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## **Do closed survey questions over-estimate public perceptions of food risks?**

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## ABSTRACT

In this paper we show that the widely accepted methodology for the assessment of risk perception – Likert type survey questions featuring a set of risks with fixed response alternatives measuring the extent of worry or concern – may over-estimate food risk perception. Using a European representative sample survey (n=26,961) that included an open-ended question asking about problems and risks with food and eating, followed by a battery of closed questions assessing food risk perception we find a similar ranking of perceived food risks across the two methods. Across Europe the five priority concerns are chronic food related illness; food origins and quality; acute food related illness; chemical contamination, and adulteration of food. However, the discrepancies between mentioning a risk in the open ended question and the expression of worry about risks in the closed question are substantial. Of those who did not mention a specific risk category in the open question, between 60% and 83% (depending on risk category) expressed worry in the closed question. This parallels previous research on the fear of crime, showing that survey responses lead to greatly inflated estimates of the public's fear of crime than is evidenced by qualitative questioning. It is also consistent with evidence from research on cognitive aspects of survey methodology suggesting that survey questions may frame the respondent's thinking about an issue. We conclude with recommendations for the use of branched questions in the quantitative elicitation of public perceptions of risk.

**Keywords:** Risk perception; food risks; survey methods and measurement; open-ended questions

### Key messages

1. Likert type survey questions may over-estimate the extent of worry about risks
2. Survey questions are not neutral, they may frame respondents perception of risks
3. European's main worries about food include risks to health, food quality and chemical contamination.
4. Branched question formats are recommended for the assessment of risk perception

## INTRODUCTION

For risk managers, policy makers, organizations, politicians and social scientists what the public think about personal and societal risks associated with new and old technologies, health related behaviours, the impacts of climate change, exposure to crime, and food safety etc. is a relevant input to risk management (Renn 1998; Slovic 2000), to the design of risk communications (Kasperson 2014; Lofstede 2015) and to theorizing about risk perception (Boholm 1998). In this context it is vital that the measurement of the public's perception of risk is reliable and valid.

The psychometric paradigm (Slovic, Fischhoff and Lichtenstein, 1982) initiated the measurement of risk perception and has become a standard methodology. Respondents are asked to assess a number of potential risks on a five or seven point scale of worry or concern. Research findings in the psychometric paradigm show that public perceptions of risk are systematically influenced by characteristics of the risk. Across a range of risks, those that are involuntary, unfamiliar and with unknown consequences are perceived as more worrying by respondents, often at variance with expert assessments (Fischhoff et al, 1978). Furthermore, while some risks are tolerated, others inspire dread – a finding that contributed to the affective heuristic (Finucane et al. 2000). The affective heuristic is taken to be a pragmatic shortcut to conscious cognitive elaboration, providing an instant, sub-conscious assessment of a risk without the need for further cognitive effort.

Conceptually, we may distinguish between three aspects of risk perception:

- 1) Awareness of a particular risk
- 2) Affective responses to risk – whether the risk is viewed positively or negatively
- 3) Cognitive elaboration of the risk – the extent of worry or concern.

Awareness of a risk is clearly a precondition for an assessment of risk perception along the lines of either (2) or (3) above. However, the issue of risk awareness is not relevant to the psychometric paradigm as the risks are specified in the questions posed to respondents, resulting in what may be termed *prompted awareness*. In terms of the measurement of risk perception, the advantages of the typical closed question are that (i) all respondents are asked the same question and offered the same set of response alternatives, potentially eliminating interviewer bias, (ii) it is economical to administer, and (iii) the response alternatives are

directly comparable and can be directly converted into a numerical scale for descriptive and inferential statistical analysis.

Measuring *unprompted awareness* of risk requires a different methodological approach, for example the use of open-ended questions. While an open-ended question gives the respondent freedom to express their views in their own words, it is problematic for a number of reasons: (i) such a question gives considerable freedom to the interviewer in terms of the extent of probing, verbal and non-verbal reinforcement and the accuracy of noting down the verbatim responses, (ii) open questions are costly to administer and (iii) the responses are time consuming to analyse whether by standard coding methods or by computer assisted qualitative data packages.

