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A real-time test of food hazard awareness

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1   *A Real-Time Test of Food Hazard Awareness*

2

3 *Abstract*

4 **Purpose**

5 Food poisoning attributable to the home generates a large disease burden, yet is an unregulated

6 and largely unobserved domain. Investigating food safety awareness and routine practices is fraught

7 with difficulties. We develop and apply a new survey tool to elicit awareness of food hazards. Data

8 generated by the approach are analysed to investigate the impact of oberservable heterogeneity on

9 food safety awareness.

10 **Design/methodology/approach**

11 We develop a novel Watch-&-Click survey tool to assess the level of awareness of a set of

12 hazardous food safety behaviours in the domestic kitchen. Participants respond to video footage

13 stimulus, in which food hazards occur, via mouse clicks/screen taps. This real-time response data is

14 analysed via estimation of count and logit models to investigate how hazard identification patterns

15 vary over observable characteristics.

16 **Findings**

17 User feedback regarding the Watch-&-Click tool approach is extremely positive. Substantive

18 results include significantly higher hazard awareness among the under 60s. People who thought they

19 knew more than the average person did indeed score higher but people with food safety

20 training/experience did not. Vegetarians were less likely to identify 4 of the 5 cross contamination

21 hazards they observed.

22 **Originality/value**

23 A new and engaging survey tool to elicit hazard awareness with real-time scores and feedback is

24 developed, with high levels of user engagement and stakeholder interest. The approach may be

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

26   research.

27   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

53   Many methods are used to assess knowledge and awareness including self-completion

54   questionnaires, interviews, focus groups and observational studies. Each has strengths and

55   limitations when seeking to understand awareness and routine behaviours. For example, whilst self-

56   reported awareness may be the most simple and convenient way to conduct such assessments there

57   is often a discord between stated and actual behaviour (Abbot, Byrd-Bredbenner, Schaffner, Bruhn,

58   & Blalock, 2007; Beattie, 2010; Kendall, et al., 2004; Medeiros, Hillers, Kendall, & Mason, 2001;

59   Redmond & Griffith, 2003a, 2003b; van Asselt, Fischer, de Jong, Nauta, & de Jonge, 2009).

60   Biases are known to cause a divergence between both reported and actual behaviours and the

61   attitudes people articulate and their behaviours. The discords are likely to be greater when

62   individuals are asked questions which they interpret to have a normative element, and hence for

63   which they perceive there to be more socially acceptable responses. This social desirability bias may

64   arise with questions concerning attitudes, opinions or behaviours.

65   Optimistic bias (OB) may also widen the gulf between attitudes and behaviours (Fischer, Frewer,

66   & Nauta, 2006; Miles, Braxton, & Frewer, 1999; Miles & Scaife, 2003; Parry, Miles, Tridente, Palmer,

67   & Group, 2004; Sharot, 2011; Sparks & Shepherd, 1994; Weinstein, 1987). Optimistic bias causes

68   people to systematically "underestimate the risks associated with many potentially risky behaviours

69   or events" (Fischer & Frewer, 2009:577) meaning, in the context of food safety, individuals believe

70   that they are less vulnerable to food safety hazards than the average person.

71   One response to the potential gulf between stated and actual attitudes/behaviours is to

72   complement, or substitute, survey methods with additional approaches such as microbiological

73   assessment or behavioural observation (Abbot, et al., 2007; Anderson, Shuster, Hansen, Levy, & Volk,

74   2004; Fischer, et al., 2007; Parry, et al., 2004; Redmond, Griffith, & Peters, 2000). Observation may

75   involve the observer being present with the participants (Curtis, et al., 2003; Evans, 2011) or the use

76   of video surveillance (Anderson, et al., 2004; Kendall, et al., 2004; van Asselt, et al., 2009). A recurring

77   issue for observational studies is minimising the effect of observation (Clayton & Griffith, 2001;

78 Evans, 2011) since people tend to behave differently if watched (Gill & Johnson, 1997; Redmond &

79 Griffith, 2003a). Well-designed self-reporting studies are still capable of yielding valuable

80 information; Milton and Mullan (2012) find positive correlations between self-reported and observed

81 food safety behaviours.

