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Uncertainty analysis: results from an empirical pilot study. A research note

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The European Food Safety Authority (EFSA) has long been an advocate of greater transparency. One of the tools promoted to achieve more transparency is to describe the underlying uncertainties within EFSA's scientific opinions. The key issue though is whether members of the European public actually want to know more about the details of the scientific uncertainties associated with a certain risk topic or a scientific opinion or would they prefer to know less about these uncertainties? In this short research note we attempt to address this question.

Keywords: uncertainty analysis; EFSA; transparency

1. Introduction

The European Food Safety Authority (EFSA) has long been an advocate of greater transparency (EFSA 2014; Way and Lofstedt 2015). One of the tools promoted to help achieve more transparency is to describe the underlying uncertainties within EFSA's scientific opinions (EFSA 2015, 2016; Van Asselt, Vos, and Rooijackers 2009). In the summer of 2015, the Agency put forward its *Guidance on Uncertainty in EFSA Scientific Assessment* document for public commentary which was subsequently updated in February 2016 (EFSA 2015, 2016; for a more thorough discussion, see Lofstedt and Boudier, [forthcoming](#)). EFSA takes the view that being more transparent about uncertainties in their scientific opinions will:

enable citizens to contribute more widely to [EFSA's] risk assessment work and thereby increase trust. (EFSA 2015, 11)

But do members of the European public actually want to know more about the details of the scientific uncertainties associated with a certain risk topic or a scientific opinion or would they prefer to know less about these scientific uncertainties? In this short research note, we attempt to address this question. We hope that our findings, along with EFSA's own ongoing work on testing messages and establishing best practice with regards to uncertainty (EFSA 2016), will assist the Agency in the ongoing pursuit to maintain and strengthen its risk communication activities.

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2. Literature review

There are a number of academic articles discussing how members of the public view uncertainty and the findings are mixed at best (for a review, see Lofstedt and Boudier, [forthcoming](#)). While Frewer, Miles, and Brennan 2002 note that individuals can accept uncertainty as part of the risk management process and prefer that to government inaction Fischhoff (2012) notes that individuals can interpret and understand explicit quantitative measures of uncertainty.

Johnson and Slovic had mixed results, identifying in their research that whilst the majority of individuals would welcome uncertainty, some would not and would prefer being told whether something is safe or not. They also show that by discussing uncertainty estimates this led some respondents to question the competency of the government agency in question (see Johnson 2003; Johnson and Slovic 1994, 1995, 1996, 1998 [but see erratum Johnson 2004]). As Johnson and Slovic conclude in one of their papers:

Uncertainty is a fact of life, but life goes on: similarly, citizens expect government action on pollution in spite of uncertainty, and may suspect the topic of uncertainty is being raised merely to justify inaction. (Johnson and Slovic 1998, 277)

Inspired by this research and with the renewed policy interest in communicating uncertainty to the public by EFSA, this research note replicates some of the key questions explored by Johnson and Slovic some 20 years ago in a European context.

3. Methodology

We developed the study in the following way. Firstly, we pretested the 1998 Johnson and Slovic survey instrument on an undergraduate school class of 40 individuals at King's College, London in the summer of 2016. Following this initial pretest, we amended the questionnaire slightly before sending it on to a couple of experts on uncertainty analysis who suggested a few more minor changes.¹

The final questionnaire comprised four parts²:

- (1) general responses to environmental health uncertainty and range bounds;
- (2) two scenarios (A and B), both focusing on a government announcement about a chemical in the person's drinking water (whether tap or bottled water) with scenario A providing less uncertain information, and scenario B providing more uncertain information;
- (3) views of government risk assessment; and
- (4) sociodemographic information. Most statements had a three-step, disagree-agree response format, with a 'don't know' option. Scenario A was provided to half of the sample, with scenario B provided to the other half.

The Johnson and Slovic study was conducted on 280 respondents in November 1995 who answered an advertisement in the University of Oregon newspaper. Our study differed in several ways. Firstly, our study was conducted in more than one geographical location in Europe. Rather than limiting the experimental study to one

location (i.e. Eugene, Oregon) we wanted to get a greater geographical spread so that we could examine possible national variations and hence cultural differences. Thus, the research was conducted over the August–September 2016 time period in three different European countries ($n = 100$ in each country), namely:

- (a) Dublin and Waterford in Ireland;
- (b) Leewarden in Netherlands;
- (c) Lille and Paris in France.

