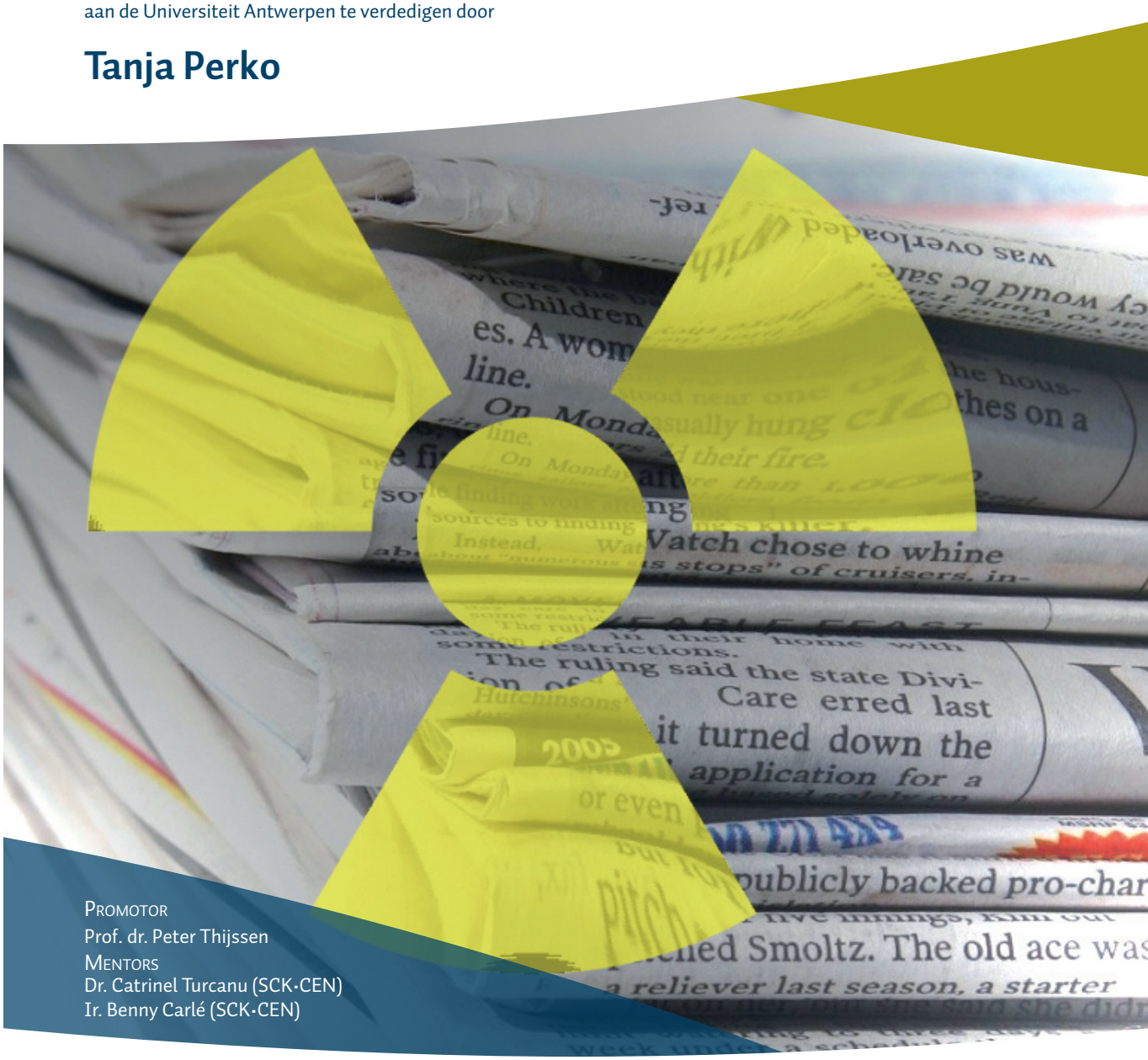
Modelling Risk Perception and Risk Communication in Nuclear Emergency Management: An Interdisciplinary Approach

Proefschrift voorgelegd tot het behalen van de
graad van doctor in de Sociale Wetenschappen
aan de Universiteit Antwerpen te verdedigen door

Tanja Perko



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Antwerpen 2012

Universiteit Antwerpen

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This research was supported by the Aspirant Wetenschappelijk Medewerker (*AWM*) program founded by the Belgian nuclear research centre SCK·CEN. The research was performed within the Programme of Integration of Social Aspects into Nuclear Research (PISA).

Cover picture design: Janez Perko

ISBN: 9789057283918

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Acknowledgements

First and foremost, I would like to express my sincere gratitude to my promoter Professor Peter Thijssen and mentor Catrinel Turcanu for their valuable guidance and support as well as for showing a great deal of understanding over the past years. Benny Carlé, thank you for introducing me to the emergency management field and further to engage your diplomacy in order to get the support of the Scientific Council at SCK·CEN which resulted in my study scholarship. Thanks to the Scientific Council for recognising the importance of social science during the so called nuclear renaissance. It took a strong team to get this support: Society and Policy Support expert group (headed by Klaas Van der Meer) accompanied by supportive Mark Loos, ex-director of the Institute for Environment, Health and Safety (EHS), the promoter and mentors. Prof. Emer. Yvan Bruynseraede, it was always a stimulating experience to defend my research work when we met on PhD days organised by Michèle Coeck. My initial scientific understanding was greatly enhanced by the able guidance of Professor Baldwin van Gorp from KU Leuven.

I thank all the members of SPS, especially Roland Carchon, Tim Vidmar, Johan Peridaens, Johan Camps and late Alain Sohier who I owe my sincere gratitude for enriching my understanding of physical aspects of the radiological and nuclear risks, contamination measurements, protective actions and related challenging discussions during the coffee breaks, emergency exercises and real interventions. As Catrinel rightly said – *Every kick in my ass was a step forward*.

It is not possible to list all the employees and researchers of the Institute for Environment, Health and Safety who have influenced my research – thanks a lot for the countless discussions and explanations offered to me – a lay person – and for occasional encouragements. Thanks also to Prof. Frank Hardeman, the director of our EHS institute for the proof-reading of this thesis and for offering much needed support.

I thank also Horst Monken Fernandes from Waste technology section and Lisa Berthelot from Incident and Emergency Centre at the International Atomic Energy Agency for giving me the opportunity to come close to the real world problems related to the communication about radiological risks.

The colleagues from Media, Movements and Politics research group (M²P) at the University of Antwerp were of immense help. The review sessions during our meetings were of great added value for my research – not to mention the competition spirit during football games at our famous M²P weekends.

During the PhD study I had a great psychological support from my friends in Belgium as well in Slovenia; Catrinel, Urša, Boštjan, Andreja, Maja, Meta, Hildegarde, Jordi, Joeri, Vera, Lusine, Svetlana, Andrei. Thanks to my dear friends from the master studies at the University of Ljubljana, Slovenia: Igor, Erik, Uroš, Aleš and Franci.

I would not have reached this stage without the three most important people in my life; Janez, Živa and Erazem. You are the most influencing independent variables in my PhD adventure. Thank you for your encouragement and help. Rada vas imam.

1. Introduction

Setting the scene

As has become clear from the lessons identified and, unfortunately, not well learnt from past nuclear and radiological events, communication is one of the most important challenges of emergency management (Abbott *et al.*, 2006; Boiarsky, 2004; Covello, 2011). The nuclear accident in Fukushima (Japan) in 2011 has once more emphasized the need to better understand how risk-related messages are processed and how the public receives and accepts messages, related to protective actions in nuclear emergencies (Kanda *et al.*, 2012; Ropeik, 2011). For instance, it is well known that one possible protective measure in case of a nuclear emergency is to take stable iodine tablets. What happened in Japan was that quite some people actually swallowed gargling agents containing povidone-iodine as a substitute for stable iodide tablets, an action which can actually be quite detrimental to someone's health (Kanda *et al.*, 2012).

Efficient communication about nuclear risks requires thorough insight into the factors that influence people's attentiveness and recall of information and, more generally speaking, the process of opinion formation related to possible recommendations. Furthermore, it is of great importance to comprehend the principles of media reporting about the nuclear emergency, since most information related to nuclear risks is not directly experienced, but rather learned through the mass media.

In general, communication research in the nuclear field, and especially opinion formation, has been approached either by social scientists or by nuclear experts. In academic research, only a limited number of such studies can be found. These mainly address risk communication and opinion formation in general, with the nuclear field being taken only as a case-study, thus without taking into account any of its specificity. On the other hand, researchers coming from the nuclear field who study communication don’t tend to apply the strict scientific standards that they are used to in their natural science experiments. Their research on communication is therefore lacking in scientific protocols and methodology, as they are not familiar with the field of social sciences. In other words, the limitations of the existing knowledge may be explained by a lack of integration of different disciplines.

Yet, the research in this field should be inherently interdisciplinary, as it embodies several research domains: risk communication, risk perception, emergency management, radiation protection, and finally, opinion formation. An integrative approach is needed in order to understand radiological risks , how people acquire information and form an opinion about these risks, how they make decisions about them and how the media translate the information provided by experts and/or risk managers.

Therefore, this dissertation uses an interdisciplinary approach and it adapts and synthesizes concepts and theoretical models stemming from a number of fields: 1) lessons learned from the field of radiation protection and nuclear emergency management (e.g. IAEA, 2006; Sohier, 2002); 2) systematic and heuristic-based information processing models (e.g.: Cacioppo and Petty, 1984; Trumbo, 2002; Zaller, 2006), 3) the theory of risk research, (e.g.: Renn, 2008; Sjöberg, 2000; Slovic *et al.*, 2004), and 4) research on media content (Gamson and Modigliani, 1989; Neuendorff, 2002; Vasterman, 2005). The first provides the specific context of nuclear emergency management, the second helps to understand how people acquire information from elites and the mass media and convert it into preferences, the third is useful in determining the factors which may ultimately affect an individual's risk-related opinion and the last explores the mass media as the main source of information related to nuclear emergency events.

This dissertation focuses on risk perception and risk communication in nuclear emergency management and in particular on three different aspects: firstly, the reception and acceptance of information will be examined.

Secondly, it will explore the influence of people's prior knowledge on the acceptance of communicated messages and the perception of the communicated risks. Lastly, the media coverage of nuclear emergency events will be discussed.

It is important to note that nuclear emergency management is structured in three phases: preparedness, response and recovery. Thus, different types of communications are applied, depending on the specific phase. In this dissertation, case studies are used to analyze preparedness communication, crisis communication and long-term communication for recovery. The main objective is not to design a new model of information processing for each type of communication. Rather, this dissertation is an attempt to bring different information processing models and different disciplines together in order to get insight into the perception of radiological risks and the information processing of nuclear emergency communication in different contexts.

After a general introduction to the central theme, we will discuss the relevant contextual characteristics of nuclear emergency management and the extent to which they matter to our investigation. Next, we will introduce the overall research design of this study and then move on to six empirical articles, in which we investigate specific nuclear information processing and the content of news coverage related to nuclear emergencies in greater detail. A last research section contains an overview of the importance of risk communication for nuclear emergency management, with an emphasis on practical findings for sound communication during and after a nuclear emergency.

Risk communication and risk perception

Risk communication in the nuclear field may have several aims: 1) to warn people in case of a nuclear emergency (IAEA, 2012), 2) to inform about radiological risks (IAEA, 2006; Rojas-Palma *et al.*, 2009), 3) to prevent panic and outrage (Sandman, 1987), 4) to support the stakeholders to make informed decisions related to radiological risks (Renn, 2004), and 5) to establish two-way communication and joint problem solving. Since human behaviour is primarily driven by perception and not by facts (Renn, 2008), risk perception is a concept of great importance when developing sound and successful risk communication.