A comparison of the strengths and weaknesses of the two methods indicates why the majority of risk researchers opt for closed format questions. Yet, the convenience of closed questions may introduce biases due to the framing the phenomenon (Gaskell, Wright and, O'Muircheartaigh 1995). Survey questions are not only a request for information from the respondent, but also provide information to the respondent (Schwarz 1995; 2007). Respondents generally assume that the questions are relevant and are about real issues. So for example, when people were asked about the proposed legislation on the Metallic Metals Act, around 70% expressed a view (Schuman and Presser 1996). While they could not have heard about this fictitious legislation, respondents must have assumed it existed, as it was mentioned in the survey. In this way the survey questions define 'reality'. In the case of food risks, closed questions circumscribe what are the relevant risks and the criterion on which the respondent should evaluate them. But does asking a question about a risk in part create the phenomenon of risk perception? How might this happen? Theorizing on the concept of the attitude has challenged the assumption that respondents treat each question as an independent stimulus that evokes a response drawn from pre-existing memory structures. The attitude is now conceptualized as an 'on-line' construction. In other words the survey respondent does not necessarily retrieve from memory an already existing attitude or opinion, but actively constructs a response to the question in the moment - 'on-line' (Zaller and Feldman 1992). The construction of the response may be affected by preceding questions (priming and context effects) and errors of omission and commission (memory effects).

Now, if it is accepted that responses are sometimes generated on-line, then is it possible that the mere fact of asking for a view on a risk acts as a prime, creating awareness as in 1) above. It may suggest to respondents that a particular risk, about which they had not been aware previously, is out there, or by making the risk more accessible in people's minds the perception of the risk might be magnified. In aggregate, across respondents and risks this could well lead to exaggerated assessments of perceptions of risk.

In a review of research on fear of crime victimisation, a form of risk perception, Farrall et al. (1997) note that empirical research in this field is almost exclusively based on quantitative social surveys. One exception is a study by Yin (1982) who found that while a Harris opinion poll showed that 23 per cent of elderly respondents reported concern about crime in a closed question, only 1 per cent of a comparable elderly population considered crime to be a personal problem when asked in an open question. To explore this further, Farrall et al. conducted face-to-face, semi-structured, interviews with 64 survey respondents about answers they had previously given to closed-format survey items measuring fear of crime. They found that in the majority of cases there was a mismatch between the levels of worry reported in the survey question and the interviewees' description of what they worried about. The mismatches showed a systematic trend to the over-reporting of fear of crime in the survey. They conclude that closed survey questions significantly over-estimate fear of crime. Might the same bias be found in other risk domains?

Against this background, using data from a survey on food risks administered to a representative sample of Europeans, we investigate the following research questions:

Research question 1: What are the relations between unprompted mentioning of food-related risks; awareness, measured by the open-ended question, and expressed worry about prompted food risks as measured by a closed question?

Research question 2: Are there differences in the factors that influence responses to the open question and the closed question with regard to the same risk category?

In addressing these two questions we examine the implications of these findings for the measurement of risk perception – in particular, whether closed questions might lead to an overestimation of ‘actual’ levels of concern as found by Farrell et al. (1997).

## METHODS

### Data

We use data from the Special Eurobarometer 345 Food-related risk public opinion survey commissioned by the European Food Safety Authority. The sample of 26,961 respondents covers 27 European member states, and is representative of the population aged 16 and over in each of these countries. About 1,000 respondents were interviewed in each country. Face-to-face interviews were held by trained interviewers in the respondent’s home. The fieldwork was carried out by the market research company ‘TNS Opinion & Social network’ and took place in June 2010 (TNS 2010).

In our analyses, we use the full sample to maximize variation on the variables of interest, in particular variation on the open question where non-response is 8 per cent, somewhat higher than the average of closed questions at 5 per cent. The findings presented in this article thus pertain to the European Member States. We statistically control for differences between countries in the analysis; however cross-national comparisons are not the subject of this article.

### Variables

The two key dependent variables of interest are measures of perceptions of food-related risks, elicited with an open and subsequently a closed-format survey question.

#### *Food-related risks: Open question*

Responses to the following question were recorded verbatim and then coded based on the coding frame shown in Table 1: “Could you tell me in your own words, what are all the things that come to your mind when thinking about possible problems and risks associated with food and eating? Just say out loud whatever comes to mind and I will write it down.”