Secondly, we decided to do face-to-face interviews, selecting participants via convenience sampling in the five urbanized areas across the three countries. This contrasts with the Johnson-Slovic study where respondents were asked to fill in a written questionnaire. Face-to-face interviews were chosen in order to ensure greater control over the comprehension of the questions so that participants provided an accurate representation of their attitudes towards uncertainty. The interviews were carried out by three Ph.D. students who were fluent in English, Dutch and French, respectively. In each of the non-English speaking countries the questionnaire was translated from English into the relevant native language. The data collection process itself was supervised by the second author, Maeve McLoughlin. Response rates varied between the three countries. We achieved 33% in Ireland, 25% in the Netherlands and 50% in France. Collectively, the group was 43% male, with the largest age group being 18–34 years. 60% were employed and 46% had children. The sample was ‘over educated’ with some 64% either having an undergraduate or graduate degree, compared to the OECD average of 35%, and the country specific measure of 43% – Ireland, 35% – the Netherlands and 31% – France (OECD 2014, 2016). See Table 1 which outlines all the socio-demographic characteristics of the sample.

Table 1. Table outlining the socio-demographic characteristics of the sample.

	Ireland	Netherlands	France
Female (%)	55	54	63
Age (Years)			
18–34	19	27	84
35–49	46	21	11
50–64	13	38	5
65+	22	14	0
Support environmental groups (%)	77	39	31
Support industry groups (%)	61	2	7
Employed (% Yes)	67	58	54
Children (% Yes)	59	52	26
Education (%)			
High school diploma & below	16	14	7
Vocational college	18	36	16
Undergrad	40	43	34
Postgrad & above	26	7	43

4. Results

Given a straightforward choice, the majority of the respondents preferred to know if a food/chemical was safe or not, rather than hearing risk estimates and ranges (see Tables 2–5). In these situations, they simply desired certainty. What is especially interesting is that our respondents were more opposed to uncertainty than those in Johnson and Slovic's 1998 study, by 24, 20, 23 and 31 percentage points, respectively, which is rather considerable (see Table 1, Questions 1(c), 1(d), 1(e) and 1(f), p265, Johnson and Slovic 1998).

Table 2. Table showing responses to Question 3: When a chemical [contaminant] is found in my food/medicine, I don't want to hear statistics, I just want to know if my food/medicine is safe.

	Ireland (%)	Netherlands (%)	France (%)	Total European countries (%)
Agree	75	76	67	73
Disagree	21	22	32	25
Don't know	4	2	1	2

Table 3. Table showing responses to Question 4: I am more comfortable with an expert's (i.e. scientist's) opinion about whether or not my food/water/medicine is safe than with a range of risk numbers from which I must draw my own conclusions.

	Ireland (%)	Netherlands (%)	France (%)	Total European countries (%)
Agree	81	63	74	73
Disagree	12	33	19	21
Don't know	7	4	7	43

Table 4. Table showing responses to Question 5: I would prefer that the government tell me that they're just not sure about the size of a health/food risk, if that is the case, rather than give me a range of risk numbers.

	Ireland (%)	Netherlands (%)	France (%)	Total European countries (%)
Agree	60	74	66	67
Disagree	35	22	26	28
Don't know	5	4	8	5

Table 5. Table showing responses to Question 6: I'd prefer a single, concrete risk number rather than a range of numbers for the food/public health risks that I face.

	Ireland (%)	Netherlands (%)	France (%)	Total European countries (%)
Agree	62	62	62	62
Disagree	27	30	14	24
Don't know	11	14	24	14

Respondents' preferences changed, however, when it came down to a choice between hearing uncertain risk information and facing a lack of transparency from the government. In this situation, people preferred transparency about uncertainty (see Table 6). This finding aligns with the conclusions from a number of studies of Europe's 'post-trust' era (see Lofstedt et al. 2011; Löfstedt 2005). In order for people to trust these authorities it appears, at least from these studies, that the public requires an increased level of transparency of decision-making processes from regulators and policy-makers. Interestingly, these results again differ from Johnson and Slovic's 1998 study, where the significant majority (74%) of their sample preferred not to be informed by the government about an uncertain environmental or public health condition, compared to 31% of our sample.

This preference for increased levels of transparency from government authorities is also seen if one compares responses with the equivalent risk communication from expert scientists (see Tables 7 and 8), signifying that people trust experts more than they do government officials.

Inferential statistics were used to analyse the data-set, considering the socio-demographic characteristics (age, employment status, whether people had children, level of education attained, sex, environment group affiliation and industry group affiliation) collected in Part iv of the questionnaire (see Table 9), and preference for uncertainty/certainty when given a straightforward choice.

Table 6. Table showing responses to Question 2: If the government is having difficulty in determining how much of a risk an environmental or public health condition poses to me, I prefer the government not to inform me about this.

	Ireland (%)	Netherlands (%)	France (%)	Total European countries (%)
Agree	29	45	19	31
Disagree	63	54	75	64
Don't know	8	2	6	5

Table 7. Table showing responses to Question 1(a): I prefer being told that a situation is safe or unsafe by expert scientists, rather than hearing risk numbers, such as a 'health risk of getting cancer is 1 in 1 million'.