For our purposes, we defined risk communication in a narrow sense, by only including risk messages related to radiological risks and protective actions sent from (1) the risk managers (the nuclear installation operators and controlling authorities) to the message transmitters (the mass media), and (2) the media to the general public in order to inform them about the radiological risks (i.e. one-way communication). We used this narrow definition because we were interested in two things. First of all, we wanted to investigate the factors influencing the response to communication and subsequent behavior. Secondly, we also intended to identify relevant target populations according to these factors and develop and test communication in different nuclear communication contexts, for selected subgroups. We were aware that the messages analyzed in our research were communicated by different means, and that information processing was thus a result of several processes, ranging from one-way communication (information distribution) to multi-way communication (stakeholder engagement). In addition risk communication in nuclear emergency management in our research consists of: preparedness communication, communication during and after crisis and recovery communication.

Risk perception is well investigated in scientific literature, especially how various factors affect people's perception of risk. However, these studies mainly focus on the qualitative characteristics of risk, the

individual differences, the context, the way the risk is processed and how the information is communicated. In these studies, risk perception is chiefly taken as a dependent variable. Little attention has been given to what extent these variables affect the different stages of risk-related information processing and in what way they influence the outcome of risk communication, which is exactly what this dissertation aims to investigate.

Many theories and concepts have been developed to explain the mental processes that lead to risk perception and the formation of an opinion related to risk communication. An overview of selected concepts is given in the section below and presented in chronological order in Table 1.1. A comprehensive discussion of the literature is beyond the scope of this dissertation. We will therefore only focus on the evolution of risk perception theories and present the main findings related to risk communication. We will discuss three theoretical approaches to risk perception and risk communication here. The first approach is the individualistic approach, which tries to define individual preferences based on the expected utility, or some combination of expectancies and values. The second, societal approach emphasizes the structure and functioning of groups within societies. The final approach, called the institutional approach, focuses on the establishments that are responsible for risk management.

Table 1.1: Risk perception theories and concepts

Onset/ key author	Risk perception paradigm	Conceptual basis	Approach to risk perception	Explanatory variables / Scales used to analyse risk perception (examples)
1969 (Starr)	Revealed preference approach	- Focus on risk acceptability, rather than quantification of consequences or likelihood; - Social acceptability treated as effectively beyond logic and predictable.	Individualistic*	- hazard vs. socially acceptable levels of exposure to risk; - cost benefit analysis, i.e. maximum social benefit at minimum social cost.
1974 (Tversky)	Availability heuristics (foundation for psychometric paradigm)	People use cognitive heuristics in sorting and simplifying information, which leads to biases in comprehension	Individualistic*	dread; newness; stigma.
1978 (Slovic)	Expressed preference approach impetus for "Psychometric Paradigm"	Focus on risk toleration, rather than acceptability	Individualistic*	*High order factors*: - knowledge (understanding risk); - anxiety (evokes feeling of fear); - exposure to risk (number of people exposed). *Other factors (examples):* - voluntariness; - uncertainty; - chronic vs. catastrophic nature; - delayed or immediate consequences; - known to science.
1980 (Vlek)	Real versus perceived risk dichotomy	- Focus on perceived threat to familiar social relationships and practices, rather than thresholds numbers defined by public acceptability; - Demonstrates and explores the real risk versus perceived risk dichotomy; - Two perspectives: elitist and rational choice.	Individualistic*	Specific: - education (for elitist perspective); - compensation vs. outrage (for rational choice perspective). Common: - personal characteristics; - personal values;

Onset/ key author	Risk perception paradigm	Conceptual basis	Approach to risk perception	Explanatory variables / Scales used to analyse risk perception (examples)
				- socio-demographic (age, gender, etc).
1982 (Douglas, Wildavsky)	Cultural theory	- Differences in risk perception between groups within society arise from differing social characteristics and patterns of social relations; - Typology of four archetypes: hierarch, individualist, egalitarian and fatalist.	Societal**	- hierarchs; - individualist; - egalitarian; - fatalist.
1988 (Kasperson *et al.*)	Social amplification of risk framework	- Risk is a complex phenomenon involving both biophysical attributes and social dimensions; - Risk is amplified by increased public attention, or attuned, by less public attention.	individualistic* and societal **	- individual biophysical, psychological, social and cultural also economic factors
1990 (Freudenburg)	Recreancy paradigm	- People have insufficient knowledge about risks from complex and potentially dangerous technologies; therefore they must rely on their judgments about whom to trust; - Scepticism is due to inadequate societal structure and functioning, rather than lack of familiarity with technology or irrational thinking.	Societal **and Institutional***	- credibility of institutions; - societal trust
Mid nineties (Bostrom)	Mental model approach	People's basic frames of reference, their previous knowledge on the subject, their set of values and the format and structure of the new information contribute to their interpretation of the information.	Societal ** and individualistic*	- knowledge; - values; - references.
2000 (Beck)	Risk society	- Society is recognized as "risk society"; - Distinguishing among hazard, technical assessment and socially/politically constructed risk perception; - Power of defining the risk.	Societal**	- cultural - other social factors
2000 (Sjöberg)	Extended psychometric paradigm	Focus on risk toleration with emphasis on beliefs	Individualistic*	- morality - unnatural vs. natural - tampering with nature - new age beliefs

Onset/ key author	Risk perception paradigm	Conceptual basis	Approach to risk perception	Explanatory variables / Scales used to analyse risk perception (examples)
2000 (Renn)	Risk Governance	Risk perception is among different actors diverse, but none is wrong. Stakeholder process bridges the differences and helps in risk governance.	Societal ** and institutional***	- stakeholders

*Individualistic approach: The individual is the prime target of analysis. It tries to define individual preferences based on the expected utility, or some combination of expectancies and values.)

**Societal Approach: The emphasis resides less with the individual or some notional population, but with the structure and functioning of groups within societies.

***Institutional approach: Analyses or risk perception focuses on the institutions that are responsible for risk management

The revealed and expressed preference approach

The earliest social science discussions of risk were framed almost exclusively in terms chosen by engineers. Communication was limited to providing the lay public with results of scientific analyses, with little interpretation or explanation (Fischhoff, 1995). Moreover, the concept of risk perception was framed in technical terms and focused mainly on identifying what risks are considered acceptable by a society (Bell, 1998). Starr (1969), for example, used a method called "*revealed preference approach"*, by which it is possible to discern the best possible option based on individuals' behaviour: "*How much risk people say they are willing to accept*", studied mainly in the context of nuclear power development. This early approach assumed that individuals behave in a rational manner, systematically weighing information before making a decision.

Afterwards, scholars in the 1980s and 1990s challenged Starr's approach by examining expressed preference (Gregory and Mendelsohn, 1993; Slovic, 1987; Slovic *et al.*, 1982). They found out, contrary to Starr's basic assumption, that people generally perceived most risks in society as being unacceptably high, but in some circumstances still tolerable. For example, when it comes to nuclear installations, people feel that even tolerable risks should be reduced to the lowest level that is reasonably possible.

Availability heuristics

How people process information, asses risk probabilities and predict values has also been explored by psychologists (Tversky, 1974; Tversky and Kahneman, 1974). In other words, how people make judgements under uncertainty. They found that intuitive judgements of probability are based on a limited number of heuristics that are usually effective, but sometimes lead to severe and systematic errors - in which case they become cognitive biases. People judge the probability by the degree to which it represents the evidence, with little or no regard for its statistical probability. They also found that heuristics lead to an overestimation of the probabilities of highly available or salient events, and to overconfidence in the assessment of subjective probability distributions (Tversky, 1974). This theory is named "*availability heuristics*". According to this theory, an event that can be more easily brought to mind or imagined is judged to be more likely than events that cannot easily be imagined. For the estimation of an unknown risk, people will often start with one piece of known information and then adjust it to create an estimate of an unknown risk. The scholars also found that there is a symmetry between gains and losses. People are risk-averse with respect to gains, preferring a sure thing over a gamble with a higher expected utility but which presents the possibility of getting nothing. On the other hand, people will be risk-averse as regards losses, preferring the chance of losing nothing rather than taking a sure, but smaller, loss.

Real versus perceived risk dichotomy

In the 1980's, a number of authors developed a new approach to risk communication that viewed risks according to their perceived threat to familiar social relationships and practices, rather than simply by threshold numbers defined by public acceptability (Vlek and Stallen, 1981). The work in this decade tends to challenge the legitimacy of the real risk versus perceived risk dichotomy. These authors realized that perception of risk can change even if the actual risk does not (Covello and Allen, 1988). The conceptual foundations for risk communication studies have been put on a firm footing, by combining techniques for the assessment of environmental hazards with communications theory. An explicit distinction between two

different stages of risk analysis took place: risk management, which applies to assimilating non-scientific factors to reach a policy decision, and risk communication, which involves communicating a policy decision.

Within the technical society, two explanations were typically given for public reactions to what the technicians estimate to be the objectively defined risk.

The first explanation, the "*elitist perspective*", claimed that the public is ignorant and/or irrational. From this perspective, a risk policy focuses on the education of the ignorant and easily manipulated public. Later, this explanation was criticized because it uses a technical definition of risk, even though risk explanation is not always precise and is actually influenced by social and cultural factors (Adams, 2005). The key finding of this criticism was that experts are not necessarily any better at estimating probabilities than lay people. Experts are often overconfident in the exactness of their estimates, and give too much confidence to small samples of data (Slovic *et al.*, 1982). Moreover, most risk communication efforts begin with the premise that scientific experts know the actual risk and the skeptical public, out of ignorance or irrational fear or both, misperceives the actual risk (Bell, 1998). It was believed that the public reaction to risk commonly reflects a mixture of ignorance and irrationality, e.g. (Cohen, 1985). The goal of risk communication was, under this paradigm, to educate the public in order to remove their irrational fears.

The second explanation is the "*rational choice perspective*", which is more often associated with economists. According to this explanation, public reactions represent economically rational weighting risks and the benefits on the individual level. From this view, risk communication policy focuses on providing adequate compensation for risks endured, e.g. the greater people perceive a benefit, the greater their tolerance for a risk (Slovic *et al.*, 1982). The shortcoming of this economic approach is how to define adequate compensation. Events vary in the amount of outrage they create and it is difficult to assign a monetary value to risk and negative health outcomes.

The psychometric paradigm

Since some early studies argue that people use cognitive heuristics in sorting and simplifying information, leading to biases in comprehension, scholars identified numerous factors responsible for influencing the individual perceptions of risk, including dread, newness, stigma, and other factors. These studies have contributed significantly to the assumptions about public irrationality. Later work, built on this foundation became known as the *psychometric paradigm.* The psychometric paradigm was created by Fischoff, Slovic and Lichtenstein (1978) and later became a leading model in the field of risk perception. In this approach, the patterns of risk perception are measured by using a numerical scaling technique. The measurement expands the factors that influence risk perception beyond the classic components of harm and probabilities of their occurrence (and hence it expands the realm of subjective judgment about the nature and magnitude of risk).

Jaeger (In Renn, 2008, p. 106) listed the four characteristics of the psychometric paradigm:

> *1. Establish risk as a subjective concept, not an objective entity;*
> *2. Include technical, physical and social, psychological aspects in assessing risks;*
> *3. Accept opinions of "the public" as a matter of academic and practical interest;* and
> *4. Analyze the cognitive structure of risk judgment, usually employing multivariate statistical procedures such as factor analysis, multidimensional scaling or multiple regression.*

Since the psychometric paradigm appears to be an effective tool for the prediction of risk perception, it has been widely tested empirically and it is still being developed in order to identify the risk attributes or dimensions supposedly underlying people's preferences. This model has been used as a basis for extensive work on risk communication by many scholars for instance, (Fischhoff *et al.*, 1978; Renn, 2008; Sjöberg, 2000a; Slovic, 1987). The model is based on a number of explanatory scales corresponding to various risk characteristics, which are an empirically driven explanation of contextual characteristics that individual decision-makers use when assessing and evaluating risks. Some of these scales involve whether the hazard was involuntary or not, whether is was catastrophic, delayed or immediate, whether it was already known to science, and other factors. The initial nine scales were later on extended to 18 and even 21 scales, such as new vs. old, or manmade vs. natural. Table 1.2 presents selected psychometric risk characteristics and possible communication approaches. The psychometric model explains up to 60 % of the variance of perceived risk - very high correlations between the basic scales and risk perception or risk acceptance were reported in different papers.

