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PEER-REVIEWED ARTICLE

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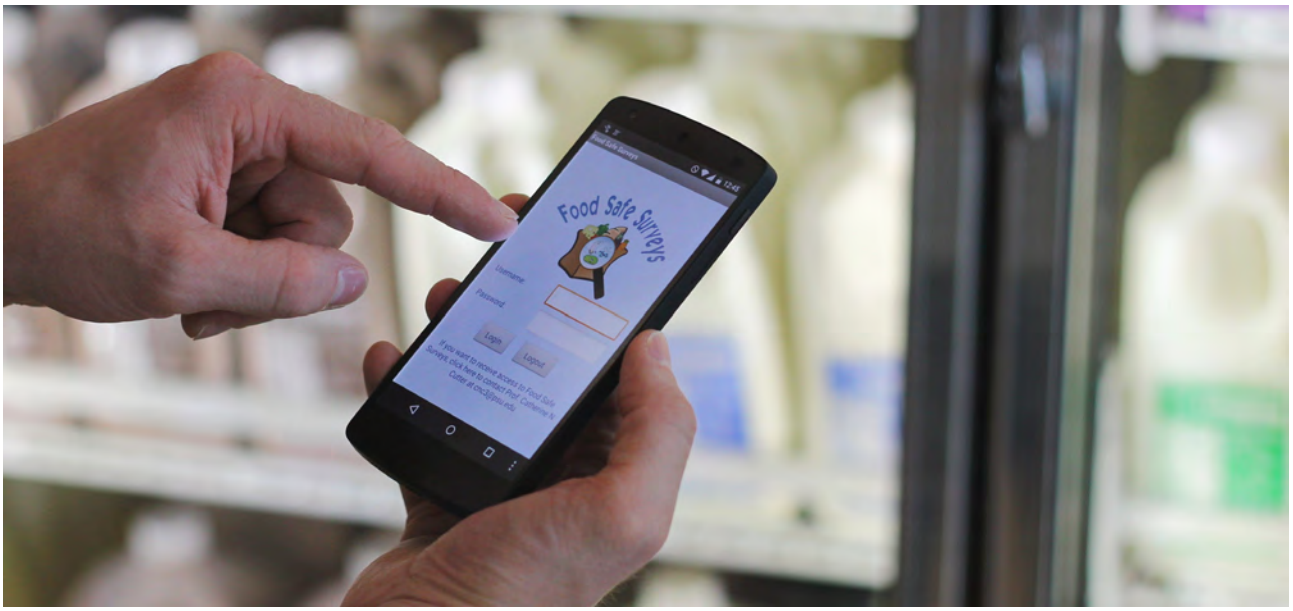

Use of the Smartphone Application "Food Safe Surveys" for Data Collection during Direct Concealed Observations

ABSTRACT

Food safety practices of food handlers often are observed for research purposes. However, if these observations are not concealed, they can result in unintended behavioral changes, commonly referred to as the Hawthorne effect (HE). Direct concealed observations (DCOs) have been used to minimize the HE during observational data collection in various settings. However, some limitations to data collection can include the need to memorize observations or take notes out of sight of those being observed. We describe a newly developed smartphone and tablet application for use as a data collection tool for DCOs. To further evaluate the use of smartphones as inconspicuous data collection tools, a short survey was developed and disseminated to assess public perceptions of smartphone use in a retail setting. Participants were shown images of individuals using either a smartphone or a clipboard in a retail environment and asked to provide open-ended responses. Ninety-five percent (95%) of participant (n = 85) responses indicated that images of clipboard use in a retail setting suggested evaluative activities (e.g., research, inspection), whereas none of the participants indicated that images of smartphone use in the same environment suggested evaluative activities. These results demonstrate that use of a smartphone for data collection in a retail setting may not be perceived as an evaluative activity, and that its application during DCOs could minimize the HE. This research may be of interest to researchers, regulatory personnel, and food industry professionals who are seeking ways to evaluate the food safety behaviors of food handlers.

