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Research Paper

Wearable Technology Effects on Training Outcomes of Restaurant Food Handlers

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ABSTRACT

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

Key words: Food handlers; Instructional design; Restaurants; Training; Training reactions; Wearable technology

Training is an integral component for organizations that must prepare their workforce to perform proper behaviors as part of their job duties. Training can be defined as a "systematic approach to learning and development to improve individual, team, and organizational effectiveness" *(21)*. Properly trained employees are more confident, effective, and efficient at their jobs *(1)*. A meta-analysis of 162 studies on organizational training effectiveness found training had a medium to large effect on learning, reaction, and behavior *(3)*. For the food industry, properly trained employees contribute to decreasing the burden of foodborne illness, which globally affects an estimated 600 million people annually, leading to 420,000 deaths *(56)*. Under the U.S. Food Safety Modernization Act, food establishments in the United States are required to train employees on safe food handling practices *(50)*. Despite the importance of food safety training, two major reviews have revealed only limited evidence for the effectiveness of training for changing behaviors *(16, 51)*. Implicit in these findings is the problem of poor transfer of training, where knowledge, skills, and attitudes presented in training modules fail to lead to adoption of long-term changes in employee behaviors *(5)*.

Baldwin and Ford *(5)* identified three factors that affect transfer of training: work environment, trainee characteristics, and training design. Understanding these factors in the context of the food industry helps to explain why food safety training may not always change behavior. Work environment reflects the degree to which food safety is prioritized by an organization and the amount of opportunity given to employees to practice food safety behaviors. In one study, leadership commitment to food safety was highly correlated with food safety behaviors *(14)*. In an extensive review, reinforcement of food safety training material was found to be rare *(16)*, reflecting low prioritization of food safety practices. High production demands can undermine training efforts by preventing employees from practicing food safety *(23)*. Trainee characteristics include individual reactions to the training, motivation to apply the training material, ability, and personality. In a study of 115 food handlers, perceived behavioral control, a similar construct to ability, was the most significant predictor of hand hygiene practices, accounting for 21% of the variance observed in hand hygiene behavior *(11)*. Poor self-efficacy for practicing food

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safety is strongly linked with high production quotas and the work environment of a food establishment. Training design can affect training transfer to the extent to which it conforms to the notion of identical elements *(46)* or how much the training reflects the transfer setting. In one study, this principle was used in a hands-on training module in which participants practiced actual hand washing (HW) *(28)*. Food handlers in the hands-on training group had higher knowledge scores than did food handlers in lecture- and video-based training groups. However, use of hands-on training is rare, and lectures that take place in settings removed from the performance context are more common *(30)*. Education and behavior change theories can inform the design of effective training materials but are rarely utilized in food safety training interventions *(51)*.

The relationship between work environment and food safety training outcomes has been well established *(12–14, 23, 36)*. However, the effect of training design on food safety training outcomes remains underexplored. Advancements in our understanding of how knowledge translates into action can help researchers design more effective training modules. Research in neuroscience has revealed how training design, specifically with regard to the perspective from which the information is presented, can affect one's ability to learn and imitate behavior *(19, 25, 29, 40, 52, 53)*. Perspective is classified as either egocentric, also known as the first-person or actor perspective, or allocentric, also known as the third-person or observer perspective *(25)*. Several studies conducted to compare the efficacy of participants' ability to imitate behavior have revealed that information presented from the first-person perspective allows for better facilitation and ease of learning *(52, 53)*. Significantly shorter lag times were observed when participants were asked to imitate foot and hand action sequences from a video presented from the first-person perspective compared with a video presented from the third-person perspective *(25)*. These findings support the notion that greater similarities between training content and performance context can result in easier task execution and better facilitate learning. Controlling for individual differences in cognitive ability, Garland and Sanchez *(19)* found improvements in performance outcomes for procedural learning tasks when the instructional media were designed from the first-person perspective. These findings have been attributed to the fact that the first-person perspective has greater contiguity with the sensory motor system, decreases the cognitive resources required to translate information for usage *(40),* and activates the mirror neuron system *(25)*. Evidence from digital gaming experiences indicates that the first-person perspective results in a more immersive experience than does the third-person perspective *(15)*.

