A real-time test of food hazard awareness

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A Real-Time Test of Food Hazard Awareness

Abstract

Purpose

Food poisoning attributable to the home generates a large disease burden, yet is an unregulated and largely unobserved domain. Investigating food safety awareness and routine practices is fraught with difficulties. We develop and apply a new survey tool to elicit awareness of food hazards. Data generated by the approach are analysed to investigate the impact of oberservable heterogeneity on food safety awareness.

Design/methodology/approach

We develop a novel Watch-&-Click survey tool to assess the level of awareness of a set of hazardous food safety behaviours in the domestic kitchen. Participants respond to video footage stimulus, in which food hazards occur, via mouse clicks/screen taps. This real-time response data is analysed via estimation of count and logit models to investigate how hazard identification patterns vary over observable characteristics.

Findings

User feedback regarding the Watch-&-Click tool approach is extremely positive. Substantive results include significantly higher hazard awareness among the under 60s. People who thought they knew more than the average person did indeed score higher but people with food safety training/experience did not. Vegetarians were less likely to identify 4 of the 5 cross contamination hazards they observed.

Originality/value

A new and engaging survey tool to elicit hazard awareness with real-time scores and feedback is developed, with high levels of user engagement and stakeholder interest. The approach may be

applied to elicit hazard awareness in a wide range of contexts including education, training and research.

Keywords: food safety; hazard awareness; Situation Awareness; Poisson; logit

1. Introduction

The incidence of foodborne infectious intestinal disease continues to be a burden to the UK with 11 million working days lost annually at a cost of £2 billion (FSA, 2010/2011, 2011). Risk management programmes have been developed in the UK for the two pathogens responsible for the greatest burden and mortality rates – *Listeria* and *Campylobacter*. *Campylobacter* causes most bacterial cases of foodborne illness in the UK and Europe. Whilst the number of *Campylobacter* outbreaks is increasing, incidence remains associated with sporadic cases of unknown origin often associated with the home (EFSA, 2012; HPA, 2012). In the UK 11% of outbreak data are associated with the home, with over a third of attributed outbreaks in Europe associated with the home (EFSA, 2012). The UK Food Standards Agency (FSA) has targeted improved domestic food practices to reduce foodborne disease (FSA, 2010/2011).

The continuing importance of the public's storing, handling and cooking of raw chicken has been emphasised by the UK poultry industry missing the 2013 contamination targets which were agreed with the FSA in 2010, and looking likely to miss the 2105 targets also – with 70% of raw chicken on sale in the UK testing positive for *Campylobacter*. Given that there seems to be no imminent decline in poultry contamination rates, then correct handling of chicken in the home is likely to be central to any reduction in the disease burden associated with Campylobacteriosis.

Food safety is one of many contexts where an assessment of hazard awareness is valuable. This may be as part of a test of knowledge (such as an examination after a training course) or for research purposes. In this paper we outline the development of a hazard awareness testing tool and report substantive results from its first application in the realm of domestic food hazard awareness. Specifically, we use the tool to investigate which domestic food hazards are more/less likely to be identified and how individual characteristics influence the (i) probability of specific hazards being identified, and (ii) the aggregate number of hazards people identify.

1.1. Eliciting Hazard Awareness

Many methods are used to assess knowledge and awareness including self-completion questionnaires, interviews, focus groups and observational studies. Each has strengths and limitations when seeking to understand awareness and routine behaviours. For example, whilst self-reported awareness may be the most simple and convenient way to conduct such assessments there is often a discord between stated and actual behaviour (Abbot, Byrd-Bredbenner, Schaffner, Bruhn, & Blalock, 2007; Beattie, 2010; Kendall, et al., 2004; Medeiros, Hillers, Kendall, & Mason, 2001; Redmond & Griffith, 2003a, 2003b; van Asselt, Fischer, de Jong, Nauta, & de Jonge, 2009).

Biases are known to cause a divergence between both reported and actual behaviours and the attitudes people articulate and their behaviours. The discords are likely to be greater when individuals are asked questions which they interpret to have a normative element, and hence for which they perceive there to be more socially acceptable responses. This social desirability bias may arise with questions concerning attitudes, opinions or behaviours.

