subscale of the Maudsley obsessive–compulsive inventory (MOCI) to assess each subject's level of fear of contamination (Foa, Kozak, Salkovskis, Coles, & Amir, 2013) and determined perceived valence among 6 common odors (3 pleasant and 3 unpleasant) by asking surveyors for their degree of agreement with the statement ("*When I smell the following odor I feel unpleasant / disgusted.*") on a 7-point Likert scale ranging from 1 ("strongly disagree") to 7 ("strongly agree"). This survey also asked openly to "please describe what language(s) were primarily spoken in your childhood home." Participants were informed that the study concerned emotions and behavior, but no further details were provided. A written informed consent was obtained from each subject prior to participation. The survey questions and study protocol were approved prior to initiating the study by the University's Human Subjects Review Committee.

Tasks and Sensory Cues. Three tasks were designed to measure the effects of sensory cues on prospective memory. These tasks, like other prospective memory studies, were used as ongoing tasks and requested the participants to organize items in different prescribed arrangements. The following arrangements of four different large bins of items with varying size were used in the study:

1. Arrange the items in a row from big to small.
2. Arrange the items in a row alternating the biggest and the smallest.
3. Arrange the items in a row from small to big.

The items, in varying sizes, positioned in each bin were fresh tomatoes, colorless sticks, colorless balloons and paper rings. Each bin was randomly labeled A, B, C or D for each trial and was ordered in alphabetical order on a table in the testing facility.

Three sensory cues representing sight, hearing and smell integrating disgust and a control were used as prospective memory reminders. The visual and auditory cues were selected from the International Affective Picture System (IAPS) and the International Affective Digital Sounds (IADS), respectively, based off the dominance of the emotion of disgust (among male and female) measured in two separate studies that determined discrete emotions of both databases on a 7-point and 9-point scale (Mikels et al., 2005a; Mikels et al., 2005b; Bradley & Lang, 2007; Lang, Bradley, & Cuthbert, 2008; Stevenson & James, 2008). For instance, the visual cue chosen (IAPS 9300) was a picture of dirty, overused toilet having means of 2.26 ±1.76, 6 ± 2.41, and 4.12 ± 2.57 for valence, arousal, and dominance and a high disgust mean (6.00 ± 1.19), while the audio cue chosen (IADS 702) was an auditory belch having means of 4.45 ± 2.57, 5.37 ± 1.95, and 5.23 ± 2.04 for valence, arousal, and dominance and a high disgust mean (7.38 ± 1.91). The chosen odor (trimethyleamine ["rotten fish"]) was based off the results of a prescreener filled out by the participants that measured terms of unpleasant/disgust and pleasant/happiness appropriate for the Northwest Arkansas region (Ferdenzi, Delplanque, Barbosa, Court, Guinard, Guo, Roberts, Schirmer, Porcherot, Cayeux, Sander, & Grandjean, D., 2013). For the control, a conventional hand-hygiene reminder poster approved by the Center of Disease Control (CDC) was used (CDC, 2014).

All tasks were performed in the University of Arkansas' pilot test kitchen. In this kitchen, additional measurements of hand washing performance was obtained from the HHV monitoring system as described earlier in this paper. This machine was attached to a hand washing station installed next to the table used to display the bins of objects and included a sink, automated soap and paper towel dispenser. Additionally, a desk positioned cattycorner to the sink was used by the test administrator to instruct participants and monitor their results.

