



THE UNIVERSITY *of* EDINBURGH

Edinburgh Research Explorer

Food Risk/Benefit Communication: A Systematic Review

Citation for published version:

Frewer, LJ, Fischer, ARH, Brennan, M, BANATI, D, Lion, R, Meertens, R, ROWE, G, SIEGRIST, M, Verbeke, W & Vereijken, C 2015, 'Food Risk/Benefit Communication: A Systematic Review' *Critical Reviews in Food Science & Nutrition*, vol. 56, no. 10, pp. 1728-1745. DOI: 10.1080/10408398.2013.801337

Digital Object Identifier (DOI):

[10.1080/10408398.2013.801337](https://doi.org/10.1080/10408398.2013.801337)

Link:

[Link to publication record in Edinburgh Research Explorer](#)

Document Version:

Peer reviewed version

Published In:

Critical Reviews in Food Science & Nutrition

Publisher Rights Statement:

© Frewer, L. J., Fischer, A. R. H., Brennan, M., BANATI, D., Lion, R., Meertens, R., ... Vereijken, C. (2015). Food Risk/Benefit Communication: A Systematic Review. *Critical Reviews in Food Science & Nutrition*. 10.1080/10408398.2013.801337

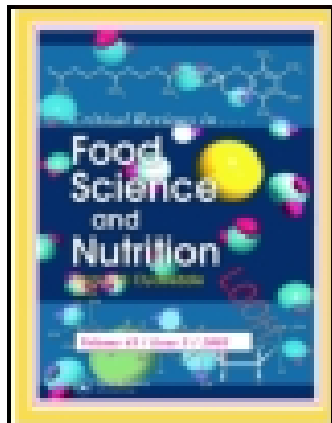
General rights

Copyright for the publications made accessible via the Edinburgh Research Explorer is retained by the author(s) and / or other copyright owners and it is a condition of accessing these publications that users recognise and abide by the legal requirements associated with these rights.

Take down policy

The University of Edinburgh has made every reasonable effort to ensure that Edinburgh Research Explorer content complies with UK legislation. If you believe that the public display of this file breaches copyright please contact openaccess@ed.ac.uk providing details, and we will remove access to the work immediately and investigate your claim.





[Click for updates](#)

Critical Reviews in Food Science and Nutrition

Publication details, including instructions for authors and subscription information:

<http://www.tandfonline.com/loi/bfsn20>

Risk/Benefit Communication about Food - A Systematic Review of the Literature

L.J. Frewer^a, A.R.H. Fischer^b, M. Brennan^a, D. Bánáti^c, R. Lion^d, R.M. Meertens^e, G. Rowe^f, M. Siegrist^g, W. Verbeke^h & C. M.J.L. Vereijkenⁱ

^a Food and Society Group, Centre for Rural Economy, SAFRD, Newcastle University, Newcastle upon Tyne, NE1 7RU, UK. Email

^b Marketing and Consumer Behaviour Group, Wageningen University, The Netherlands

^c International Life Sciences Institute, Europe, Brussels, Belgium

^d Unilever R&D Vlaardingen, Vlaardingen, The Netherlands

^e Department of Health Promotion, Nutrition and Toxicology Research Institute Maastricht (NUTRIM) and Care and Public Health Research Institute (Caphri), Maastricht University, P.O. Box 616, 6200 MD Maastricht, The Netherlands

^f Gene Rowe Evaluations, 12 Wellington Road, Norwich, NR2 3HT, UK

^g ETH Zurich, Institute for Environmental Decisions (IED), Consumer Behaviour, Universitätsstrasse 22, CHN J76.3, CH-8092 Zurich, Switzerland

^h Ghent University, Department of Agricultural Economics, Coupure links 653, 9000 Gent, Belgium

ⁱ Danone Research - Centre for Specialised Nutrition, Bosrandweg 20, 6704 PH Wageningen, The Netherlands

Accepted author version posted online: 09 Jan 2015.

To cite this article: L.J. Frewer, A.R.H. Fischer, M. Brennan, D. Bánáti, R. Lion, R.M. Meertens, G. Rowe, M. Siegrist, W. Verbeke & C. M.J.L. Vereijken (2015): Risk/Benefit Communication about Food - A Systematic Review of the Literature, Critical Reviews in Food Science and Nutrition, DOI: [10.1080/10408398.2013.801337](https://doi.org/10.1080/10408398.2013.801337)

To link to this article: <http://dx.doi.org/10.1080/10408398.2013.801337>

Disclaimer: This is a version of an unedited manuscript that has been accepted for publication. As a service to authors and researchers we are providing this version of the accepted manuscript (AM). Copyediting, typesetting, and review of the resulting proof will be undertaken on this manuscript before final publication of the Version of Record (VoR). During production and pre-press, errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal relate to this version also.

PLEASE SCROLL DOWN FOR ARTICLE

Taylor & Francis makes every effort to ensure the accuracy of all the information (the "Content") contained in the publications on our platform. Taylor & Francis, our agents, and our licensors make no representations or warranties whatsoever as to the accuracy, completeness, or suitability for any purpose of the Content. Versions of published Taylor & Francis and Routledge Open articles and Taylor & Francis and Routledge Open Select articles posted to institutional or subject repositories or any other third-party website are without warranty from Taylor & Francis of any kind, either expressed or implied, including, but not limited to, warranties of merchantability, fitness for a particular purpose, or non-infringement. Any opinions and views expressed in this article are the opinions and views of the authors, and are not the views of or endorsed by Taylor & Francis. The

accuracy of the Content should not be relied upon and should be independently verified with primary sources of information. Taylor & Francis shall not be liable for any losses, actions, claims, proceedings, demands, costs, expenses, damages, and other liabilities whatsoever or howsoever caused arising directly or indirectly in connection with, in relation to or arising out of the use of the Content.

This article may be used for research, teaching, and private study purposes. Terms & Conditions of access and use can be found at <http://www.tandfonline.com/page/terms-and-conditions>

It is essential that you check the license status of any given Open and Open Select article to confirm conditions of access and use.

Risk/benefit communication about food – a systematic review of the literature

**Frewer, L.J.^{1*}, Fischer, A.R.H.², Brennan, M.¹, Bánáti, D.,³ Lion, R.⁴, Meertens, R.M.⁵,
Rowe, G.⁶, Siegrist, M.⁷, Verbeke, W.⁸ and Vereijken, C. M.J.L.⁹**

*** Author to whom correspondence should be addressed.**

**¹ Food and Society Group, Centre for Rural Economy, SAFRD, Newcastle University,
Newcastle upon Tyne, NE1 7RU, UK. Email Lynn.Frewer@Newcastle.ac.uk**

² Marketing and Consumer Behaviour Group, Wageningen University, The Netherlands

³ International Life Sciences Institute, Europe, Brussels, Belgium

⁴ Unilever R&D Vlaardingen, Vlaardingen, The Netherlands

**⁵ Department of Health Promotion, Nutrition and Toxicology Research Institute Maastricht
(NUTRIM) and Care and Public Health Research Institute (Caphri), Maastricht
University, P.O. Box 616, 6200 MD Maastricht, The Netherlands**

⁶ Gene Rowe Evaluations, 12 Wellington Road, Norwich, NR2 3HT, UK

⁷ **ETH Zurich, Institute for Environmental Decisions (IED), Consumer Behaviour,
Universitätsstrasse 22, CHN J76.3, CH-8092 Zurich, Switzerland**

⁸ **Ghent University, Department of Agricultural Economics, Coupure links 653, 9000 Gent,
Belgium**

⁹ **Danone Research – Centre for Specialised Nutrition, Bosrandweg 20, 6704 PH
Wageningen, The Netherlands**

Running head: Review of risk/benefit communication and food

**Key words: Risk perception; risk communication; benefit communication; food hazard;
food safety; trust.**

Abstract

A systematic review relevant to the following research questions was conducted 1) the extent to which different theoretical frameworks have been applied to food risk/benefit communication and 2) the impact such food risk/benefit communication interventions have had on related risk/benefit attitudes and behaviours. Fifty four papers were identified. The analysis revealed that (primarily European or US) research interest has been relatively recent. Certain food issues were of greater interest to researchers than others, perhaps reflecting the occurrence of a crisis, or policy concern. Three broad themes relevant to the development of best practice in risk (benefit) communication were identified: the characteristics of the target population; the contents of the information; and the characteristics of the information sources. Within these themes, independent and dependent variables differed considerably. Overall, acute risk (benefit) communication will require advances in *communication process* whereas chronic communication needs to identify *audience requirements*. Both citizen's risk/benefit perceptions and (if relevant) related behaviours need to be taken into account, and recommendations for behavioural change need to be concrete and actionable. The application of theoretical frameworks to the study of risk (benefit) communication was infrequent, and developing predictive models of effective risk (benefit) communication may be contingent on improved theoretical perspectives.

Introduction

Effective risk (and benefit) communication about food issues is important from the perspective of optimising consumer protection associated with food consumption (e.g. Verbeke et al., 2008), and increasing societal trust in those institutions responsible for assessing and managing (perceived) food risks (Poortinga and Pidgeon, 2005). The need for effective risk communication might result from the application of specific agricultural practices or food processing technologies which have the potential to generate societal concern, such as genetic modification of crops and animals for food production processes or the use of nanotechnology in food processing and agriculture (Costa-Font et al., 2008; Frewer et al., 2011; Frewer et al., in press 2013; Frewer et al., 2011; Siegrist et al., 2007a; Fischer et al., in press). Alternatively, the need for effective communication with the public may arise from chemical, microbiological or physical contamination of foods (Kher et al., 2011). In addition, communication may be required as a consequence of the occurrence of a food crisis following a food safety incident, (Siegrist et al., 2007b), for example as a result of accidental or deliberate actions or changes in the food supply chain (Verbeke, 2001), in response to chronic food safety issues (for example, associated with domestic food hygiene practices (Fischer et al., 2007) or following the identification of new scientific knowledge about specific food risks (van Kleef et al., 2009).