INTRODUCTION

Food safety practices of consumers and food handlers are often observed for research and educational purposes. However, these observations can result in unintended behavioral changes in the individuals being evaluated. Human behavioral changes associated with individuals who are

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knowingly being inspected, watched, or tested, are generally referred to as reactivity effects *(5, 7, 13, 16)*. The Hawthorne effect (HE) is a type of reactivity effect in which individuals change their behavior in a manner they expect will be favorable to the researcher or person who is conducting the observation *(1)*. This effect is a particular problem when the research or observation is measuring the appropriateness of a behavior in a particular situation, such as a food safety-related behavior in a food retail setting. The impact of the HE has been investigated previously in the areas of education, health, and childcare *(3, 5, 7, 13)*. In general, changes in the observed individual can result in positive or negative outcomes, depending upon feedback provided by the observer. Although observer feedback may be unintentional, individuals may modify their behaviors based on their perceptions. As a result, studies involving observations of retail and consumer food safety practices might be vulnerable to data collection bias and decreased internal validity *(11)*.

One way to avoid unintended behavioral changes during retail or consumer observations is to utilize direct concealed observations (DCOs) or "mystery shopping" methods *(22)*. These methods have been used successfully to record food safety-related behaviors of retail deli workers, farmers' market vendors, medical professionals, and temporary retail food handlers *(1, 2, 14, 18, 19, 21)*. Data collection methods used by researchers during food safety-related DCOs have included inconspicuous recording of observations on paper-based checklists, memorizing of observations and making recordings out of view of participants, notational analysis, and, most recently, use of smartphone survey software *(2, 14, 18, 20, 21)*. Although traditional paper-based recordings of observations can be effective, the ubiquitous nature of smartphone use provides a promising tool for researchers seeking to reduce the HE during observational studies.

Smartphones have been used as data collection tools in many other areas of research, including weight management psychology, diary keeping, social behavioral studies, emotion recognition, carbon impact, smog exposure, and fast food exposure *(6, 9, 12, 15, 17)*. However, none of these studies reported a validation or investigation on how the use of the smartphone could affect the outcomes of the study. This report, to our knowledge, is the first attempt to validate the reaction of participants to a smartphone used as a data collection tool. In addition, previous research studies utilizing smartphones have evaluated their impact only when these were used by the subjects or participants and not by the researchers themselves. In contrast, Behnke et al. *(2)* utilized Qualtrics™ survey software formatted for use on an iPhone (Apple, Cupertino, CA) to record food-handling practices of temporary food service workers at Indiana farmers' markets. In their study, the researchers recorded over 900 food transactions with little notice by food handlers. Although successful, the researchers noted that the software used in their study required a constant Internet connection, and the repeated motion of looking up at the workers and then down at the phone was an additional important limitation of the technology.

In an effort to mitigate the cost, increase customizability, and eliminate previously identified limitations with current commercial smartphone survey software, a new smartphone application, specifically designed for recording observations in the retail food service environment or in food processing establishments, was created. The purpose of this research was to assess potential public perceptions of smartphone technology use as a data collection tool in a retail setting.

FOOD SAFE SURVEYS

The "Food Safe Surveys" smartphone application was developed in collaboration with AHG, Inc. (State College, PA) in an effort to provide researchers with a simple and customizable data collection tool to be used during observational studies in retail food service and food processing environments. The application consists of a web-based survey development tool, a private server, and a smartphone or tablet application interface. "Food Safe Surveys" allows users to develop custom surveys consisting of four question types (multiple choice, Yes/No, free text, and scale), using the web-based survey development tool *(Fig. 1)*. Custom surveys are saved on the secure private server of the "Food Safe Surveys" and are accessed by the smartphone application interface for download using wireless Internet provided through a commercial phone service or a Wi-Fi connection.