Procedure. Prospective memory refers to the act of planning an act in the future. This mechanism is the opposite of retrospective memory which refers to remembering information learned in the past (McDaniel & Einstein, 2007). Similar to other prospective memory tasks, a cover task (or ongoing task) was used in conjunction with prospective memory events (Guynn, Mcdaniel, & Einstein, 1998; Burgess, Scott, & Frith, 2003). For this study, an event-based prospective memory procedure was used with one intention. This intention (or event) was for the subjects to wash their hands after any activity that involved touching vegetables, rocks, cotton, or metal. This prospective memory event and triggering items were read out loud to subject off a handout which they were allowed to study for up to one minute. Additionally, items listed on this handout were randomized per participant, and directions and words were in English (top of page) and the participants' childhood language (bottom of page). Next, subjects were given two distraction tasks which were used as a buffer between prospective memory instructions and the ongoing tasks instructions. For the first distraction task, subjects were asked to complete seven 6th grade level math problems in five minutes. The second distraction task was a retrospective task where subjects were shown 30 random words (displayed on a screen one at a time with a 2 second duration per word) and after their presentation were given two minutes to recall (write down) as many words as they can remember. After the distraction tasks, subjects were read and given a piece of paper outlining the procedure of the three ongoing tasks (with their corresponding numbers) and they were instructed to memorize the directions for up to one minute; however, the objects in each bin were never mentioned. Additionally, directions and tasks of this handout were in English (top of page) and the participants' childhood language (bottom of page). Participants were then escorted into the testing facility to begin the testing procedure without the benefit of being able to refer back to the task directions. Here, the test administer called out a number and a letter, representing the task for the subject to perform on a particular bin of objects. Participants were asked to perform a randomized set of 15 tasks on the bins; however, only 2 (or 20%) of these tasks involved handling the bin of tomatoes.

Throughout the ongoing tasks, participants were subjected to one of three cues or a control. The control / visual cue and odor were constantly present via poster (positioned at eye level in the middle of the bins) and a hidden vaporizer respectively. Furthermore, the vaporizer had 140 mL of water with 500μL of the trimethylamine-oil solution (50:1 oil to trimethylamine votexed for 30 seconds). The audio cue was played every 15 seconds with a recording time of 5 seconds at 70 dB via speakers. Each hand washing event during a food-related task and its associated variables were recorded by the electronic hand washing monitoring system, and the length and correctness of each task was recorded by the administrator. Furthermore, no immediate feedback was given to the participants regarding errors or other aspects of their performance.

Statistical Analysis. Participants with a MOCI score seven or higher or reporting a fear of contamination, and those under the odor condition not reporting an agreement that "rotting fish" was disgusting / unpleasant in the prescreening survey were excluded from further data analysis. This exclusion removed three participants (2 males and 1 female), resulting in eighty remaining participants (24 men and 56 women), with ages ranging from 18 to 44 years [M ± SD = 24.73 ± 5.12 years]. These participants were further balanced across all four conditions by mean age [$F(3, 78) = 1.05$, $p = 0.37$] and gender ratio (for all conditions, 6 males and 14 females). Additionally, there was no significant difference of MOCI scores ($F(3, 78) = 0.36$, $p = 0.78$) or PM event study times ($F(3, 65) = 0.88$, $p = 0.45$) across treatments.

To determine the treatments that aided in memory planning and influenced hand washing behaviors a simple binary logistic regression model was used. The response was if the individuals washed their hands (yes or no) while the fixed predictor was the treatment in which they performed the tasks (control, visual disgust, auditory disgust, and olfactory disgust). Additionally, odds ratio tests were performed to measure difference between the treatments.

To examine the difference of hand washing performance across treatments a one-way ANOVA was performed between the predictive performance score means and the four treatments. The predictive performance score was calculated for each hand washing event by inputting the variables recorded from the electronic hand washing machine (lathering time, hand washing time, and water usage) into the performance model developed in Experiment 1.

Data was analyzed using JMP (version 11.2, SAS Institute, Inc., Cary, NC, USA). A statistically significant difference for all tests was defined as $p < 0.05$ at an alpha of .05.