Cultural theory

As a challenge to the psychometric paradigm, *"cultural theory"* arose. The theory was developed by Douglas and Wildavsky (1982) and was later on integrated into quantitative studies (Dake, 1992; Wildavsky and Dake, 1990). In this theory, the individual approach to risk evaluation is replaced by a societal approach. The emphasis lies on the structure and functioning of groups in societies, and risk evaluation is placed on the meaningful relationships of either individuals or populations with understanding of the contextual and cultural structures of individuals within social groups. Cultural theory explains why people come to accept or reject environmentalism and why they choose which potential hazards to fear and which to ignore. It proposes that differences in risk perception between groups within society, such as experts and lay people, arise from different social characteristics and patterns of social relations, rather than because one group is inherently more logical or rational than the other. The theory is based on anthropological research and holds that patterns of social relationships are dependent on an individual's worldview. It refers to the extent to which individuals are bound by feelings of belonging or solidarity. The tighter the bonds, the less individual choice can personally be controlled.

The main criticism against cultural theory is that the model has not been able to explain more than 5 % - 10 % of the variance of perceived risk (Sjöberg, 1999; Sjöberg, 2000b). However, in a study by Buss and Craik (1983), cultural theory explained 16 % of variances for risk perception of nuclear power. In addition, the explained variance of the perceived risk can increase if the elements of cultural theory are integrated into more extensive models.

Table 1.2: Some psychometric risk characteristics and possible communication approaches. Adapted and upgraded from literature (Covello, 1983), (Slovic, 1987), (Renn, 2003), (Havenaar *et al.*, 2003), (Knight and Warland, 2005), and (Sjöberg, 2000b).

Some qualitative characteristics	Explanation of influence and some authors	Explanatory scale	Some comparable risks	Possible communication approach
Personal control	Increases risk tolerance	controllable – not controllable	Driving car vs. flying in the airplane	Practical and emotional involvement in risk governance.
Institutional control	Depends upon confidence in institutional performance	trust, confidence in institution	Accident in high trusted company vs. accident in low trusted company	Building social and institutional trust in risk management.
Number of exposed	Decreases risk tolerance	catastrophic – chronic	Plane accident – car accident	Preventive actions e.g. exercises and transparent risk management.
Voluntariness	Increases risk tolerance	voluntary – involuntary	Smoking vs. food poisoning	Stakeholder process
Mortality	Decreases risk tolerance	fatal – not fatal	Aids vs. angina	
Knowledge	Increases risk tolerance	new technology – established technology	Genetically modified food vs. using pesticides	Communication program for increasing knowledge and experiences.
Familiarity	Increases risk tolerance	familiar – not familiar	Medical X rays vs. nuclear waste	Communication campaign makes it familiar
Dread / fear	Decreases risk tolerance	fear – no fear	Nuclear accident vs. Radiation of mobile phone	Since feeling of helplessness triggers fear give the instruction what to do …
Artificiality of risk source	Amplifies attention to risk Often decreases risk tolerance	human – natural	Radon vs. nuclear installation	Clarify the meaning of "natural" e.g. using preservatives in food, or explain natural radiation.
Blame	Increases quest for social and political responses	Degree of legal or social responsibility	Deliberate release vs. accidental release from nuclear installation	Since more the risk is seen as unfair the more is judged as severe and unacceptable the sharing the responsibility and stakeholder process are good comm. approach.
Benefit	Increase risk tolerance	Benefit to self-vs. unclear or inequitable	Worker's exposure vs. public exposure	Dialog with the local community
Effect on children	Decrease risk tolerance	Children specifically at risk	Higher cancer risk	Recognition of differences in the risk incurred, and modification of policy accordingly

Social amplification of the risk framework

In contrast with to mono-disciplinary approaches to risk research, a group of scholars from a wide range of disciplines combined findings from psychology, sociology, anthropology and communications theory to develop the *"Social Amplification of Risk Framework*" (SARF) (Kasperson *et al.*, 1988). This framework aimed at explaining how communications of risk events pass from the sender through intermediate stations to a receiver, and if the process serves to amplify or attenuate perceptions of risk. All links in the communication chain - individuals, groups, the media, etc. - contain filters through which information is sorted and understood. The main thesis of SARF states that risk events interact with individual psychological, social and other cultural factors in ways that either increase or decrease public perceptions of risk. Behaviours of individuals and groups then generate secondary social or economic impacts, while also increasing or decreasing the physical risk itself. The theory attempts to explain the process by which risks are amplified, receiving public attention, or attuned, receiving less public attention. Risk is recognized as a complex phenomenon that involves both biophysical attributes and social dimensions. The concept of the social amplification and attenuation of risk provides an approach that it makes it possible to study how the way that social institutions process a risk will shape both its effects upon society and the responses of management institutions and people. The theory may be used to compare responses from different groups in a single event, or analyze the same risk issue in multiple events. In addition, it was comprehended that in a single risk event, some groups may amplify their perception of risks, while other groups may adjust or decrease it (Kasperson *et al.*, 1988). Scientists have started to argue that risk is socially constructed. The interpretation of physical threats is not just a subjective process engaged in by individuals, but it is also strongly affected by the way of life, world view, society, norms, values, institutions and other influences that the members of social groups have in common. The physical risk is therefore prioritized in order to facilitate collective action.

The meaning of trust

The meaning of trust in the field of risk perception and communication was examined in many studies for instance food-related risks in study of Frewer *et al.* (1996), study related to opposition to a high-level radioactive-waste repository by Flynn *et al.* (1992), study related to a nuclear power plant by Lofsted (1996) or Costa-Font *et al.* (2008) and studies related to nuclear accidents (Greenberg and Truelove, 2011). These studies found that the perception of trust and credibility of a communicator is dependent on the perceptions of his/her knowledge and expertise, honesty and care (Peters *et al.*, 1997). It was proven that effective communication requires respected and trustworthy sources (Fischhoff, 1991; Morgan *et al.*, 1992). Conversely, not knowing whom or what to believe can make risk decisions intractable, and a lack of credibility and trust can erode relations between experts (the communicator) and the public. In general, people will be more accepting of risks that are perceived to be generated by a trusted source, compared to a questionable one (Fischhoff, 1991). However, trust is not created by knowledge in itself. Rather, trusted sources are seemingly characterized by multiple positive attributes, since sources with moderate accountability are seen as the most trusted ones (Frewer *et al.*, 1996). In the late 1990s, concerns were expressed about the quality of risk-related public discourse and communication that took place with regard to complex and controversial technologies. The question was raised whether society or individuals might be harmed by contentious, overly adversarial public debate about new technologies, including nuclear technologies. Some scholars, for instance Fischoff (1995), discussed the obligations of citizens and societal institutions to facilitate a well-reasoned discourse that is respectful of the opinions of others. It was noted that, with the increasing complexity of technological innovations, people find themselves in a position of not

knowing much about highly complex and potentially dangerous technologies and novelties. They therefore must rely upon their judgments about whom to trust (Gaskell *et al.*, 2004).

Societal trust and the recreancy paradigm

The concept of "*societal trust*" was introduces by the research group of Freudenburg, who also used the term "recreancy" (Freudenburg, 1993; Freudenburg and Gramling, 1992; Freudenburg and Pastor, 1988). Recreancy refers to the failure of institutional actors to carry out their responsibilities with the degree of vigour that is necessary to merit the societal trust they enjoy. It was confirmed that public reactions and attitudes towards new technologies are guided by the social trust and confidence people have in companies and government agencies. Analyses of survey data find that the recreancy perspective explains roughly three times as much variance in levels of risk-related concern as do socio-demographic and cultural variables combined (Freudenburg, 1993). Numerous studies have also rejected the belief that additional information, alone, will shift risk perceptions, and supported the importance of social trust for risk perception and risk communication (Freudenburg, 1993). Social trust has been reported to have a considerable influence on the perception of the risks associated with hazardous waste disposals (Bord and Oconnor, 1992), on the perception of a nuclear waste repository (Flynn *et al.*, 1992) and on the acceptance of food irradiation (Bord and Oconnor, 1990). In addition, as indicated by the results related to the perception of nuclear technology, social trust is a key predictive factor of the perceived risks and benefits of a technology (Siegrist *et al.*, 2000).

Mental model approach

In order to evaluate the impact of risk communication, the "*mental models approach*" was proposed by Bostrom and others (1994). This approach is seen rather as a social methodology. It employs multiple evaluation methods including think-aloud protocol analysis, problem solving and a true-false test that allows respondents to express uncertainty about their answers. Since traditional research and communication efforts were unable to successfully resolve decision-making concerns on some hazards (such as ecological effects), taking into account mental models can effectively supply recipients with the information they need to make informed, independent judgments. Some mental models are founded on the premise that people's basic frames of reference, their previous knowledge on the subject, their set of values, and the format and structure of the new information will all contribute to their interpretation of risk-related information (Morgan *et al.*, 2002; Pond *et al.*, 1997).

Summary

In short, risk research is a broad multidisciplinary field involving many kinds of scholars who do not speak with one voice. Moreover, in perception of risk, the individualistic, societal or institutional approach is used. In general, risk perception and communication theory do not provide any constant assumptions about risk perception, but are rather oscillating from logical, predictable and rational interpretation to illogical, unpredictable and emotional-driven ones.

This dissertation uses several of these concepts from risk perception and risk communication theory. A combination of all approaches -individual, societal and also institutional - is used to explain radiation risk perception and risk communication. The scales applied range from individual, psychological, cultural, societal to political and are tested in different populations and different contexts. For instance, we paid

attention to the differences between the general population and the population that was exposed to radiation risk after a nuclear accident (Chapter 2). Moreover, we have considered the political characteristics of the society at hand and whether there was any correlation to the risk communication after the nuclear accident (Chapter 4 and Chapter 6). One of the main contributions of this dissertation is an empirical testing whether variables that have been traditionally used in risk research, for instance trust, fear, knowledge or catastrophic potential, have a different effect in the different stages of nuclear risk-related information processing (Chapters 2 and 3).

Introducing the context: Nuclear emergency management

Nuclear emergency management is composed of the following phases: risk assessment, emergency planning, response, recovery and evaluation (see Figure 1.1). Each phase is associated with specific actions (countermeasures) taken to protect the population and the environment from radiological risks. Within the countermeasures in the emergency that (could) involve exposure to radiation can be dealt with interventions to reduce or avert (the likelihood of) exposure to radiation sources. The aim of countermeasure is to provide an appropriate standard of protection for people without unduly limiting the beneficial practices giving rise to radiation exposure (*ICRP*, 2007).