Once downloaded, surveys can be used without any Internet connection. Prior to accessing the smartphone application or survey development tool, users must gain access, through a 256-bit encrypted connection, by using a username and password menu *(Fig. 2)*. Once having gained access, users have the option to download and start a new survey or continue with a saved, in-progress survey. Survey questions are organized within categories, customized by the user, and each category can contain an infinite number of individual questions *(Fig. 3)*. Within each question category, questions are organized horizontally, and users navigate through scrolling actions *(Fig. 4)*. Questions are answered by selecting individual drop-down menus or typing in free-text boxes *(Fig. 5)*. Users also have the ability to take "notes" in the form of text, audio, video, and photos, utilizing the user's smartphone camera and microphone *(Fig. 6)*. Through this simple and easy-to-use interface, users can collect customized observational data rapidly in numerous environments and situations. Furthermore, the ability to record video and audio, and to take photos, could eliminate the need to look away during DCOs.

Completed surveys are saved in the user's smartphone DCIM directory in a (.csv) file format compressed as a (.zip) file format. Data files (.csv) can be read by Microsoft Excel™ or other (.csv) readers. No Internet or phone service

Figure 1. "Food Safe Surveys," web-based survey development tool.

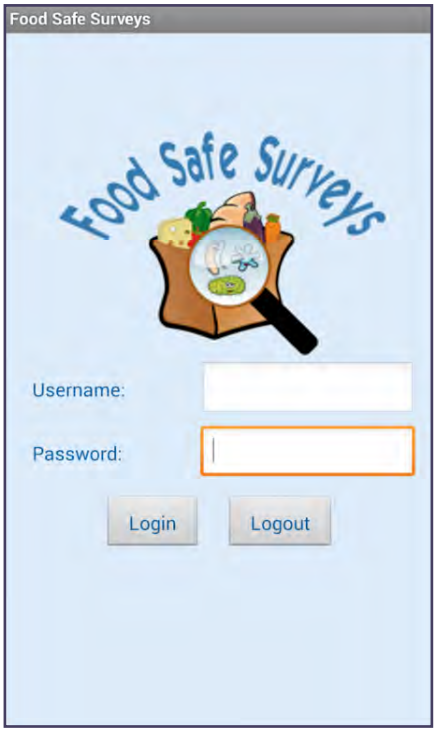

Figure 2. "Food Safe Surveys," smartphone interface login menu.

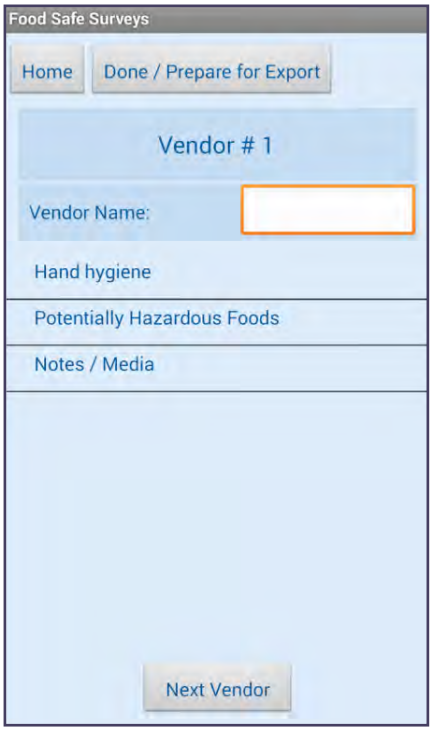

Figure 3. "Food Safe Surveys," survey navigation screen.

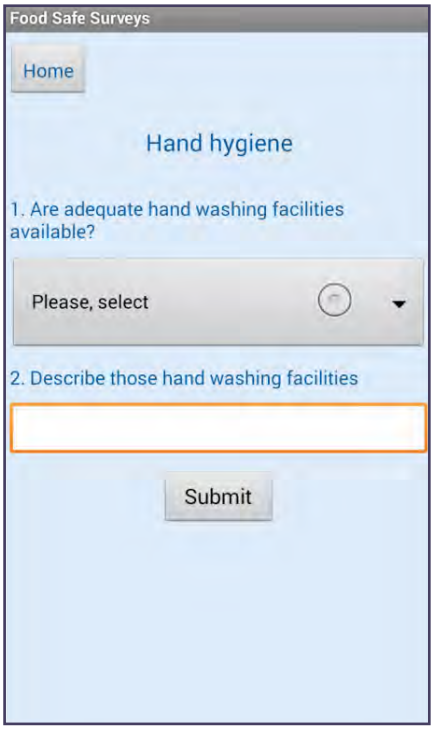

Figure 4. "Food Safe Surveys," question navigation screen.