Innovations in and the increased affordability of small high-resolution wearable technology now make it easier to film training segments from the first-person perspective. Wearable technology is a broad term that can be applied to any small digital device that interacts with its user. Of relevance to the present study are head-mounted displays, such as Google Glass, and high-resolution personal action cameras, such as GoPros. Head-mounted displays are worn by the user much like a pair of glasses frames and consist of a small unobtrusive screen that allows the user to read instructions within his or her field of vision. Although the use of head-mounted displays in training is in its infancy, the technology has already been successfully adopted to present neurosurgery training to medical residents *(33)*. The use of head-mounted displays in the food industry could radically transform how food safety training and auditing is conducted *(9)*. Personal action cameras are typically mounted on the head and secured through a strap. During recording, these devices capture very detailed first-person perspective footage for demonstrations or self-evaluation and are being widely adopted in the medical field for applications such as orthopedic surgery *(26),* plastic surgery *(35),* and eye surgery *(32)*.

To date, little is known how training filmed from the first-person perspective using personal action cameras affects employee reactions to the training. According to Kirkpatrick and Kirkpatrick's *(27)* four-tier model of training evaluation, employers who evaluate their employees' reactions to the training demonstrate organizational concern for performance outcomes such as food safety behaviors, and employee feedback about the training provides the data needed to redesign elements of the training to better serve employees. Examples of training reactions that managers can collect include the participants' perception of how useful the training was, overall satisfaction with the training, preference compared with other training types, and self-efficacy, defined as one's belief in one's ability to perform the training material. An employee's reaction to the training is beneficial for gauging job motivation, which may affect learning. This process is characterized by changed attitudes and increased knowledge that can lead to long-term changes in behavior *(39)*. Research on employee reactions to food safety training overall is limited and underdeveloped *(17, 28, 30, 44)*. To date, pre- and posttest knowledge scores have been the primary metrics of concern for the majority of food safety training interventions *(16, 51)*; however, knowledge-focused training may be inadequate for encouraging food safety behaviors *(36)*. Whether food safety training module preferences affect training outcomes has not been conclusively determined *(28),* but some evidence suggests that overall satisfaction with food safety training can have a positive impact on learning outcomes *(42)*.

To the best of our knowledge, little work in the food industry has explored the effects of food safety training design on training outcomes, such as trainee reactions. Research in this area would provide a basis for future studies to test how instructional design impacts behavior. More research also is needed to clarify the effect of viewpoint on training outcomes. In one study of various imitation models, although the first-person perspective resulted in faster, more perceptively easier imitation, participants were more accurate after being exposed to the third-person perspective *(34)*. In other studies, no significant differences in observational learning were found between the first- and third-person viewpoint *(40)*.

The objectives of the present study were to (i) develop first- and third-person food safety training modules, (ii) determine the relationship between camera perspective and

training reactions, and (iii) assess whether camera perspective affects employees' posttraining motivation to perform food safety behaviors.

MATERIALS AND METHODS

Sample. Prior to data collection, the study was approved by the University of Arkansas Institutional Review Board for human subjects. The Washington County, Arkansas Health Department was contacted for a list of food establishments with valid permits. Participation was limited to food handlers from restaurants that served high-risk foods. A food handler was defined as "any person involved in a food business who handles or prepares food whether open (unwrapped) or packaged (food includes drink and ice)" *(10)*. High-risk foods were defined as "ready-to-eat foods which, under favorable conditions, support the multiplication of pathogenic bacteria and are intended for consumption without further treatment that would destroy the pathogens" *(45)*. Our definition of restaurants excluded institutions, food carts, restaurants located in supermarkets, supermarkets, mobile food units, caterers, and temporary food stands *(22)*. Because of resource restrictions, a cluster sampling procedure based on random sampling by zip code was used to contact and recruit restaurants.