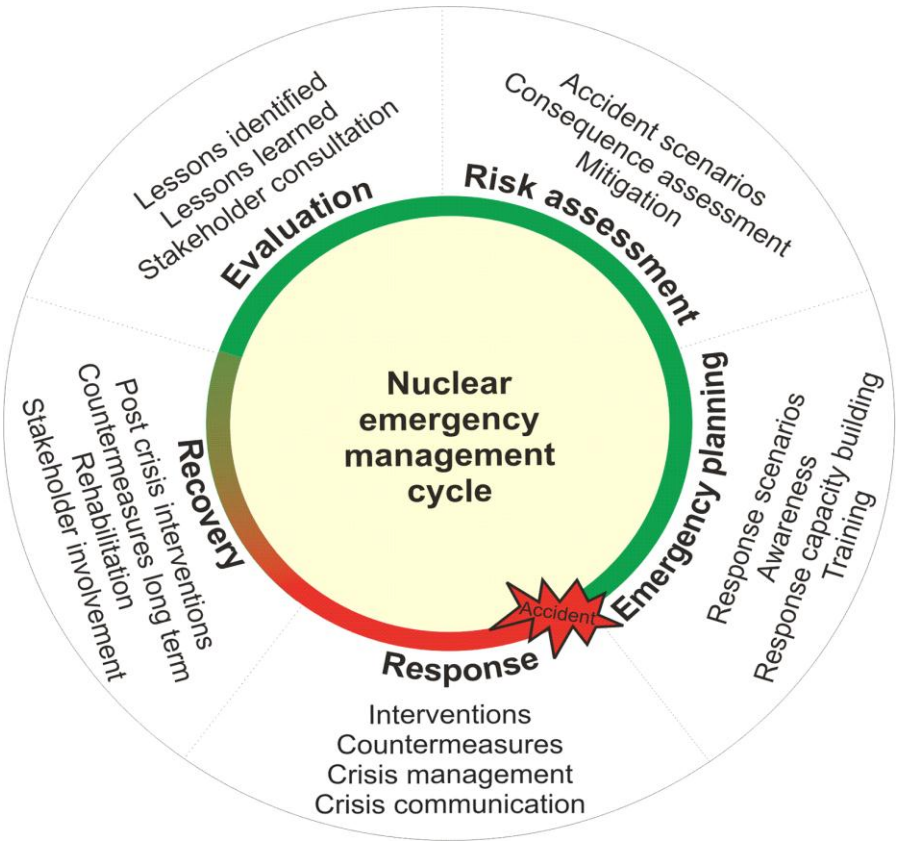

Figure 1.1: Nuclear emergency management cycle

The application of countermeasures might be needed in case of a radiological release, at first to reduce the radiological risks of people living in the affected territory or consuming vegetable and animal products from the contaminated zones. These countermeasures must be evaluated from two perspectives: radiological and societal. First, the countermeasures must be justified and optimized with respect to the radiological dose that can be averted for the population, in addition to the dose reduction that would occur anyway due to natural processes. Second, the countermeasures must be evaluated from a sociological, economic, political and ethical viewpoint and need to be adapted to the circumstances of the event. In terms of radiation protection this is expressed by fundamental principles of justification and ALARA (As Low As Reasonably Achievable) (ICRP, 2007, p. 109). For instance, long-term countermeasures in the recovery phase and remediation actions aim at restoring normal life in the affected regions as quickly as possible, allowing unrestricted activities and the production of clean produces. Last but not least, countermeasures might be needed to reassure the local population. Apart from this, preventive actions may be applied in the emergency planning phase in order to prepare the population for a possible radiation release, for instance by the preventive distribution of stable iodine tablets.

The interdependency between the two evaluations, the radiological and the socio-politico-economic evaluation, is crucial for selecting appropriate countermeasures. Risk managers have to answer basic questions, such as *What may happen?*, *What happened?*, *Is there a hazard for the population?*, *Now?*, *In the near future or later?*, and *What do we need to do and when?* (Brunner, 2002). To ensure the effectiveness of the chosen countermeasures, the support and cooperation of the population and other stakeholders are needed. This is only possible if there is sound communication in all the phases of nuclear emergency management, including preparedness. Some of the possible countermeasures for emergency response and recovery are presented in Table 1.3.

Table 1.3: The phases of emergency response and associated countermeasures.

Emergency response phase	Some countermeasures*
Pre-release	(Preventive) evacuation Pre-distribution of stable iodine tablets
Early phase (contaminated atmosphere)	Evacuation Sheltering Stable iodine Agricultural protection measures
Intermediate phase (rather rapidly decreasing contamination of surfaces and vegetation)	Relocation Food control
Late phase (long-lasting contamination of the environment)	Relocation Food control Decontamination Environmental remediation process Restriction on diet Change in life styles

* For more complete overview please advise EURANOS project e.g. MANAGEMENT OF CONTAMINATED FOOD PRODUCTIONS SYSTEMS AND WATER.

Risk communication in nuclear emergency management can be used to increase awareness and understanding of countermeasures, as well to mitigate a population response (IAEA, 2012). For instance, sound risk communication helps adjust behavioural intentions (for instance, spontaneous evacuation) that may intuitively seem correct, but may actually cause additional negative health effects and safety consequences (Covello, 2011; Hunt and Grunig, 1994; Palenchar and Heath, 2005). In this way, risk communication helps make nuclear emergency management fully functional.

However, no research has yet been done on one of the most pivotal questions with regard to communication in nuclear emergency: whether the predictors for reception and acceptance of risk-related information are the same in the different phases of emergency management or not? Does the strength of the influence of these predictors vary across preparedness response and recovery communication? How is the media, as main communication channel, used in case of a real emergency?

The empirical studies reported in this thesis cover the entire emergency management cycle and the connected communication contexts: nuclear emergency planning communication, crisis communication during a nuclear accident with severe radiological consequences and during a nuclear event without any radiological consequences, and long-term communication in evaluation. How the applied countermeasures were communicated to the public and reported in the media is analyzed by means of a content analysis.

Nuclear emergency information processing: reception and acceptance of countermeasures

At the very beginning of our investigation, there is one central question: exactly at which stage of information processing do predictors such as risk perception, trust, knowledge and other predictors traditionally used in risk research, start to influence opinion formation?

Over the past 40 years, many information-processing models have been developed: (e. g. Eagly, 1992; Griffin *et al.*, 1999; Kahlor *et al.*, 2006; Lang, 2006; Lang *et al.*, 1999; Petty and Cacioppo, 1986; Shiffrin and Schneider, 1984; Trumbo, 1999; Trumbo, 2002). The models of information processing mainly recapitulate the process in two different processing modes: the memory-based mode and the on-line mode. The specifics of the related modes are summarized in Table 1.4. Both types of models specify a direct correspondence between the two stages: recall of information and judgment (opinion formation). In our research we name these two stages reception and acceptance, as suggested by Zaller (2006).

The scholars that support memory-based mode for instance Tversky and Kahneman (1974), argue that, when people bump into relevant information, they neither elaborate on it nor exact its evaluative implications. No judgment is made or updated at this time, only the information is transformed from working memory into long-term memory. Later, when the judgment is called for, they initiate a search of their long-term memory for relevant information. The final judgment thus reflects the information that people can successfully recall (Hastie and Park, 1986). The memory-based model is founded on the research and experiments studying memory-judgement relationships. For instance, the research of Lichtenstein *et al.* (1978) revealed significant correlations between judged frequencies of death and the frequencies of reports of causes of death in newspaper articles. It is interesting that the reporting rates related to the events reported in newspapers articles were not correlated with the actual frequencies. This finding supports the conclusion that newspaper reporting rates bias memory availability, which in turn influences the frequency estimates. Similar findings

concerning the memory-judgement relationship have been found in many risk-related studies (Combs and Slovic, 1979; Lichtenstein *et al.*, 1978; Tversky and Kahneman, 1974).

The scholars of on-line mode argue that evaluations are formed and updated in sequence, as information is encountered. For instance, the research of Winter and Uleman (1984) showed that people make many judgements spontaneously, without weighting the information. Information processing is conceived here as a counter in the "working memory" that integrates new information into a "judgment operator". Such kind of information processing does not necessarily include the cognitive limits of the person. It assumes that, when exposed to new information, people can operate naturally as cognitive accumulators by simply retrieving the evaluation counter from their memory, updating this summary count, storing the new value in their long-term memory and then forgetting the actual pieces of evidence that contributed to the evaluation (Hastie and Park, 1986).

In this dissertation, we do not focus on the mode people use to process the information related to nuclear emergencies; instead, we concentrate on the identification of certain independent variables as potential predictors for the different stages of information processing. The importance of the two information processing stages rises from the needs of nuclear emergency management, where there are always people who do not get the (necessary) information, and where people often have difficulties to form an opinion about the risk associated with complex nuclear technologies. For this purpose, we adopted two theoretical concepts named reception and acceptance. The two concepts are taken from Zaller (2006), and they explain opinion formation.

According to the definition of Price and Zaller (1993: 134), *reception* entails a sequence of information processing steps: (1) attending to the information, (2) comprehending it, and (3) retaining it. This is, according to the authors, mostly a cognitive process, which involves individuals' selective reprocessing and storing of information, and thus affects their recall. Recall of information is used as a measurement for the reception construct in our research.

The concept of *acceptance* refers to a person's resisting the information or accepting it. It is a result of "marriage" between the information received and values. The values are in Receive-Accept-Sample (RAS) model named as predispositions (Zaller 2006). Accordingly, the acceptance of a message is being conceived as a result of the interaction between the awareness and the predispositions (Dobrzynska and Blais 2007). Opinion about the received information is used as a measurement for the acceptance construct in our research. Thus, an opinion is the verbal expression of an attitude towards communicated protective actions in the case of an nuclear emergency. The expressed attitudes could lead (but not necessary) to specific behaviour in the case of an emergency. As Zaller (2006:44) puts it, "*people tend to resist arguments that are inconsistent with their predispositions, but they do so only to the extent that they possess the contextual information necessary to perceive a relationship between the message and their predispositions*". Accordingly, the acceptance of a message is being conceived as a result of the interaction between awareness and predispositions (Dobrzynska & Blais, 2007).

These concepts are explained in detail and compared with the other models in Chapter 2 and Chapter 3 of this dissertation. Until now, the concepts have for the most part been empirically studied in the context of political communication (Dalton *et al.*, 1996; Dobrzynska and Blais, 2007; Zaller, 2006) or in risk research, for instance in the context of information seeking (Griffin *et al.*, 1999).

Although in this study the basic dependent concepts are taken from Zaller (2006), the operationalization of several independent concepts was driven by the risk research theory developed by Griffin (1999), Slovic (2004), Renn (2008) and others.

Why did we take Zaller's concepts and model as the backbone of this research? Although these concepts were originally designed for political communication, they make it possible to easily and empirically determine influential predictors for the *reception* and *acceptance* of risk-related information. Thus, the model highlights the stage of information processing in which the different predictors start to influence opinion formation. Moreover, risk communication seems to be a critical context to test the model in, since the risk (e.g. the consequences of a nuclear accident) is typically intensively communicated, but the familiarity with the messages among the population is usually low. In addition, risk discussions frequently appear in the political agenda. Finally, public attention to a particular risk is often defined by politics (Beck, 2006; Jones and Baumgartner, 2005). According to Zaller, this is precisely the context in which an individual will receive the communicated message and not necessary accept it. Moreover, these concepts have not been applied so far for investigating opinion formation regarding nuclear risks or emergency management. In the present study, this model is applied to risk communication for the first time and subsequently empirically tested by means of a large-scale public opinion survey.

Table 1.4: Information processing models.