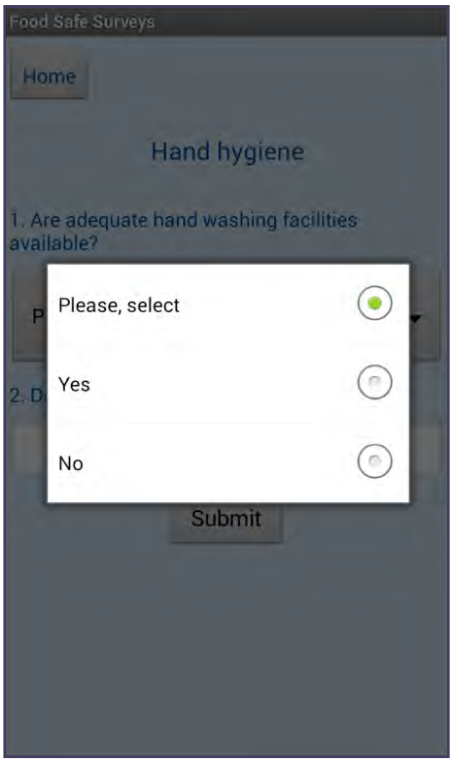

Figure 5. "Food Safe Surveys," question option menu.

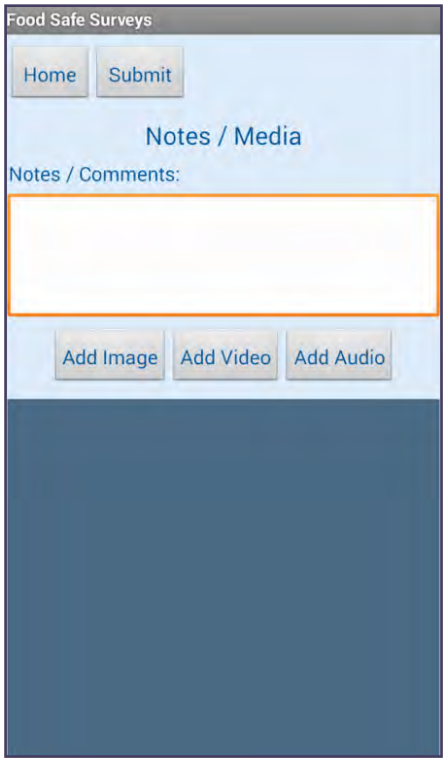

Figure 6. "Food Safe Surveys," notes and media screen.

connection is necessary to save survey data, and data files can be transferred to a computer manually by use of a USB connection, or through the use of third-party cloud services (e.g., Google Drive™). "Food Safe Surveys" is currently available, free of charge, on the Google Play™ online market; however, usernames and passwords must be issued by the authors, through individual requests. "Food Safe Surveys" was developed for the android operational system using the Java Development Kit (JDK™) and Eclipse Integrated Development Environment (IDE). A Representational State Transfer (REST) application programming interface (API) encrypted by Hypertext Transfer Protocol Secure (HTTPS) with 256-bits encryption is used for all communications, to and from the application.

FARMER'S MARKET PILOT STUDY

Researchers at the University of Rhode Island, Department of Nutrition and Food Sciences, utilized "Food Safe Surveys" to collect food safety-related DCOs of farmers' market vendors in Rhode Island. Over the period of one year, Vandeputte et al. *(21)* recorded food handling practices of 26 vendors selling foods that were categorized as high-risk. These observations revealed unsafe food handling practices such as eating, talking on the phone, and touching money and then touching food. The authors were able to identify key gaps in food safety-related vendor behaviors and will use the results to develop future outreach and educational programs for farmers' market vendors. The results of this study have demonstrated the potential use of "Food Safe Surveys" as a promising new tool for observational research, DCOs, and data collection.