Results

The logistic regression analysis showed a significant difference on hand washing probability between the four conditions ($p < 0.001$). These differences were quite large (Figure 3 and compared to the control, all disgust-related reminders showed significantly higher probabilities that the individual remembered the prospective memory and acted accordingly (e.g. washed their hands after handling vegetables). The olfactory disgust treatment showed the highest significance difference compared to the control ($p < 0.0001$) while visual disgust and auditory showed smaller, but still significantly higher probability to increase hand washing attempts than the control ($p < .05$ each). For instance, participants were 14 times more likely to wash their hands when the olfactory was stimulated with the disgust condition than the control, and 3 times more likely to wash under the visual and auditory disgust. Additionally, the olfactory disgust treatment had a significantly larger effect than the auditory and visual treatments ($p < 0.01$), and there was no difference between the visual and auditory disgust treatments ($p = 1$).

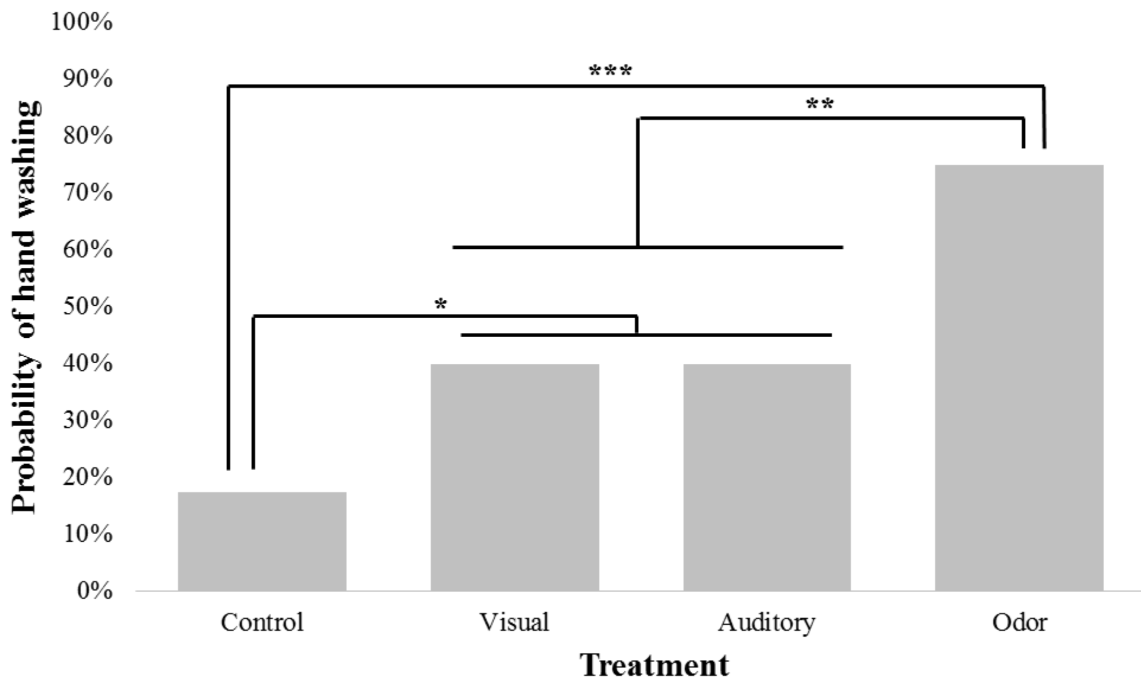


Figure 4. Logistic regression analysis showed the probability for individuals to wash their hands was different across the four conditions: control, visual, auditory, and odor ($p < .0001$). Compared to the control, visual and auditory disgust conditions showed a significant increase in Prospective Memory (PM) task initiation ($p < .05$ each) while odor showed a larger significant increase ($p < .0001$). Additionally, odor was significantly larger than both the visual and auditory disgust conditions ($p < .01$).

Among these hand washing actions, there was no difference of hand washing performance among treatments [F(3, 64) = 0.72, p = 0.55]. The visual disgust condition showed the largest performance score mean (110531 ± 13212.79 ppm) compared to the control (103499 ± 15139.65 ppm) and the auditory disgust (103404.56 ± 12997.35 ppm) which was the lowest; however, this effect was not significant. Additionally, evaluating the tasks themselves, there was no difference in the average time they took to complete the tasks among the conditions [F(3, 1146) = 2.54, $p = 0.055$], but there was a difference in correctness of the completed tasks among the conditions ($\chi^2 = 30.53$; $p < .0001$). Here, the probability of completing the tasks correctly was significantly higher in the visual disgust condition than all other conditions ($p < .0001$) with the largest difference being the auditory disgust condition.