	On-line model or Perception based models	Memory based model or Memory-causes-judgment process model
Judgment made	- From "working memory" at the time the information is encoded on previous judgments - Revise as items of evidence are encountered. - Heuristically (educated guesses, intuitive judgments or common sense).	- From accessible ideas and evidences in "long term memory", the weighting of evidence and then the computation of summary evaluation. - Memory availability causes judgment. - Systematically (deliberate, conscious and controlled)
Sequence of information processing explained in experiments	- In the experiment of Anderson (1981): The judgment is based on a memory system different from the recall. As each adjective was received, the valuation operation extracted its implications for the task at hand. Further processing, especially the integration, was performed on these implications. The verbal material itself, no longer necessary, was transferred to a verbal memory or forgotten. -Information for the operator follows a path form the stimulus environment external to the subject into working memory and directly to the judgment operator	- In the experiment of Hastie and Park (1986): When evidence information is available in the external environment, the subject encodes that information in working memory. The judgment is not established; usually the subject is unaware that the information is relevant to a future judgment. - Further encoding of the evidence information by transforming it from working-memory codes into long term memory traces. - When a judgment is called for, the subject initiates the judgment process and retrieves information from long-term memory to use as input into a judgment operator. - Judgment is generated on the basis of evidence retrieved from long-term memory. - The memory retrieval process is repeated and the subject responds on the memory test. A relationship is produced between judgment and memory because any tendency that the subject may have to selectively remember information will be reflected in biased input to the judgment operator and the biased sample of information reported on the memory test.
Explanation of the information processing model	Individual is forming the judgment "on the fly" as evidence is encountered and updating the online evaluation immediately, without having to first store each piece of evidence in long term memory. Later laboriously compute a summary evaluation from whatever memory traces are still available.	- A summary judgment is thought to be computed from the specific memory traces e.g. evidences recalled at the time the assessment is called for. - To deal with complex information in the social world is through the use of abstract knowledge structure representing beliefs, values or stereotypes (Hamilton *et al.*, 1980) - The availability heuristic is applicable to absolute estimates of frequency or probability (Tversky, 1974; Tversky and Kahneman, 1974). - Availability heuristics mostly stems from correlations of judgment and memory biases.
Some selected models	Impression formation (Anderson and Hubert, 1963) Perception based task (Reyes *et al.*, 1980)	Availability Heuristics (Tversky, 1974; Tversky and Kahneman, 1974) Reception-Acceptance-Selection model (Zaller, 2006)
Conditions that will produce judgment	Spontaneous, impression, stereotype, moral evaluation, persuasion…	Surprise, need to make an opinion about something which was not expected …

The importance of prior knowledge

We continue the research by highlighting the importance of prior knowledge for risk perception and risk communication in different societal and cultural contexts. Increasing audience-specific knowledge is often set as a primary objective of nuclear risk communication efforts, for instance to educate the public about radioactive waste (Železnik, 2010) or about the use of stable iodine tablets in the case of a nuclear accident (Van Bladel *et al.*, 2000). But is it worthwhile focusing risk communication strategies solely on enhancing specific knowledge? The additional contradictory question addressed in this dissertation is whether the level of knowledge has the same effect on risk communication in different countries and in two different contexts.

Previous research has attributed strong effects to the level of knowledge in regard to memory-based information processing models. Whereas in communication research Griffin *et al.* (2008), Kahlor *et al.*(2006) and Huurne *et al.* (2009) have found a positive direct relationship between knowledge and the perceived information-gathering capacity, political communication scholars such as Price and Zaller (1993) and Dobrzynska and Blais (2007) considered prior audience knowledge as the most powerful predictor for information reception. The more extensive such prior knowledge, the better the person in question is able to engage in issue-relevant thinking. Several other studies have indicated that, as the extent of prior knowledge increases, more issue-relevant thoughts occur, the influence of the argument strength of persuasive effects increases, and the influence of heuristic predictors of information processing (such as message length or trust in the communicator) decreases (O'Keefe, 2002). Thus, from this point of view, prior knowledge also has an effect on the acceptance stage of information processing.

However, in the nuclear field it is known that the public lacks knowledge and only rarely has acknowledged experiences with radioactivity (Kuklinski *et al.*, 1982; Miller, 1998; Perko *et al.*, 2010; Van Aeken *et al.*, 2007). Thus, the combination of the importance of prior knowledge for information processing and a low level of knowledge in the population poses a big challenge for risk communicators. In other words, are people motivated and able to make informed decisions related to a radiological risks if they lack basic knowledge related to radiological risks (if they, for instance, don't even know that they live in the vicinity of a nuclear installation)?

In our research, we tested the relationship between the level of knowledge and radiation risk perception and we empirically tested if the level of prior knowledge is important for opinion formation related to risk communication in the nuclear field. In addition, we studied the importance of knowledge for risk communication in diverse societal and cultural environments, which has not yet been done in such an extensive empirical research.

Media coverage of a nuclear emergency event

The average individual in today's society is exposed to a large amount of risk-related information, definitely more than one can easily absorb. Risk has become an important element in our daily lives as we live, according to Beck (2006), in a "risk society". In risk societies, risk-related information is a prevalent type of information distributed or produced by the mass media and is frequently a subject of journalism.

The mass media and journalism play a progressively important role in contemporary crisis situations. They help create, shape and terminate a crisis (Berkowitz, 2008; Kovach and Rosenstiel, 2007; Wilson, 1996). Journalists do not only report about reality, they also influence it. Communication scholars, for instance Franklin *et al.* (2005) point out that journalists have an active role to play in reporting about an event (crisis).

They represent, interpret, and construct it, and additionally, the related political and public salience of various issues is partly driven by them (Rupar, 2007; Rupar, 2010; Vliegenthart and Walgrave, 2008). Moreover, mainly the information about the nuclear domain is not directly experienced, but rather learned through elite discourse and communication in the media (Boomgaarden and de Vreese, 2007; Perko *et al.*, 2012).

This dissertation does not investigate the causal relationships between the nuclear accident, the media reporting and the public opinion, but it is limited to the analysis of media reporting and journalism in two types of nuclear emergencies: first, a minor nuclear event without any radiological consequences (Chapter 6), and second, a nuclear accident with severe radiological contamination of the environment (Chapter 5).

Since the media play a major role in communicating with the public in case of a nuclear emergency, it is important to know what messages the media deliver and how they frame a nuclear event. The analysis of media reporting on a nuclear event can be beneficial for nuclear emergency management in two major aspects. On the one hand, such an analysis shows how to deliver risk messages effectively through the media. On the other hand, it gives insight into the information that has to be communicated by the emergency managers to the mass media. The changes in the public opinion on several issues related to the nuclear accident itself and to nuclear energy in general are also addressed in this dissertation.

A number of studies have investigated media reporting on the past nuclear accidents, for instance the Chernobyl accident (Cantone *et al.*, 2007; Gamson and Modigliani, 1989; Triandafyllidou, 1995), the media reporting around the 10th anniversary of the Chernobyl accident (Rowe *et al.*, 2000), or the research on the media reporting about the nuclear accident at Three Mile Island (McDermott, 1982). Scholars testify that media reporting about nuclear accidents does not increase the knowledge and understanding of radiological risks, but rather increases negative feelings and risk perception.

There are considerable methodological and conceptual problems in the existing research. Firstly, it only addresses media reporting about severe nuclear accidents, whereas media reporting about minor nuclear events has not been scientifically investigated. Secondly, the scientific methodology used to analyze media content is, with the exception of the discourse analysis by Gamson and Modigliani, questionable. The authors of the media content research related to nuclear emergency events do not report about coding protocols, measurement methods, code books, or inter-coder reliabilities. Furthermore, the sampling of media items is often unclear. In this dissertation, we address both shortcomings in the existing research. Keeping to the high standards of media content analysis validity and reliability (Krippendorff alphas >0.70), we have analyzed media reporting about a minor nuclear event (Chapter 6) and media reporting about a severe nuclear accident (Chapter 5). Moreover, we have developed a codebook that can be applied for the content analysis of any nuclear emergency event (see annex). In doing so, the present study is the first to investigate media content about nuclear emergencies in a comprehensive way.

Research design

This dissertation sets out to capture and explain the factors that influence people's attentiveness to nuclear emergency information and its recall, the opinion formation related to given recommendations and the principles of media reporting about the nuclear emergency, since most nuclear risks related information is not directly experienced but rather learned through the mass media. The overall research design combines empirical data collected by public opinion surveys, different population samples and media content analysis

of nuclear emergency news coverage. This combination of different research methods provides a more elaborate account of detecting and explaining the processes behind radiation risk perception and nuclear emergency communication. Most of the methods reported on and introduced below have been specifically designed for the purpose of this study, giving us full control over the design and the operationalization of variables that are of substantive interest to our objective. In the following section, we will describe each of the design components in greater detail and discuss their function and interconnectedness within the overall research design of this dissertation.

Public opinion survey data

The main empirical objective of this dissertation is to test whether the variables that have been traditionally used in risk research have a different effect in i) the different stages of information processing, ii) different countries and iii) the different contexts of nuclear emergency management. Therefore, this dissertation draws on different surveys data from representative samples of the Belgian and Slovenian population.

In Chapter 2 and Chapter 3, we use data from a public opinion survey that was conducted in July and August 2009 on a large sample of the Belgian population (n=1031) in the language of their choice: French or Dutch (Perko *et al.*, 2010). The survey method employed was Computer Assisted Personal Interviewing (CAPI), which entailed face-to-face interviews at the respondents' homes. The interviewing was performed by a professional company and professional interviewers. The sample of respondents was representative of the Belgian adult population with respect to the following variables: province, region, level of urbanization, gender, age and professionally active status. Out of the 1031 interviews representative of the Belgian population, 778 (75 %) of the encounters were random, whereas 253 (25 %) were meetings with subjects referred by other people. A pilot study (n=32) was performed in advance of the fieldwork and, based on the results, the questionnaire was modified in order to improve its quality.

Capturing the predictor effects in crisis communication with a survey design requires studying crisis communication in a real crisis, for instance by interviewing individuals that were exposed to some countermeasures after a radiological accident. Thus, next to the general population, this survey was also conducted on a (stratified) sample of the population living in the area neighbouring the location of a real radiological accident (n=104). This area was defined on the basis of the postal code of the municipality in which the accident occurred. This additional population was compared to the general population in Chapter 2, and it serves to compare and test hypothetical predictors in the population that was exposed to certain protective measures after a radiological accident thus in the context of a crisis communication.

To capture the influence of hypothetical predictors on the reception of messages related to protective actions after long-term communication, in Chapter 3 we will examine the population remembering the stable iodine pre-distribution campaign in Belgium. From the general population presented above, we selected the respondents who remembered the campaign (n= 519). As such, it was possible to make an in-depth analysis of the reception of specific messages from the campaign. This subsample of respondents answered an additional set of four questions related to the campaign. Among the people who were familiar with the iodine campaign, 53 % were men and 47 % were women, while 44 % spoke French and 56 % spoke Dutch. In this respect, the subsample was similar to the representative sample for the Belgian population (in which 48 % were men, 52 % women, 42 % French speaking and 58 % Dutch speaking).

In a third empirical study presented in this dissertation (Chapter 4), the cross-country comparison, we used the data from one survey conducted in Belgium and two surveys conducted in Slovenia. The data collected for the general population in Belgium are described above. In order to analyze the target population of long-term communication, special attention was paid to the respondents from the general population that indicated that they *"lived or have lived in an area close (within a 20 km radius) to a nuclear installation (power plant, nuclear research institute)"*. This radius was selected due to the intensive and reoccurring communication campaign related to iodine tablets. We thus retained and analysed the data from 207 respondents, i.e. 20 % of the initial general population.

The data from the general population in Slovenia were collected by Computer Assisted Telephone Interviewing (CATI). The telephone interviewing was performed by a professional company on behalf of the Slovenian Agency for Radioactive waste (ARAO). A pilot study was conducted in advance of the fieldwork in order to improve the questionnaire. The sample of the general population (n=983) was representative of the Slovenian adult population with respect to the following variables: gender, age, education, level of urbanization and region. An additional sample of the local population (n=217) was taken from two municipalities, where participation in the form of local partnerships with citizens was established from 2006 on, and where the Slovenian Nuclear power plant Krško has been operating for almost 30 years.

The research presented in Chapter 5, related to the media reporting about a severe nuclear accident (Fukushima, 2011) and changes in the public opinion after the accident, is based on a large-scale public opinion survey in the Belgian population in 2011 (Turcanu *et al.*, 2011). The data collection method employed was Computer Assisted Personal Interviewing, consisting (CAPI) of personal interviews of about 45 minutes carried out at the respondents' homes. Similar to the 2009 survey, the fieldwork was performed by a market research company with professional interviewers, and was carried out in May and June 2011. The population sample consisted of 1020 respondents and was representative of the Belgian adult population (18+) with respect to sex, age, region, province, habitat and social class. For this survey, too, the pilot study was conducted before the fieldwork. These data were compared to those collected by same method in 2002 (Carlé and Hardeman, 2003), 2006 (Van Aeken *et al.*, 2007) and 2009 (Perko *et al.*, 2010). In combination with other methods, such as media content analysis, the changes observed in the population can be related to the characteristics of the events that took place between the surveys.