PUBLIC PERCEPTION OF SMARTPHONE USE

Survey methodology

A brief web-based survey was developed to assess the public's perceptions on the use of a smartphone in a retail setting. The goal was to determine how the public would perceive someone using a smartphone, versus a clipboard in the same manner, using simulated images of a retail setting. The use of a clipboard was chosen on the basis of its common use as a data collection tool during research, inspections, and other formalized information gathering. The survey, delivered online, consisted of showing participants separate images of two individuals using either a smartphone or a clipboard, either in a blank setting or in a food retail environment. Participants were shown each image separately and asked to provide an open-ended response on their perceptions of the image before moving to the next image *(Fig. 7)*. Participants were shown the four images in the following sequence: Image A, smartphone

Participants (n = 85) were individually shown the above images (A-D), in sequence and were provided unlimited time to write an open-ended response to the question below for each image. Participants could provide multiple responses and navigated to each subsequent image at their own pace.

Directions: (1) Please look at the image above and describe in your own words what you believe this person is doing. Please be as specific as you can in your description. If you do not have an opinion on the image, please write "I do not know" in the text box below.

Figure 7. Images (A–D) and questions presented to participants during the web-based survey.

in hand with a blank background; Image B, smartphone in hand in a retail setting; Image C, clipboard in hand with a blank background; Image D, clipboard in hand in a retail setting. Participants also were asked to provide their age and gender. Penn State Institutional Review Board approval was obtained prior to participant recruitment, and survey data were collected and managed by use of REDCap (Research Electronic Data Capture) electronic data capture tools *(8)*.

Survey recruitment

Social media platforms were used to recruit participants for this study, because of their popularity, impact, and ability to reach large numbers of the general public rapidly *(4, 10)*. A recruitment message and a link to the survey were disseminated by the authors through personal email, Facebook™, and Google+™ accounts. Participants were encouraged to further disseminate the recruitment message by use of their preferred social media platforms. The use of this recruitment method was successful, resulting in eighty-five completed surveys within one week. However, it should be noted that this method of recruitment resulted in a non-random convenience sample and does not statistically reflect the U.S. population as a whole.

Survey results and discussion

Participants (n = 85) of the survey were composed of 64 females (75%) and 21 males (25%), with an average age of 32 years. The age distribution (years) of participants was as follows: 18–24 (22%; 19/85); 25–34 (47%; 40/85); 35–44 (15%; 13/85); 45–54 (4%; 3/85); 55–64 (6%; 5/85); 65+ (1%; 1/85); and undisclosed (5%; 4/85). The open-ended responses to the survey were evaluated first to identify categories of responses; however, responses were not coded into specific categories at this step. It was determined that responses to Image A and B fell into eight common categories *(Fig. 8)*, while responses to Image C and D fell into six categories *(Fig. 9)*. Each response was then coded and grouped into the previously identified categories, independently, by two separate researchers. The percent agreement between the coders was 95%, 84.3%, 92%, and 86.5% for Images A, B, C, and D, respectively. Overall agreement was 89.4%. Because of the high percent agreement, responses were not re-coded. Responses that were coded differently by the two coders were discussed, and results shown are based on the consensus of both coders. Participants' responses for each image could be coded into multiple categories, resulting in a total number of assigned codes greater than the sample size (n = 85). Response proportions were compared, using a two-sample proportion z-test with an alpha level of 0.05.

Image A (smartphone in hand with a blank background) and Image B (smartphone in hand in a retail setting), elicited contrasting responses from participants *(Fig. 8)*. No (0%; 0/121) participant perceived Image A as an individual using a smartphone to look up food-related information or grocery lists, in contrast to participants' perceptions of Image B (food-related information: 21%; 23/108; grocery list: 23%; 25/108). Alternatively, the percentages of participants