Responses were recorded verbatim.

#### *Food related risks: Closed question*

Respondents were asked to rate the extent to which they worry about seventeen food-related risk items on a four point scale ranging from 1 “not at all worried” to 4 “very worried”. The risks were chosen by scientific and communication experts at the European Food Safety



Authority. The majority of the risks involve human health and safety issues, others were chosen as they had been found to be of concern to the public regardless of any scientific basis e.g. GMOs.

The seventeen items were: the mad cow disease, genetically modified organisms found in food or drinks, having an allergic reaction to food or drinks, additives like colours, preservatives or flavourings used in food or drinks, food poisoning from bacteria like salmonella in eggs or listeria in cheese, pesticide residues in fruit, vegetables or cereals, residues like antibiotics or hormones in meat, pollutants like mercury in fish and dioxins in pork, substances contained in plastics or other materials coming into contact with food, not having a healthy and balanced diet, getting a diet-related disease such as diabetes, heart or liver problems, putting on weight, new viruses found in animals like avian or bird flu, cloning animals for food products, the welfare of farmed animals, the quality and freshness of food, and nano-particles found in food. Each response was recoded into whether respondents worried (1) or did not worry (0) about a specific risk.

To facilitate comparability between the open and closed questions, responses to both questions were classified into one of seven standard food risk categories (See Table I).

- Table 1 about here -

To explore the correlates of food risk perception a number of other questions in the survey serve as explanatory variables: Generalized risk sensitivity, trust in food safety authorities, self-efficacy, engagement with food, and media exposure. We also control for socio-demographic variables. We estimate a separate one-factor model for each of the key explanatory variables and derive factor scores using the Bartlett method of regression. For ease of interpretation, factor scores are rescaled to values ranging from 0 to 10. The explanatory variables are described in detail below.

#### *Generalized Risk Sensitivity:*

[Reference blinded for peer review] found that at both individual and national levels concern about a range of risks to the person is a strong predictor of food risk perception. As such it

might be argued that for some people food risk perception is merely part of a generalized syndrome of risk sensitivity.

Respondents were asked to rate how likely they thought it was that each of the following risks would happen to them personally (on a four-point scale ranging from 1 = not very likely to 4 = very likely): (1) being a victim of crime, (2) the economic crisis negatively affecting your life, (3) being injured in a car accident and (4) getting a serious illness. Exploratory factor analysis found one factor explaining 54.50% of the variance of all variables ( $\alpha=0.72$ ). The responses were combined into a factor score.

#### *Trust in EU authorities:*

Trust is always associated with unpredictability and with the perception of risk. If the outcome of a decision is predictable then there would be no need for trust. With trust the future can be contemplated without, or at least with less, anxiety (Luhmann 1979). We expect trust to be inversely correlated with risk perception (Earle 2010).

Trust in EU authorities was measured asking respondents the extent to which they trusted public authorities in the European Union are doing enough to protect the public from the possible risks from the following five items (on a four-point scale ranging from 1 = 'no, certainly not' to 4 = 'yes, definitely'): (1) chemical contamination of foods, for example pesticide residues or environmental pollutants like mercury in fish, (2) from bacterial contamination of foods, for example salmonella in eggs, (3) to health from your diet, for example high fat intakes and heart disease, (4) from new technologies such as animal cloning and nanotechnology, and (5) from animal infections or diseases which could be transmitted to humans such as mad cow disease. Exploratory factor analysis produced one factor explaining 67.59% of the variance of these four variables ( $\alpha=0.88$ ).

#### *Self-efficacy:*

Self-efficacy, in the context of food risks, refers to a person's belief in their own ability to avoid or minimize harm from food risks. Self-efficacy as a social psychological concept has been applied in a variety of contexts (Bandura 1991). In the context of food, eating and health behaviours, greater self-efficacy has been shown to be associated with lower food risk perceptions (Gordon, 2003; AbuSabha and Achterberg, 1997)

In the survey, respondents were asked to rate the extent to which they believed they themselves could take steps to protect themselves from the following possible risks (on a four-point scale ranging from 1 = not at all confident to 4 = very confident): (1) chemical contamination of foods, for example pesticide residues or environmental pollutants like mercury in fish, (2) from bacterial contamination of foods, for example salmonella in eggs, (3) to health from your diet, for example high fat intakes and heart disease, (4) from new technologies such as animal cloning and nanotechnology, and (5) and from animal infections or diseases which could be transmitted to humans such as mad cow disease. Exploratory factor analysis estimation produced one factor explaining 57.97% of the variance of these variables ( $\alpha=0.81$ ). Again, responses to the survey items are combined into a factor score.