Additional details on the design of all surveys included in the research can be found in Chapter 1, Chapter 2, 3 and 4 respectively.

Media content analysis

Content analysis, discourse analysis and framing analysis are a few among the text analysis methods. Although academic use of the text analysis methods has increased in scientific articles, the definitions of different text analysis methods are mixed. Several well-regarded books and articles provide instruction in the methods of content analysis (Krippendorff 2004, Neuendorff 2002), discourse analysis (Schiffrin, Tannen and Hamilton 2003) and framing analysis (Scheufel 1999). In the literature, there is a great deal of disagreement regarding the definition of "content analysis" and "discourse analysis", respectively; in reality there is a lot of overlap between the two methods. From several studies in the literature reporting either content analysis or discourse analysis, we can observe the following: (1) both methods use numbers to quantify some aspects of text; (2) both reflect on the identities and motivations of the authors; (3) they can both be used to examine either the stability or the flux in the discourse around an issue; and (4) researchers

using any of the two techniques either make use of computer assistance or choose to perform their analyses entirely manually (Shaw, 2006).

Analyzing the content of nuclear emergency coverage is of central importance to this study, since nuclear emergencies are mainly communicated by the mass media and are not directly experienced. Our research applies a quantitative and qualitative approach to content analysis. The replicable and valid inferences from data to their context give a condition that a content analysis allows to arrive at meaningful observations about social reality (Krippendorf, 1980). Key issues with regard to any deductive content analytical approach are the identification of a representative sample of material, as well as the reliability of the measures that are employed in analyzing the material (Krippendorf, 2004; Neuendorff, 2002).

The content analyses we report on were specifically designed for the purpose of this study. The first content analysis carried out, reported in Chapter 6, is related to a minor nuclear emergency event at the Krško nuclear power plant in Slovenia, 2008. We analyzed newspaper articles, radio news and TV news published or broadcasted between the 4th of June and the 14th of June, 2008 in 43 different media from 14 countries. All media items containing the word "Slovenia" and/or "Krško nuclear power plant" were included in the analysis. In total, 207 media texts were manually coded by two coders for each language, with the exception of Hungarian and Italian, where the text items were coded by only one coder. The focus is on the traditional media in particular, since EU citizens repeatedly reported them as their most important source of information related to nuclear events (Eurobarometer, 2008; Eurobarometer, 2010; Perko *et al.*, 2010).

The second content analysis was related to the Fukushima nuclear accident in Japan, 2011, and is presented in Chapter 5. This analysis improved and upgraded the measures and analysis of the material reported in Chapter 5. It was carried out on press articles from two major Belgian quality newspapers (*De Standaard* and *Le Soir)* published in the period between the 11th of March and the 11th of May, 2011. This time sampling of two months after the accident was focused on the "critical discourse moment", which made the nuclear energy issue visible in the mass media. The focus is on the press in particular, because in the first content analysis no difference was observed among the traditional media content. In other words, what was broadcasted on TV or radio was also reported in newspapers. In total, 143 newspapers articles were manually coded by two Dutch native speakers and 117 newspapers articles by two French native speakers. Rather than relying on a sample, all news items containing word "Fukushima" and "nuclear" have been included in the analysis. This provides a complete picture of the overall information related to nuclear emergency management in the media content. The reliability of all the content analysis measures was formally assessed by inter-coder reliability tests (reported in the subsequent chapters).

The content analysis in this dissertation serves to identify particular features and characteristics of news media coverage that are of theoretical and practical relevance in explaining media coverage of nuclear emergencies (see discussion above). More details on the design of the content analysis can be found in Chapters 5 and 6.

Outline of the dissertation

This dissertation proceeds with six articles that are related in the following manner:

In Chapter 2, we address the question if the application of the reception-acceptance model from political communication to risk communication can provide a better insight into the processing of risk information, by

highlighting which predictors are related to the different stages of the process. The hypothetical predictors are tested in a crisis and a post-crisis communication context, respectively.

In Chapter 3, we investigate the relevance of heuristic and systematic predictors for information processing, with a focus on information reception. Furthermore, we identify subgroups of the population who were expected to be particularly attentive to communication about nuclear emergencies. The communication context addressed in this chapter is related to nuclear emergency preparedness.

In Chapter 4, we provide further evidence for the importance of prior knowledge for risk communication and risk perception. The goal of this chapter was to empirically test the predictors of information processing (identified in the first two chapters) in two independent case studies in different countries. Both communication contexts in these studies are related to long-term communication as part of emergency preparedness and risk assessment.

In Chapter 5, we turn to the question what kind of information related to nuclear accidents people may receive from the media, since the mass media are the main information channel in case of a nuclear emergency. How and what did the media report about a severe nuclear accident (Fukushima , 2011), what did they focus on and how long was the accident newsworthy? The changes in public opinion related to nuclear issues are addressed and the influence of collective memory on media reporting is identified. The communication context investigated in this chapter is crisis communication.

In Chapter 6, we focus on media coverage of a minor nuclear event. Is information reported in the media influenced by the geographical distance to the location of the event, or by the level of political discussion about nuclear energy? What are the main information sources and what are the central issues of the media items in case of a minor nuclear event? The communication context in this chapter is crisis communication.

In Chapter 7, we give an overview of communication applied in historical nuclear accidents. From theoretical findings in previous chapters, tools, methods and practical guidelines are given for sound risk communication in nuclear emergency management, with an emphasis on crisis and post-crisis communication in the recovery phase of emergency management in Japan after the Fukushima nuclear accident.

The final chapter summarizes the key findings of this dissertation, discusses their implications within a wider theoretical framework and reflects on relevant shortcomings. The conclusion also presents a list of proposals for future research.

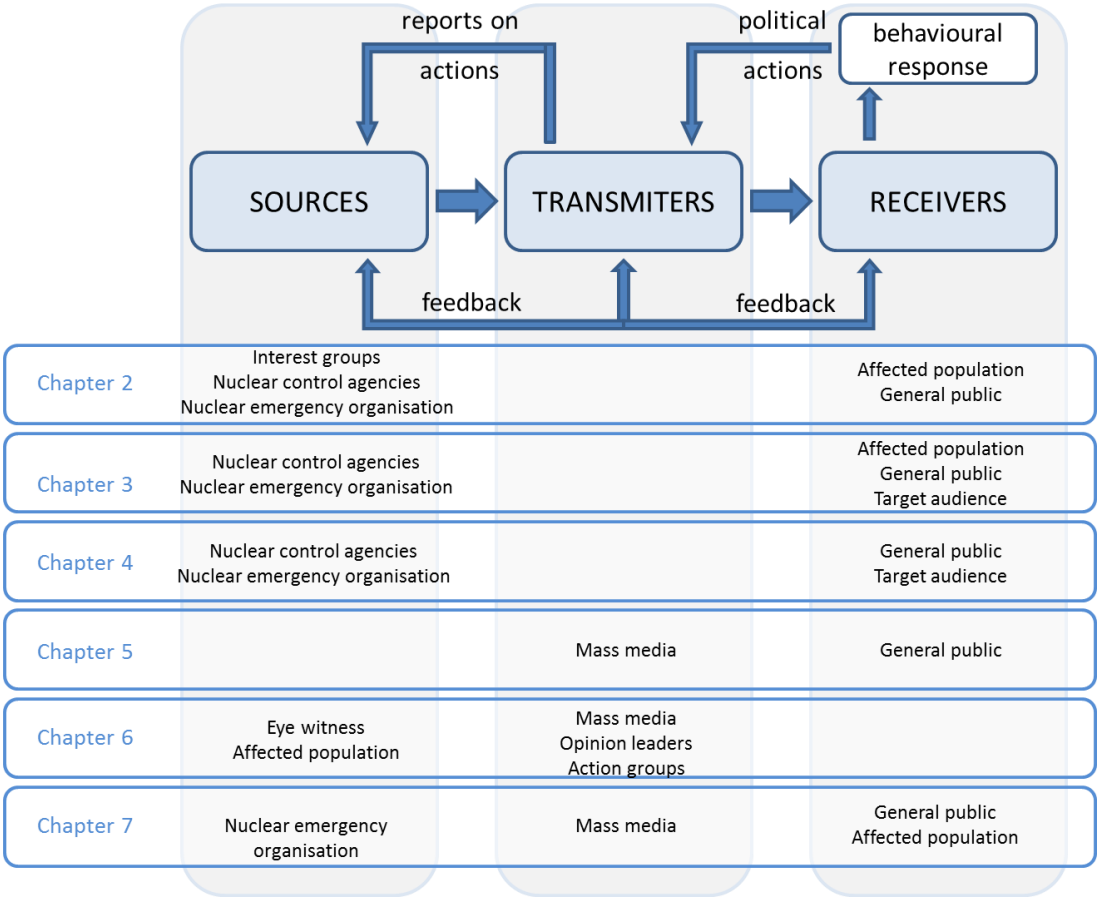

Figure 1.2: Content of the dissertation. Upper part: the source-transmitter-receiver model adopted from Renn (1992); lower part: elements of the model addressed in this dissertation

References

Abbott, P., Wallace, C., Beck, M., 2006. Chernobyl: Living with Risk and Uncertainty. *Health Risk & Society*, 8, 105-121.

Adams, J., 2005. Risk. *New Scientist*, 187, 36-36.

Anderson, N.H., 1981. Foundations of information integration theory. Academic Press, New York.

Anderson, N.H., Hubert, S., 1963. Effects of Concomitant Verbal Recall on Order Effects in Personality Impression-Formation. *Journal of Verbal Learning and Verbal Behavior*, 2, 379-391.

Beck, U., 2006. Living in the world risk society. *Economy and Society*, 35, 329-345.

Bell, M.M., Diane B. Mayerfeld, D. B. , 1998. The Rationalization of Risk XII Congress of the International Sociological Association, Montreal, Canada.

Berkowitz, A.D., 2008. Reporters and Their Sources. in: K. Wahl-Jorgensen, Hanitzsch (Eds.), The Handbook of Journalism Studies. Routledge, New York, pp. 102-115.

Boiarsky, C., 2004. Avoiding disasters with better communication. Trans. C. Soc Tech 51st Annual Conference of the Society-for-Technical-Communication. Soc. Technical Communication, Baltimore, MD, pp. 387-391.

Boomgaarden, H.G., de Vreese, C.H., 2007. Dramatic real-world events and public opinion dynamics: Media coverage and its impact on public reactions to an assassination. *International Journal of Public Opinion Research*, 19, 354-366.

Bord, R.J., Oconnor, R.E., 1990. Risk Communication, Knowledge and Attitudes - Explaining Reactions to a Technology Perceived as Risky. *Risk Analysis*, 10, 499-506.

Bord, R.J., Oconnor, R.E., 1992. Determinants of Risk Perceptions of a Hazardous-waste Site. *Risk Analysis*, 12, 411-416.

Bostrom, A., Atman, C.J., Fischhoff, B., Morgan, M.G., 1994. Evaluating Risk Communicatons - Completioning and Correcting Mental Models of Hazardous Processes 2. *Risk Analysis*, 14, 789-798.

Brunner, H.H., 2002. The Emergency Plan: Organization and Requirements. in: A. Sohier (Ed.) A European Manual for Off-site Emergency Planning and Response to Nuclear Accidents. SCK CEN, Mol, Belgium, pp. 257-278.

Buss, D.M., Craik, K.H., 1983. Contemporary Worldviews: Personal and Policy Implications. *Journal of Applied Social Psychology*, 13, 259-280.

Cacioppo, J.T., Petty, E.R., 1984. The Elaboration Likelihood Model of Persuassion. A*dvances in Consumer Research Volume*, 11, 673-675.

Cantone, M.C., Sturloni, G., Brunelli, G., 2007. The Role Played by Stakeholders in the Public Debate that Brought Italy out of the Club of Nuclear Energy Producers. *Health Physics*, 93, 261-266.