Optimistic bias (OB) may also widen the gulf between attitudes and behaviours (Fischer, Frewer, & Nauta, 2006; Miles, Braxton, & Frewer, 1999; Miles & Scaife, 2003; Parry, Miles, Tridente, Palmer, & Group, 2004; Sharot, 2011; Sparks & Shepherd, 1994; Weinstein, 1987). Optimistic bias causes people to systematically "underestimate the risks associated with many potentially risky behaviours or events" (Fischer & Frewer, 2009:577) meaning, in the context of food safety, individuals believe that they are less vulnerable to food safety hazards than the average person.

One response to the potential gulf between stated and actual attitudes/behaviours is to complement, or substitute, survey methods with additional approaches such as microbiological assessment or behavioural observation (Abbot, et al., 2007; Anderson, Shuster, Hansen, Levy, & Volk, 2004; Fischer, et al., 2007; Parry, et al., 2004; Redmond, Griffith, & Peters, 2000). Observation may involve the observer being present with the participants (Curtis, et al., 2003; Evans, 2011) or the use of video surveillance (Anderson, et al., 2004; Kendall, et al., 2004; van Asselt, et al., 2009). A recurring issue for observational studies is minimising the effect of observation (Clayton & Griffith, 2001;

Evans, 2011) since people tend to behave differently if watched (Gill & Johnson, 1997; Redmond & Griffith, 2003a). Well-designed self-reporting studies are still capable of yielding valuable information; Milton and Mullan (2012) find positive correlations between self-reported and observed food safety behaviours.

Survey techniques typically employed to elicit people's behaviours or attitudes prompt the participant to be slow and thoughtful in their responses. There is however increasing interest in the notion that people use differing cognitive processes when they navigate their everyday experiences as opposed to more unusual, challenging situations. This conjecture of System 1 (fast, intuitive) and System 2 (slow, deliberate) thinking (Kahneman, 2003) poses some interesting challenges for researchers who prompt people to use System 2 thinking when taking part in research concerning behaviours that typically involve System 1 thinking.

The Situation Awareness (SA) (M.R. Endsley, 1995) approach to assessing hazard awareness seeks to test an individual's ability to identify inappropriate behaviours, or dangerous conditions or events, taking into account the surrounding environment and the processes taking place within it. SA is defined as the 'perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future' (pg 36: M.R. Endsley, 1995).

Situation Awareness testing typically involves the use of video footage or a simulator to create a realistic scenario within which hazard awareness or specific skills are tested. The process or simulation is viewed by the participant and they respond to hazards as they become apparent during the process. Thus Situation Awareness (SA), which brings together a range of cognitive processes, is the active processing of situational information as new information is combined with existing knowledge and a composite picture of the situation is developed.

Much of the situation awareness research has been conducted in test settings, for example an early driving test (Pelz & Krupat, 1974) used a driver's-view video footage with respondents pulling a lever as they saw hazards develop. Situation Awareness has been used to elicit hazard perception in many settings, often associated with highly skilled operator tasks such as driving and air traffic control (Mica R. Endsley & Rodgers, 1994; Horswill & McKenna, 2004; McGowan & Banbury, 2004; Wetton, et al., 2010) as well as the fields of sport, healthcare and chess (Durso, et al., 1995; Gaba, Howard, & Small, 1995; James & Patrick, 2004; Rowe & McKenna, 2001; Wright, Taekman, & Endsley, 2004).

SA approaches have been subject to validation tests. The most widely known example is the driving hazard perception test which has been successfully validated against real behaviour in a number of ways (Horswill and McKenna (2004). Real driving behaviour has been compared to test behaviour (Watts & Quimby, 1979) and the comparison between SA test scores and actual behaviour has been undertaken with a very specific and germane form of behaviour: motoring accidents (Pelz & Krupat, 1974). More recently differences in SA tests were compared between novice and experienced practitioners (Wetton, et al., 2010).

The Watch-&-Click Hazard Awareness testing tool reported in this paper is rooted in this approach, eliciting hazard awareness using a video stimulus that prompts non-verbal responses under time pressure.

2. The Watch-&-Click Hazard Testing Tool

We now set out the development of the Watch-&-Click tool for eliciting hazard awareness and its first application, the investigation of food hazard awareness in the domestic kitchen.

The tool allows assessment of the level of awareness of potentially hazardous food behaviours by asking respondents to view and respond, via mouse click or screen tap, to hazards embedded in video footage of food preparation. This is done online, in real-time. Following on-screen explanatory details and instructions, participants take the Watch-&-Click test which is embedded within a broader survey including questions on demographic, behavioural and attitudinal characteristics.