Discussion

To date, most laboratory prospective memory studies have been limited to paper-based word associations, computer-based or board game simulations which are unable to test more complex human behaviors that involve both cognitive and physical engagement (Guynn, Mcdaniel, & Einstein, 1998; Rendell & Craik, 2000). Similarly, more naturalistic event-based studies conducted outside the lab can only look at simple tasks and do not benefit from the controls offered from more traditional laboratory studies (Huppert, Johnson, & Nickson, 2000). Our study provides a reliable laboratory design to study complex behaviors associated with memory and measure differences in environmental changes that influence these behaviors. Additionally, incorporating realistic situations into the design allows measurements of the actual application and allows practitioners to easily implement study findings.

Interestingly, comparing our real-time prospective memory scenario and other more common techniques, individuals are not as likely to engage in prospective memory (PM) tasks under control conditions (e.g. basic reminders). For instance, Guynn, Mcdaniel & Einstein (1998), in a paper-based word association task, showed no differences in a basic reminder and no reminder where the proportion of people completing the PM task was around 45 % for both. Similarly, the second part of their study which looked at reminders with additional action and context targeting showed PM task initiation up to 95 %. However, in our study, a merely 17 % of individuals engaged appropriately to the PM task under the control reminder (which reiterated the action of the PM task). This may be due to the additional cognitive resources needed during an ongoing activity resembling daily activities which competes with the PM task (Smith, Hunt, McVay, & McConnell, 2007), or the complexity of the intended action may pose additional memory challenges to remembering that something needs to be done (McDaniel & Einstein, 2000). Additionally, the use of categories as PM targets may have reduced the distinctiveness of the target thus reducing initiation.

A significant finding in our study is how control-like posters, typical of hand washing interventions may be ineffective at maintaining wanted behaviors such as hand hygiene. A cause for this may be miscommunication among individual of diverse cultures or they simply are overlooked (York et al. 2009; Po et al., 2011; Woolsey, 1989). According to Po, Bourquin, Occena, & Po (2011), due to the diverse workforce in the modern food service industry, visuals or text prompts that are used in food safety interventions must be cross cultural and multilingual in order to be effective. Similarly, Nieto-Montenegro et al. (2008) prescreened their materials and visual for cultural understanding, and made the appropriate modifications before implementing their intervention to increase hygiene practices in Hispanic mushroom workers. This intervention, using Health Action Model (HAM), significantly increased hand washing. Secondly, typical visual prompts may have been overlooked or not engaging with. As mentioned previously, Guynn, Mcdaniel & Einstein (1998) showed no differences in the proportion for subjects completing the PM task when given a basic reminder ("Remember the three words that you studied at the beginning of the experiment.") and no reminder, and later found increases in PM task completion when target and action reminders were used in combination. The authors concluded that prospective remembering occurs because an associative link is activated past some threshold such that presentation of the target event automatically elicits the representation of the intended activity; however only reminders that incorporate the target intention plus another component are effective. Reversely, our visual control (e.g. CDC poster) incorporated an action without the target and the lack of effectiveness could be similar.