82   Survey techniques typically employed to elicit people's behaviours or attitudes prompt the

83 participant to be slow and thoughtful in their responses. There is however increasing interest in the

84 notion that people use differing cognitive processes when they navigate their everyday experiences

85 as opposed to more unusual, challenging situations. This conjecture of System 1 (fast, intuitive) and

86 System 2 (slow, deliberate) thinking (Kahneman, 2003) poses some interesting challenges for

87 researchers who prompt people to use System 2 thinking when taking part in research concerning

88 behaviours that typically involve System 1 thinking.

89   The Situation Awareness (SA) (M.R. Endsley, 1995) approach to assessing hazard awareness

90 seeks to test an individual's ability to identify inappropriate behaviours, or dangerous conditions or

91 events, taking into account the surrounding environment and the processes taking place within it. SA

92 is defined as the 'perception of the elements in the environment within a volume of time and space,

93 the comprehension of their meaning, and the projection of their status in the near future' (pg 36:

94 M.R. Endsley, 1995).

95   Situation Awareness testing typically involves the use of video footage or a simulator to create a

96 realistic scenario within which hazard awareness or specific skills are tested. The process or

97 simulation is viewed by the participant and they respond to hazards as they become apparent during

98 the process. Thus Situation Awareness (SA), which brings together a range of cognitive processes, is

99 the active processing of situational information as new information is combined with existing

100 knowledge and a composite picture of the situation is developed.

101   Much of the situation awareness research has been conducted in test settings, for example an

102   early driving test (Pelz & Krupat, 1974) used a driver's-view video footage with respondents pulling a

103   lever as they saw hazards develop. Situation Awareness has been used to elicit hazard perception in

104   many settings, often associated with highly skilled operator tasks such as driving and air traffic

105   control (Mica R. Endsley & Rodgers, 1994; Horswill & McKenna, 2004; McGowan & Banbury, 2004;

106   Wetton, et al., 2010) as well as the fields of sport, healthcare and chess (Durso, et al., 1995; Gaba,

107   Howard, & Small, 1995; James & Patrick, 2004; Rowe & McKenna, 2001; Wright, Taekman, & Endsley,

108   2004).

109   SA approaches have been subject to validation tests. The most widely known example is the

110   driving hazard perception test which has been successfully validated against real behaviour in a

111   number of ways (Horswill and McKenna (2004). Real driving behaviour has been compared to test

112   behaviour (Watts & Quimby, 1979) and the comparison between SA test scores and actual behaviour

113   has been undertaken with a very specific and germane form of behaviour: motoring accidents (Pelz &

114   Krupat, 1974). More recently differences in SA tests were compared between novice and

115   experienced practitioners (Wetton, et al., 2010).

116   The Watch-&-Click Hazard Awareness testing tool reported in this paper is rooted in this approach,

117   eliciting hazard awareness using a video stimulus that prompts non-verbal responses under time

118   pressure.

2. The Watch-&-Click Hazard Testing Tool

120   We now set out the development of the Watch-&-Click tool for eliciting hazard awareness and its

121   first application, the investigation of food hazard awareness in the domestic kitchen.

122   The tool allows assessment of the level of awareness of potentially hazardous food behaviours

123   by asking respondents to view and respond, via mouse click or screen tap, to hazards embedded in

124   video footage of food preparation. This is done online, in real-time. Following on-screen explanatory

125   details and instructions, participants take the Watch-&-Click test which is embedded within a

126   broader survey including questions on demographic, behavioural and attitudinal characteristics.

127   The system's components are video footage containing the practices of interest in which hazards

128   occur. This is embedded within an interface which allows respondents to view the footage and

129   register their perception of a hazard (via mouse clicks/screen taps) with the response data (temporal

130   and spatial coordinates) recorded. The third element is a database in which the response data are

131   stored, and routines combine the predefined hazard definitions with respondents' click data to

132   define whether each hazard is hit or missed. Individualised scores and appropriate feedback can then

133   be generated and displayed to the respondent.