The system's components are video footage containing the practices of interest in which hazards occur. This is embedded within an interface which allows respondents to view the footage and register their perception of a hazard (via mouse clicks/screen taps) with the response data (temporal and spatial coordinates) recorded. The third element is a database in which the response data are stored, and routines combine the predefined hazard definitions with respondents' click data to define whether each hazard is hit or missed. Individualised scores and appropriate feedback can then be generated and displayed to the respondent.

We now explain these elements with reference to the food safety application before reporting substantive results.

2.1. Hazard selection, definition and filming

Given that raw chicken presents a significant risk if mishandled, particularly with respect to the pathogens *Campylobacter* and *Salmonella* (Neimann, Engberg, Molbak, & Wegener, 2003; Parry, Palmer, Slader, Humphrey, & Grp, 2002) the video footage featured the preparation of a chicken salad. In the film, hazardous behaviours associated with raw chicken were present along with other, more general, food safety hazards. The hazards included behaviours which could contaminate either the food prepared, the 'cook' or surfaces/items in the kitchen. Table 1 details the hazards featured in the video footage stimuli.

Table 1. Hazards used in the survey

The hazards included were intended to vary in terms of likelihood of identification by respondents, to ensure a mix of hazard difficulty. The obvious hazard of undercooked chicken was not included since the extent of chicken cooking is difficult to convey unobtrusively in film and so text annotation was added to the film to indicate the chicken was fully cooked.

2.1.1. Storyboarding, staging, filming and editing

The film was structured so as to include the hazards in a naturalistic sequence in which an individual prepared a warm chicken salad for two. During filming and editing, enactment of the hazards was managed to ensure that hazards were temporally spaced, appropriately visible (without obvious signposting) and that inadvertent hazards were not introduced. Care was also taken to ensure that there was a sufficient gap between hazards, to minimise the risk of misattribution (a late click for one hazard being interpreted as a click for a subsequent hazard). Two films were made, comprising different combinations of the hazards listed in Table 1.

2.2. Development of the Watch-&-Click interface

The films were converted to Adobe Flash format for web delivery and embedded within a bespoke online survey system. Participants were only shown one film, to which they were allocated at random. Software was developed to enable the time and location of the hazard identification clicks/taps to be recorded in real-time. Figure 1 shows a screenshot of the video challenge in progress. The clicks are recorded in the database and the respondent is able to see their clicks being registered via a click counter.

Fig. 1. The web interface showing the click counter

2.3. Survey Questions

Attitudinal questions were asked prior to the Watch-&-Click test. These were designed to measure respondents' perceptions of their own levels of risk, control and knowledge regarding food poisoning in the home, and those of the average person. These allowed optimistic bias to be identified at the individual level (Parry, et al., 2004). The three pairs of risk, control and knowledge questions were of the form "how much [risk] do you think there is to you personally [to the average person] from food poisoning in the home?"

The survey's final stage comprised questions on demographics and food-specific questions concerning experience of food illness, diet and any training or qualifications in food safety.

3. *Research and Modelling approach*

The Watch-&-Click approach is applied to domestic food hazard awareness in the domestic kitchen. A number of research questions can be addressed using the data generated:

1. Which food hazards are more/less likely to be identified?
2. How do individual characteristics influence the probability of identification of specific hazards?
3. How many hazards in aggregate do people identify?
4. How do individual characteristics influence these aggregate hazard identification scores?

While research questions 1 and 3 are investigated by simple tabulations of the data, models are estimated on the click-response data to interrogate questions 2 and 4 concerning the impact of individual characteristics on (i) the probability of specific hazards being identified, and (ii) aggregate hazard identification scores.

A logit model was estimated in which the probability of a hazard being identified (*Y*=1 for hazard hit; *Y*=0 for a miss) is a function of characteristics X:

$$P(Y=1) = \frac{\exp\,(\alpha + \sum \beta_K X_K)}{1 + \exp\,(\alpha + \sum \beta_K X_K)} \qquad (1)$$

with the effects of those characteristics on the probability of hazard identification captured by the estimated β coefficients.