#### *Engagement with food:*

Fischler argues that the modern eater is an increasingly anxious consumer, torn between the appeal of cheap, convenient and palatable processed food, and the repulsion of factory farming and pesticides, new ingredients and processes and additives to replace natural ingredients (Fischler 2011). With the decline of tradition and culture we see the emergence of individual choice, he argues; for some desirable, for others the cause of anxiety, bewilderment and the state of ‘gastro-anomie’. Individuals are often at a loss as to how to make choices in the general nutritional cacophony of prescriptions and proscriptions about food. All in all, in our modern times food and eating are as likely to be seen by some as a source of stress rather than pleasure.

Respondents were asked to what extent they associated food and eating to the following three items (on a four-point scale ranging from 1=not at all to 4=to a large extent): satisfying hunger (1), enjoying a meal with friends or family (2), selecting fresh and tasty foods (3). Exploratory factor analysis using maximum likelihood estimation produced one factor explaining 51.78% of the variance of all three variables ( $\alpha=0.52$ ). The responses are combined into a factor score using the method described above.

#### *Media exposure:*

The media has been argued to work as an “amplification station”. The media often covers risk events that are rare or dramatic in disproportionate ways (Kasperson et al. 1988) and therefore might be relevant in increasing people’s concerns about different types of risks.

However, other authors have highlighted a lack of conclusive evidence on the role of the media on risk perception (Boholm 1998; Wahlberg and Sjöberg 2000). We therefore control for media exposure and evaluate its effect on food risk perceptions.

Respondents were asked the following question: “Please tell me when was the last time you read in the press, saw on the Internet or television, or heard on the radio, that food may be unsafe, for example due to a chemical found in it” (1 “within the last seven days”, 2 “within the past month”, 3 “within the past six month”, 4 “longer than six month ago”, and 5 “never”). Responses were recoded into two categories: 0=longer than six month ago and 1=six month or less.

In addition, the socio-demographic variables age, gender and educational attainment are included in the analyses.

## RESULTS

The first aim of this study is to compare respondents’ mentioning of food related risks in the open question (OQ) – unprompted awareness, with their expressed worry about food risks in the closed question (CQ) - worry. Table 2 shows the percentage of respondents in the sample that mentioned each specific risk category in the OQ and CQ.

- Table 2 about here -

A first and important observation is that there are similarities in the rank order in which the risk categories appear. Both the open and the closed questions identify *chronic food related illness, food origins and quality, chemical contamination* and *adulteration* of food as the European public’s top five food-related risk concerns. Similarly, *new viruses* is one of the least mentioned concerns in both rankings.

However, secondly there are also striking discrepancies between unprompted awareness and the extent of worry. While 82% of respondents reported worrying about *gene technologies* when asked in the CQ (ranked third), only 8% did so in the OQ (ranked sixth). Similarly, while *acute food related illness* was ranked third in the OQ (17%) it was only ranked sixth in the CQ (64%). And, while no one mentioned *animal welfare* in the OQ, 63% reported worrying about it in the CQ.

A third observation is that the spontaneous mentions are far lower in percentage terms than the expressed level of worry in CQ: while eight of the risk categories were mentioned by between 3% and 29% of respondents in the OQ, between 61% and 85% of respondents reported worrying to some extent for the different risk categories when prompted to evaluate them.

Finally, in the OQ, 15% of the respondents said that they did not feel that there were any problems and risks associated with food. In the CQ, this attitude would be reflected by responding ‘not at all worried’ or ‘not worried’ to all of the risk categories. Only 4% of the respondents showed this response pattern.