134   We now explain these elements with reference to the food safety application before reporting

135   substantive results.

2.1. Hazard selection, definition and filming

137   Given that raw chicken presents a significant risk if mishandled, particularly with respect to the

138   pathogens *Campylobacter* and *Salmonella* (Neimann, Engberg, Molbak, & Wegener, 2003; Parry,

139   Palmer, Slader, Humphrey, & Grp, 2002) the video footage featured the preparation of a chicken

140   salad. In the film, hazardous behaviours associated with raw chicken were present along with other,

141   more general, food safety hazards. The hazards included behaviours which could contaminate either

142   the food prepared, the 'cook' or surfaces/items in the kitchen. Table 1 details the hazards featured

143   in the video footage stimuli.

144

145   *Table 1. Hazards used in the survey*

146

147   The hazards included were intended to vary in terms of likelihood of identification by

148   respondents, to ensure a mix of hazard difficulty. The obvious hazard of undercooked chicken was

149   not included since the extent of chicken cooking is difficult to convey unobtrusively in film and so text

150   annotation was added to the film to indicate the chicken was fully cooked.

2.1.1. Storyboarding, staging, filming and editing

152   The film was structured so as to include the hazards in a naturalistic sequence in which an

153   individual prepared a warm chicken salad for two. During filming and editing, enactment of the

154   hazards was managed to ensure that hazards were temporally spaced, appropriately visible (without

155   obvious signposting) and that inadvertent hazards were not introduced. Care was also taken to

156   ensure that there was a sufficient gap between hazards, to minimise the risk of misattribution (a late

157   click for one hazard being interpreted as a click for a subsequent hazard). Two films were made,

158   comprising different combinations of the hazards listed in Table 1.

2.2. Development of the Watch-&-Click interface

160   The films were converted to Adobe Flash format for web delivery and embedded within a

161   bespoke online survey system. Participants were only shown one film, to which they were allocated

162   at random. Software was developed to enable the time and location of the hazard identification

163   clicks/taps to be recorded in real-time. Figure 1 shows a screenshot of the video challenge in

164   progress. The clicks are recorded in the database and the respondent is able to see their clicks being

165   registered via a click counter.

166

167   *Fig. 1. The web interface showing the click counter*

168

2.3. Survey Questions

170   Attitudinal questions were asked prior to the Watch-&-Click test. These were designed to

171   measure respondents' perceptions of their own levels of risk, control and knowledge regarding food

172   poisoning in the home, and those of the average person. These allowed optimistic bias to be

173   identified at the individual level (Parry, et al., 2004). The three pairs of risk, control and knowledge

174   questions were of the form "how much [risk] do you think there is to you personally [to the average

175   person] from food poisoning in the home?"

176   The survey's final stage comprised questions on demographics and food-specific questions

177   concerning experience of food illness, diet and any training or qualifications in food safety.

3. Research and Modelling approach

179   The Watch-&-Click approach is applied to domestic food hazard awareness in the domestic

180   kitchen. A number of research questions can be addressed using the data generated:

181   1. Which food hazards are more/less likely to be identified?

182   2. How do individual characteristics influence the probability of identification of specific

183   hazards?

184   3. How many hazards in aggregate do people identify?

185   4. How do individual characteristics influence these aggregate hazard identification scores?

186   While research questions 1 and 3 are investigated by simple tabulations of the data, models are

187   estimated on the click-response data to interrogate questions 2 and 4 concerning the impact of

188   individual characteristics on (i) the probability of specific hazards being identified, and (ii) aggregate

189   hazard identification scores.

190   A logit model was estimated in which the probability of a hazard being identified (*Y*=1 for hazard

191   hit; *Y*=0 for a miss) is a function of characteristics X:

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

10

193   with the effects of those characteristics on the probability of hazard identification captured by the

194   estimated β coefficients.