To investigate the impact of characteristics on individuals' total hazard identification scores a right censored Poisson count model is estimated (Hilbe & Judson, 1999). The count modelled is the number of hazards identified by the individual. We assume a Poisson distribution for the dependent variable (number of hazard hits) and a censored model is estimated since the number of hazards is capped (8 for Film1; 6 for Film2).

A random variable Y is said to have a Poisson distribution with parameter u if it takes values y = 0, 1, 2....with a probability

$$P(Y = y) = \frac{e^{-u}u^{y}}{y!} \qquad (2)$$

The likelihood function for the censored Poisson model (Hilbe & Judson, 1999) is:

$$L(u, X) = \prod_{i=1}^{N} f(x_i, u)^{\,I(p_i=1)} \left(\sum_{j=0}^{x_i} f(j, u)\right)^{I(p_i=0)} \left(1 - \sum_{j=0}^{x_i} f(j, u)\right)^{I(p_i=-1)} \qquad (3)$$

where

- N is the number of cases
- p_i = 1 if the ith observation is not censored, 0 if left censored, -1 if right censored
- $I(p_i)$ is the indicator function, taking the value one when the statement in parentheses is true, otherwise taking the value 0
- f is the probability density function of a Poisson random variable with parameter u
- u = exp($X\beta$)
- $1 - \sum_{j=0}^{x_i} f(j, u)$ is the probability of observing x_i or more events when $E(Y) = u$
- $\sum_{j=0}^{x_i} f(j, u)$ is the probability of observing x_i or fewer events when $E(Y) = u$
- x_i are characteristics

Many characteristics to be included in these models were readily available from the survey, but some had to be derived from raw data. Perceptions are measured from the attitudinal questions regarding risk, control and knowledge extending the work of Parry et al. (2004). From these data optimistic bias is tested for using a difference score between a respondent's answers to the questions about themselves and those about the average person. Typically, OB has been tested using a one-sample t-test (Parry, et al., 2004; Sargeant, Majowicz, Sheth, & Edge, 2010; Weinstein, 1987). However, as the difference scores are ordinal not interval we use the non-parametric Wilcoxon Mann-Whitney test to test the hypothesis that the sample median is equal to zero and therefore shows no bias. Whilst optimistic bias is a group effect (Parry, et al., 2004; Rothman, Klein, & Weinstein, 1996), we create a bias rating (0=no bias, 1=bias) for individuals.

4. Results

4.1. Recruitment and demographics

Recruitment occurred via snowball sampling. Thirty three seed emails were sent to individuals in the UK, one to Australia and one to the US. Subsequent recruitment was rapid with over 300 people completing the survey within three weeks - in total 576 responses were gathered. The characteristics of the sample are set out in Table 2 indicating that 404 (70%) of the participants were female with 14% from outside the UK (from the Netherlands, France, Ireland, the USA and Australia). The sample was ethnically diverse with 31% of the sample from a non-white British background. 11% of participants were vegetarian or vegan. One hundred and forty seven (26%) reported having had food poisoning in the last 5 years, but only 29 had visited the doctor of whom 16 had had laboratory confirmation of their food poisoning. Some knowledge, experience or qualification in food safety was claimed by 266 (46%) respondents.

Table 2. Summary of characteristics used in the analysis

4.2. User Experience

The rapid recruitment process provided some evidence that people found the Watch-&-Click survey engaging and accessible. This was further borne out by the comments left at the survey's end (no adverse comments were left) of which this selection are indicative:

- "I think the video is a very nice method to see if people are aware of where the risks are. I think it is much more efficient than a questionnaire for example"
- "Very innovative and realistic video"
- "Interesting to have a video clip instead of the usual boring old tick box questionnaire"
- "Great Learning experience"

As the Watch-&-Click Hazard Awareness tool runs in real-time a debrief question was asked to assess if the speed of the film (and the participant's ability to keep pace) was problematic. Participants responded favourably, with 367 (63.72%) of individuals stating that the speed was "fine", and 129 (22.4%) "a little fast but I managed". Only 11 respondents indicated that the film was "too fast".

We now turn to some substantive results yielded by the approach, combining the data described and the models set out in Section 3.

4.3. Identification of hazards

Individuals' click behaviour was analysed to calculate the number of hazards identified (hazard hits). Whilst temporal and spatial click coordinates were stored in a server side database sitting 'behind' the web interface experienced by respondents, only temporal click coordinates were analysed in this study. Figure 2 shows the distribution of hazard identification scores for each of the 2 films in which the maximum number of hazards was 8 (film 1) and 6 (film 2).