In addition to the impacts on human health (Dosman et al., 2001), communication may also focus on potential environmental impacts of food production (Lampila and Lähteenmäki, 2007) and the mitigation or risk management measures applied to contain risks (van Kleef et al., 2009). In addition, risk communication is important in relation to different socio-economic impacts, for

example, on employment, food costs, rural livelihoods, or cultural structures and institutional relationships (Koenig et al., 2010; Lusk et al., 2005). Examples of different types of food safety issues, which have been classified according to whether they have been deliberately or accidentally introduced into the food chain, or are naturally occurring, are provided in table 1.

.....

Table 1 about here

.....

The potential human health, environmental or economic impacts of failing to develop effective food risk communication with consumers has been well established, both in terms of negative health and environmental impacts and economic consequences (Verbeke, 2001; El Gazzar and Marth, 1992). However, despite the need to ensure an effective flow and/or exchange of information between consumers and other actors in the area of food safety (for example, risk assessors, regulators and the food industry), to our knowledge there has been no systematic analysis of the different approaches to risk communication, and (if applicable) underlying theories used to inform these. The aim of this review was to apply a systematic review to peer-reviewed published research on food risk and risk-benefit communication with consumers and/or citizens. As part of this review, the range of theoretical approaches which have been adopted was mapped, the impact of different risk communication interventions assessed, and implications for best practice in food risk communication identified.

Various factors can be identified which may be influential in determining how effective risk communication is, whether designed to reduce risky behaviours on the part of consumers or to provide the basis for informed choice regarding food consumption decisions. The (perceived) characteristics of the potential hazard under consideration, and the target audience(s), and their preferred method of information delivery must be taken into account when developing risk communication. Peoples' risk perceptions should be taken into account when developing an effective risk communication strategy (Kirk et al., 2002) including whether the potential hazard is perceived to be artificial or naturally occurring in origin (Rozin et al., 2004), and whether it has been accidentally or deliberately introduced into the food chain. Whether a risk is presented in an "acute" or "chronic" context is also relevant when considering the communication process, (Glik, 2007), as is the issue of whether, and how, to communicate uncertainties associated with risk estimates where these exist (Frewer, 2003). Consumer and/or citizen trust in information provided (Berg, 2004; Savadori et al., 2007), as well as the regulatory framework put into place to protect consumers (van Kleef et al., 2006), and the transparency of internal decision-making processes, may also be influential, and should be included in the development of efficacious information where relevant. Food consumption may be simultaneously associated with (perceived) risks and benefits, and under these circumstances risk-benefit communication may be more appropriate than risk communication used in isolation (Hooper et al., 2006; Saba and Messina, 2003; Verbeke et al., 2005; Van Dijk et al., 2011). Communication of uncertainty regarding the scientific assessment risks and benefits may also be relevant where this exists, and needs to be communicated to consumers in terms of consumer protection or the generation of consumer confidence in information (e.g. Beck and Kropp, 2011; Thompson, 2002). Potential

cultural differences in risk perceptions and communication preferences also need to be considered (Renn and Rohrman, 2000). Psychometric mapping, or the “psychometric paradigm” (e.g. Fischhoff et al., 1978; Slovic, 2000) been widely used in the literature as a means of capturing or describing risk perceptions associated with different hazards, (e.g. See Fife-Schaw and Rowe, 2006), and it has been argued that understanding such perceptions is an important first step in developing effective risk communication.

The first set of approaches focuses on how information about risks and benefits is *processed* by individuals, and typically utilise “dual processing” theories in developing effective risk communication interventions. These approaches essentially posit that both intuition and reasoning may be utilised by people when processing incoming information, depending on the information characteristics and the context in which it is received. Intuitive processes rely to a large extent on automatic or unconscious processes, such as the use of heuristics or emotional cues, and result in very rapid decision-making. Reasoned or conscious processes are more dependent on the content of the information itself as opposed to the cues associated with it, such as information source characteristics. Dual process models are very common in the study of attitude change and persuasive communication. Examples include Petty and Cacioppo's Elaboration Likelihood Model (e.g. Petty and Cacioppo, 1986) and Chaiken's Heuristic Systematic Model (Chaiken, 1980). Various scholars have applied such models to the development of effective risk communication in general (Verplanken, 1991; Visschers et al., 2008) and research on the impact of food risks in particular (e.g. Frewer et al., 1997).

A second set of theoretical approaches focuses on behavioural determinants that may be influenced by risk-benefit communication. An example of such an approach is the Theory of Planned Behaviour (TPB, Azjen, 1991), which posits that when an individual has a positive attitude towards a particular behaviour, thinks that significant others want him to perform the behaviour (subjective norm), and assumes that the behaviour is not too difficult to perform (perceived behaviour control), this will result in an intention to engage in the behaviour. This intention will lead to the behaviour, unless unexpected internal or external barriers arise. Various extensions to the Theory of Planned Behaviour, such as past behaviour/habits and perceived moral obligation, have been added to the basic model (Conner and Armitage, 1998; Verbeke and Vackier, 2005). Applications to risk perception include acceptance of genetic modification of crops and novel food technologies (Sparks et al., 1995; Tenbült et al., 2008), although direct tests of the theory in risk communication are less frequent.

The Risk Information Seeking and Processing model (RISP), developed by Griffin et al. (1999) and Trumbo (Trumbo and McComas, 2003) combines elements from both dual processing theory and the TPB (Ter Huurne and Gutteling, 2008), and focuses on understanding how people come to seek and process information about a given risk, and how (and whether) this results in behavioural intention.

The third approach, the Social Amplification of Risk Framework, (SARF) focuses on how risk information is communicated through society. The SARF attempts to explain how communications of risk events pass from the sender through intermediate “stations” to a message

receiver. Risk perception amplification (or increase) or attenuation (decrease) may occur in the transmission process, which has strong parallels with risk communication processes. In practice, the SARF has been more commonly applied to understanding societal responses during a crisis (Pidgeon et al., 2003; Yang and Goddard, 2011).

An important question in the area of food risk communication is therefore whether different theoretical approaches have been applied with greater or lesser degrees of success for different types of potential hazard, and whether the “timeframe” influences the success of communication (e.g., communicating in response to a specific crisis or chronic and on-going issue). Independent of theoretical inputs, due consideration needs to be given to how “successful communication” is measured, and, once an assessment has been identified and validated, for how long continuous assessment of post- risk communication intervention is required to demonstrate a meaningful effect on risk-related attitudes and behaviours. The evidence base for best practice will be assessed in the current review.

Methods

A systematic review was conducted to identify and assess appropriate papers for inclusion in the review. A systematic review uses an explicit, rigorous and transparent methodology for identifying, selecting and coding papers (Greenhalgh et al., 2005). It aims to support evidence based policy and practice (Chalmers, 2003) through the identification of the best available evidence for a particular research question (Bambra, 2011). To ensure rigour and transparency a systematic review should follow an established process for: 1) Identifying the review question;

2) Locating and selecting relevant studies; 3) Critically appraising the selected studies; 4) Analysing and synthesising the findings from the studies; and 5) Reporting (and disseminating) the review findings (Briner and Rousseau, 2011).

In this review, the research question formulated was designed to assess: 1) the extent to which different theoretical frameworks have been applied to food risk/benefit communication and 2) the impact such food risk/benefit communication interventions have had on related risk/benefit attitudes and behaviours of the general public.

Locating and selecting studies

A list of search terms was developed. The research question was broken down into 5 key groupings of possible keywords : 1. “food”; 2. “risk”; 3. “public”; 4. “attitudes and behaviours”; and 5. “communication”. A set of specific search terms for each of these key elements of the full search string were compiled in order to ensure that the papers identified demonstrated high face validity (i.e. ensuring the inclusion of key papers and authors), while at the same time restricting the number of irrelevant papers. Non-peer reviewed journal papers were excluded from the review to ensure appropriate academic rigour. For pragmatic reasons, language of publication was limited to English. The final search string is presented in Table 2. The search was performed on 5th September 2011 in Scopus ¹ The search yielded 368 unique references.

.....
Table 2 about here
.....

¹ The Scopus database provides access to over 18500 peer-reviewed journals, with a strong presence in scientific, technical, medical and social sciences fields as well arts and humanities.

Stage 1 of the selection process involved a rapid evaluation of all 368 abstracts by two researchers independently. Table 3 outlines the screening criterion used and the number of papers excluded after each screening criterion was imposed. Inter-coder agreement with respect to inclusion/exclusion decisions was 81.75% (Cohen’s Kappa =0.63). This is an acceptable level of inter-coder agreement. Remaining differences were resolved through personal consultation between by the two coders. The rapid evaluation resulted in the exclusion of 163 abstracts, leaving 205 papers for the next phase of the review.

.....
Table 3 about here
.....

For the next stage (stage 2), a search for the full text of all 205 abstracts was undertaken using the libraries accessible to the authors through their institutional affiliations. The full text of 24 papers was not immediately retrievable, but further efforts to obtain these papers were undertaken. Finally, the review team accepted that they were unable to retrieve the full text for 6 of the papers despite considerable effort, and excluded them. The remaining 199 papers were then screened based on full paper content by the reviewers, using a single criterion: “*Does the paper report a relevant empirical primary study on risk/benefit communication?*” The papers were distributed evenly across the 9 reviewers, with 20% of the papers (N=41) being reviewed twice by different members of the review team to allow for inter-coder agreement. Of the 199 papers, 86 were scored, using this single criterion, as relevant with an inter-coder agreement of

86% (Cohen's Kappa =0.64). Differences were discussed between researchers and all were resolved. This set of 86 papers was taken forward to full coding.