Relative to the visual control, disgust cues effectively increased the probability of individuals to remember to act on a planned behavior. These results support the idea that distinctive, novel cues can be more effective at initiating planned behavior (McDaniel & Einstein, 1993), and is in line with research that has shown increases in hand hygiene activity with disgusting visuals (Porzig-Drummond et al., 2009; Judah et al, 2009). For instance, Porzig-Drummond et al. (2009), in a two part study, showed that priming an individual with disgusting videos (e.g. someone sneezing with residual snot) can effectively increase the initiation of hand washing with objects that are not visible dirty. They subsequently placed disgust/education-based posters in two bathrooms and educational posters in two other bathrooms, exhorting participants to wash their hands, and found that the disgust-based intervention was significantly better at promoting hand hygiene. Moreover, in a prior study, Judah (2009) showed visual text prompts of disgusting messages increased hand washing for men in a naturalistic setting. In our study, we show this effect to be cross-cultural by increasing the awareness of the intended hand washing behavior among Hispanic / Latino populations. Similarly, a national hand washing program in Ghana used disgust to motivate hand washing after changing a diaper or going to the bathroom thus increasing self-reported hand washing using both soap and water before eating by 30% (Scott, Schmidt, Aunger, Garbrah-Aidoo & Animashaun, 2008). To this degree, disgust, as shown in other studies, is a universal emotion that drives the behavioral avoidance of infectious disease and can be leveraged to increase hand washing among different ethnic groups (Curtis & Brian, 2001).

Additionally, the disgusting odor (“rotten fish”) proved to be an effective prospective reminder. Prospective memory research has shown that salient or unusual stimuli, may produce involuntary orienting responses that are neither executive nor self-initiated direction thus reducing the resources needed for retrieval of the PM task (McDaniel & Einstein, 2000). This may explain part of the odor induced effect since the ongoing tasks under the odor condition did not have additional costs (e.g. average time to complete tasks) compared to the other conditions. However, to quickly discount this effect as an attentional response to a salient reminder would be unjustified since the disgusting sound in another condition showed a significantly smaller effect. Another type of automatic process in prospective memory is memory-based. To this account, odor has long been associated with memory, and more importantly, this odor-memory association is highly correlated with emotion (Herz & Schooler, 2002; Willander & Larsson, 2007). For instance, Hertz and Schooler (2002) showed that autobiographical memories induced by odor was experienced as more emotional, and associated with stronger feelings of being brought back in time to the initiation of the event compared to memories evoked by verbal or visual cues. Additionally, this work was consistent with past findings that odor evokes emotional influence at the time of recall (Herz, Eliassen, Beland, & Souza, 2004). This may be due to the placement and connectivity of the olfactory cortex which is embedded within the brain's limbic system and amygdala, where emotions are born and emotional memories are stored (Herz, Eliassen, Beland, & Souza, 2004). Additionally, odor stimulus has been shown to produce larger, more startled emotional responses than visual or auditory presentations (Herz, 2004; Adolph & Pause, 2012). Our work supports these findings and further shows that this odor-memory association in context with a disgusting emotion can help engage individuals to act on an intention thus providing a unique tool for behavioral interventions. Here, the odor of disgust may evoke avoidance, a common signal from the olfactory system which warns about microbial threats (Stevenson, 2010), and this avoidance may in turn remind an individual to perform the intended decontamination PM target of washing their hands.

Conclusion

This study provides a prospective memory framework to study complex behaviors in changing environments, and provides additional support of reminders to reduce the intention behavior gap associated with behavioral change. It also shows the potency of disgust stimuli to influence behaviors related to self-protection while typical informational posters (targeting the intended action) may be ineffective in comparison. Interestingly, unpleasant odor, an often overlooked stimuli used behavioral change, shows the highest potency at reminding individuals to wash their hands under a prospective memory paradigm. However, these stimuli compared to the control do not increase or decrease hand washing performance, and additional research should look at stimuli that may increase hand washing to acceptable levels to remove pathogens and reduce the possibility of cross-contamination. Furthermore, research should look at the rate of decline of stimuli potency and if this rate is slower than the rate at which beneficial habits are formed.