Fig. 2. Hazard identification scores (by film)

7% of the film1 sample (10 %, film2) identified none of the hazards, and 15% (17%, film2) identified 2 or less of the hazards they saw. 12% and 23% of participants identified all of the hazards they saw in films 1 and 2 respectively. Figure 3 shows the hazard identification rates for each of the hazards. The most commonly identified hazards were cross contamination from hands which had handled raw chicken (cc-bowl, 84%), storage of raw chicken in the fridge's top shelf (cc-store, 81%) and wiping (rather than washing/replacing) a chopping board and knife which had been used with raw chicken before cutting salad ingredients (cc-board, 79%).

Fig. 3. Hazard identification rate

The least commonly identified hazards were the use of utensils covered in raw marinade to serve cooked chicken (cc-utensils, 53%) and the inappropriately high fridge temperature (8.9°C) evident from the digital fridge thermometer (temp, 57%, in film 1). Identification rates for this fridge temperature hazard is worthy of a little more discussion. While the hazardous behaviours embedded in the film were designed to be as naturalistic as possible, it was difficult to display the fridge temperature without it being a little conspicuous. Consequently, two films were created, with different temperatures displayed in each. In film 1 a hazardous temperature of 8.9°C was visible, while in film 2 a safe temperature of 4.7°C was visible. While 57% identified 8.9°C as a hazard, 48% of film 2 viewers identified 4.7°C as a hazard. This suggests the proportion of the sample knowing safe/hazardous fridge temperatures is far below the 57% shown in Figure 3.

4.4. Optimistic Bias

The presence of OB was tested by calculating the difference between individuals' rating of their own, and the average person's, levels of risk, control and knowledge. For all 3 dimensions the scores are significantly different from zero indicating OB was present within the group. The participants indicated that the average person is at a significantly greater risk of getting food poisoning ($p<0.001$), has less knowledge ($p<0.001$) and less control ($p<0.001$) compared to themselves. An individual level characteristic was generated to indicate whether the person exhibited each form of OB. Descriptive statistics for these 3 dummies are displayed in Table 2, with 63% of participants exhibiting OB in relation to risk, 37% in relation to control and 75% regarding knowledge.

Having summarised the hazard identification patterns and levels of optimistic bias descriptively, we now report results of modelling work to identify the role of observable characteristics on hazard identification scores, and the probability of identifying specific food safety hazards.

4.5. Explaining variation in hazard awareness

Estimation of the Poisson count model outlined in Section 3 allowed investigation of the effect of independent variables (characteristics) on individuals' Hazards Identification Score (HIS). These characteristics included gender, age group, children in the household, food safety qualifications, food poisoning within 5 years and whether they were a vegetarian. Respondents' perceptions, biases and experience of the survey process were also included: personal perceptions of risk, control and knowledge, dummies for OB (risk) OB (control) and OB (knowledge) and perception of the film's speed (fine/a little fast but ok/ too fast). A summary of these variables and their descriptive statistics are in Table 2.

Table 3 shows results of full (model 1) and parsimonious (model 2) Poisson models with explanatory variables removed using a stepwise approach until all remaining variables were significant at $p\leq0.05$. For ease of interpretation the effects are displayed as incidence rate ratios calculated by exponentiation of raw coefficients. Young adults (aged 18-29) and Adults (aged 30-59) were significantly more likely to score higher than those aged over 60, with an increased HIS of 29% and 21% respectively. There was a positive effect of claimed levels of knowledge with each additional point on the 6 point knowledge scale corresponding to a 10% increase in the HIS. In contrast there was no significant difference in the HIS for those professing to have food safety qualifications or training. This was also the case for those reporting they found the film too fast, indeed those reporting it “a little fast” scored significantly higher than those who reported the speed as “fine”.

Table 3. Poisson regression results: impact of characteristics on Hazard Identification Score (HIS)

The effect of characteristics on the probability of specific hazards being identified was investigated using multivariate logistic regression. The independent variables listed above were again removed using a stepwise approach to produce a final model for each hazard, each of which is set out in Table 4.