Full Coding of Selected Studies

The final set of 86 papers was again randomly distributed across the reviewers. During a series of interactive workshops involving all researchers, a detailed coding scheme had been developed, which was pre-tested on 3 papers by all 9 reviewers. The coding scheme was further refined and a second pre-test was conducted, resulting in the finalisation of a coding scheme containing the following superordinate code categories: 1) identification of each paper, (title, authors, year, journal); 2) relevant information about the methodologies utilised (for example, whether quantitative or qualitative data collection was utilised); 3) the theoretical approach adopted (if any), or the experimental paradigm used (if any); 4) the issue communicated about (type of food); 5) whether risk alone was the focus of communication, or whether risk-benefit communication was utilised; 6) the channel or media of communication (e.g. information leaflet, TV; print; online, social media); and; 7) the aim of the communication (for example, behaviour change). In addition, the main conclusions and any recommendations for risk communication policy and practice and for future research were recorded using an open coding format. Of the 86 papers coded at stage 3, it was determined that 54 of the 86 papers contained a sufficient amount of data relevant to the full coding scheme. The results of systematic full coding of this final set of 54 papers are presented below. The remaining papers were excluded as full coding was impossible due to missing information on several coding variables, or the detailed coding process revealed that the papers did not report empirical primary research.

Final coding of key results

The results of the different codes were summarised through a multi-stage process: first, two different coders read through each paper and noted the key results related to effects of communications about risks and benefits. A third coder then compared the two summaries and wrote a concise summary, when the two summaries were similar; when they were somewhat dissimilar, this coder returned to the text to adjudicate between the summaries. By and large, the third coder found the summaries similar and did not need to refer back to the original paper. The third coder's summary was then discussed in a meeting amongst several of the paper authors.

Results

The oldest paper identified was published in 1990² and the most recent paper in 2011 (when the search was discontinued). Most papers were published in the journal "Risk Analysis" (18 papers in total). Year of data collection was not mentioned in 46% of the papers (N=25). Most papers reported on data originating in Europe (N=26) or Northern America (N=23). A few papers reported on data from Asia (N=4) and Australia (N=1). Other regions of the world (including the BRIC countries, Brazil, Russia, India and China) were not represented. Participants were most frequently drawn from the general population (N=25, 46%). In addition participants were sampled from specifically targeted populations such as pregnant women or those exposed to risk through behaviour, for example people who engaged in fishing for personal consumption (N=9, 17%). Frequently, participants were drawn from populations broader than those who were the

² The database has an incomplete coverage before 1996

intended recipients of the communication (N=17, 31%). In terms of sampling methodology, convenience sampling was most frequently applied (N=20, 37%, with more than half of these (N=11) using university students). Random or quota sampling was the next most frequently applied (N=18, 33%). Two papers combined random and convenience sampling. Five papers used “snowballing” to recruit participants, 6 used self-selection through initial contact made via commercial mailing lists, and another 6 selected participants using a small selection of the population under study, but which was too small to be described as representative (e.g. for focus groups).

Methodologies applied

Many papers reported the use of single methods, specifically, experiments (N=24), surveys (N=15), qualitative methods (focus groups and interviews, N= 7). One paper reported longitudinal time series analysis. In addition, 7 papers reported utilising two types of methods: both surveys and qualitative methods and surveys (N=6), or experiments and qualitative methods combined with experiments (N=1).

Food Risks considered

Of the papers included, the majority focused on technological or technologically-related risks. Fifteen focused on chemical contaminants, 9 on genetic modification of foods, 3 on food irradiation, and 1 on the use of pesticides. BSE was the topic of one paper, and microbiological risk of 4 papers. Two papers did not discuss a specific food safety risk. Twelve reported comparative analysis of various combinations of these food risks. Additional topics (either alone

or in combination) included food additives (N=4), antibiotics used in animal production systems (N=2), natural toxins (N=2), hormones used in animal production (N=3), animal and plant diseases (n=2), bioterroristic attack (N=1), Mycotoxins (N=1) and radio nucleotides (N=1).

When specific foods were mentioned, (which was relatively infrequently), the majority focused on fish or seafood consumption (N=11), followed by beef (N=3) and chicken/poultry (N=4), fruits and/or vegetables (N=5). However, many papers did not utilise specific examples of potential foods.

Risk and/or Benefit communication

Of the 54 papers included, 10 provided information focused on generic or non-specified risks or benefits. Three papers reported on benefit communication only, while 19 papers reported only on risk communication. Of the papers which focused on communication of both risks and benefits, 12 reported on information reporting about health risks and benefits. Five papers included information on economic benefits in addition to other benefits. None of the papers reported on economic risks. There is no indication that more recent papers more frequently report on both risk and benefit communication compared to older papers (table 4).

.....

Table 4 about here

.....

How is the communication provided?

One-way communication predominated in the papers included in the review, with 43 papers using this approach to investigate communication. Interactive dialogue was reported in 3 of the papers. Eight papers did not explicitly report whether one-way or two-way communication was investigated, although this may reflect an assumption that communication is one-way by default.

The use of leaflets was the most common media channel utilised (N=14). Information on packaging labels was included in the experimental design 3 times, as were information in newspaper articles and information embedded in the questionnaire used in the research. The internet was utilised as an information source once in experimental designs reported in the published papers, with computer programs, verbal presentation, press release and vignettes as information channels once. In addition, several papers included the use of multiple channels: video or audio in combination with leaflets (N=5), television and newspapers (N=2); internet and leaflets (N=1); and verbal presentation and leaflets (N=1).

In terms of source attribution, governmental institutions were the most commonly used as information sources, (N=9), followed by the media, the academic community and the food industry (N=2), and the healthcare sector (N=1). Some papers compared more than 1 source: 4 papers compared communication provided by government, industry and NGO sources; 3 compared governmental with academic sources, 2 compared governmental sources with medical sources. Different combinations of comparative sources were reported once: academia-healthcare; Government-NGO ; academia-industry; government-industry-healthcare; academia-healthcare-NGO; government-academia-NGO. One paper reported a comparison of six sources:

governmental, academia, NGO, media, industry and healthcare. Fifteen papers did not attribute information to a specific source at all.

Objective of risk (benefit) communication and measured outcomes

The majority of the papers focused on changing attitudes and perceptions, opinions, or other potential cognitive determinants of behaviour (N=38; 69%). Thirty per cent focused on changing behavioural intention (N=17; 31%). Only 9 (17%) reported examining the impacts of the communication on changing behaviour. A total of 18 papers aimed at multiple changes, of which 1 measured cognitive determinants, behavioural intention and (self-reported) behavioural change.

Risk perception was measured as sole dependent in 11 papers. In 4 papers risk and benefit perception were measured but nothing else. In 1 paper risk perception and attitude was measured, and in 5 papers risk perception and intention. In 4 papers risk perception, benefit perception and attitude were measured, in 1 paper risk perception, benefit perception and intention, and in 1 paper risk perception, benefit perception, attitude and intention. In addition a number of papers did not include risk perception as outcome measure of the study but considered attitude (N=3), intention (N=6), or both attitude and intention (N=1) simultaneously. Sixteen papers considered only other measures. Some papers, which aimed to study the effect of communication on intention or behaviour included only scales for cognitive constructs such as risk perception, rather than measures for intention or (self-reported) actual behaviours (see table 5).

.....

Table 5 about here

.....

Experimental design

Many of the papers did not report that systematic variations of the information was included as part of the study design. Similarly, participant characteristics and the reason why communication testing was being conducted were infrequently taken into account. Understanding the relative merits of information presentation is important when developing effective risk (benefit) communication. Comparing the impact of risk (benefit) messages different population or target groups (in particular those most at risk if appropriate) is important when developing targeted communication. Table 6 summarises the number of papers varying information characteristics or taking into account participant characteristics in the analysis of effects.

.....

Table 6 about here

.....

Underlying paradigms and theories

Twenty of the papers adopted a formal theoretical approach or theory. Of those which did, 4 utilised dual processing theories in some way (the ELM was used in 3 studies, HSM in one). In addition, negativity bias, and trust as heuristic were used once. The effect of information order on information processing was also investigated once, as was Rational Actor models for behaviour selection. The Risk Information Seeking and Processing model was used in 2 studies.

ACCEPTED MANUSCRIPT

Social judgement theory was used in 2 studies. Perceptual risk mapping (or the “psychometric paradigm”), symbolic adoption, mental models, risk communication planning model, situational theory, and media dependency were used once each.

The other papers utilised an empirical or applied approach which did not use an *a priori* selected theoretical framework as the basis of the study design. There is no evidence that the proportion of papers utilising a theoretical approach increased over time.

Finally, as well as the summary tables provided above, it is also relevant to consider the individual content of the different papers, and this information is provided in summary tables 7a, 7b and 7c.

.....

Table 7a about here

.....

.....

Table 7b about here

.....

.....

Table 7c about here

.....

The results seemed to address three main themes: results concerning target characteristics (i.e. where differences amongst study participants were related to different responses to a communication); results concerning the nature of the information (i.e. where difference in the nature of information communicated was related to differences in participant responses); and results concerning the characteristics of the information sources (i.e. where differences between sources of information were related to differences in participant responses to a communication). Table 7.a, 7b and 7c show which papers produced results related to these aspects, linking the article reference in the first column to the pertinent results in a second column. Some articles produced results that spoke to two of these three aspects, such as where interactions were found between different types of information and different target characteristics – and in these (relatively few) cases, the article appears in two of the three tables (none of the articles provided results that were recorded in all three tables). In each table, the key factors are italicised. As can be seen from the tables, although broader themes could be identified, the range of issues covered within each theme were fragmented, and varied between studies. As before, this would suggest that research in the area of food risk-benefit communication has been fragmented and lacking theoretical structure.