Next, we turn to the question of the extent to which responses to the OQ and CQ are consistent. To do so, we profile respondents on the basis of their responses to the open-ended question eliciting unprompted awareness (OQ) and closed questions, eliciting the extent of worry (CQ).

Figure 1 shows a decision tree that illustrates how responses can be seen as consistent or inconsistent. Thus respondents who mention a risk in the OQ and then express worry in the CQ, and also those who do not mention a risk in the OQ and subsequently say they are not worried in the CQ can be seen as consistent. But mentioning a risk in the OQ followed by saying not worried in the CQ, and not mentioning a risk in the OQ but then saying they are worried in the CQ can be characterized as inconsistent.

- Figure 1 about here -

Table 3 shows the percentage of inconsistent responses to the open and closed questions and shows the conditional probabilities of the four response patterns.

- Table 3 about here -

Table 3 shows that when people mention a risk in the OQ, there is a high probability that they will say they worry about it in the CQ. This is particularly the case for *chemical contamination* and *gene technology*, where an OQ mention leads to reported worry in 96%

and 97% of cases, respectively. By contrast, only about three quarters of respondents who mention *acute illness* and *food origins and quality* go on to say that these risks worry them.

The picture is markedly different for those who did not mention a risk in the OQ : between 60% and 83% of respondents reported worrying about different risks in the CQ even though they had not mentioned it in the OQ. Overall the percentage of inconsistent, mismatched responses is high – from 55% for *acute illnesses* to 75% for *gene technology*. For all the risk categories, those people who did not mention them in the OQ are still more likely to say they are worried in the CQ than to say they are not worried. Overall, the inconsistencies show a systematic pattern of mismatches. Respondents who did not mention a particular risk in the open ended question subsequently recorded worrying about the risk when prompted by the closed question. Taking *chemical contamination* as an example, 69% of the 70% mismatches stem from respondents not mentioning it in the OQ but saying they are worried/very worried about it in the CQ. As a result, worry expressed in the CQ is higher than that expressed in the open question (see Table 1).

This finding points to an important conclusion about the nature of unprompted awareness. Between 76%-97% of respondents who mention a particular risk category in the open question say they are worried about this particular risk in the closed question. This suggests that for most respondents, unprompted awareness is concerned awareness. Does this finding imply that the open and closed questions are tapping into the same underlying mental model of risk?

This leads on to the second research question: What factors are related to awareness and expressed concern? If the open and closed questions measure the same underlying construct, we would expect them to have the same antecedents. To address this question, we used a multilevel multinomial logistic regression model (using the Gllamm Package in Stata 13) to predict the four possible response combinations to the open and closed question, i.e. not mention/not worried; mentioned/not worried; not mentioned/worried, and mentioned/worried. To reduce complexity, we present this analysis for one risk category only and chose *food origins and quality* because it has the highest marginal percentage of inconsistent responses. The multilevel model allows for the inclusion of country-level random intercepts to control

for the possible clustering of data by country<sup>1</sup>. Furthermore, multinomial logistic regression predicts an unordered nominal response variable in terms of a number of covariates. In multinomial logistic regression one of the categories of the response variable is used as a reference category against which the other categories are compared. In this case, we predict the odds of ‘neither mentioned nor worried’, ‘mentioned but not worried’ and ‘mentioned and worried’ about ‘*food origins and quality*’ in comparison to the consistently unworried (‘neither mentioned nor worried’, the reference category).

We consider the following explanatory variables: age, gender, educational attainment, generalised risk sensitivity, trust, self-efficacy, food engagement and media exposure. The explanatory variables predict the odds of showing one of the other three response combinations against the reference category. For example, Table 4 shows that being female rather than male significantly increases the odds of being in the category ‘mentioning and worrying’ about *food origins and quality* rather than not mentioning and not worrying about this risk. Specifically, the odds of women are 1.23 times the odds of men, or 23% higher ( $p < 0.01$ ). Similarly, the odds of ‘not mentioning but worrying’ about this risk are 1.29 for women compared to men, or 29% higher ( $p < 0.01$ ). There is no statistically significant difference between men and women in the odds of mentioning a particular risk, meaning that females are no more likely than males to mention a risk, but they are significantly more likely to worry about the risk.