195   To investigate the impact of characteristics on individuals' total hazard identification scores a

196   right censored Poisson count model is estimated (Hilbe & Judson, 1999). The count modelled is the

197   number of hazards identified by the individual. We assume a Poisson distribution for the dependent

198   variable (number of hazard hits) and a censored model is estimated since the number of hazards is

199   capped (8 for Film1; 6 for Film2).

200   A random variable Y is said to have a Poisson distribution with parameter u if it takes values $y =$

201   0, 1, 2....with a probability

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

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

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

205   where

206   -   N is the number of cases

207   - p_i = 1 if the ith observation is not censored, 0 if left censored, -1 if right censored

208   - $I(p_i)$ is the indicator function, taking the value one when the statement in parentheses is

209   true, otherwise taking the value 0

210   - f is the probability density function of a Poisson random variable with parameter u

211   - u = exp($X\beta$)

212   - $1 - \sum_{j=0}^{x_i} f(j, u)$ is the probability of observing x_i or more events when $E(Y) = u$

213   - $\sum_{j=0}^{x_i} f(j, u)$ is the probability of observing x_i or fewer events when $E(Y) = u$

214   - x_i are characteristics

215   Many characteristics to be included in these models were readily available from the survey, but

216   some had to be derived from raw data. Perceptions are measured from the attitudinal questions

217   regarding risk, control and knowledge extending the work of Parry et al. (2004). From these data

218   optimistic bias is tested for using a difference score between a respondent's answers to the

219   questions about themselves and those about the average person. Typically, OB has been tested using

220   a one-sample t-test (Parry, et al., 2004; Sargeant, Majowicz, Sheth, & Edge, 2010; Weinstein, 1987).

221   However, as the difference scores are ordinal not interval we use the non-parametric Wilcoxon

222   Mann-Whitney test to test the hypothesis that the sample median is equal to zero and therefore

223   shows no bias. Whilst optimistic bias is a group effect (Parry, et al., 2004; Rothman, Klein, &

224   Weinstein, 1996), we create a bias rating (0=no bias, 1=bias) for individuals.

4. Results

4.1. Recruitment and demographics

227   Recruitment occurred via snowball sampling. Thirty three seed emails were sent to individuals in

228   the UK, one to Australia and one to the US. Subsequent recruitment was rapid with over 300 people

229   completing the survey within three weeks - in total 576 responses were gathered. The characteristics

230   of the sample are set out in Table 2 indicating that 404 (70%) of the participants were female with

231   14% from outside the UK (from the Netherlands, France, Ireland, the USA and Australia). The sample

232   was ethnically diverse with 31% of the sample from a non-white British background. 11% of

233   participants were vegetarian or vegan. One hundred and forty seven (26%) reported having had food

234   poisoning in the last 5 years, but only 29 had visited the doctor of whom 16 had had laboratory

235   confirmation of their food poisoning. Some knowledge, experience or qualification in food safety was

236   claimed by 266 (46%) respondents.

237

238   *Table 2. Summary of characteristics used in the analysis*

239

4.2. User Experience

241   The rapid recruitment process provided some evidence that people found the Watch-&-Click

242 survey engaging and accessible. This was further borne out by the comments left at the survey's end

243 (no adverse comments were left) of which this selection are indicative:

244   - "I think the video is a very nice method to see if people are aware of where the risks are.

245   I think it is much more efficient than a questionnaire for example"

246   - "Very innovative and realistic video"

247   - "Interesting to have a video clip instead of the usual boring old tick box questionnaire"

248   - "Great Learning experience"

249   As the Watch-&-Click Hazard Awareness tool runs in real-time a debrief question was asked to

250 assess if the speed of the film (and the participant's ability to keep pace) was problematic.

251 Participants responded favourably, with 367 (63.72%) of individuals stating that the speed was

252 "fine", and 129 (22.4%) "a little fast but I managed". Only 11 respondents indicated that the film was

253 "too fast".

254   We now turn to some substantive results yielded by the approach, combining the data described

255 and the models set out in Section 3.