Recommendations for best practice

Eleven papers identified the need to use balanced and transparent risk communication as best practice. Six papers indicated that it is important to design communication to a specific consumer group or segment taking due account of their current behaviours and/or habits (and implicitly research would be needed to determine what this might be). In line with this, the need to target

risk communication to the needs of relevant consumer groups (e.g. vulnerable groups), was identified as representing best practice in 3 papers, which implicitly suggests that further research would be needed to refine both information content and the information delivery channel to the needs of these groups in relation to communication about specific food risk cases. Three papers indicated that it would be important to proactively provide risk information to the public about a specific (potentially) hazardous event before its occurrence. Trust in information sources was emphasised as an important determinant of people's responses to risk communication in 3 papers. Risk mitigation measures were also identified as an important element of the information content, whether by the relevant authorities (N=2 papers) or consumers themselves (N=2).

Finally, 3 papers concluded that it is important to train communicators (independent of whether they have a natural or social science background) to understand both technical risk assessment associated with food risk, and the factors (for example, risk perception) which drive societal responses to risks in addition to the technical issues., in order to link technical risk assessments with societal concerns, which can then be addressed in the development of communication.

.....
Table 8 about here
.....

Gaps in knowledge and future research needs

The most commonly identified future research needs related to further understanding individual differences in risk communication requirements (identified in 6 papers), and the need for further empirical investigation of trust in information sources (5 papers). Understanding the role of the media as a risk (benefit) communication channel was identified as important in four papers. Four papers mentioned the need for longitudinal analysis which could assess the impact of communication in line with the occurrence of external events (for example, a major food safety incident). In terms of the impact of risk (benefit) communication, the need to assess long term effects on perceptions were identified in 4 papers, the impact on risk-related behaviour in 2 papers, and the extent to which the information was regarded as useful by recipients in 5 papers. The need for more research regarding the communication of uncertainty was identified in 3 papers. The need to investigate risk communication in real contexts and environments was mentioned twice.

.....
Table 9 about here
.....

Discussion

Food safety has been a major concern in many parts of the world over recent decades. How to effectively communicate messages about food safety, so as to appropriately impart necessary information, yet not unduly alarm the public, has become a consequent challenge. This paper has sought to review and analyse relevant empirical studies on the topic, in order to identify any

consistent approaches, significant findings, as well as to identify gaps in knowledge where future research ought to be directed.

Focusing first on the results of the systematic review and analysis the final dataset comprised 54 papers. Most of this research, unsurprisingly (given biases in the search strategy e.g. for English language papers), has taken place in Europe and the US, mainly using general population samples. Chemical contaminants and genetic modification have been the main topics of communication, (perhaps reflecting societal negativity to these hazards in particular- see also Frewer et al., 2011) and messages have concerned a wide range of food types. Much of the research has focussed on the communication of (health) risks, or of combined risks and benefits. Many different media and formats were used, though often these were of written verbal form, such as using information leaflets. One-way communication dominated, as opposed to interactive two-way approaches. The authors suspect that much of the research on two-way communication (for example, through public engagement) was excluded as a result of the search strings applied, as the goal of such activities is frequently not stated as being risk communication *per se*, but rather the establishment of societal priorities for risk assessment and management policies. Research using social media was not found, even towards the end of the time period considered, despite this being frequently discussed as a useful risk communication tool,. This maybe not only because of the relative novelty of social media as a communication tool, but also because of difficulty in replicating the use of social media in an empirical study on one hand, and measuring the impact of social media messaging on attitudes and behaviour in a “natural” experiment following social media discussion of a food risk on the other.

Another issue of interest relates to the topics of the risks in the paper, which (perhaps unsurprisingly) is dominated by the more controversial societal food safety issues over the last two decades, in particular associated with chemical contamination, and genetic modification. In terms of food type, there has been considerable focus on fish, possibly associated with the controversies associated with health promotion being at odds with intake of potential contaminants, as well as differential impact of risks across the population. It is likely that beef and other meats were also a focus because of the impact of the BSE and dioxin crises, and the role this played in setting the international agenda for debate about food risk and its management (e.g. the development of food traceability or establishment of the European Food Safety Authority). However, presentation of specific cases of food risk was infrequent. The majority of the papers (about two-thirds) focused on changing attitudes/ perceptions/ opinions, while approximately one-third focused on changing behavioural intention, and relatively few (9 of 54) examined the impacts of the communication on changing behaviour. Of the dependent variables assessed, risk perception was most frequently studied (in approximately half of the papers); fewer papers measured attitudes, benefit perceptions or intention to behave in a particular way as a consequence of the communication provided. It is of note that several of the papers claiming to study intentions or behaviours specified their outcome variables at the level of attitudes, rather than measuring change in behavioural intention. Other papers assessed information content or trust in the message or source. The independent variables generally were related to the nature of the information being presented (framing, message source, type of information, quantity of information, order of presentation, type of risk), with fewer studies considering variables related

to the participant sample (sample characteristics, motivation, prior attitude to the topic). Given that there has been considerable emphasis in the literature in taking participant characteristics into account when developing risk (benefit) communication, this observation is somewhat surprising.

Of the papers considered, only 20 out of 54 utilised formal theoretical approach or theory in their theoretical design, and of these no one theoretical approach dominated. This finding, although at face value surprising, has been reported elsewhere (Kellens et al., 2013). Research which, for example, compares the relative efficacy of different theoretical approaches (for example, regarding the impact of combined information/source characteristics on attitudes and subsequent behaviour) is needed. An important issue relates to the inconsistent application of theoretical frameworks, which have been infrequently and applied. A more theoretically rigorous and unitary approach to empirically testing risk communication should be developed in order to allow more systematic comparisons. While the theoretical approaches described (for example, the RISP) potentially offer a solid theoretical basis for future empirical test, it would also be useful to conduct additional exploratory work in order to develop theory specific to the current field of enquiry. Grounded theory, (see, *inter alia*, Henwood and Pidgeon, 2003), for example, might be used as the basis for further theoretical development, which could be tested by application of positivist research designs. Once different theoretical approaches have been developed, and tested, it should be possible to build up a corpus of results that might be easier to understand, for example through application of formal meta-analysis or data synthesis. The most promising theoretical approaches can then be integrated into future research. Ultimately, such

research should lead to a theory with good predictive validity that will usefully inform the development of better communication tools and processes. One prerequisite of such a theory is that it should incorporate simultaneously theoretical perspectives salient to the characteristics of the target population, the contents of the information, and the (perceived) characteristics of the information sources. Even within this theoretical context, the practical need to address differences in perceptions between hazard types and target populations suggests that there is unlikely to be a single ‘magic bullet’ for risk/benefit communication. Recommendations for best practice suggest that information needs to be targeted to the needs of the intended audience, in terms of the structure and relevance of the content, the existing behaviours and habits of the target group, and the demographic, phenotypic and cultural “boundaries” by which vulnerable groups can be identified. Thus communication format and audience characteristics may interact – and hence ensure the need, suggested above, to broaden the scope and range of studies to look at other communication media and other sample types. In all of this, audience perceptions of the source of any communication, seen through the filter of pre-existing attitudes and knowledge, are likely to be significant determinants of the nature and direction of impact of the communication, and this should be explicit in a successful theory.

Future research will need to consider the difference between communications under acute or chronic conditions. Acute risks (in particular when presented in a crisis context) may be difficult to predict in terms of what type of hazard will occur, when, and who will be affected.

Recommendations will therefore need to focus on the process of communication (i.e. Generic guidelines to communication following potential incident). In contrast, for chronic risks, it is

plausible that more information regarding the impact of the risk, and who is affected, is available, and it may be more feasible to tailor messages according to consumer/citizen perceptions of the risks and benefits, the needs of those most affected, and in terms of current behaviours and/or habits. For both acute and chronic risks which are also associated with benefits, identification of what these benefits are (and understanding consumer perceptions of these benefits where appropriate) is of interest. In the case of chronic risks presented as a “crisis” in light of new scientific evidence, consumer and citizen trust in scientific processes may be compromised. Under these circumstances, communication about potential risk mitigation measures (by risk managers and consumers) may be relevant. In addition, the recommendation that effective communication about uncertainties (and what is being done to reduce this) needs to be operationalized through research aimed at further understanding of how to do this.

Considering the differentiation between instrumental and accidental introduction of food hazards into the food chain, trust may be compromised in two ways. Instrumental introduction can be considered in terms of whether it resulted in unintended consequences (in which case communication about mitigation measures and related research activities may be relevant) or deliberate contamination (in which case information about enforcement and identification may be of interest to consumers). Similar recommendations may apply to cases of accidental introductions of food hazards, although in the case of acute or crisis contexts the information channel used may be a critical factor in getting information to affected populations. The risks of naturally occurring hazards may be underestimated by consumers. However, the available data do not systematically compare risk communication about natural and unnatural hazards regarding the tailoring of information content, independent of whether these are acute, or

presented as such) or chronic. In the case of chronic hazards it may be important to conduct longitudinal studies which can gauge the impact of new risk-benefit communication interventions, and the changes in perceptions, attitudes and behaviours of target groups. In the case of potential hazards associated with both risks and benefits, consumers may lose something from not consuming a particular food, or switching to alternatives. Benefit communication is important in this context too.