Table 4. Binary Logit Regression: Impact of characteristics on probability of identifying specific hazards

The age effects identified in the aggregate count model results are present again, but only for some of the hazards. Young adults and adults were more likely to identify the cross contamination hazard of utensils coated in raw marinade being used to serve up food (cc-utensils), the raw marinade being poured over the salad as a dressing (cc-marinade) and dirty hands being used to touch the radio (cc-radio). There were no age effects for other hazards. Women were more likely to identify two of the cross contamination hazards (dirty hands being used to touch the radio (cc-radio) and marinade bottle (cc-bottle)). The presence of children in the model had no effect for 6 of the 8 hazards, but there were effects, of opposite sign for 2 hazards: people with children were more likely to spot the raw marinade being used as a dressing (cc-marinade) but less likely to spot a hygiene hazard (hyg-nose). Vegetarians were less likely to identify 3 of the hazards, and more likely to spot none of the others. The washing of chicken (cc-chicken) was less likely to be spotted by them as were 2 cross contamination hazards (cc-radio, cc-bottle).

Having had food poisoning in the last 5 years affected the probability of identifying only one of the hazards, with such formerly ill people less likely to notice the same utensils being used with raw and later cooked chicken (cc-utensils). People claiming to have food safety qualifications/knowledge (qual) and those believing they had more knowledge (obknow), and at lower risk (obrisk), than the average person were found to be more likely to identify a series of hazards.

People with food safety qualifications/knowledge (qual) were more likely to spot the excessively warm fridge (temp) as well as the utensil cross contamination problem (cc-utensil). Respondents' belief that they had more food safety knowledge than the average person (obknow) affected the probability of spotting more hazards than any other characteristic. This trait affected the chances of spotting 5 hazards, positively in all cases. It was the only characteristic that increased the likelihood of identifying poor hand washing practices. It was one of only two characteristics (the other being obrisk) that increased the probability of people identifying the washing of raw chicken as a hazard (cc-chicken). People exhibiting OB (obknow, obrisk) were also more likely to identify the marinade as dressing hazard (cc-marinade). While the effects of OB regarding risk and knowledge were positive in all cases, people exhibiting OB (control) were found not to be more or less likely than the sample average to spot any of the hazards.

These effects of individual-level characteristics can be summarised for the individual hazards. Hence identifying the washing of chicken (cc-chicken) as a hazard was less likely among vegetarians (veggie), but more likely for those believing they had more knowledge or lower risk than the average person (obknow, obrisk). Similarly, the use of raw marinade as a salad dressing (cc-marinade) was more likely to be identified by those under 60 (young, adult), those with children in the household (child) and those believing they had more knowledge or were at lower risk than the average person (obknow, obrisk).

5. Discussion

This study was initiated to assess the awareness of hazardous food behaviours in the domestic kitchen. In the process of doing so a novel method of eliciting hazard awareness was conceptualised, developed and applied. The method developed was rooted in Situation Awareness.

The aim was to design a simple, intuitive and engaging testing tool. Whilst we do not have user experience ratings to compare with an equivalent, standard format survey, the speed with which the survey spread from initial seed emails and the number of completions amassed suggests a positive user experience. More direct evidence is available from the comments respondents left which were unanimously positive and which in many cases made unprompted, positive, comparisons with more typical standard formats. These responses suggest the method exhibits good face validity.

Some findings resonate with other research. For example washing raw chicken was not identified as a hazard by 38% of the sample, a rate similar to the 41% who report always washing poultry in the FSA's 'Food and You' (F&Y) survey (FSA, 2014). The fridge temperature of 8.9°C was identified as a hazard by 57% of the film1 sample, a rate which corresponds to the 53% of respondents in waves 2 and 3 of the F&Y survey which correctly identified the correct temperature range (0 - 5 °C). However the inferences that can be drawn from these results are questioned by the finding that 48% of the film2 sample identified the safe temperature of 4.7°C as a hazard. This highlights the need to understand the impact upon respondent behaviour of the means by which knowledge is elicited, whether it be visual (this study) or the use of interval response options (F&Y survey). Just as a fridge temperature being displayed was probably taken as a 'clue' by some respondents, the correct temperature range presented in the F&Y survey adjacent to the categories of below 0°C, and 5-8°C may well have prompted an overestimate of knowledge of correct temperatures.