4.3. Identification of hazards

257   Individuals' click behaviour was analysed to calculate the number of hazards identified (hazard

258 hits). Whilst temporal and spatial click coordinates were stored in a server side database sitting

259 'behind' the web interface experienced by respondents, only temporal click coordinates were

260 analysed in this study. Figure 2 shows the distribution of hazard identification scores for each of the

261 2 films in which the maximum number of hazards was 8 (film 1) and 6 (film 2).

262

Fig. 2. Hazard identification scores (by film)

264

265   7% of the film1 sample (10 %, film2) identified none of the hazards, and 15% (17%, film2)

266 identified 2 or less of the hazards they saw. 12% and 23% of participants identified all of the hazards

267 they saw in films 1 and 2 respectively. Figure 3 shows the hazard identification rates for each of the

268 hazards. The most commonly identified hazards were cross contamination from hands which had

269 handled raw chicken (cc-bowl, 84%), storage of raw chicken in the fridge's top shelf (cc-store, 81%)

270 and wiping (rather than washing/replacing) a chopping board and knife which had been used with

271 raw chicken before cutting salad ingredients (cc-board, 79%).

272

273 *Fig. 3. Hazard identification rate*

274

275   The least commonly identified hazards were the use of utensils covered in raw marinade to serve

276 cooked chicken (cc-utensils, 53%) and the inappropriately high fridge temperature (8.9°C) evident

277 from the digital fridge thermometer (temp, 57%, in film 1). Identification rates for this fridge

278 temperature hazard is worthy of a little more discussion. While the hazardous behaviours embedded

279 in the film were designed to be as naturalistic as possible, it was difficult to display the fridge

280 temperature without it being a little conspicuous. Consequently, two films were created, with

281 different temperatures displayed in each. In film 1 a hazardous temperature of 8.9°C was visible,

282 while in film 2 a safe temperature of 4.7°C was visible. While 57% identified 8.9°C as a hazard, 48% of

283 film 2 viewers identified 4.7°C as a hazard. This suggests the proportion of the sample knowing

284 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≤0.05. 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)

310 were significantly more likely to score higher than those aged over 60, with an increased HIS of 29%

311 and 21% respectively. There was a positive effect of claimed levels of knowledge with each additional

312 point on the 6 point knowledge scale corresponding to a 10% increase in the HIS. In contrast there

313 was no significant difference in the HIS for those professing to have food safety qualifications or

314 training. This was also the case for those reporting they found the film too fast, indeed those

315 reporting it "a little fast" scored significantly higher than those who reported the speed as "fine".

316

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

318

319   The effect of characteristics on the probability of specific hazards being identified was

320 investigated using multivariate logistic regression. The independent variables listed above were again

321 removed using a stepwise approach to produce a final model for each hazard, each of which is set

322 out in Table 4.

323

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

325 *hazards*

326

327   The age effects identified in the aggregate count model results are present again, but only for

328 some of the hazards. Young adults and adults were more likely to identify the cross contamination

329 hazard of utensils coated in raw marinade being used to serve up food (cc-utensils), the raw

330 marinade being poured over the salad as a dressing (cc-marinade) and dirty hands being used to

331 touch the radio (cc-radio). There were no age effects for other hazards. Women were more likely to

332   identify two of the cross contamination hazards (dirty hands being used to touch the radio (cc-radio)

333   and marinade bottle (cc-bottle)). The presence of children in the model had no effect for 6 of the 8

334   hazards, but there were effects, of opposite sign for 2 hazards: people with children were more likely

335   to spot the raw marinade being used as a dressing (cc-marinade) but less likely to spot a hygiene

336   hazard (hyg-nose). Vegetarians were less likely to identify 3 of the hazards, and more likely to spot

337   none of the others. The washing of chicken (cc-chicken) was less likely to be spotted by them as were

338   2 cross contamination hazards (cc-radio, cc-bottle).

339   Having had food poisoning in the last 5 years affected the probability of identifying only one of

340   the hazards, with such formerly ill people less likely to notice the same utensils being used with raw

341   and later cooked chicken (cc-utensils). People claiming to have food safety qualifications/knowledge

342   (qual) and those believing they had more knowledge (obknow), and at lower risk (obrisk), than the

343   average person were found to be more likely to identify a series of hazards.