-Table 4 about here -

Beyond the significant difference in worrying about the risk of *food origins and quality* between men and women, socio-economic do little to predict the other response combinations. While statistically significant, the effect of age on the odds of mentioning risks and problems associated with *food origins and quality* are very small in size, and there is no statistically significant effect of education.

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<sup>1</sup> We first run a variance component model and observed an intraclass correlation of 0.13, showing that a reasonable amount of variance is accounted by the country level. We thus decided to run a multinomial random intercept model to predict mentioning and worrying about food risks rather than a regular multinomial model.

By contrast, the odds of worrying about the *food origins and quality* are higher for respondents with higher levels of food engagement and generalized risk sensitivity. For every one-unit increase in food engagement (on a scale from 0 to 10) the odds of not mentioning but worrying increases by 14% and the odds of mentioning and worrying increases by 21% ( $p < 0.01$ ). Similarly, for every one-unit increase in generalized risk sensitivity (on a scale from 0 to 10) the odds of not mentioning but worrying increased in 23% and the odds of mentioning and worrying increase by 18%. Media exposure to food risks during the last 6 months increases the odds of mentioning *food origins and quality*. In particular, respondents who were exposed to media were 40% more likely to mention and worry about this particular risk.

Finally, trust in EU authorities with regard to food safety and self-efficacy reduce the likelihood of worrying. For every one-unit increase in trust (on a scale from 0 to 10) respondents were 4% less likely to worry without mentioning a risk, and 6% less likely to worry and mention a risk. Similarly, for every one-unit increase in self efficacy (on a scale from 0 to 10) respondents were 5% less likely to not mention and worry and 7% less likely to mention and worry about a particular risk.

To summarise, the odds of mentioning *food origins and quality* in the open question are significantly higher for respondents who are older, display greater engagement with food, have lower generalised risk sensitivity and higher trust in EU authorities. In turn, the odds of worrying about *food origins and quality* are significantly higher for respondents who are female, have greater engagement with food, high risk sensitivity, low trust in EU authorities, low self-efficacy and who have been exposed to food risks in the media within the past six months.

## DISCUSSION

In this paper we compare food risk perception as elicited with qualitative and quantitative formats – an open ended question and the typical Likert type closed question respectively. Across the two response formats respondents are relatively consistent in the rank ordering of the food risks. The more significant concerns are chronic food related illness, food origins and quality, acute food related illness, chemical contamination, and adulteration of food. This



finding suggests that the two question formats are drawing on the same underlying mental model of food risks. A further indication of functional equivalence between the open and closed question is the finding that 76%-97% of respondent who mention a particular risk category in the open question also say they worry about it in the closed question. This suggests that the open question is tapping into concerned awareness. It is notable that the risk categories for which the inconsistencies are lowest are those risk categories which might be expected to be widely shared general knowledge: *acute food related illnesses* (e.g. stomach upsets, diarrhoea) and *food origins and quality* (e.g. lack of freshness and expired 'use by' dates of food items). Inconsistency was highest for *gene and new technologies* and *chemical contamination* (e.g. residues, pesticides),

However, the discrepancies in percentages of the public mentioning a risk in the open question and registering worry about it in the closed question format are substantial. Of those who did not mention a particular risk in the open question, the majority (60%-83%) say they worry about it once prompted in the closed question. Mismatches in the opposite direction, mentioning a particular risk in the open question but saying it is not a worry in the closed question, are rare. As a result, the closed question leads to significantly higher estimated levels of public concern about food related risk in this population-representative sample. For example, while only 29% of respondents mention *chronic food related illnesses* in the open question, 84% express worry about it in the closed question. Overall, while between 0% and 29% of respondents mention the different risk categories in the open ended question, when answering the closed questions between 61% and 85% report worrying about it to some degree.

If the closed question results are to be believed, this representative survey suggests that circa 306 - 428 million Europeans are anxious about what they buy and eat. We consider that this number is likely to be an artefact of the survey context leading to an over-estimate of the extent of concern about food risk. Farrall et al. (1997) and Yin's (1980) studies of public fear of crime concluded that closed question survey formats inflate estimates of public fear of crime. Our study of public perception of food risks mirrors these findings. What, however, if the discrepancy is not a survey artefact, but the two questions in fact measure two distinct constructs?