Individuals claiming to have food safety qualifications or knowledge (qual) were found to be more likely to identify 3 of the 8 hazards. The characteristic that was positively correlated with identification of the highest number of hazards was the belief that one had more knowledge of food safety at home than the average person (obknow). People believing this to be the case were more likely to spot 5 of the 8 hazards. These 2 effects were, together, significant across all 8 of the hazards, but never together; suggesting that the personal assessment of knowledge was a more powerful predictor than a person having been through training *per se*. The results do pose a question as to whether the assessment of people believing they know more than the average person really is a bias – the results in this study suggest that, on average, these people do indeed know more about food safety at home (premised on the belief that the scores generated by the survey are a robust measure of food safety knowledge). Believing one had more control over the food poisoning risk at home was not positively correlated with spotting any of the hazards.

Those exhibiting OB in knowledge were also found to score higher in aggregate within the test (by 11%). This effect was however far less strong than that associated with age: being aged 18-29 or 30-59 meant increases in the HIS of approximately 20% and 30% respectively. While older age groups have been found previously to be more likely to deviate from recommended food safety practices in the home (for example in F&Y reports), younger age groups have been found to have the same tendency. The results from the Poisson and logit models here are contrary to this: the 18-29 group effects were positive and typically stronger than the 30-59 effects.

Respondents' self-reported levels of knowledge and whether they have specialist training or experience being positively correlated with higher probabilities of identifying many of the hazards, suggest the approach exhibits convergent validity. Further support for the validity of the approach can be drawn from past validity investigations of Situation Analysis methods (see Section 1) most commonly involving driver behaviour. The reliability of the Watch-&-Click Hazard Testing Tool is further investigated by testing the internal consistency for each film - Film 1 (Cronbach's alpha = .82), film 2 (Cronbach's alpha = .74). These levels compare well with reported consistencies in hazard perception tests for example 0.83 and 0.84 (Bruce, Unsworth, Tay, & Dillon, 2015) and 0.72 (McGowan & Banbury, 2004). Horswill and McKenna (2004) highlights that the psychometric reliability of hazard perception test is variable with the number of hazards and the definition of hazard limiting internal consistency – the lower number of hazards may explain the lower reported alpha for film 2.

6. Conclusions

Food behaviours in the home are difficult to observe and unlike the commercial food sector there is no training required or inspection programme in operation. Poor practices in storing and preparing food in the home cause significant health and economic damages. Whilst interventions along the food chain can reduce public exposure to food pathogens, behaviour in the home can still be a major factor in generating cases of foodborne illness. In the case of *Campylobacter* which is strongly associated with the consumption of chicken, FSA targets for the poultry sector set in 2010 were missed in 2013 and are likely to be missed again in 2015.Since *Campylobacter* contamination of birds is declining little if at all, then there is still a considerable public health burden falling upon the consumer. Understanding, and potentially improving, people's food safety knowledge in the home offers potential to reduce the disease burden.

The Watch-&-Click Hazard Testing Tool developed and applied here, rooted in Situation Awareness, attempts to provide participants with an environment that is not too different to that of a normal domestic kitchen. Participants complete the study online and anonymously, potentially reducing observer bias. The use of real-time responses creates a time pressure thereby discouraging users to over-deliberate instead utilising fast, automatic, associative processes. By limiting the amount of time that an individual has to consider the hazards, it is hoped that this in turn allows less time for the respondent to consider what they should 'do' and increases the likelihood they will respond in accordance with their own routine behaviours.

Further work could be undertaken to make formal comparisons of how the click response data correlate with more traditionally elicited survey responses. A more challenging task will be to test the hazard awareness scores against real practices in the home. The approach has potential to be applied in other contexts, indeed some respondents contacted the authors to enquire whether the approach could be applied to non-food settings in which they worked or trained. Further work is underway to refine the statistical analysis of participants' click response data to account for variation in the number of times they click. This seeks to capture the possibly differing levels of information contained within a click from a heavy clicker as opposed to a sparse one.

The Watch-&-Click Hazard Testing Tool has since late 2014 been trialled with pupils in UK secondary schools. The positive user experience identified in this paper has been replicated, with both teachers and pupils extolling its virtues in terms of accessibility and engagement. This resonates with the rapid recruitment rates and positive feedback from participants and food industry and food safety stakeholders in this study. This suggests that the Watch-&-Click tool can be a positive addition to the range of existing methods for eliciting and improving food safety awareness.

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