344   People with food safety qualifications/knowledge (qual) were more likely to spot the excessively

345   warm fridge (temp) as well as the utensil cross contamination problem (cc-utensil). Respondents'

346   belief that they had more food safety knowledge than the average person (obknow) affected the

347   probability of spotting more hazards than any other characteristic. This trait affected the chances of

348   spotting 5 hazards, positively in all cases. It was the only characteristic that increased the likelihood

349   of identifying poor hand washing practices. It was one of only two characteristics (the other being

350   obrisk) that increased the probability of people identifying the washing of raw chicken as a hazard

351   (cc-chicken). People exhibiting OB (obknow, obrisk) were also more likely to identify the marinade as

352   dressing hazard (cc-marinade). While the effects of OB regarding risk and knowledge were positive in

353   all cases, people exhibiting OB (control) were found not to be more or less likely than the sample

354   average to spot any of the hazards.

355   These effects of individual-level characteristics can be summarised for the individual hazards.

356   Hence identifying the washing of chicken (cc-chicken) as a hazard was less likely among vegetarians

357 (veggie), but more likely for those believing they had more knowledge or lower risk than the average

358 person (obknow, obrisk). Similarly, the use of raw marinade as a salad dressing (cc-marinade) was

359 more likely to be identified by those under 60 (young, adult), those with children in the household

360 (child) and those believing they had more knowledge or were at lower risk than the average person

361 (obknow, obrisk).

362

5. Discussion

364 This study was initiated to assess the awareness of hazardous food behaviours in the domestic

365 kitchen. In the process of doing so a novel method of eliciting hazard awareness was conceptualised,

366 developed and applied. The method developed was rooted in Situation Awareness.

367 The aim was to design a simple, intuitive and engaging testing tool. Whilst we do not have user

368 experience ratings to compare with an equivalent, standard format survey, the speed with which the

369 survey spread from initial seed emails and the number of completions amassed suggests a positive

370 user experience. More direct evidence is available from the comments respondents left which were

371 unanimously positive and which in many cases made unprompted, positive, comparisons with more

372 typical standard formats. These responses suggest the method exhibits good face validity.

373 Some findings resonate with other research. For example washing raw chicken was not identified

374 as a hazard by 38% of the sample, a rate similar to the 41% who report always washing poultry in the

375 FSA's 'Food and You' (F&Y) survey (FSA, 2014). The fridge temperature of 8.9°C was identified as a

376 hazard by 57% of the film1 sample, a rate which corresponds to the 53% of respondents in waves 2

377 and 3 of the F&Y survey which correctly identified the correct temperature range (0 - 5 °C). However

378 the inferences that can be drawn from these results are questioned by the finding that 48% of the

379 film2 sample identified the safe temperature of 4.7°C as a hazard. This highlights the need to

380 understand the impact upon respondent behaviour of the means by which knowledge is elicited,

381   whether it be visual (this study) or the use of interval response options (F&Y survey). Just as a fridge

382   temperature being displayed was probably taken as a 'clue' by some respondents, the correct

383   temperature range presented in the F&Y survey adjacent to the categories of below 0°C, and 5-8°C

384   may well have prompted an overestimate of knowledge of correct temperatures.

385   Individuals claiming to have food safety qualifications or knowledge (qual) were found to be

386   more likely to identify 3 of the 8 hazards. The characteristic that was positively correlated with

387   identification of the highest number of hazards was the belief that one had more knowledge of food

388   safety at home than the average person (obknow). People believing this to be the case were more

389   likely to spot 5 of the 8 hazards. These 2 effects were, together, significant across all 8 of the hazards,

390   but never together; suggesting that the personal assessment of knowledge was a more powerful

391   predictor than a person having been through training *per se*. The results do pose a question as to

392   whether the assessment of people believing they know more than the average person really is a bias

393   – the results in this study suggest that, on average, these people do indeed know more about food

394   safety at home (premised on the belief that the scores generated by the survey are a robust measure

395   of food safety knowledge). Believing one had more control over the food poisoning risk at home was

396   not positively correlated with spotting any of the hazards.