In addition to the various gaps in knowledge identified in the papers, some additional knowledge lacunae are suggested by the authors. The first relates to the use of social media to deliver risk and benefit communication, and the need to examine the potential and pitfalls of using social media methods in addition to traditional approaches (and compare and contrast the merits of these). To date, empirical examination of the utility of social media has been scarce (see also Rutsaert, et al., 2013). The second relates to conducting more research using non-verbal, i.e. graphical/pictorial, methods for communicating risk/benefit concepts. Third, most of the research included in this review has focused on attitudinal change or intention to behave, rather than (mostly self-reported) behavioural change, and there is evidence that these two concepts are not always well correlated (Webb & Sheeran, 2006), let alone well correlated with actual consumption behaviour.

The next steps which are required comprise the following. First, exploratory research should be applied in order to develop new, and refine existing, theoretical approaches to (food) risk (benefit) communication. Second, empirical tests of these theories (including across different

hazard domains and risk (benefit) characteristics, such as those associated with acute and long term consequences) will deliver a robust test of theory, and facilitate the future translation of theory into practice. As part of this, the impact of risk (benefit) communication on both attitudes and behaviours is needed, as the links between these are sometimes tenuous. Third, following on, there is a need to develop a set of standardised, concrete and actionable guidelines for practitioners, outlining which risk (benefit) communication approaches may work, or not work, under what circumstances, to facilitate application of best practice in food risk communication.

Conclusions

The research which has been conducted into risk (benefit) communication associated with food has been fragmented, and theoretical approaches infrequently applied. Despite this, broad themes in the results of the research (in terms of the characteristics of the target population, the contents of the information, and the of the information sources) can be identified. Some commonalities were identified. For example, both citizen's risk perceptions and risk-related behaviours need to be taken into account in relation to any potential food hazard, and recommendations for behavioural change need to be concrete and actionable. Research has infrequently assessed the impact of risk (benefit) communication on behaviour itself, but has tended to use proxies for behaviour such as attitudinal changes or behavioural intention, perhaps because of procedural difficulties, although this merits consideration in future research.

Acknowledgements

This work was conducted by an expert group of the European branch of the International Life Sciences Institute (ILSI Europe). This publication was coordinated by Fabienne Malherbe, Communication Manager at ILSI Europe. The expert group received funding from the ILSI Europe Consumer Science Task Force. Industry members of this task force are listed on the ILSI Europe website at www.ilsieurope.eu. For further information about ILSI Europe, please email info@ilsieurope.be or call +32 2 771 00 14. The opinions expressed herein and the conclusions of this publication are those of the authors and do not necessarily represent the views of ILSI Europe nor those of its member companies.

C.M.J.L. Vereijken is employee of Danone Research – Centre for Specialised Nutrition; R. Lion is employee of Unilever. L. J. Frewer is a member of the ILSI Research Foundation Board of Trustees. The other authors declare no conflict of interest. The authors would like to thank Nikki Parker for her help in preparing the manuscript.

References

Azjen, I. (1991). The Theory of Planned Behavior, *Organizational Behavior and Human Decision Processes*, **50**: 179-211.

Bambra, C. (2011). Real world reviews: a beginner's guide to undertaking systematic reviews of public health policy interventions. *Journal of epidemiology and community health*, **65**(1): 14-19.

Beck, G., and Kropp, C. (2011) . Is science based consumer advice prepared to deal with uncertainties in second modernity? - The role of scientific experts in risk communication in the case of food supplements. *Science, Technology and Innovation Studies*, **6**: 1-16.

Berg, L. (2004). Trust in food in the age of mad cow disease: A comparative study of consumers' evaluation of food safety in Belgium, Britain and Norway. *Appetite*, **42**: 21-32.

Briner, R. B., and Rousseau, D. M. (2011). Evidence-based I–O psychology: not there yet. *Industrial and Organizational Psychology*, 4(1): 3-22.

Chalmers, I. (2003). Trying to do more good than harm in policy and practice: the role of rigorous, transparent, up-to-date evaluations. *The Annals of the American Academy of Political and Social Science*, **589**(1): 22-40.

Chaiken, S. (1980). Heuristic versus systematic information processing and the use of source versus message cues in persuasion. *Journal of Personality and Social Psychology*, **39**(5): 752-766.

Conner, M. and Armitage, C. J. (1998). Extending the theory of planned behavior: A review and avenues for further research. *Journal of Applied Social Psychology*, **28**(15): 1429-1464.

Costa-Font, M., Gila, J. M., and Traill, W. B. (2008). Consumer acceptance, valuation of and attitudes towards genetically modified food. Review and implications for food policy, *Food Policy*, **22**: 99-111.

Henwood, K., and Pidgeon, N. (eds), (2003), *Grounded theory in psychological research*. Washington, DC, US: American Psychological Association doi: 10.1037/10595-008

Dijk, H. van, Fischer, A. R. H. and Frewer, L. J. (2011). Consumer responses to integrated risk-benefit information associated with the consumption of food. *Risk Analysis*, **31**: 429–439.

Dosman, D. M., Adamowicz, W. L. and Hrudehy, S. E. (2001). Socioeconomic determinants of health-and food safety-related risk perceptions. *Risk Analysis*, **21**: 307–318

El-Gazzar, F. E., and Marth, E. H. (1992). Foodborne disease: Investigative procedures and economic assessment. *Journal of Environmental Health*, **55**(2): 24-27.

Fife-Schaw, C., and Rowe, G. (2006). Public perceptions of everyday food hazards: A psychometric study. *Risk Analysis*, 16(4), 487-500.

Fischer, A. R., van Dijk, H., de Jonge, J., Rowe, G., and Frewer, L. J. (in press). Attitudes and attitudinal ambivalence change towards nanotechnology applied to food production. *Public Understanding of Science*.

Fischer, A. R., De Jong, A. E., Van Asselt, E. D., De Jonge, R., Frewer, L. J., and Nauta, M. J. (2007). Food safety in the domestic environment: an interdisciplinary investigation of microbial hazards during food preparation. *Risk Analysis*, 27(4): 1065-1082.

Fischhoff, B., Slovic, P., Lichtenstein, S., Read, S., and Combs, B. (1978). How safe is safe enough? A psychometric study of attitudes towards technological risks and benefits. *Policy sciences*, 9(2): 127-152.

Frewer, L. (2003). Societal issues and public attitudes towards genetically modified Foods. *Trends in Food Science and Technology*, 14: 319-332.

Frewer, L. J., Bergmann, K., Brennan, M., Lion, R., Meertens, R., Rowe, G., Siegrist, M., and Vereijken, C. (2011). Consumer response to novel agri-food technologies: Implications for predicting consumer acceptance of emerging food technologies, *Trends in Food Science and Technology*, 22 (8): 442-456.

Frewer, L. J., van der Lans, I. A., Fischer, A. R. H., Reinders, M. J., Menozzi, D., Zhang, X., van den Berg, I., and Zimmermann, K. L. (in press 2013). Public Perceptions of Agri-food Applications of Genetic Modification – A Systematic Review and Meta-Analysis. *Trends in Food science and Technology*.

Frewer, L. J., Howard, C., Hedderley, D., and Shepherd, R. (1997). The elaboration likelihood model and communication about food risks. *Risk Analysis*, 17 (6): 759-770.

Glik, D. C. (2007). Risk Communication for public health emergencies. *Annual Review of Public Health*, 28: 33 -54.

Greenhalgh, T., Robert, G., McFarlane, F., Bate, P., and Kyriakidou, O. (2004). Diffusion of innovations in service organizations: Systematic review and recommendations. *The Milbank Quarterly*, 82(4): 581-630.

Greenhalgh, T., Robert, G., McFarlane, F., Bate, P., and Kyriakidou, O. (2005). Diffusion of innovations in service organizations: A Systematic review. Massachusetts: Blackwell Publishing.

Griffin, R. J., Dunwoody, S., and Neuwirth, K. (1999). Model of the relationship of risk information seeking and processing to the development of preventive behaviors. *Environmental Research Section A*, 80: S230-S245.

Hooper, L., Thompson, R. L., Harrison, R. A., Summerbell, C. D., Ness, A. R., Moore, H., Worthington, H. V., Durrington, P. N., Higgins, J. P. T., Capps, N. E., Riemersma, R. A., Ebrahim, S. B., and Smith, G. D. (2006). Risks and benefits of omega 3 fats for mortality, cardiovascular disease, and cancer: systematic review. *British Medical Journal*, 332(7544): 752-755.

Kher, S. V., De Jonge, J., Wentholt, M. T. A., Deliza, R., de Andrade, J. C., Cnossen, H. J., Luijckx, N. B. L., and Frewer, L. J. (2011). Consumer perceptions of risks of chemical and microbiological contaminants associated with food chains: a cross-national study. *International Journal of Consumer Studies*, 37(1): 73-83.

Kirk, S. F. L., Greenwood, D., Cade, J. E., and Pearman, A. D. (2002). Public perception of a range of potential food risks in the United Kingdom. *Appetite*, 38: 189-197.

Kellens, W., Terpstra, T., and De Maeyer, P. (2013). Perception and communication of flood risks: A systematic review of empirical research. *Risk Analysis*, 33: 24-49.

Kleef, E. van , Frewer, L. J., Chryssochoidis, G. M., Houghton, J. R., Korzen-Bohr, S. , Krystallis, T., Lassen, J., Pfenning, U., and Rowe, G. (2006). Perceptions of food risk management among key stakeholders: Results from a cross-European study, *Appetite*, 47(1): 46-63.

Kleef, E. van, Ueland, Ø. , Theodoridis, G. , Rowe, G., Pfenning, U., Houghton, J., van Dijk, H., Chryssochoidis, G., and Frewer, L. J (2009). Food risk management quality: consumer evaluations of past and emerging food safety incidents. *Health, Risk and Society*, 11(2): 1-27.

