Exploring the Feasibility of Using a Simulated Environment to Enhance Food Safety Training and Research Opportunities

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Introduction

By law, food manufacturing business are required to ensure that appropriate supervision and training are provided to food handlers to enable them to handle food in the safest way within their working environment[1].

In the food manufacturing sector, real life scenarios aren't always accessible to deliver training and study expertise as production is the priority. However, immersive user-testing facilities such as the Perceptual Experience Laboratory (PEL) allow real environments to be simulated using projected media, contextual props and multi-sensory variables under laboratory conditions[2,3,4].

This method aims to provide necessary situational realism (presence) and context[5] to engage subjects with set tasks[6] and elicit knowledge in line with existing proficiency in the field[7]. In contrast to field environments the simulation enables greater control over extraneous variables[8,9] which improves session consistency and validity of study data[10,11]. What's more, this method is suited to behavioural research approaches such as discrete surveillance[12] and wearable eye-tracking technologies[13], recording unbiased subject engagement.

Consequently, there is a need to explore the feasibility of using the PEL and behavioural technology to deliver robust and meaningful food safety training in the food manufacturing sector.

Purpose

The aim of this research was to explore the feasibility of using a simulated environment to deliver food safety training within food industry conditions that are not readily accessible.

Methods

Environment: The research was conducted across two matched conditions, using a simulated scenario which was commercially available on campus. The FIC bakery was staged with a range of microbial, allergen, physical, and health & safety hazards (*n*=19). Media created from the physical setup was presented using the PEL, replicating a bakery hazard condition consistent with the commercial condition.

Recruitment: The participants (*n*=16) were drawn from FIC staff and food industry affiliates with food safety experience. Convenience sampling was used due to COVID-19 pandemic restrictions being in place and the reduced availability of suitable employees and visitors.

Data Collection: Counterbalancing was used to deal with the order effects of this repeated measures design. Participants experienced both conditions, dressed in appropriate Personal Protective Equipment (PPE) and fitted with eye tracking glasses. A debrief session was used to collect survey data (Qualtrics) and conduct in-depth interviews.

Ethical Approval: Granted by the Health Care and Food, Ethics Committee at Cardiff Metropolitan University (Ref: 06_1920_B(JB)).

Results

Overview / Procedure & Technical Setup

Participant sessions took place when the commercial bakery was not in use. Therefore, it was necessary to follow a technical setup sheet (Figure 1) during repeated preparation of hazards to ensure consistency of the environments.

Figure 1. Technical setup sheet for the arrangement of hazards across matched conditions.

The familiar practice of doing appropriate PPE (hair net, white coat and shoe coverings) and hand washing took place, followed by the procedure of fitting wearable eye-tracking glasses (Tobii glasses 2 / 50 Hz) before participants entering each training condition (Figures 2 & 3).

Participants' took part one at a time with sessions conducted by a primary researcher who was aided by a secondary researcher charged with eye tracking and PEL devices. To ensure an unbiased experience and robust data collection the viewing order of both conditions was changed within the participant group.

Figure 2. The PEL Simulating a Commercial Bakery to Deliver Food Safety Training.

Figure 3. Participant session in the commercial bakery.

Participants were directed to a fixed viewing location in both conditions, allowing hazards to be viewed in a matched line of sight. Once standing in front of the staged training scenario the following search task instructions were given:

"You have entered a bakery environment that has been vacated for lunch - please verbally identify all visible hazards such as microbial, allergen and OH&S types."

Involvement in the search task lasted around five minutes in each condition, afterwards the eye-tracking equipment was removed and PPE discarded.

Identification of hazards

Wearable eye-tracking technology was used to establish the viewing behaviour of participants across both conditions. The visual attention of participants during each condition was initially analysed using an environment snap shot image (Figure 4).

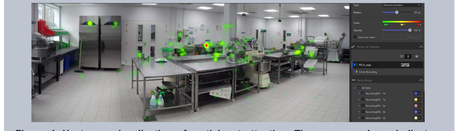

Figure 4. Heat map visualisation of participant attention. The warmer colours indicate a greater viewing time.

