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

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*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 behaviors. 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 behaviors need to be taken into account, and recommendations for behavioral 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.*

**Keywords** Risk perception, risk communication, benefit communication, food hazard, food safety, trust

## INTRODUCTION

Effective risk (and benefit) communication about food issues is important from the perspective of optimizing 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 (Siegrist et al., 2007a; Costa-Font et al., 2008; Frewer et al., 2011; Frewer et al., 2011; Frewer et al., in press 2013; Fischer et al., in press). Alternatively, the need for effective communication with the public

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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 (e.g., 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 (Lusk et al., 2005; Koenig et al., 2010). 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.

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 (El Gazzar and Marth, 1992; Verbeke, 2001). 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 (e.g., 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 behaviors 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 (Saba and Messina, 2003; Verbeke et al., 2005; Hooper et al., 2006; 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. Thompson, 2002; Beck and Kropp, 2011). 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 utilize "dual-processing" theories in developing effective risk communication interventions. These approaches essentially posit that both intuition and reasoning may be utilized 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 behavioral determinants that may be influenced by risk-benefit communication. An example of such an approach is the Theory of Planned Behavior (TPB, Azjen, 1991), which posits that when

**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.

	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 positive	Consequences potentially negative	Consequences potentially negative and positive
Acute	<i>Negative impacts may be the consequence of deliberate and unintended introductions</i>	<i>Consumer behaviors directed toward one societally approved outcome may accidentally introduce increased risks</i>	<i>Food hazards frequently presented in a "crisis" context and as such specific incidents are less easy to predict</i>	<i>Introduction of novel foods may increase nutrition levels while simultaneously introducing risks</i>	<i>Microbiological contamination "outbreak" or microbiological contamination incident</i>	<i>Foods may be associated both risks and benefits associated with nutrients or other food constituents</i>
	<i>Deliberate introduction of hazard</i>	-Consumers may use microbiologically contaminated foods leftover to reduce household food waste	-Dioxin food chain contamination incidents (Belgium, Germany, Ireland, etc.)	-The introduction of meat substitutes such as insect proteins may not only have beneficial impacts on the environment (reduced meat production resulting 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)	-Salmonella, Campylobacter, E-coli O157H7 outbreaks associated with specific food outlets	-Natural toxins, e.g., kidney beans containing naturally a toxin known as phytohaemagglutinin if inappropriately prepared
	- Melamine contamination of milk powder (deliberate fraud)	-Increased production of biofuels increases food prices with concomitant impacts on food safety as consumers use food which has passed its best-before ate	-Radioactive contamination of foods (Chernobyl, Fukushima)			
	-Horse meat in beef meat (adulteration)	-Consumer requirement for "minimally processed foods," promotion of "sous-vide" foods (mild treatment)	-Guargum contamination			

Chronic	Negative impacts may be presented in a crisis context, but represent a "chronic" risk in terms of duration and associated mitigation strategies	Unintended introduction of hazard	Negative consequences may also include negative consumer responses, independent of technical risk assessments. Ethical objections may also be raised	Unintentional use of hazardous ingredient instead of a safe equivalent	Food associated with health promotion introduces additional risks to potentially vulnerable groups	Emerging hazards may result as a consequence of concomitant external changes	Foods may increase both risks and benefits associated with long-term nutrient intake
			<ul style="list-style-type: none"> <li>-Food irradiation, pesticides used in food production, -nanotechnology used in food packaging</li> </ul>	<ul style="list-style-type: none"> <li>-Illicium anisatum (Japanese star anise) used in error instead of Illicium verum (Chinese star anise)</li> </ul>	<ul style="list-style-type: none"> <li>-Methyl mercury contamination of fish (consumption simultaneously associated with increased omega three fatty acids)</li> </ul>	<ul style="list-style-type: none"> <li>-Mycotoxins (due to lack of Good Agricultural Practice) and their emerging occurrence (e.g., as a consequence of climate change)</li> </ul>	<ul style="list-style-type: none"> <li>-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</li> </ul>
	<ul style="list-style-type: none"> <li>-BSE in cattle and new variant CJD in humans mitigated over a time period</li> </ul>	<ul style="list-style-type: none"> <li>-Use of artificial food additives</li> </ul>			<ul style="list-style-type: none"> <li>-Food allergies/allergic foods (e.g., kiwi)</li> </ul>		
	<ul style="list-style-type: none"> <li><i>Deliberate introduction of hazard</i></li> <li>-Methanol in wine to improve organoleptic properties</li> </ul>	<ul style="list-style-type: none"> <li>-Animal cloning for food supply</li> <li>-Genetic modification of plants and animals</li> </ul>					
		<ul style="list-style-type: none"> <li>-GMOs</li> </ul>	<ul style="list-style-type: none"> <li><i>Other risks may arise as a consequence of inappropriate consumption</i></li> </ul>				
			<ul style="list-style-type: none"> <li>-Use and misuse of some functional ingredients or enriched foods (for example, high intake of foods enriched with some vitamins)</li> </ul>				
			<ul style="list-style-type: none"> <li>-Fortification of foods with vitamins/micronutrients (risk of overdose)</li> </ul>				