Knuth, B. A., Connelly, N. A., Sheeshka, J., and Patterson, J. (2003). Weighing health benefit and health risk information when consuming sport-caught fish. *Risk Analysis*, 23(6): 1185-1197.

König, A., Kuiper, H.A., Marvin, H.J.P., Boon, P.E., Busk, L., Cnudde, F., Cope, S., Davies, H.V., Dreyer, M., Frewer, L.J., Kaiser, M., Kleter, G.A., Knudsen, I., Gérard, P., Prandini, A., Renn, O., Smith, M.R., Traill, B.W., van der Voet, H., van Trijp, H., Vos, E., and Wentholt, M.T.A. (2010). The SAFE FOODS framework for improved risk analysis of foods. *Food Control*, 21, 12, 1566–1587.

Lampila, P., and Lähteenmäki, L. (2007). Consumers' attitudes towards high pressure freezing of food. *British Food Journal*, 109: 838-851.

Lusk, J. L., Jamal, M., Kurlander, L., Roucan, M., and Taulman, L. (2005). A meta-analysis of genetically modified food valuation studies. *Journal of Agriculture and Resource Economics*, 30(1): 28-44.

Petty, R., and Cacioppo, J. (1986). The elaboration likelihood model of persuasion. *Advances in Experimental Social Psychology*, 19: 123-205.

Pidgeon, N., Kasperson, R., and Slovic, P., Eds. (2003). *The Social Amplification of Risk*. Cambridge UK: Cambridge University Press.

Poortinga, W., and Pidgeon, N. F. (2005). Trust in Risk Regulation: Cause or Consequence of the Acceptability of GM Food? *Risk Analysis*, 25: 199–209.

Renn, O., and Rohrman, B. (2000). *Cross-cultural risk perception: A survey of empirical studies*. Boston, Dordrecht and London: Kluwer.

Rozin, P., Spranca, M., Krieger, Z., Neuhaus, R., Surillo, D., Swerdlin, A., and Wood, K. (2004). Preference for natural: instrumental and ideational/moral motivations, and the contrast between foods and medicines. *Appetite*, 43: 147-154.

Rutsaert, P., Regan, Á., Pieniak, Z., McConnon, Á., Moss, A., Wall, P., and Verbeke, W. (in press 2013). The use of social media in food risk and benefit communication. *Trends in Food Science and Technology*. Doi: 10.1016/j.tifs.2012.10.006.

Saba, A., and Messina, F. (2003). Attitudes towards organic foods and risk/benefit perception associated with pesticides. *Food Quality and Preference*, 14: 637-645.

Savadori, L., Graffeo, M., Bonini, N., Lombardi, L., Tentori, K., and Rumiati, R. (2007). Rebuilding consumer trust in the context of a food crisis. In: *Trust in risk management* pp.159-171.

Siegrist, M., Earle, T. C., and Gutscher, H., Eds., Earthscan, London, Washington.

Siegrist, M., Cousin, M. E., Kastenholz, H., and Wiek, A. (2007a). Public acceptance of nanotechnology foods and food packaging: The influence of affect and trust. *Appetite*, 49(2): 459-466.

Siegrist, M., Gutscher, H., and Keller, C. (2007b). Trust and confidence in crisis communication: Three case studies. In: *Trust in risk management*, pp. 267-286.

Siegrist, M., Earle, T. C., and Gutscher, H., Eds., Earthscan, London, Washington.

Sparks, P., Shepherd, R., and Frewer, L. J. (1995). Assessing and structuring attitudes towards the use of gene technology in food production: The role of perceived ethical obligation. *Journal of Basic and Applied Social Psychology*, 16: 267-285.

Slovic, P. E. (2000). *The perception of risk*. Earthscan Publications.

Tenbült, P., De Vries, N. K., Dreezens, E., and Martijn, C. (2008). Intuitive and explicit reactions towards "new" food technologies: Attitude strength and familiarity. *British Food Journal*, 110(6): 622-635.

Ter Huurne, E., and Gutteling, J. (2008). Information needs and risk perception as predictors of risk information seeking. *Journal of Risk Research*, 11: 847-862.

Thompson, K. M. (2002). Variability and uncertainty meet risk management and risk communication. *Risk Analysis*, 22(3): 647-654.

Trumbo, C.W., and McComas, K. A. (2003). The function of credibility in information processing for risk perception. *Risk Analysis*, 23(2): 343-353.

Verbeke, W. (2001). Beliefs, attitude and behaviour towards fresh meat revisited after the Belgian dioxin crisis. *Food Quality and Preference*, 12: 489-498.

Verbeke, W., Sioen, I., Pieniak, Z., Van Camp, J., and De Henauw, S. (2005). Consumer perception versus scientific evidence about health benefits and safety risks from fish consumption. *Public Health Nutrition*, 8(4): 422-429.

Verbeke, W., and Vackier, I. (2005). Individual Determinants of Fish Consumption: Application of the Theory of Planned Behaviour. *Appetite* 44(1): 67–82.

Verbeke, W., Vanhonacker, F., Frewer, L. J., Sioen, I., De Henauw, S., and Van Camp, J. (2008). Communicating risks and benefits from fish consumption: Impact on Belgian consumers' perception and intention to eat fish. *Risk Analysis*, 28: 951-967.

Verplanken, B. (1991). Persuasive communication of risk information: A test of cue versus message processing effects in a field experiment. *Personality and Social Psychology Bulletin*, 17: 188-193.

Visschers, V. H. M., Meertens, R. M., Passchier, W. F., and de Vries, N. K. (2008). Audiovisual risk communications unraveled: effects on gut feelings and cognitive processes. *Journal of Risk Research*, 11: 207-221.

Webb, T. L., and Sheeran, P. (2006). Does changing behavioral intentions engender behaviour change? A meta-analysis of the experimental evidence. *Psychological Bulletin*, 132: 249-268.

Yang, J., and Goddard, E. (2011). The evolution of risk perceptions related to bovine spongiform encephalopathy- Canadian consumer and producer behaviour. *Journal of Toxicology and Environmental Health, Part A*, 74: 191-225.

	Instrumental change results in introduction of potential food hazard into the human food chain		Accidental introduction of potential food hazard into the human food chain		Naturally occurring potential food hazards	
	Consequences potentially negative	Consequences negative and/or positive	Consequences potentially negative	Consequences potentially negative and positive	Consequences potentially negative	Consequences potentially negative and positive
Acute	<p><i>Negative impacts may be the consequence of deliberate and unintended introductions</i></p> <p><i>Deliberate introduction of hazard.</i></p> <ul style="list-style-type: none"> - Melamine contamination of milk powder (deliberate fraud) - Horse meat in beef meat (adulteration) 	<p><i>Consumer behaviours directed towards one societally approved outcome may accidentally introduce increased risks</i></p> <ul style="list-style-type: none"> -Consumers may use microbiologically contaminated foods leftover to reduce household food waste -Increased production of biofuels increases food prices with concomitant impacts on food safety as consumers use food 	<p><i>Food hazards frequently presented in a "crisis" context and as such specific incidents are less easy to predict</i></p> <ul style="list-style-type: none"> -Dioxin food chain contamination incidents (Belgium, Germany, Ireland etc) - Radioactive contamination of foods (Chernob 	<p><i>Introduction of novel foods may increase nutrition levels while simultaneously introducing risks.</i></p> <ul style="list-style-type: none"> -The introduction of meat substitutes such as insect proteins may have beneficial impacts on the environment (reduced meat production resulting 	<p><i>Microbiological contamination "outbreak" or microbiological contamination incident</i></p> <ul style="list-style-type: none"> - Salmonella, Campylobacter, E-coli O157H7 outbreaks associated with specific food outlets - Microbiological contamination of foods associated with 	<p><i>Foods may be associated both risks and benefits associated with nutrients or other food constituents.</i></p> <ul style="list-style-type: none"> -Natural toxins e.g. Kidney beans containing naturally a toxin known as phytohaemagglutinin if inappropriately prepared.

		which has passed its best-before date _ Consumer requirement for “minimally processed foods”, promotion of “sous-vide” foods (mild treatment)	yl, Fukushima) - Guargum contamination	in more efficiencies in the production chain) and improved consumer health (reduced fat intake) but also have negative consequences (environmental impacts following environmental escape of farmed animals or introduction of novel allergens, unintended exposure to existing allergens)	domestic hygiene practices -Listeria monocytogenes outbreaks (cheese made of unpasteurised milk, pate)	
Chronic	Negative impacts may be presented in a crisis context, but	Negative consequences may also include negative consumer responses, independent	Unintentional use of hazardous ingredients instead	Food associated with health promotions introduce	Emerging hazards may result as a consequence of concomit	Foods may increase both risks and benefits associated with long term