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

Training development. HW was chosen as the food safety behavior of emphasis because of pervasive poor compliance issues in the food industry *(47)* and because poor personal hygiene is a major risk factor for foodborne illness *(49)*. Training videos were filmed in a commercial kitchen. Each video depicted five scenarios requiring HW and proper HW procedure according to the state food code *(2)*: (i) before food preparation, (ii) after handling raw food and before touching ready-to-eat foods, (iii) after handling dirty equipment, (iv) before putting on gloves prior to food preparation, and (v) after eating or drinking.

Each scenario requiring HW and each step in proper HW procedure was indicated by a caption that flashed across the video screen. The third-person perspective video was filmed using a Sony α6000 camera with an 18- to 105-mm power zoom lens, and the first-person perspective video was filmed using a GoPro Hero4 12.0 MP Action Camera. Both HW scenarios and proper HW procedures were filmed simultaneously, with one researcher filming the third-person perspective and another researcher filming the first-person perspective (Fig. 1). This approach served as an internal control because the same footage was used for each perspective. Each video was just under 4 min long and was viewed without sound.

Training assessment. Posttraining reactions to each video were assessed with 10 questions (Table 1). Eight questions were based on a 7-point Likert scale from "strongly disagree" to "strongly agree." Five questions concerned perceived training utility modeled after the approach of Ruona et al. *(41)* and previously evaluated as having high reliability *(55)*. Perceived utility describes the value employees assign to the training and is highly correlated with long-term implementation of the training (up to 1 year later) *(4)*. One question captured the food handlers' overall satisfaction with the training video, and two questions pertained to the food handlers' intentions to wash their hands after having watched the training video *(28)*. Two questions were based on self-efficacy for HW for the recommended number of times and in the proper way, measured with confidence intervals on a scale of 1 to 10 ranging from "can't do at all" to "highly certain I can" *(6, 7)*. Self-efficacy may have an indirect effect on food safety behavior *(31)* and a direct effect on routine food safety behaviors such as HW *(24)*. After watching both videos, participants were given one survey question concerning which video they preferred overall, which was indicated by the participant with a check mark next to either the first- or third-person video choice.

Data analysis. Data were analyzed with Statistical Package for the Social Sciences v. 24 (SPSS, IBM, Armonk, NY) and R v. 3.2.2 *(38)*. A one-proportion z test was used to determine which video perspective was preferred more by employees. Dependent samples t tests were used to determine differences in training reactions between the first- and third-person videos. Pearson correlation coefficients were calculated to assess how the relationship between the attitudinal variables may have differed between videos.

RESULTS

Sample demographics. A total of 108 food handlers from restaurants that served high-risk foods in northwestern Arkansas participated in the study. An even number of men and women took part in the study. Over three-fourths of the participants were 18 to 29 years of age, and a small percentage were 50 years old or older. Eighty-eight percent of the food handlers had at least 1 year of food service experience, and 50% had been working at their current place of employment for less than 1 year. One-third of the employees worked part time at their food establishment, and 89% had received some form of food safety training prior to watching the HW videos.

Video preference. A one-proportion z test revealed that a significantly greater proportion of food handlers (64%) preferred the first-person video ($z = 5.00$, $P < 0.001$) (Table 2). Chi-square tests ($n = 108$) were used to determine whether the differences in video preference were related to demographic variables. No significant relationships were found between the demographic variables of gender ($\chi^2(1) = 0.361$, $P = 0.548$), age ($\chi^2(2) = 1.69$, $P = 0.430$), years of food service experience ($\chi^2(4) = 2.22$, $P = 0.70$), years working at current operation ($\chi^2(3) = 4.41$, $P = 0.220$), work status ($\chi^2(1) = 0.024$, $P = 0.877$), and whether participants had received food safety training prior to viewing the videos ($\chi^2(1) = 0.045$, $P = 0.832$).