(Continued on next page)

**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. (*Continued*)

	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
Chronic risk presented as a "crisis" in light of new scientific knowledge or increase in societal concern	<i>Negative impacts may be presented in a crisis context, but represent a "chronic" risk in terms of duration and associated mitigation strategies</i>	especially in case of regular consumption of food supplements) <i>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</i>	<i>Increasing evidence base results in policy responses or media dissemination of information</i>	<i>Novel risk assessment methodologies highlight "new risks" associated with potential hazards previously thought to be safe</i>	Increased understanding of toxicology may identify "new" food risks	<i>Foods continually associated with different reports of risks and benefits</i>
	-BSE in cattle and new variant CJD in humans -Acrylamide in baked products	-Genetic modification of food crops and animals for food products, pesticide application to food crops	-Antibiotic use as growth promoters in animal and fish farming may be associated with increase of antibiotic resistant strains of pathogens	-Pesticide residues on fruit and vegetables	-Differential vulnerabilities to toxic substances across the population may require targeted risk communication strategies	-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 consumption (vegetarian vs. paleolithic diets in evolutionary psychology)
	-Transfats used in food processing			-Chemicals migrating onto food from food packaging		
	-Certain applications of nanotechnology in food processing			-(Certain) Food colorants		

an individual has a positive attitude toward a particular behavior, thinks that significant others want him to perform the behavior (subjective norm), and assumes that the behavior is not too difficult to perform (perceived behavior control), this will result in an intention to engage in the behavior. This intention will lead to the behavior, unless unexpected internal or external barriers arise. Various extensions to the Theory of Planned Behavior, such as past behavior/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 behavioral 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 postrisk communication intervention is required to demonstrate a meaningful effect on risk-related attitudes and behaviors. 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 rigor 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) analyzing and synthesizing 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 behaviors of the general public.

### ***Locating and Selecting Studies***

A list of search terms was developed. The research question was broken down into five key groupings of possible keywords: (1) “food”; (2) “risk”; (3) “public”; (4) “attitudes and behaviors”; 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. Nonpeer reviewed journal papers were excluded from the review to ensure appropriate academic rigor. 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.<sup>1</sup> The search yielded 368 unique references.

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 intercoder 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.

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 six 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:

<sup>1</sup>The Scopus database provides access to over 18,500 peer-reviewed journals, with a strong presence in scientific, technical, medical, and social sciences fields as well arts and humanities.

**Table 2** Final search string applied in the search

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) (communicate* or dialogue)
AND
Peer reviewed and English language

“Does the paper report a relevant empirical primary study on risk/benefit communication?” The papers were distributed evenly across the nine reviewers, with 20% of the papers ( $N = 41$ ) being reviewed twice by different members of the review team to allow for intercoder agreement. Of the 199 papers, 86 were scored, using this single criterion, as relevant with an intercoder 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 pretested on three papers by all nine reviewers. The coding scheme was further refined and a second pretest was conducted, resulting in the finalization of a coding scheme containing the following superordinate code categories: (1) identification of each paper, (title, authors, year, and journal); (2) relevant information about the methodologies utilized (e.g., whether quantitative or qualitative data collection was utilized); (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 utilized; (6) the channel or media of

**Table 3** Rapid evaluation screening criteria

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 $N = 4$

communication (e.g., information leaflet, TV; print; online, and social media); and (7) the aim of the communication (e.g., behavior 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 summarized through a multistage 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 1990<sup>2</sup> 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 behavior, 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 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

<sup>2</sup>The database has an incomplete coverage before 1996.

“snowballing” to recruit participants, six used self-selection through initial contact made via commercial mailing lists, and another six 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, seven papers reported utilizing 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, nine on genetic modification of foods, three on food irradiation, and one on the use of pesticides. BSE was the topic of one paper, and microbiological risk of four 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 utilize specific examples of potential foods.

### **Risk and/or Benefit Communication**

Of the 54 papers included, 10 provided information focused on generic or nonspecified 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).

### **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 three 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 utilized ( $N = 14$ ). Information on packaging labels was included in the experimental design three times, as were information in newspaper articles and information embedded in the questionnaire used in the research. The internet was utilized 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 one source: four papers compared communication provided by government, industry and NGO sources; three compared governmental with academic sources, two 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

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

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%

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 behavior ( $N = 38$ ; 69%). Thirty percent focused on changing behavioral intention ( $N = 17$ ; 31%). Only 9 (17%) reported examining the impacts of the communication on changing behavior. A total of 18 papers aimed at multiple changes, of which 1 measured cognitive determinants, behavioral intention and (self-reported) behavioral change.

Risk perception was measured as sole dependent in 11 papers. In four papers, risk and benefit perception were measured but nothing else. In one paper, risk perception and attitude was measured, and in five papers risk perception and intention. In four papers, risk perception, benefit perception, and attitude were measured; in one paper, risk perception, benefit perception, and intention; and in one 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 behavior included only scales for cognitive constructs such as risk perception, rather than measures for intention or (self-reported) actual behaviors (see Table 5).