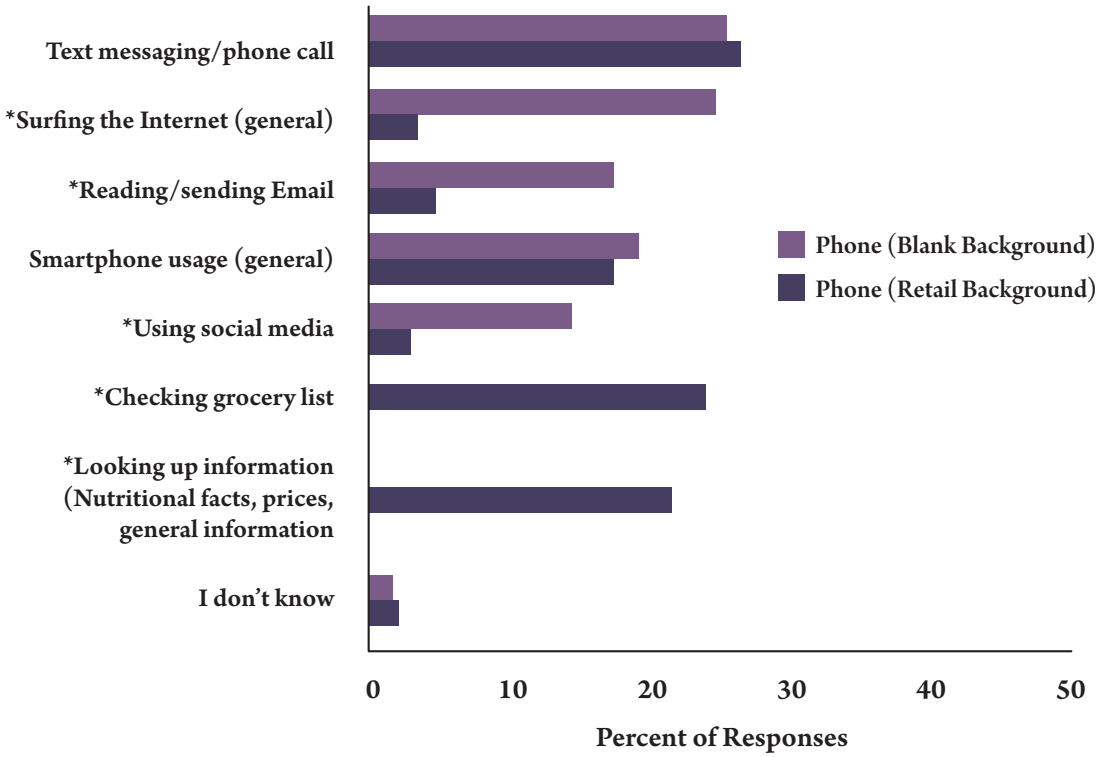

Figure 8. Categorized participant responses to viewing Image A (phone use on a blank background; n = 121) and Image B (phone use on a retail background; n = 110). Responses to each image include multiple responses per participant. Asterisks before response text indicate statistically significant difference at P < 0.05.