Our findings suggest that the closed and open question measure largely similar, however perhaps not identical constructs. While the rank order of public concern about the seven food risk categories is similar, and few of those who did mention a particular risk in the open question did not proceed to say they are worried about it (i.e. were merely knowledgeable or aware of the risk, but not personally worried about it), the multinomial logistic regression analysis suggest some small, but statistically significant, differences in the antecedents of responses to the open and closed question. While a higher generalized risk sensitivity increases the odds of worrying also about food-related risks, it reduces the odds of unprompted awareness. While greater trust in EU authorities is associated with lower worry about food related risks, it increases the odds of unprompted awareness of risks. Other factors such as gender, self-efficacy and media exposure only have a significant effect on worry about food-related risks, but do not significantly alter the odds of unprompted awareness.

A possible interpretation is that the open and closed questions elicit responses that capture overlapping but not identical conceptions of risk. The open question seems to be measuring awareness of a risk and for the majority of respondents this appears to be concerned awareness as they go on to express worry about these risks in the subsequent closed question. The closed questions, which prompt the respondent to consider a particular risk, may be measuring affective responses and/or the cognitive elaboration of the risk.

Asked in the open question what comes to mind about problems and risks with food and eating, respondents draw on what they have heard or seen in the media; recollections past of food scares e.g. mad cow disease, and personal/family experiences. In this way awareness might almost be general knowledge with some local personal colour.

When asked about a particular risk in the closed question format we speculate that one of two processes occurs. First, is the framing effect. If the respondent had not heard about the risk, the fact that it is included in the survey questions gives it a reality. Why otherwise would they be asked about it? And if it sounds unpleasant, respondents register their concern. "I may not have come across X, but now you mention it, it is clearly something to worry about". The second effect is accessibility. For respondents who have prior awareness of the risk, that it appears in a battery of risk items increases the accessibility and salience of the risk and with comes a more extreme response.

Since, for a variety of understandable reasons closed questions are likely to remain the prevalent method for assessing risk perception, increasing the reliability and validity of measurement would be beneficial. One possible approach is advocated by Krosnick and Berent (1993). They show that branched questions - involving a two-step process in which respondents are first asked to report the direction of their attitudes (e.g. positive, negative or neutral) and then to report the strength of this attitude (e.g. strongly or weakly)- provided more reliable measures of party identification and political attitudes than unbranched questions.

Measuring the public's fear of crime is another example. Compared to the standard question "How worried are you about being the victim of a crime?" a branched question shows that this conventional closed survey questions overestimate the public's fear of crime. Branching questions provide a more accurate measure. Here, respondents were first asked whether they had worried about being the victim of a crime in the last year. For those who said 'yes' a follow up question asked "on the last occasion how fearful did your feel?" (Gray, Jackson and Farrall 2008).

In conclusion, we recommend using questions that combine the measurement of awareness and concerns about food risks by asking respondents whether they have thought about a specific risk during (a specified target window or since a particular date) and then ask those who respond affirmatively the extent to which they have worried. This, we suggest, may provide policy makers and practitioners concerned with public perceptions of risk with a more accurate measurement of the nature and extent of public worry about food-related and other risks.

#### Declaration of interests

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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Table 1 Coding frame for open and closed questions.

Category	Open question	Closed question
<i>Chemical contamination</i>	Chemical products, pesticides, toxic substances	Pesticide residues in fruit, vegetables or cereals; Residues like antibiotics or hormones in meat; Pollutants like mercury in fish and dioxins in pork; Substances contained in plastics or other materials coming into contact with food
<i>Adulteration of food</i>	Additives, colouring, preservatives; Food is not natural industrial artificial	Additives like colours, preservatives or flavourings used in food or drinks
<i>Acute food related illness</i>	Food poisoning, bacteria; Digestive problems and discomforts	Food poisoning from bacteria like salmonella in eggs or listeria in cheese
<i>Chronic food related illness</i>	Obesity, overweight; Diet too high in fat, sugar or calories Unbalanced diet; Allergies; Mad cow disease; Diet-related diseases; Anorexia Bulimia; cancer	Mad cow disease; Having an allergic reaction to food or drinks; Not having a healthy and balanced diet; Getting a diet-related disease such as diabetes, heart or liver problems; Putting on weight
<i>Food origins and quality</i>	Lack of freshness, expiry dates; We do not know what we are eating; traceability; Poor food quality; Lack of sanitary controls, hygiene	The quality and freshness of food
<i>Gene and new technologies</i>	GMOs; New technologies (e.g. animal cloning, nanotechnology)	Genetically modified organisms found in food or drinks; Cloning animals for food products; Nano-particles found in food
<i>New viruses</i>	New viruses	New viruses found in animals like avian or bird flu
<i>Animal welfare</i>	Animal welfare issues	The welfare of farmed animals