	Ireland (%)	Netherlands (%)	France (%)	Total European countries (%)
Agree	76	59	72	69
Disagree	17	30	18	22
Don't know	7	11	10	9

Table 8. Table showing responses to Question 1(b): I prefer being told that a situation is safe or unsafe by the government, rather than hearing risk numbers, such as a 'health risk of getting cancer is 1 in 1 million'.

	Ireland (%)	Netherlands (%)	France (%)	Total European countries (%)
Agree	29	45	32	35
Disagree	63	49	53	55
Don't know	8	6	15	10

Table 9. Table showing the background questions and required responses that were included in Part iv of the questionnaire.

Part iv. Background questions	
Q.22	What year were you born?
Q.23	Do you support environmental groups such as Greenpeace? (Yes/No)
Q.24	Do you support industry organizations such as [Ireland specific: IBEC, Irish Business & Employers Confederation] (Yes/No)
Q.25	Are you presently employed? (Yes/No)
Q.26	Do you have children? (Yes/No)
Q.27	How much education have you had? (Choose a, b, c, d or e)
	(a) Some high school/gymnasium
	(b) High school diploma
	(c) Some college
	(d) Undergraduate degree
	(e) Postgraduate studies
Q.28	Gender? (Male/Female)

The results indicated little variation between a number of socio-demographic characteristics, including employment status, sex, environmental and industry group affiliation, and the preference for uncertainty/certainty.

The following socio-demographic characteristics did show variation as described below.

4.1. Age

Cross-tabulation analysis of Part i of the questionnaire indicated that respondents over 65 years wanted fewer details of uncertainty than any other age band. The results also indicated that respondents aged 18–35 years (the youngest age band) wanted more details about uncertainty than any other age band, except when the information was being provided by experts.

4.2. Children

Cross-tabulation analysis of Question 1 of Part i indicated that respondents with children wanted more details on uncertainty than those without children. However, the statistical analysis for Question 3: ‘When a chemical is found in my food/medicine, I don’t want to hear statistics, I just want to know if my food/medicine is safe’, indicated that respondents with children didn’t want to hear statistics. They simply wanted to know if the food was safe.

4.3. Education

The results were mixed in relation to education bands and preferences, however cross-tabulation analysis of Question 2, 4 and 6 of Part i of the questionnaire indicated that the least educated group (obtained high school diploma and below) were less likely to want details of uncertainty than any other group. This aligns with

Johnson and Slovic's 1998 study where they found that 'support for receiving a range of risk estimates seemed to have been enhanced by a college-derived familiarity with the concept that uncertainty is common on good science. To the extent that such support is knowledge-based, [Johnson and Slovic] would not expect it to be more common among populations with average education...[thus] less-educated audiences would be less familiar with, and less accepting of, uncertainties (holding other potential factors such as trust in authorities, constant).' Simply put, they expect that a sample with an average education would have less preference for uncertainty, and a sample with an over-average education would have more preference, except in situations where trust in the authority is a factor.

4.3.1. Responses to range bounds

A further finding relates to the responses to range bounds. To do this, we asked about agreement with the statement 'If a range of food/public health risk numbers are given (ranging from 60 to 40%), I would believe that the highest risk number is the correct one', and we took agreement with this statement as a valid measure of 'upward bias' in line with Johnson and Slovic's 1998 study. Overall, we found that half (41%) of our respondents would not believe the highest risk number if a range was provided (akin to a type of positivity bias for the upper bound), although this was a slim majority, with nearly as many (36%) believing it (akin to a type of negativity bias for the lower bound) (23% did not know) (see Table 10). This was in contrast to the Johnson and Slovic 1998 study, and Viscusi, Magat, and Huber's 1991 study, both of which had a majority trend towards negativity bias. At a country level, the findings were more definitive. Ireland showed a strong trend towards a negativity bias, with over half (56%) believing the highest risk number if a range was provided, similar to the Johnson and Slovic 1998 study, and larger than the Viscusi, Magat, and Huber 1991 study (22%). In contrast, both the Netherlands and France showed trends towards a positivity bias (55 and 41%, respectively), although it should be noted that a significant number of the French sample did not know (36%).

The current presentation of the findings is a preliminary review of the response set to the interview data that were collected, from which general conclusions can be drawn with regard to the insights on general attitudes towards uncertainty in the context of food safety.

Table 10. Table showing responses to Question 7: If a range of food/public health risk numbers are given (ranging from 60 to 40%), I would believe that the highest risk number is the correct one.