	<p>represent a “chronic” risk in terms of duration and associated mitigation strategies.</p> <p><i>Unintended introduction of hazard</i></p> <ul style="list-style-type: none"> -BSE in cattle and new variant CJD in humans mitigated over a time period. <p><i>Deliberate introduction of hazard</i></p> <ul style="list-style-type: none"> -Methanol in wine to improve organoleptic properties 	<p>of technical risk assessments . Ethical objections may also be raised</p> <ul style="list-style-type: none"> -Food irradiation, pesticides used in food production, - Nanotechnology used in food packaging -Use of artificial food additives -Animal cloning for food supply -genetic modification of plants and animals - GMOs <p>Other risks may arise as a consequence of inappropriate consumption</p> <ul style="list-style-type: none"> -Use and misuse of some functional ingredients or enriched foods (for example, high intake of foods 	<p>of a safe equivalent</p> <ul style="list-style-type: none"> -Illicium anisatum (Japanese star anise) used in error instead of Illicium verum (Chinese star anise) 	<p>additional risks to potentially vulnerable groups</p> <ul style="list-style-type: none"> -Methyl mercury contamination of fish (consumption simultaneously associated with increased omega three fatty acids) - Food allergies/allergic foods (e.g. kiwi) - Milk for babies 	<p>ant external changes</p> <ul style="list-style-type: none"> - Mycotoxins (due to lack of Good Agricultural Practice) and their emerging occurrence (e.g. as a consequence of climate change) 	<p>nutrient intake</p> <ul style="list-style-type: none"> -Seaweed represents a “novel” food for many Europeans. Seaweed consumption may introduce increase consumption of iodine to deficient populations, but increase salt consumption to unacceptable levels.
--	---	---	--	--	---	---

		enriched with some vitamins) / - Fortification of foods with vitamins/micro nutrients (risk of overdose especially in case of regular consumption of food supplements)				
Chronic risk presented as a “crisis” in light of new scientific knowledge or increase in societal concern	Negative impacts may be presented in a crisis context, but represent a “chronic” risk in terms of duration and associated mitigation strategies. -BSE in cattle and new variant CJD in humans, - Acrylamide in	Often related to the introduction of controversial existing or emerging food technologies, where new research regarding putative risks and/or benefits are associated with extensive media attention. -Genetic modification of food crops and animals for food products, pesticide application to food crops	Increasing evidence base results in policy responses or media dissemination of information -Antibiotic use as growth promoters in animal and fish farming may be associated with increase of antibiotic resistant strains of pathogen	Novel risk assessment methodologies highlight “new risks” associated with potential hazards previously thought to be safe -Pesticide residues on fruit and vegetables - Chemicals migrating onto food from food packaging	Increased understanding of toxicology may identify “new” food risks - Differential vulnerabilities to toxic substances across the population may require targeted risk communication strategies	Foods continually associated with different reports of risks and benefits -Red wine consumption has variously been reported as having beneficial health effects (e.g. on cardiovascular system) as well as negative health effects related to alcohol content -Debate about Meat

	baked products - Transfats used in food processing - Certain applications of nanotechnology in food processing		s	· -(Certain) Food colorants		consumption (vegetarian vs. paleolithic diets in evolutionary psychology)
--	---	--	---	--------------------------------	--	---

Table 1. Examples of different types of potential food hazards classified according to whether or not they have been deliberately or accidentally introduced into the food chain, or are naturally occurring, and whether they represent acute or chronic risks. Please note that this table is not intended to be inclusive, and the examples provided are illustrative only.

TITLE-ABS-KEY
Search term 1 (AND)
(food* or agri* or agro*)
Search term 2 (AND)
(risk*)
Search term 3 (AND)
(public or consumer* or citizen or lay or individual)
Search term 4 (AND)

(attitude* or percept* or accept* or opinion* or view*)
Search term 5 (AND)
(communicat* or dialogue)
AND
Peer reviewed and English language

Table 2. Final search string applied in the search

Decision Questions	Coding Decision
Is the abstract primarily focused on research on food and agriculture? If no then exclude.	Excluded N=79
Is the abstract reporting research that deals with risks associated with food/agriculture? If no then exclude.	Excluded N=12
Is the abstract reporting research that focuses on the communication of food/agriculture risks to the general public?	Excluded N=68
Not sufficient detail to answer questions above	Excluded N=4

Table 3: Rapid evaluation screening criteria

What was assessed in terms of risk and benefit perception	Year of publication			
	1990-1996	1997-2001	2002-2006	2007-2011
No risk or benefit perception assessed	5 71.43 %	2 33.33 %	6 37.50 %	13 52.00 %
Only risk perception assessed	1 14.29 %	2 33.33 %	6 37.50 %	9 36.00 %
Risk and benefit perception assessed	1 14.29 %	2 33.33 %	4 25.00 %	3 12.00 %

Table 4. Assessment of risk perceptions, benefit perceptions, and both risk and benefit perceptions with time

Outcome measure reported:	Risk perception	Attitude	Behavioural intention	Risk & Benefit perception	Risk perception & Attitude	Risk perception & Behavioural intention	Attitude	Behavioural intention	Intention	Attitude & Behavioural intention	Behavioural intention	TOTAL
Effect of communication aimed at change in:												
Cognitive impact / Attitude	5	2	1	2	0	0	3	1	0	0	1	15
Intention	1	0	2	0	0	0	0	0	0	0	0	3
Behaviour	1	0	0	0	0	1	0	0	0	0	0	2
Cognitive impact/Attitude & Intention	1	0	3	0	1	3	1	0	1	1	0	11
Cognitive impact/Attitude & Behaviour	1	0	0	0	0	1	0	0	0	0	0	2
Cognitive impact/Attitude & Intention & Behaviour	0	0	0	1	0	0	0	0	0	0	0	1
TOTAL	9	2	6	3	1	5	4	1	1	1	1	34

Table 5: Measured outcomes against stated aim of paper. For the shaded cells, the outcome measure is not directly linked to the intended effect of the communication intervention.

Information variations	N
Type of risk	4
Framing	6
Source	6
Order of arguments	3
Quantity of information	3
Type of information	5
Information format	2
Participant characteristics	
Sample demographics	2
Prior attitude	2
Motivation	1

Table 6. Variation in information qualities and participant characteristics

Article	Results concerning TARGET CHARACTERISTICS
Aizakia, Nakashima, Ujiie, Takeshita, & Taharae, 2011	Consumers who are <i>interested in</i> , and enquiring about, risk information are more likely to access food risk information.
Angulo & Gil, 2007	Higher <i>education levels</i> are related to higher confidence in food safety and lower risk perception.
Chipman, Kendall, Slater, & Auld, 1996	Different media have different effects according to <i>audience differences</i> in concern level prior to communication.
Derrick, Miller, & Andrews, 2008	Risk communication can improve knowledge and influence behaviour change appropriately for specific behaviours and

	<i>vulnerable groups.</i>
Figuié & Fournier, 2008	Public <i>confidence</i> in their own risk avoidance strategies can be an obstacle to introducing new practices in risk communication.
Fisher & Chen, 1996	People are more satisfied with risk information about things in which they are primarily <i>interested in.</i>
Frewer, Howard, & Shepherd, 1998	<i>Initial attitude</i> was the most important determinant of post-communication attitude. Also, <i>admitting risk uncertainty</i> increased acceptance of technology communicated about.
Frewer, Scholderer, & Bredahl, 2003	<i>Prior attitude</i> is the dominant predictor of post information risk/benefit perception and attitude. <i>Trust</i> follows from prior attitude and does not influence post information attitude or RP or BP.
Glik, Drury, Cavanaugh, & Shoaf, 2008	<i>Misinterpretation</i> of key words and concepts by the public can make communication materials ineffective. When new knowledge is presented, it must be <i>compatible</i> with what people already know and how it is organised before it can be assimilated into memory.
Hughner, Maher, Childs, & Nganje, 2009	The provision of advisory information about a food product has a differential impact on different population groups. Groups that have been assessed to be <i>not at risk</i> are most likely to discard information.
Kim & Paek, 2009	Level of <i>motivation</i> plays a role in heuristic and systematic processing of information on risks (and benefits), affecting extent of attitude change.
Kjærnes, 2006	Different <i>nationalities</i> have differing levels of trust in food. <i>Social/demographic variables</i> have only limited impact apart from <i>gender</i> where women were found to be more sceptical and distrustful than men.
Koç & Ceylan, 2009	The purchasing habits of consumers can change differentially for different <i>socioeconomic parameters</i> (<i>age, employment, education, sex</i>). as a result of the provision of risk information from various sources in various formats.
Kuttschreuter, 2006	An individual who is actively <i>trying to avoid a risk</i> will seek out more information about that risk and this process of seeking information influences their perceptions of, and affective responses to, a risk.
Meijnders, Midden, Olofsson, Öhman, Matthes, Bondarenko, & Rusanen, 2009	A source of information was considered more trustworthy if expressed attitudes were <i>congruent</i> with those of the person(s) receiving the information.
O'Neil, Elias, & Yassi, 1997	Risk Communication outputs must be sensitive to <i>cultural and public health values</i> as well as <i>scientific output.</i>
Shimshack, Ward, &	Information-based initiatives can be effective by reducing

Beatty, 2007	expenditure on and consumption of risky products amongst a targeted <i>at risk group</i> . However, not the whole target population may be reached while non-target population may act on the communication not intended for them.
Tucker, Whaley, & Sharp, 2006	Food safety risk perceptions, in particular towards biotechnology, are elevated as <i>media dependency</i> (attachment to mass media) increases.
van Dijk, Houghton, van Kleef, van der Lans, Rowe, & Frewer, 2008	There are <i>cross-cultural (national) differences</i> in interpretation of risk communication messages.
Vardeman & Aldoory, 2008	Contradictory health communications analysed in several ways, such as filtering information against <i>prior beliefs</i> , and influenced by <i>personal situation</i> (e.g. pregnant women focus more on health risk than benefit communication compared to others).
Verbeke & Van Kenhove, 2002	Increased <i>need for information</i> and higher <i>importance of risk information</i> associated with lower emotional stability during crisis.
Verbeke, Vanhonacker, Frewer, Sioen, De Henauw, & Van Camp, 2008	Differential impact of risk, benefit, and balanced information (on perceptions of attributes and behavioural intention), that may have been mediated by <i>initial perceptions of the topic</i> communicated about (here, positive).