Comparing posttraining motivation. Table 1 lists mean (±standard deviation [SD]) scores for survey items used in the study to compare training reactions to the first- and third-person videos. The overall satisfaction scores were 5.31 ± 1.39 for the first-person video and 5.41 ± 1.33 for the third-person video. The first- and third-person videos had

FIGURE 1. *Video footage used to train food handlers to wash hands, filmed from the first-person perspective (left) and the third-person perspective (right).*

compliance intention scores of 5.57 ± 1.25 and 5.58 ± 1.39, respectively, perceived utility ratings of 5.19 ± 1.03 and 5.29 ± 1.00, respectively, and compliance self-efficacy construct scores of 9.46 ± 0.83 and 9.37 ± 1.21, respectively.

No significant differences were found between the survey constructs, including overall satisfaction ($t(107) = -0.936$, $P = 0.351$), compliance intentions ($t(107) = -0.119$, $P = 0.906$), perceived utility ($t(107) = -1.75$, $P = 0.082$), and self-efficacy ($t(107) = -0.928$, $P = 0.356$).

For both videos, the perceived utility of the training was significantly correlated with overall satisfaction for the first-person video, $r(108) = 0.557$, $P < 0.001$ and the third-person video, $r(108) = 0.605$, $P < 0.001$ (Table 3). A significant correlation was found between compliance intentions and self-efficacy but only for the first-person video, $r(108) = 0.361$, $P < 0.001$.

DISCUSSION

The purpose of the present study was to explore the effect of camera angle on posttraining motivation of restaurant food handlers. Differences were observed between the two videos in how employees' intentions to wash their hands and self-efficacy were correlated. Evidence of a correlation could have positive implications for trainers in the food industry because changes in intentions can lead to changes in behavior *(54)* and intentions play a role in food safety behavior *(11, 24, 31, 43, 44)*. Self-efficacy was significantly correlated with intentions when participants viewed the first-person video but not when they viewed the third-person video. This difference may be due to the way in

TABLE 1. *Survey items comparing reactions to hand washing training videos filmed from the first- and third-person perspective*

Survey variable with measurement items	Repeated measures scores (mean ± SD)	
	First-person video	Third-person video
Overall satisfaction[a]		
I would recommend the training video to others in my workplace.	5.31 ± 1.39	5.41 ± 1.33
Compliance intentions[a]		
Intention frequency: Quite frankly, after watching this video, I would wash my hands just as much as I did before.	5.67 ± 1.44	5.78 ± 1.41
Intention efficacy: Quite frankly, after watching this video, I would wash my hands just like how I did before.	5.48 ± 1.44	5.39 ± 1.59
Perceived utility[a]		
The training video provided me with new ways of thinking about my job.	4.48 ± 1.59	4.49 ± 1.65
I was disappointed with the training I received from this video.[b]	5.35 ± 1.46	5.37 ± 1.36
My time was well spent watching this video.	5.09 ± 1.38	5.12 ± 1.30
The training objectives were met.	5.76 ± 1.02	5.82 ± 1.01
I learned something I can apply immediately to my work.	5.29 ± 1.58	5.36 ± 1.36
Compliance self-efficacy[c]		
Self-efficacy frequency: Having watched this video, rate how confident you are about being able to wash your hands the times you should.	9.46 ± 0.88	9.36 ± 1.21
Self-efficacy efficacy: Having watched this video, rate how confident you are about being able to wash your hands the right way.	9.45 ± 1.01	9.38 ± 1.30

[a] Measured on a 7-point Likert scale from 1 (strongly disagree) to 7 (strongly agree).
[b] This survey item was reverse coded.
[c] Measured on a 10-point Likert scale from 1 (can't do at all) to 10 (highly certain I can).

TABLE 2. *Comparison by demographic variables of preference for hand washing training video perspective filmed in the first and third person*

Variable	% of participants	
	First-person video	Third-person video
Gender		
Men	52	46
Women	48	54
Age (yr)		
18–29	77	74
30–49	16	23
50+	7	3
Food service experience (yr)		
<1	12	13
1–3	29	33
4–7	26	18
8–12	20	28
13+	13	8
Time at current operation (yr)		
<1	49	51
1–3	23	33
4–7	19	5
8+	9	10
Work status		
Full time	68	67
Part time	32	33
Prior food safety training		
Yes	88	90
No	12	10
Overall video preference[a]	64	36

[a] $P < 0.001$.