	Ireland (%)	Netherlands (%)	France (%)	Total European countries (%)
Agree	56	30	23	36
Disagree	27	55	41	41
Don't know	17	15	36	23

5. Discussion/analysis

As described previously, our sample was young and ‘over-educated’ compared to the OECD and national averages. Analysis of the preferences of these socio-demographic characteristics indicated that respondents aged 18–34 years (the youngest age band) and the largest age group, wanted more details about uncertainty than any other age band, except when the information was being provided by trusted experts, in which case they were happy to accept less detailed, certain information. Our analysis also indicated that the least educated group were less likely to want details of uncertainty than any other group. This led us to consider, in line with Johnson and Slovic’s 1998 expectations, that such support is knowledge-based. Thus a sample with an over-average education (such as ours) appears to have the conceptual apparatus for handling more uncertainty. Based on this analysis, and in view of our ‘skewed’ sample, a high preference for uncertainty was expected, except in situations where trusted experts communicated the information, in which case, our sample would be content to receive less detailed, certain information.

To some extent, our expectations were met. In situations where the government was specified as the risk communicator, the majority of our sample preferred more detailed, uncertain information. Put simply, they cared more about the basis on which the details of uncertainty were communicated. This preference for increased levels of transparency from government authorities is considered directly related to low levels of public trust in government, as previously highlighted by Lofstedt et al. (2011) and Löfstedt (2005), and to some extent affirms EFSA’s view. However, in situations where people had a straightforward choice, the majority of people preferred certainty to uncertainty, both in relation to risk estimates and ranges, overriding the expected skew from our youthful, educated sample, in contrast to Johnson and Slovic’s expectations.

In addition, we found an overall slim majority trending towards positivity bias (i.e. regarding the upper bounds of reporting risk: 60% over 40%), in further contrast to Johnson and Slovic’s 1998 study, as well as Viscusi, Magat, and Huber’s 1991 study. What is interesting is that of all the results, this finding had national variations. The Netherlands and France continued to show a strong trend towards positivity bias. However, Ireland showed a strong trend in the opposite direction (56% of the Irish sample believed that the highest risk number in a range was the correct one, compared to 27% who did not believe this [17% did not know]), confirming in this Irish case the findings from Johnson and Slovic, as well as Viscusi, Magat, and Huber (1991).

These differences between European countries in terms of accepted preference for high risks associated with public health/environmental risks have been previously identified by researchers examining effective policy communication in food safety (Lobb et al. 2006; Frewer et al. 1996). For example, Lobb et al. (2006) found that the French may have a higher level of trust in their food chain actors in line with their tendency to purchase food from higher quality sources, which may explain their positivity bias. The negativity bias by Irish consumers towards food/health risks has been identified in a previous study by Kennedy et al. (2009). In their study into public perceptions immediately after the dioxin in Irish pork crisis in December 2008, despite assurances from both the media and the food safety authorities that there was no risk to human health from contaminated pork, it was found to be the primary concern of most respondents in the study. Kennedy et al. 2009 found

that this perception could not be explained by issues of trust. Instead they explained it by dread, such as described by Slovic, Fischhoff, and Lichtenstein 1984; lack of knowledge and/or a lack of perceived control. The researchers considered that the lack of consumer understanding and effects of the available heuristic in relation to food risks had such important implications for food safety agencies in Ireland, that they recommended further work was merited in monitoring consumers' perceptual shifts in relation to food safety over time. During the time that the Irish interviews were conducted (summer 2016), a number of respondents expressed concern in relation to lead in service connection water pipes, which has been recently identified as a human health risk to approximately 180,000 homes across Ireland, to be removed by the Irish Water agency over the course of the next decade (Kelly 2016). Perhaps this recent and ongoing scare has affected Irish consumer bias towards such risks, in a similar manner via lack of understanding and/or the availability heuristic?

6. Policy implications of our findings

Contrary to what EFSA has been noting in their uncertainty guidance documents ((EFSA) European Food Safety Authority 2015, 2016), given a straightforward choice, the majority of the Europeans interviewed in this study appeared to want to know less about the details of scientific uncertainties associated with a certain risk topic or scientific opinion. That said, trust is an essential requirement to accepting certainty. Where public trust in an authority is low, more transparency about scientific uncertainties may help increase those levels of trust.

Caution should be exercised when considering age, education, and other socio-demographic characteristics as indicators of an audience's preference for certainty/uncertainty. Europeans are more likely to respond in culturally specific ways, and cultural differences, rather than socio-demographic characteristics, should be taken into account when developing risk communication strategies, suggesting a need for country-specific policy design, as recommended by Lobb et al. (2006).

We therefore take the view that EFSA should be careful in how they plan to roll out their uncertainty guidance going forward and perhaps avoid a one-size-fits-all policy regarding risk/uncertainty communication. The minimum that EFSA could do is to test the final uncertainty messages derived from the scientific opinions on the European public to see if they are welcomed.

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Notes

1. These changes included building in an increased emphasis on the issues of public trust in government authorities and experts, and transparency; and defining an expert ('scientist') for the purposes of this questionnaire.
2. See Section 4. Results for specific questions.

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