Carlé, B., Hardeman, F., 2003. Perception des Risques et de la Sécurité, Résultats du sondage de Novembre 2002 en Belgique SCK•CEN BLG 939, ISSN 1379-2407. Belgian Nuclear Research Centre, Mol, Belgium.

Cohen, B.L., 1985. A Simple Probabilistic Risk Analysis for High-Level Waste Repositories. *Nuclear Technology*, 68, 73-76.

Combs, B., Slovic, P., 1979. Newspaper Coverage of Causes of Death. *Journalism Quarterly*, 56, 837-843.

Costa-Font, J., Rudisill, C., Mossialos, E., 2008. Attitudes as an Expression of Knowledge and "Political Anchoring": The Case of Nuclear Power in the United Kingdom. *Risk Analysis*, 28, 1273-1287.

Covello, V.T., 1983. The Perception of Technological Risks - A Literature Review. *Technological Forecasting and Social Change*, 23, 285-297.

Covello, V.T., 2011. Risk Communication, Radiation, and Radiological Emergencies. *Health Physics*, 101, 511-530.

Covello, V.T., Allen 1988. Seven cardinal rules of risk communication. in: O.o.P.A. US Environmental Protection Agency (Ed.), Washington, DC.

Dake, K., 1992. Myths of Nature - Culture and the Social Construction of Risk. *Journal of Social Issues*, 48, 21-37.

Dalton, R.J., Beck, P.A., Huckfeldt, R., 1996. Partisan cues and the media: Information flows in the 1992 presidential election American Political Science Review. Amer political science assoc, San Francisco, California, pp. 111-126.

Dobrzynska, A., Blais, A., 2007. Testing Zaller's Reception and Acceptance Model in an Intense Election Campaign. *Polit. Behav*, 30, 259-276.

Douglas, M., Wildavsky, A., 1982. Risk and Culture. University of California Press, Berkely.

Eagly, A.H., 1992. Uneven Progress - Social Psychology and the Study of Attitudes. *Journal of Personality and Social Psychology*, 63, 693-710.

Eurobarometer, 2008. Eurobarometer: Attitudes Towards Radioactive Waste. European Commission.

Eurobarometer, 2010. Europeans and nuclear safety; Special Erobarometer 324. in: E. Commission (Ed.) Eurobarometer, Brussels, Belgium.

Fischhoff, B., 1991. Value Elicitation - Is There Anything in There. *American Psychologist*, 46, 835-847.

Fischhoff, B., 1995. Risk Perception and Communication Unplugged: 20 Years of process. *Risk Analysis*, 15, 137-145.

Fischhoff, B., Slovic, P., Lichtenstein, S., Read, S., Combs, B., 1978. How Safe is Safe Enough - Psychometric Study of Attitudes Towards Technological Risks and Benefits. *Policy Sciences*, 9, 127-152.

Flynn, J., Burns, W., Mertz, C.K., Slovic, P., 1992. Trust as a Determinant of Opposition to a High-level Radioactive-waste Repository - Analysis of a Structural Model. *Risk Analysis*, 12, 417-429.

Franklin, B., Hamer, M., Kinsey, M., Richardson, E.J., 2005. Key Concepts in Journalism Studies. SAGE, London.

Freudenburg, W.R., 1993. Risk and Recreancy - Weber, the Division of Labor and the Rationality of Risk Perception. *Social Forces*, 71, 909-932.

Freudenburg, W.R., Gramling, R., 1992. Community impacts of Technological Change Toward a Longitudinal Perspective. *Social Forces*, 70, 937-955.

Freudenburg, W.R., Pastor, S.K., 1988. Nimbys and Lulus - Stalking the Syndromes. Trans. A. Soc Risk 1988 Annual Meeting of the Soc for Risk Analysis. Plenum Publ Corp, Washington, Dc, pp. 39-61.

Frewer, L.J., Howard, C., Hedderley, D., Shepherd, R., 1996. What determines trust in information about food-related risks? Underlying psychological constructs. *Risk Analysis*, 16, 473-486.

Gamson, W.A., Modigliani, A., 1989. Media discourse and public opinion on nuclear power: a constructionist approach. *The American Journal of Sociology* 95, 1 - 37.

Gaskell, G., Allum, N., Wagner, W., Kronberger, N., Torgersen, H., Hampel, J., Bardes, J., 2004. GM foods and the misperception of risk perception. *Risk Analysis*, 24, 185-194.

Greenberg, M., Truelove, H.B., 2011. Energy Choices and Risk Beliefs: Is It Just Global Warming and Fear of a Nuclear Power Plant Accident? *Risk Analysis*, 31, 819-831.

Gregory, R., Mendelsohn, R., 1993. Perceived Risk, Dread, and Benefits. *Risk Analysis*, 13, 259-264.

Griffin, R.J., Dunwoody, S., Neuwirth, K., 1999. Proposed Model of the Relationship of Risk Information Seeking and Processing to the Development of Preventive Behaviors. *Environmental research*, A80, 230-245.

Griffin, R.J., Yang, J., Huurne, E., 2008. After the Flood: Anger, Attribution, and the Seeking of Information. *Science Communication*, 29, 285-315.

Hamilton, D.L., Leirer, V., Katz, L.B., 1980. Cognitive Representation of Personality Impressions - Organizational Processes in 1st Impression-Formation. *Journal of Personality and Social Psychology*, 39, 1050-1063.

Hastie, R., Park, B., 1986. The Relationship Between Memory and Judgement Depends on Whether the Judgement Task is Memory-Based or Online. *Psychological Review*, 93, 258-268.

Havenaar, J.M., de Wilde, E.J., van den Bout, J., Drottz-Sjöberg, B.M., van den Brink, W., 2003. Perception of risk and subjective health among victims of the Chernobyl disaster. *Social Science & Medicine*, 56, 569-572.

Hunt, T., Grunig, J., 1994. Public Relations Techniques. Fort Worth, TX: Harcourt, Brace.

Huurne, E., Griffin, R.J., Gutteling, J.M., 2009. Risk Information Seeking Among U. S. and Dutch Residents: An Application of the Model of Risk Information Seeking and Processing. *Science Communication*, 31, 215-237.

IAEA, 2006. Manual for first Responders to a Radiological Emergency. in: I.A.E. Agency (Ed.) Emergency Preparedness and Response, Vienna.

IAEA, 2012. Communication with the Public in a Nuclear or Radiological Emergency. EPR-Public Communications, IAEA, Vienna.

ICRP, 1991. Recommendation of the International Commission on Radiological Protection. in: I.C.o.R. Protection (Ed.). Pergamon Press, Oxford, New York, Frankfurt, Seoul, Sydney, Tokyo.

ICRP, 2007. Annals of the ICRP: The 2007 Recommendation of the International Commission on Radiological Protection. in: Publication 103, Valentin J. (ed.). Elsevier.

Jones, B., Baumgartner, F., 2005. The Politics of Attention. How Government Prioritizes Attention. University of Chicago Press, Chicago.

Kahlor, L.A., Dunwoody, S., Griffin, R.J., Neuwirth, K., 2006. Seeking and Processing Information About Impersonal risk. *Science Communication*, 28, 163-194.

Kanda, R., Tsuji, S., Yonehara, H., 2012. Perceived Risk of Nuclear Power and Other Risks During the Last 25 Years in Japan. *Health Physics*, 102, 384-390.

Kasperson, R.E., Renn, O., Slovic, P., Brown, H.S., Emel, J., Goble, R., Kasperson, J.X., Ratick, S., 1988. The Social Amplification of Risk - A Conceptual Framework. *Risk Analysis*, 8, 177-187.

Knight, A.J., Warland, R., 2005. Determinants of food safety risks: A multi-disciplinary approach. *Rural Sociology*, 70, 253-275.

Kovach, B., Rosenstiel, T., 2007. The Elements of Journalism: What Newspeople Should Know and The Public Should Expect Three Rivers Press, New York.

Krippendorf, K., 1980. Content analysis: An introduction. Sage, Thousand Oaks, CA.

Krippendorf, K., 2004. Reliability in Content Analysis. *Human Communication Research*, 30, 411-433.

Kuklinski, J.H., Metlay, D.S., Kay, W.D., 1982. Citizen Knowledge and Choices on the Complex Issue of Nuclear Energy. *American Journal of Political Science*, 26, 615-642.

Lang, A., 2006. Using the Limited Capacity Model of Motivated Mediated Message Processing to Design Effective Cancer Communication Messages. *Journal of Communication*, 56, S57-S80.

Lang, A., Bolls, P., Potter, R.F., Kawahara, K., 1999. The Effects of Production Pacing and Arousing Content on the Information Processing of Television Messages. *Journal of Broadcasting & Electronic Media*, 43, 451-475.

Lichtenstein, S., Slovic, P., Fischhoff, B., Layman, M., Combs, B., 1978. Judged Frequenccy of Lethal Events. *Journal of Experimental Psychology-Human Learning and Memory*, 4, 551-578.

Lofstedt, R.E., 1996. The Barseback nuclear plant case. *Energy Policy*, 24, 689-696.

McDermott, J.J., 1982. Three Mile Island. (The malfunction and its effects on American public opinion). *Fizikai Szemle*, 32.

Miller, J.D., 1998. The Measurement of Civic Scientific Literacy. *Public understanding of science*, 7, 203 - 223.

Morgan, M.G., Fischhoff, B., Bostrom, A., Atman, C.J., 2002. Risk communication: A mental models approach. Cambridge University Press, New York.

Morgan, M.G., Fischhoff, B., Bostrom, A., Lave, L., Atman, C.J., 1992. Communicating Risk to the Public. *Environmental Science & Technology*, 26, 2048-&.

Neuendorff, K., 2002. The Content Analysis Guedebook. Sage Publication, Thousand Oaks, California.

O'Keefe, D.J., 2002. Persuasion; Theory and Research. Sage Publications, London.

Palenchar, M.J., Heath, R.L., 2005. Strategic risk communication: Adding value to society Conference on New Perspectives on Crisis Communication. Elsevier Science Inc, Washington, DC, pp. 120-129.

Perko, T., Turcanu, C., Carlé, B., 2012. Media Reporting of Nuclear Emergencies: The Effects of Transparent Communication in a Minor Nuclear Event. *Journal of Contingencies and Crisis Management*, 20, 52-56.

Perko, T., Turcanu, C., Schröder, J., B., C., 2010. Risk Perception of the Belgian Population; Results of the Public Opinion Survey in 2009. SCK CEN, Mol, pp. 202.

Peters, R.G., Covello, V.T., McCallum, D.B., 1997. The determinants of trust and credibility in environmental risk communication: An empirical study. *Risk Analysis*, 17, 43-54.

Petty, E.R., Cacioppo, J.T., 1986. The Elaboration Likehood Model of Persuasion. in: A.D. Berkowitz (Ed.) Advances in Experimental Social Psychology. Academic Press, New York, pp. 124-192.

Pond, R.G., Kucklick, J.H., Walker, A.H., Bostrom, A., Fischbeck, P., Aurand, D., Api, 1997. Bridging the gap for effective dispersant decisions through risk communication. Trans. U.S.E.P.A.A.P.I.I.P.I.E.C. Us Coast Guard, I.M.O. Assoc International Oil Spill Conference - Improving Environmental Protection. Amer Petroleum Inst, Ft Lauderdale, Fl, pp. 753-759.

Price, V., Zaller, J., 1993. Who Gets the News? Alternative Measures of News Reception and their Implications for Research. *Public Opinion Quarterly*, 57, 133-164.

Renn, O., 2003. Perception of risks. Trans. T. European Soc 41st Congress of the European-Societies-of-Toxicology. Elsevier Sci Ireland Ltd, Florence, Italy, pp. 405-413.

Renn, O., 2004. The role of stakeholder involvement in risk communication. *Atw-International Journal for Nuclear Power*, 49, 602-+.