TABLE 3. *Pearson correlation coefficients of repeated measures survey constructs from the first- and third-person hand washing training videos based on overall satisfaction with the training, compliance intention to wash hands, perceived utility of the training, and compliance self-efficacy to wash hands*

Survey construct	Correlations			
First-person video				
Overall satisfaction	1			
Compliance intention	0.140	1		
Perceived utility	0.557[a]	−0.085	1	
Compliance self-efficacy	0.169	0.361[a]	0.141	1
Third-person video				
Overall satisfaction	1			
Compliance intention	0.067	1		
Perceived utility	0.605[a]	−0.136	1	
Compliance self-efficacy	0.120	0.181	0.178	1

[a] Correlation is significant at $P < 0.01$ (two tailed).

which the training was presented; the first-person video showed how a food handler might approach HW compliance from his or her perspective rather than from an observer's point of view. In this regard, the first-person perspective adheres more closely to the notion of identical elements by mimicking how food handlers view and understand their work environment *(46)*. Training design can be enhanced when there is greater continuity between the training and work setting *(18)*. Viewing from the first-person perspective may also have placed a lower demand on cognitive resources *(40)*, making it easier for the employee to visualize performing the behavior. The employees may also have felt more involved with the first-person training perspective *(15)*. These two factors could explain why a more concomitant relationship was found between self-efficacy and the intention to wash hands frequently and effectively.

Close to two-thirds of the food handlers in the study preferred the first-person video to the third-person video, a significantly higher proportion. Although a slightly larger percentage of men preferred the first-person video, this gender difference was not significant. The preference for the first-person training perspective also was not related to participant age, years of food service experience, years working in the current position, or whether participants had received food safety training prior to watching the videos. The food industry includes employees from a broad range of ages; thus, it is important to design trainings that will appeal to a wide age demographic to ensure learner engagement. New technologies presented in training sessions can generate feelings of uncertainty and incompetency, especially among older workers *(37)*. In this study, the first-person perspective instructional media style did not interfere with acceptance by older workers of training modules that incorporate these methods. This age effect is important because the proportion of workers age 55 years and older is expected to increase through 2050 *(48)*. This facet of our findings has broader implications as augmented reality training is used more often *(8)* and advances are made in wearable technology designed specifically for the food industry *(9)*.

Our data suggest that neither video perspective significantly bolstered intentions to wash hands more frequently or effectively. On average, participants either somewhat agreed or agreed that watching the videos would not change their HW intentions. This result could be attributed in part to a potential ceiling effect of HW intentions; previous research has indicated that intentions to perform food safety behaviors are generally high *(11, 24, 43, 44)*. Future studies could be designed to measure baseline HW intentions before the training to determine whether the different camera angles change HW motivation or the ceiling limitation effect exists. The perceived utility of a training module can function as an antecedent that affects overall satisfaction with the training *(20)*. The results in this study confirmed that perceived utility was the only attitudinal variable significantly correlated with overall satisfaction for both first- and third-person videos, which also implies that camera angle did not affect the relationship.

This study was limited because it measured only one of the four tiers in Kirkpatrick and Kirkpatrick's *(27)* model for training evaluation. Future studies could be conducted to investigate the impact of instructional design on learning outcomes and behaviors. Another limitation of this study was the focus on only HW, one of five food safety behaviors

that contribute to increased risk of transmission of foodborne illness *(49)*.

In conclusion, food handlers must be trained in proper food safety behaviors to minimize the risk of foodborne illness transmission. Our study contributes to the growing body of knowledge on the impacts of wearable technology and perspective on training outcomes. In this study, the HW training videos presented from the first-person perspective were preferred by employees, regardless of age or other demographic characteristics. Perspective impacted the relationship between food handler behavior intentions for HW and self-efficacy to perform HW behaviors. Although no significant differences were observed between the attitudinal variables, prior research findings suggest that the first-person perspective can result in a more immersive training experience. Future research should be conducted to explore the relationship between training design and training outcomes for various food safety behaviors and to measure the effects on compliance with these behavioral guidelines.

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