To confirm which hazards were viewed, each was demarked as an area of interest (AOI) (Figure 5) allowing fixation data to be swiftly and exactly calculated across study search task recordings.

Figure 5. Areas of interest.

Numerical analysis of gaze data was purposely pared back to enable rapid appraisal of knowledge, using a fixation count metric to confirm viewed hazards.

Paired t-tests demonstrated no significant difference between viewed hazards (p>.05) or reported hazards (p>.05) across the matched bakery conditions, suggesting that simulated environments are a reliable alternative experience to real life scenarios when delivering robust food safety training.

A two-way within-subjects ANOVA was conducted on viewed and reported hazards. The main effect was statistically significant (p=.0005), and suggested that where hazards were viewed and not reported, training is required.

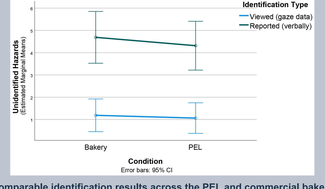

Figure 6. Comparable identification results across the PEL and commercial bakery.

Perceptions of the simulated environment

Once both conditions had been experienced the participants completed a post-participation questionnaire and participated in an interview regarding their experience in both test conditions. Participants expressed positive attitudes regarding how realistic the simulated bakery felt:

- 88% strongly/somewhat agreed that the simulated bakery was a realistic representation of the real bakery
- 82% strongly/somewhat agreed that the simulated bakery felt like being in a real bakery environment

Participants believe training in real environments to be more effective than classroom based, however such training is not feasible:

- 65% believed that training in a real manufacturing environment can be more effective than in a classroom environment
- 94% agreed that training in the real environment is not always feasible
- 77% agreed that training in the real environment can be challenging

As an alternative to real environment training, and classroom based training, positive attitudes regarding the use of simulated environments were expressed:

- 71% somewhat/strongly agreed that the simulated environment would be more effective than a class room environment
- 94% strongly agreed that a simulated environment could offer enhanced food safety training compared to classroom training.
- 100% believed that interactive training tasks in a simulated environment would be beneficial

Discussion with participants also indicated positive perceptions of using simulated environments for training. It was discussed that the staged hazards were typical of what they had seen and experienced in industry.

Some made suggestion on how to improve the simulated environment (Participant 01). In terms of the differences between the real and simulated environments, some suggested that the simulated environment was less distracting than the real (Participants 11 and 15).

Many benefits of using the simulated environment for training were discussed (Participant 13), it was suggested that the simulated environment could be used to ensure auditor consistency (Participant 05).

"The only thing that is missing there is people. [In an audit], you would be looking at people as much as anything else in the environment. So if you've got a dummy, wearing the PPE incorrectly, that might have been a little more realistic." (Participant 01)

"I think I felt a little bit more distracted in the bakery and because it was a real environment." (Participant 15)

"Oh, wow, there's lots of pros because you can't really walk into an industrial unit and do training with staff, because there's so much activity going on. Whereas (the simulated environment) could do that." (Participant 13)

"I found the bakery slightly overwhelming. But I found the (simulated) environment a little bit easier, because I could start from one side and go around. I found the (simulated) environment calmer. I found it very realistic. Obviously, I know it's not a real bakery, but it's quite visual. And you can see the exact same things." (Participant 11)

"I can imagine you could use it as a way of calibrating auditors to make sure people are looking for the same thing. So I think it would be really useful. So you could use it for initial training, refresher training, and anybody teaching internal auditing." (Participant 05)

Significance of study

- This study demonstrates evidence in support of using simulated environments, such as the PEL, as a more appropriate and robust research method when field research is impractical.
- Simulated training environments demonstrated rapid setup and with improved repeatability over comparable field conditions, allowing the location of machinery and staged hazards to remain matched across all sessions.
- Eye-tracking apparatus was shown to function just as well across field and simulated environments. Importantly, gaze data analysis was a fitting method to reveal if critical elements were viewed when not reported, evidencing gaps in vital knowledge.
- Discussions with participants indicated positive attitudes towards using simulated environments for training such as auditor consistency.
- Further large-scale studies are required to validate the research capabilities and training services of the PEL within food industry settings to provide meaningful and alternative educational opportunities within diverse commercial settings.

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