Table 2. Percentage of respondents mentioning or expressing worry about food-related risks in open and closed questions (multiple response allowed).

	Open question % mentioned	Closed question % worried
Chronic food related illness	29%	84%
Food origins and quality	21%	70%
Acute food related illness	17%	64%
Chemical contamination	17%	85%
Adulteration of food	16%	70%
No problem	15%	4%
Gene and new technologies	8%	82%
New viruses	3%	61%
Animal Welfare	0%	63%

Figure 1. Consistent and inconsistent response patterns.

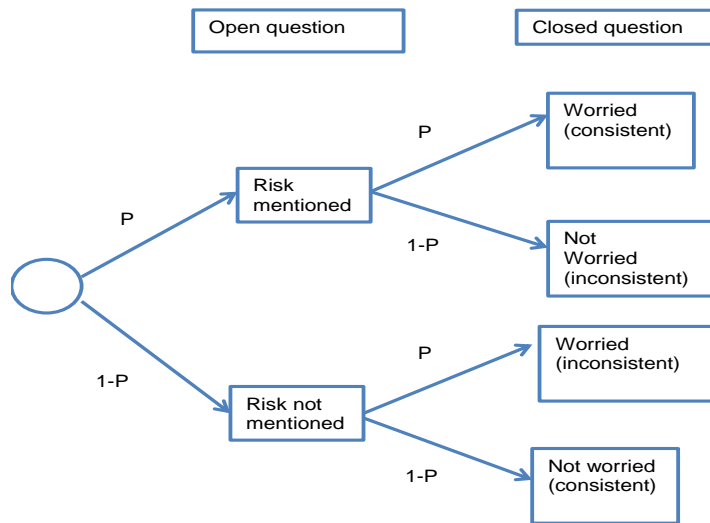




Table 3. Profiling open and closed questions response combinations.

	Conditional % (base: not mentioned and mentioned, respectively)				Mismatched responses (base: total responses)		
	Not mentioned		Mentioned		Mentioned/ not worried	Not mentioned /worried	Total
	Not worried	Worried	Not worried	Worried			
Chemical contamination	17%	83%	4%	96%	1%	69%	70%
Adulteration of food	34%	66%	11%	89%	2%	56%	58%
Acute food related illness	38%	62%	24%	76%	4%	51%	55%
Chronic food related illness	17%	83%	12%	88%	4%	59%	63%
Food origins and quality	31%	69%	23%	77%	5%	54%	59%
Gene and new technologies	19%	81%	3%	97%	0%	75%	75%
New viruses	40%	60%	20%	80%	1%	59%	60%

Table 4. Multinomial logistic regression predicting combinations of mentioning and worrying about different risks.

	Mentioned but not worried	Not mentioned but worried	Mentioned and worried
Female	0.90	1.29 **	1.23 **
Age	1.01 **	1.00	1.00
Education (ref: no education)			
15 years or under	4.09	0.98	0.80
16-19 years	4.77	0.90	0.89
20 years plus	5.13	0.85	0.76
Still studying	4.91	0.82	0.77
Food engagement	1.04 *	1.14 **	1.21 **
Generalized risk sensitivity	0.93 **	1.23 **	1.18 **
Trust in EU authorities	1.04 *	0.96 **	0.94 **
Self efficacy	0.98	0.95 **	0.93 **
Media exposure	1.13	1.22 **	1.40 **

Note. Reference category: not mentioned and not worried. Odds ratios are shown. Intraclass correlation of variance component model: 0.13; Intraclass correlation of random intercept model: 0.11

\*  $p < 0.05$ , \*\*  $p < 0.01$