397   Those exhibiting OB in knowledge were also found to score higher in aggregate within the test

398   (by 11%). This effect was however far less strong than that associated with age: being aged 18-29 or

399   30-59 meant increases in the HIS of approximately 20% and 30% respectively. While older age groups

400   have been found previously to be more likely to deviate from recommended food safety practices in

401   the home (for example in F&Y reports), younger age groups have been found to have the same

402   tendency. The results from the Poisson and logit models here are contrary to this: the 18-29 group

403   effects were positive and typically stronger than the 30-59 effects.

404   Respondents' self-reported levels of knowledge and whether they have specialist training or

405   experience being positively correlated with higher probabilities of identifying many of the hazards,

406   suggest the approach exhibits convergent validity. Further support for the validity of the approach

407   can be drawn from past validity investigations of Situation Analysis methods (see Section 1) most

408   commonly involving driver behaviour. The reliability of the Watch-&-Click Hazard Testing Tool is

409   further investigated by testing the internal consistency for each film - Film 1 (Cronbach's alpha = .82),

410   film 2 (Cronbach's alpha = .74). These levels compare well with reported consistencies in hazard

411   perception tests for example 0.83 and 0.84 (Bruce, Unsworth, Tay, & Dillon, 2015) and 0.72

412   (McGowan & Banbury, 2004). Horswill and McKenna (2004) highlights that the psychometric

413   reliability of hazard perception test is variable with the number of hazards and the definition of

414   hazard limiting internal consistency – the lower number of hazards may explain the lower reported

415   alpha for film 2.

6. Conclusions

417   Food behaviours in the home are difficult to observe and unlike the commercial food sector

418   there is no training required or inspection programme in operation. Poor practices in storing and

419   preparing food in the home cause significant health and economic damages. Whilst interventions

420   along the food chain can reduce public exposure to food pathogens, behaviour in the home can still

421   be a major factor in generating cases of foodborne illness. In the case of *Campylobacter* which is

422   strongly associated with the consumption of chicken, FSA targets for the poultry sector set in 2010

423   were missed in 2013 and are likely to be missed again in 2015. Since *Campylobacter* contamination of

424   birds is declining little if at all, then there is still a considerable public health burden falling upon the

425   consumer. Understanding, and potentially improving, people's food safety knowledge in the home

426   offers potential to reduce the disease burden.

427   The Watch-&-Click Hazard Testing Tool developed and applied here, rooted in Situation

428   Awareness, attempts to provide participants with an environment that is not too different to that of

429   a normal domestic kitchen. Participants complete the study online and anonymously, potentially

430   reducing observer bias. The use of real-time responses creates a time pressure thereby discouraging

431 users to over-deliberate instead utilising fast, automatic, associative processes. By limiting the

432 amount of time that an individual has to consider the hazards, it is hoped that this in turn allows less

433 time for the respondent to consider what they should 'do' and increases the likelihood they will

434 respond in accordance with their own routine behaviours.

435 Further work could be undertaken to make formal comparisons of how the click response data

436 correlate with more traditionally elicited survey responses. A more challenging task will be to test

437 the hazard awareness scores against real practices in the home. The approach has potential to be

438 applied in other contexts, indeed some respondents contacted the authors to enquire whether the

439 approach could be applied to non-food settings in which they worked or trained. Further work is

440 underway to refine the statistical analysis of participants' click response data to account for variation

441 in the number of times they click. This seeks to capture the possibly differing levels of information

442 contained within a click from a heavy clicker as opposed to a sparse one.

443 The Watch-&-Click Hazard Testing Tool has since late 2014 been trialled with pupils in UK

444 secondary schools. The positive user experience identified in this paper has been replicated, with

445 both teachers and pupils extolling its virtues in terms of accessibility and engagement. This resonates

446 with the rapid recruitment rates and positive feedback from participants and food industry and food

447 safety stakeholders in this study. This suggests that the Watch-&-Click tool can be a positive addition

448 to the range of existing methods for eliciting and improving food safety awareness.

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