### ***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 summarizes the number of papers varying information characteristics or taking into account participant characteristics in the analysis of effects.

### ***Underlying Paradigms and Theories***

Twenty of the papers adopted a formal theoretical approach or theory. Of those which did, four utilized dual-processing

theories in some way (the ELM was used in three 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 behavior selection. The RISP model was used in two studies. Social judgment theory was used in two 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 utilized 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 utilizing 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.

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). Tables 7a, 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 italicized. 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 behaviors 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

**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

Outcome measure reported: Effect of communication aimed at change in:	Risk perception	Attitude	Behavioral intention	Risk and benefit perception	Risk perception and attitude	Risk perception and behavioral intention	Risk perception and benefit perception and attitude	Risk perception and benefit perception and behavioral intention	Risk perception and attitude and behavioral intention	Risk perception and benefit perception and attitude and behavioral intention	Attitude and behavioral intention	Total
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
Behavior	1	0	0	0	0	1	0	0	0	0	0	2
Cognitive impact/attitude and intention	1	0	3	0	1	3	1	0	1	1	0	11
Cognitive impact/attitude and behavior	1	0	0	0	0	1	0	0	0	0	0	2
Cognitive impact/attitude and intention and behavior	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 6** Variation in information qualities and participant characteristics

Information variations	<i>N</i>
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

representing best practice in three 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 emphasized as an important determinant of people's responses to risk communication in three 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, three 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 (e.g., 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.

### **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 six papers), and the need for further empirical investigation of trust in information sources (five 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 four papers, the impact on risk-related behavior in two papers, and the extent to which the information was regarded as useful by recipients in five papers. The need for more research regarding the

communication of uncertainty was identified in three papers. The need to investigate risk communication in real contexts and environments was mentioned twice.

### **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 analyze 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 focused 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 (e.g., 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 toward 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 behavior 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

**Table 7a** Results concerning target 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 behavior change appropriately for specific behaviors 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 postcommunication 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 organized 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 skeptical 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, and 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, & Beatty, 2007	Information-based initiatives can be effective by reducing 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 nontarget 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 analyzed 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 behavioral intention), that may have been mediated by <i>initial perceptions of the topic</i> communicated about (here, positive).

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 behavioral intention, and relatively few (9 of 54) examined the impacts of the communication on changing behavior. Of the dependent variables assessed, risk perception was most frequently studied (in approximately half of the papers); fewer papers measured attitudes, benefit perceptions

**Table 7b** Results concerning the nature of information

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>nontechnical</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 behavior change appropriately for <i>specific behaviors 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) than <i>uncertainty due to lack of action</i> or <i>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 ( <i>age, employment, education, and sex</i> ) 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 behavior change requires <i>communication at the moment of the behavior</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, and ecosystem) raised demand for labeling 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 favorable 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</i> by <i>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, & McMahon, 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 favorably the public responds to that technology.
van Dijk, Fischer, & Frewer, 2011	

(Continued on next page)

**Table 7b** Results concerning the nature of information (*Continued*)

Article	Results concerning "Nature of Information"
van Kleef, Ueland, Theodoridis, Rowe, Pfenning, Houghton, & Frewer, 2009	Using <i>QALYS</i> to communicate risk/benefit information may be useful though it is <i>format</i> and <i>situation dependent</i> . 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 prioritized</i> and risk managers 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> analyzed 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 behavioral intention), that may have been mediated by initial perceptions of the topic communicated about (here, positive).

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 behaviors specified their outcome variables at the level of attitudes, rather than measuring change in behavioral 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, and type of risk), with fewer studies considering variables related to the participant sample (sample characteristics, motivation, and 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 utilized 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 (e.g., regarding the impact of combined information/source characteristics on attitudes and subsequent behavior) 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 (e.g., 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

**Table 7c** Results concerning characteristics of information sources

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, and (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 behaviors.

**Table 8** Recommendations for future research by year of publication

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 behavior?	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 /noncrisis)	0 0.00%	0 0.00%	1 7.10%	3 13.60%
Long term effects on perceptions/behavior	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%

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

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

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 behaviors	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%

there is unlikely to be a single “magic bullet” for risk/benefit communication. Recommendations for best practice (see Tables 8 and 9) 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 behaviors 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 behaviors 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 behaviors 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 nonverbal, that is, 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) behavioral change, and there is evidence that these two concepts are not always well correlated (Webb and Sheeran, 2006), let alone well correlated with actual consumption behavior.

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 behaviors is needed, as the links between these are sometimes tenuous. Third, following on, there is a need to develop a set of standardized, 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 behaviors need to be

taken into account in relation to any potential food hazard, and recommendations for behavioral change need to be concrete and actionable. Research has infrequently assessed the impact of risk (benefit) communication on behavior itself, but has tended to use proxies for behavior such as attitudinal changes or behavioral intention, perhaps because of procedural difficulties, although this merits consideration in future research.

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## STATEMENT OF INTEREST

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