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Overall Conclusion

These studies presented in this body of work encompass several areas of hand hygiene. First, it reviews the current motivational models used in the foodservice industry, comparing their similarity and differences to working models in the healthcare industry, and then examines the habitual nature of complying with good hand hygiene. To date, models fail to maintain a sustainable compliance of good hand hygiene practices in the food service since they do not consider cultural difference, the type of behavior being changed, and focus on initiation rather than maintenance leading to a widening intention-behavior gap after intervention. To help the industry correct such issues we explored hand washing behaviors and internal factors of motivation among cultures, and additionally tested sensory reminders and the emotion of disgust to reduce the intention-behavior gap. Here, we showed individuals tended to wash their hands more frequently for foods they perceived as more hazardous, and their motives to wash varied among variables of gender (self-protection for men, carryover effects for women), culture (self-protection for Caucasians, texture for Hispanics) and the type of food (self-protection for chicken, smell for fish). Additionally, emotions of disgust played a significant role in influencing individuals to wash their hands when handling less hazardous foods which has been recently responsible for outbreaks of *Escherichia coli*, *Salmonella*, *Shigella*, and *Norovirus.* Furthermore, we showed disgust can also be leveraged to increase hand washing using three sensory modalities (sight, hearing, and smell) compared to informational prompts common to interventions. These findings provide the food industry with more information to make appropriate hand washing interventions that are suitable for relevant cultures. It also demonstrates the power of novel reminders to increase hand hygiene compliance. The authors believe that this body of work will provide foodservice managers the background, theoretical basis and practical applications for making long-term changes in their employees on hand washing and similar critical behaviors in food service industry

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Appendix

Research Compliance Protocol Letters

IRB # 14-04-653

UNIVERSITY OF ARKANSAS

Office of Research Compliance
Institutional Review Board

April 18, 2014

MEMORANDUM

TO:	Philip Crandall Bob Pellegrino Tonya Tokar
FROM:	Ro Windwalker IRB Coordinator
RE:	New Protocol Approval
IRB Protocol #:	14-04-653
Protocol Title:	*Disgust Ratings for Common Foods Handled in the Food Industry*
Review Type:	☒ EXEMPT ☐ EXPEDITED ☐ FULL IRB
Approved Project Period:	Start Date: 04/18/2014 Expiration Date: 04/17/2015

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 (http://vpred.uark.edu/210.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 7,000 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 210 Administration Building, 5-2208, or irb@uark.edu.

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IRB # 14-04-652

UNIVERSITY OF ARKANSAS

Office of Research Compliance
Institutional Review Board

May 16, 2014

MEMORANDUM

TO:	Philip Crandall Bob Pellegrino Han-Seok Seo Corliss O'Bryan
FROM:	Ro Windwalker IRB Coordinator
RE:	PROJECT MODIFICATION
IRB Protocol #:	14-04-652
Protocol Title:	*Emotional and Behavioral Responses to Handling Different Food Stimuli among Diverse Cultures*
Review Type:	☐ EXEMPT ☒ EXPEDITED ☐ FULL IRB
Approved Project Period:	Start Date: 05/14/2014 Expiration Date: 04/20/2015

Your request to modify the referenced protocol has been approved by the IRB. **This protocol is currently approved for 60 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, 210 Administration.

For protocols requiring FULL IRB review, please submit your request at least one month prior to the 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 210 Administration Building, 5-2208, or irb@uark.edu.

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IRB # 14-04-653

UNIVERSITY OF ARKANSAS

Office of Research Compliance
Institutional Review Board

March 19, 2015

MEMORANDUM

TO:	Philip Crandall Bob Pellegrino Han-Seok Seo
FROM:	Ro Windwalker IRB Coordinator
RE:	PROJECT MODIFICATION
IRB Protocol #:	14-09-149
Protocol Title:	*Effectiveness of Sensory Cues as Memory Prospective Reminders for Diverse Cultures Handling Foods*
Review Type:	☒ EXEMPT ☐ EXPEDITED ☐ FULL IRB
Approved Project Period:	Start Date: 03/17/2015 Expiration Date: 10/08/2015

Your request to modify the referenced protocol has been approved by the IRB. **This protocol is currently approved for 105 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.

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