Table 7.a Results concerning target characteristics

Article	Results concerning NATURE OF INFORMATION
Batrinou, Dimitriou, Liatsos, & Pletsas, 2005	<i>Relevant information</i> can lead to more positive attitudes about the acceptability of a technological innovation.
Blanchemanche, Marette, Roosen, & Verger, 2010	<i>Conflicting risk and benefit information</i> confuses people and leads them to resort to habitual food choices.
Bord & O'Connor, 1990	Information type has differential impact on attitudes to a novel food technology: <i>technical information</i> had less impact than <i>non-technical</i> concerning history of (safe) usage and prestigious endorsers.
Chipman, Kendall, Slater, & Auld, 1996	Different <i>media</i> have different effects according to audience differences in concern level prior to communication.
Connelly & Knuth, 1998	<i>Multiple information formats</i> are best at communicating information. Also, a <i>cajoling</i> rather than <i>commanding</i> tone is better at communicating information.
Feng, Keller, Wang, & Wang, 2010	<i>Risk communication</i> can improve knowledge and influence behaviour change appropriately for <i>specific behaviours and vulnerable groups</i> .
Fischer & Frewer, 2009	Certain characteristics of information appear to lead to increased attention, notably, <i>risk information over benefit information</i> ; information on <i>unfamiliar</i> as opposed to <i>familiar</i> products; and information presented <i>first</i> .
Fleming, Thorson, & Zhang, 2006	Different <i>media</i> channels, used for the provision of risk information, may result in different selection and usage of a certain information-processing strategy (e.g. elaboration more likely when reading a <i>newspaper</i> story than when watching <i>TV</i>) by the public.
Frewer, Howard, Hedderley, & Shepherd, 1997	Credibility of source related to risk perception, but mediated by factors such as <i>perceived hazard characteristics</i> and <i>information content</i> .
Frewer, Miles, Brennan, Kuznesof, Ness, & Ritson, 2002	<i>Uncertainty with the scientific process</i> of risk management is more accepted (in communications) <i>than uncertainty due to lack of action or lack of interest</i> on the part of the government.
Knuth, Connelly, Sheeshka, & Patterson, 2003	<i>Order</i> in communication affects preferences, specifically, asking about risk first increases risk perceptions; asking about benefits first increases benefits perceptions.
Koç & Ceylan, 2009	The purchasing habits of consumers can change differentially for different socioeconomic parameters (age, employment, education, sex). as a result of the provision of risk

	information from <i>various sources</i> in <i>various formats</i> .
Miles & Frewer, 2003	People respond to different types of uncertainty in a similar way. Optimistic bias demonstrated regarding <i>likelihood of personal risk versus risk to others</i> after risk communication.
Nauta, Fischer, Van Asselt, De Jong, Frewer, & De Jonge, 2008	As people receive information about food safety, their motivation to adopt safer food preparation practices increases. Actual behaviour change requires <i>communication at the moment of the behaviour</i> .
Ogoshi, Yasunaga, Obana, Ogawa, & Imamura, 2010	<i>More information</i> leads to lower anxiety.
Park & Lee, 2003	<i>Framing</i> a technology in different ways influences benefit perception (Genetic engineering more positive than Genetic modification or Biotechnology) and risk perception (Genetic engineering lowest, than Biotech, Gen Mod most risky), but no differences on uncertainty, attitude or purchase intention.
Qin & Brown, 2006	<i>Process related consequences</i> (on molecular level, fish fertility, and ethical cultural consequences) and <i>product consequences</i> (business impact, benefits to food system, improved regulation requirement, consumer choice, ecosystem) raised demand for labelling and information and multiple stakeholders acting in consensus.
Rodriguez, 2007	Provision of <i>information</i> on a food technology results in receivers being initially less favourable about a technology, perceiving it as more of a safety risk than those who received <i>no information</i> .
Sapp & Korsching, 2004	The effect of negative information can be reduced over time by <i>positive endorsements by opinion leaders</i> suggesting that confidence in social institutions may influence public adoption of a food technology/product.
Saulo & Moskowitz, 2011	<i>Food safety messages</i> were <i>not</i> found to increase consumers' willingness to pay a premium for safer food.
Siegrist & Cvetkovich, 2001	Certain information is more trusted – notably, <i>information indicating health risks</i> versus <i>information not indicating health risks</i> (independent of trust in source).
Singer, Williams, Ridges, Murray, & McMahan, 2006	Presenting a short health statement on the front of package is trusted more if <i>more comprehensive data</i> is printed at the back of pack.
Sparks, Shepherd, & Frewer, 1994	<i>Framing</i> of a technology by selecting specific expressions has an effect on how favourably the public responds to that technology.
van Dijk, Fischer, &	Using QALYS to communicate risk/benefit information may

Frewer, 2011	useful though it is <i>format</i> and <i>situation dependent</i> .
van Kleef, Ueland, Theodoridis, Rowe, Pfenning, Houghton, & Frewer, 2009	Preferred characteristics of communications about risk management include: <i>proactive</i> (over <i>reactive</i>); <i>prompt communication</i> about novel hazards; <i>messages on stringent enforcement</i> . Trust relates to perceptions that <i>public health is prioritised</i> and risk manager have <i>no vested interests</i> . <i>Uncertainty</i> has no negative impact on source trust but may be a cause for alarm in itself
Vardeman & Aldoory, 2008	<i>Contradictory health communications</i> analysed in several ways, such as filtering information against prior beliefs, and influenced by personal situation (e.g. pregnant women focus more on health risk than benefit communication compared to others).
Verbeke, Vanhonacker, Frewer, Sioen, De Henauw, & Van Camp, 2008	Differential impact of <i>risk, benefit, and balanced information</i> (on perceptions of attributes and behavioural intention), that may have been mediated by initial perceptions of the topic communicated about (here, positive).

Table 7.b Results concerning the nature of information

Article	Results concerning CHARACTERISTICS OF INFORMATION SOURCES
Dean & Shepherd, 2007	<i>Conflict</i> and <i>consensus</i> between sources in a communication can affect public perceptions of risks differentially.
Frewer, Howard, Hedderley, & Shepherd, 1997	<i>Credibility</i> of source related to risk perception, but mediated by factors such as perceived hazard characteristics and information content.
Frewer, Howard, Hedderley, & Shepherd, 1996	Different information sources are associated with different characteristics (<i>accuracy; knowledgeable; past history; level of concern for public welfare</i>) and these influences how differentially trusted a source is by the public.
Meijnders, Midden, Olofsson, Öhman, Matthes, Bondarenko, & Rusanen, 2009	A source of information was considered more trustworthy if expressed attitudes were <i>congruent</i> with those of the person(s) receiving the information.
Redmond & Griffith, 2005	Rank order of <i>preferred source</i> : (1) packaging (2) doctor (3) leaflet (4) tv documentary (5) recipe (6) tv cooking show (7) magazines (8) posters (9) tv other (10) radio (11) family (12) friends (13) school (14) fridge magnets (15) printed towels.
Sapp & Korsching, 2004	The effect of negative information can be reduced over time by positive endorsements by opinion leaders suggesting that <i>confidence in social institutions</i> may influence public adoption of a food technology/product.
Velicer & Knuth, 1994	<i>Newspapers and Regulatory Guides</i> are important sources of information for opinion leaders and specific groups of individuals. These groups were stimulated by such information to engage in risk reducing behaviours.

Table 7.c Results concerning characteristics of information sources

Recommendation for future research	Year of publication of paper			
	1990-1996	1997-2001	2002-2006	2007-2011
None	4 66.70%	3 50.00%	3 21.40%	8 36.40%
Theoretical innovation needed	1 16.70%	0 0.00%	1 7.10%	0 0.00%
Utility of information/ how useful is content?	0 0.00%	1 16.70%	0 0.00%	1 4.50%
Trust in information source	0 0.00%	1 16.70%	4 28.60%	0 0.00%
How do you assess impact on behaviour?	0 0.00%	0 0.00%	0 0.00%	1 4.50%
Communicating uncertainty	0 0.00%	0 0.00%	1 7.10%	2 9.10%
Longitudinal analysis (crisis /non-crisis)	0 0.00%	0 0.00%	1 7.10%	3 13.60%
Long term effects on perceptions/behaviour	1 16.70%	0 0.00%	1 7.10%	2 9.10%
Media as a communication channel	0 0.00%	0 0.00%	1 7.10%	0 0.00%
Interactive studies in complex systems	0 0.00%	0 0.00%	1 7.10%	1 4.50%
Individual differences	0 0.00%	1 16.70%	1 7.10%	4 18.20%

Table 8. Recommendations for future research by year of publication

Risk communication recommendation	Year of publication			
	1990-1996	1997-2001	2002-2006	2007-2011
Use balanced and transparent risk (benefit) information when structuring communication	2 40.0%	0 .0%	2 25.0%	5 45.5%
Base communication on prior knowledge of what consumers do..including habitual behaviours	2 40.0%	0 .0%	2 25.0%	2 18.2%
Address alternative value systems as part of communication	0 .0%	0 .0%	1 12.5%	0 .0%
Communicators need to understand both technical and perceptual risk characteristics	0 .0%	1 50.0%	1 12.5%	0 .0%
Be proactive with the public i.e. communicate as soon as an emerging or new risk is identified	0 .0%	0 .0%	1 12.5%	1 9.1%
Use multiple/ appropriate communication channels to reach target audiences	0 .0%	1 50.0%	0 .0%	0 .0%
Target risk communication to (e.g.) vulnerable groups or other relevant message recipients	1 20.0%	0 .0%	1 12.5%	0 .0%
Communicate concrete and actionable risk reduction measures which individuals can take	0 .0%	0 .0%	0 .0%	2 18.2%
Consider the role of trust in information source and/or information channel	0 .0%	0 .0%	0 .0%	1 9.1%

Table 9. Recommendations in best practice for risk communication about food by time