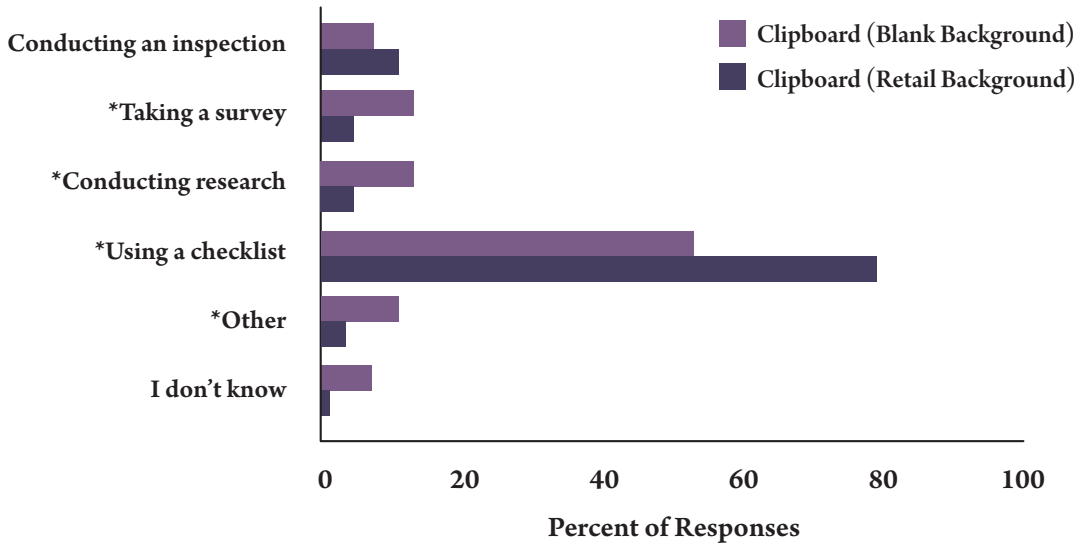

Figure 9. Categorized participant responses to viewing Image C (clipboard use on a blank background; n = 96) and Image D (clipboard use on a retail background; n = 96). Responses to each image include multiple responses per participant. Asterisks before response text indicate statistically significant difference at P < 0.05.

perceiving both images as someone texting or making a phone call (Image A: 26%; 32/121; Image B: 27%; 29/108) and using the smartphone for general use (Image A: 19%; 23/121; Image B: 18%; 19/108) were not significantly different. In addition, a significantly higher percentage of participants ($P < 0.05$) perceived Image A as someone surfing the Internet (Image A: 26%; 31/121; Image B: 3%; 3/108) and reading or sending E-mail (Image A: 15%; 181/121; Image B: 4%; 4/108), compared with perceptions of Image B in those categories. These results suggest a shift in participant perceptions from typical smartphone uses in Image A to more task-oriented uses in Image B. Image C (clipboard in hand with a blank background) and Image D (clipboard in hand in a retail setting) elicited few contrasting responses, with some notable differences *(Fig. 9)*. Over half of the participants perceived Image C as someone using a checklist (54%; 52/96), although this response was significantly greater ($P < 0.05$) with Image D (78%; 75/96). Interestingly, the participants perceived both Image C (54%; 52/96) and D (78%; 75/96) as someone using a checklist overwhelmingly more often ($P < 0.05$) than any of the other response categories, including conducting an inspection (Image C: 6%; 6/96; Image D: 10%; 10/96), taking a survey (Image C: 13%; 12/96; Image D: 4%; 4/96), and conducting research (Image C: 13%; 12/96; Image D: 4%; 4/96). There were no significant differences between male and female responses for images A, B, or C. However, for image D, males' responses (36%; 10/28) were three times more likely ($P < 0.05$) than females' responses (12%; 8/68) to indicate the use of a clipboard in a retail setting as an evaluative activity (i.e., inspection, research, survey). Female participants also were more likely (87%; 59/68) than males (57%; 16/28) to view Images C and D as someone using a checklist ($P < 0.05$). No relevant significant differences between age groups were identified.

As expected, responses to Images A and B were found to be mainly associated with smartphone usage activities, in contrast to the responses to Images C and D, which were associated exclusively with data collection activities. These findings indicate that in this study, the use of a clipboard in a retail setting was perceived as a data collection tool (evaluative), whereas the use of a smartphone was not. The results also demonstrate that perceptions of the use of a smartphone can change, depending on the setting in which it is used.

CONCLUSIONS

The "Food Safe Surveys" smartphone application is a new tool specifically designed for use by researchers, inspectors, and educators in performing evaluative activities in various settings, where data collection is required. Although specifically designed to record direct concealed observations (DCOs) in a retail food service or food processing setting, the easy-to-use and fully customizable features of "Food Safe Surveys" provides versatility and potential for its use in other fields. Through a brief survey, we demonstrated that the simulated use of a smartphone in a retail setting is not perceived by a sample of adults as an activity related to data collection and could therefore reduce potential Hawthorne effects during DCOs. This conclusion was further supported through the successful pilot study using "Food Safe Surveys" to collect food safety-related observations of farmers' market vendors in Rhode Island. A limitation of this study was the use of images showing a simulated retail environment through an online survey, versus the use of in-person surveys in an actual retail setting. However, the methods used in this study were simple and low cost, and they provided a rapid method to survey consumers. Future studies are necessary to further validate the use of "Food Safe Surveys" and similar smartphone technology for data collection in other fields and environments.

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