Renn, O., 2008. Risk Governance; Coping with Uncertainty in a Complex World. Earthscan, London.

Reyes, R.M., Thompson, W.C., Bower, G.H., 1980. Judgmental Biases Resulting from Differing Availabilities of Arguments. *Journal of Personality and Social Psychology*, 39, 2-12.

Rojas-Palma, C., Liland, A., Jerstad, A.N., Etherington, G., Perez, M.R., Rahola, T., Smith, K., 2009. TMT Handbook; Triage, Monitoring and Treatment of people exposed to ionising radiation following malevolent act. Lobo Media AS, Norway.

Ropeik, D., 2011. Poor Risk Communication In Japan Makes the Fear Much Worse Psychologiy Today, http://www.psychologytoday.com/blog/how-risky-is-it-really/201103/poor-risk-communication-in-japan-makes-the-fear-much-worse.

Rowe, G., Frewer, L., Sjöberg, L., 2000. Newspaper reporting to hazard in the UK and Sweden. *Public Understanding of Science*, 9, 59-78.

Rupar, V., 2007. Newspapers' production of common sense; The 'greenie madness' or why should we read editorials? *Journalism*, 8, 591-610

Rupar, V., 2010. Journalism and Meaning-Making; Reading the Newspaper. Hampton Press.

Sandman, P.M., 1987. Risk Communication: Facing Public Outrage. *Environmental Protection Agency Journal*, 13, 21-22.

Shaw, E., 2006. (De)coding Content: Code Scheme Development in Content Analysis Annual Meeting of the American Political Science Association, September 3. University of California, Berkeley.

Shiffrin, R.M., Schneider, W., 1984. Automatic and Controlled Processing Revisited. *Psychological Review*, 91, 269-276.

Siegrist, M., Cvetkovich, G., Roth, C., 2000. Salient value similarity, social trust, and risk/benefit perception. *Risk Analysis*, 20, 353-362.

Sjöberg, L., 1999. Risk perception in Western Europe. Trans. S. Royal Swedish Acad Seminar on Assessment of Risk in a National and International Perspective. Royal Swedish Acad Sciences, Stockholm, Sweden, pp. 543-549.

Sjöberg, L., 2000a. Factors in risk perception. *Risk Analysis*, 20, 1-11.

Sjöberg, L., 2000b. Perceived risk and tampering with nature. *Journal of Risk Research*, 3, 353-367.

Slovic, P., 1987. Perception of Risk. *Science*, 236, 280-285.

Slovic, P., Finucane, M.L., Peters, E., MacGregor, D.G., 2004. Risk as analysis and risk as feelings: Some thoughts about affect, reason, risk, and rationality. *Risk Analysis*, 24, 311-322.

Slovic, P., Fischhoff, B., Lichtenstein, S., 1982. Why Study Risk Perception. *Risk Analysis*, 2, 83-93.

Sohier, A., 2002. A European Manual for OFF-site Emergency Planning and Response to Nuclear Accidents. December, 2002 ed. Belgian Nuclear Research Centre, SCK CEN, pp. 339.

Starr, C., 1969. Social Benefit Versus Tecnological Risk. *Science*, 165.

Triandafyllidou, A., 1995. The Chernobyl Aaccident in the Italian Press - A Media Story-Line. *Discourse & Society*, 6, 517-536.

Trumbo, W.C., 1999. Heuristic-Systematic Information Processing and Risk Judgement. *Risk Analysis*, 19, 391-400.

Trumbo, W.C., 2002. Information Processing and Risk Perception: An Adaption of the Heuristic-Systematic Model. *Journal of Communication*, 52, 367-382.

Turcanu, C., Perko, T., Schröder, J., 2011. The SCK•CEN Barometer 2011 - Perception and attitudes towards nuclear technologies in the Belgian population Open Report. Belgian Nuclear Research Centre SCK•CEN, Mol; Belgium, pp. 150.

Tversky, A., 1974. Assessing uncertainty. *Journal of the Royal Statistical Society Series B-Methodological*, 36, 148-159.

Tversky, A., Kahneman, D., 1974. Judgement Under Uncertainty - Heuristics and Biases Science, pp. 1124-1131.

Van Aeken, K., Turcanu, C.O., Bombaerts, G., Carlé, B., Hardeman, F., 2007. Risk perception of the Belgian population. Results of the public opinion survey in 2006. . Belgian Nuclear Research Centre SCK•CEN BLG-1038, Mol, Belgium.

Van Bladel, L., Pauwels, A., Smeesters, P., 2000. The challenge of interacting with the public on nuclear emergency preparedness and iodine prophylaxis. in: O. NEA (Ed.) OECD-NEA Workshop Investing in Trust: Nuclear Regulators and the Public. OECD, Paris, France, pp. 141-147.

Vasterman, P., 2005. Media-Hype. Self-reinforcing News Waves. Journalistic Standards and the Construction of Social Problems. *European Journal of Communication*, 20, 508-530.

Vlek, C., Stallen, P.J., 1981. Judging risks and benefits in the small and in the large. *Organizational Behavior and Human Performance*, 28, 235-271.

Vliegenthart, R., Walgrave, S., 2008. The Contingency of Intermedia Agenda-Setting. A Longitudinal Study in Belgium. *Journalism and Mass Communication Quarterly* 85, 860-877.

Wildavsky, A., Dake, K., 1990. Theories of Risk Perception - Who Fears What and Why. *Daedalus*, 119, 41-60.

Wilson, J., 1996. Understanding Journalism. Routledge, London and New York.

Winter, L., Uleman, J.S., 1984. When are Social Judgements Made - Evidence for the Spontaneousness of Trait Inferences. *Journal of Personality and Social Psychology*, 47, 237-252.

Zaller, J., 2006. The Nature and Origins of Mass Opinion. Cambridge university press New York.

Železnik, N., 2010. Mental Models of Radioactivity and Attitudes towards Radioactive Waste. http://nuklearno-drustvo.hr/hr/skupovi/konferencije.html ed 8th International Conference on Nuclear Option in Countries with Small and Medium Electricity Grids Dubrovnik, Croatia.

2. The Potential use of the Reception and Acceptance Model for Risk Communication

Manuscript in the second review before publication in Journal of Risk Research as:

Perko T., Thijssen P., Turcanu C., Van Gorp B. - ***The Potential use of the Reception and Acceptance Model for Risk Communication***

Abstract

The objective of this study is to test if the effect of variables such as knowledge, attitudes, trust, risk perception and psychometric risk characteristics changes in the different stages of risk-related information processing. To address this question, a distinction is made between two information processing steps, *reception* and *acceptance*. An empirical study was conducted, using a radiological accident (2008) in Belgium as a case study. The Reception-Acceptance Model was used to produce new insights into risk communication. The results demonstrate that knowledge was only the driving factor for the *reception* of risk messages, while heuristic predictors such as psychometric risk characteristics, attitudes and trust were most influential for the *acceptance* of risk messages.

Introduction

Efficient communication about risks requires a good understanding of the factors that influence people's attentiveness to information and, most importantly, their decision to follow recommendations. This is of paramount importance in emergency situations.

One of the theoretical models that distinguish between the different steps of information processing, Zaller's reception-acceptance model (RAS) (2006), comes from the field of political communication. Although it has rarely been empirically tested, the model is a leading theory in political communication and opinion formation (Bützer and Marquis, 2002; Dobrzynska and Blais, 2007; Goren, 2004; Krosnick and Brannon; Kulakovski, 2009; Liu, 2005). In the present study, this model is applied to risk communication for the first time and subsequently empirically tested by means of a large-scale public opinion survey.

The application of the Reception-acceptance model to risk communication makes it possible to determine influential predictors for the *reception* and *acceptance* of risk-related information, thus highlighting the stage of information processing in which the different predictors start to influence opinion formation. Moreover, risk communication is an ideal area to test the model in, since the risk (e.g. the consequences of a nuclear accident) is typically intensively communicated, but the familiarity with the messages among the population is usually low. In addition, risk discussions appear frequently in a political agenda. Finally, public attention to a particular risk is often defined by politics (Beck, 2006; Jones and Baumgartner, 2005). According to Zaller, this is precisely the context in which an individual will receive the communicated message and not necessary accept it.

The adaptation of the Reception-acceptance model to risk communication requires the integration of two disciplines: political communication and risk research. Although in this study the basic model is taken from Zaller (2006), the operationalization of several concepts was driven by the risk research theory developed by Griffin (1999), Slovic *et al.* (2004), Sjöberg (2006), Renn (2008) and others. The objective of this study is to empirically test whether the variables that have been traditionally used in risk research have a different effect in the different stages of information processing. These variables are the following: specific knowledge, attitudes, trust in the authorities, risk perception and psychometric risk characteristics (disaster potential, tampering with nature and unfamiliarity with the risk).

Although the risk research literature has seen a growing interest in information processing (Huurne *et al.*, 2009; Jooyoung and Hye-Jin, 2009; Petty and Cacioppo, 1986; Trumbo, 2002), it has not been evaluated to what extent these variables affect the different stages of risk- related information processing.

According to the RAS model (2006), an opinion is formed in two stages of information processing: *reception* and *acceptance*. *Reception* of information refers to the extent to which an individual pays attention to, understands what he/she has encountered and retains the information. Reception of information is thus set apart from the decision making part (Price and Zaller, 1993). The latter occurs in the so-called *acceptance* stage which refers to "resisting or accepting the information" (Zaller, 2006:44).

To provide a concrete framework to apply the RAS model to the reception and acceptance of risk information, we used the risk communication after a radiological accident as a case study. The accident in question occurred in 2008, in a nuclear installation located in the area of Fleurus, Belgium. The subsequent radioactive release to the environment was assumed to pose a risk for the population living in this area. To examine the intensity of the campaign and its effect, two samples were studied. The first sample (N=1031) is representative for the Belgian adult population, the second one (N=104) is a sample of the population living in the area of the radiological accident. More details are given in section Method.

The Reception-Acceptance model

Theoretical framework

John Zaller formulated the Receive-Accept-Sample (RAS) model in order to explain - in the context of political communication - the nature and origins of mass opinion. He identified predictors of information processing and recognized the importance of political awareness and predispositions in opinion formation. Since his first publication in 1992, the RAS model has become the most prominent model of opinion formation (Bützer and Marquis, 2002; Dobrzynska and Blais, 2007; Goren, 2004; Krosnick and Brannon; Kulakovski, 2009; Liu, 2005).

The RAS model is constructed along four axioms: reception, resistance, accessibility and sampling (Zaller, 2006:42-51). These four axioms comprise a conceptual framework explaining how individuals process the information related to political issues. The RAS model argues that an individual's judgment reflects considerations that have been received, accepted and sampled. In our research the first three axioms are addressed.

According to the Zaller's model, an opinion is formed in two stages, named *reception* and *acceptance*. (In our research this two variables are dependent variables.) *Reception* entails a sequence of information-processing steps, attending to, comprehending and retaining the information (Price and Zaller, 1993:134). According to the model, in the *reception* stage, "*the greater a person's level of cognitive engagement (awareness) with an issue, the more likely she or he is to be exposed to and comprehend (i.e. "receive") messages concerning that issue"* (Zaller, 2006:42). The impact of awareness depends on the characteristics of the message. The weaker the intensity of the message and the person's familiarity with it, the stronger the effect of awareness is. If a message is intense and familiar, even the people who are least aware of it will receive it and be able to make the appropriate connections with their basic values (Zaller, 2006:154-155).

Acceptance may refer to a person resisting to the information or accepting it. As Zaller puts it, "*People tend to resist arguments that are inconsistent with their predispositions, but they do so only to the extent that they possess the contextual information necessary to perceive a relationship between the message and their predispositions"* (Zaller, 2006:44). Accordingly, the acceptance of a message is being conceived as a result

of the interaction between political awareness and political predispositions (Dobrzynska and Blais, 2007) (see Figure 2.1).

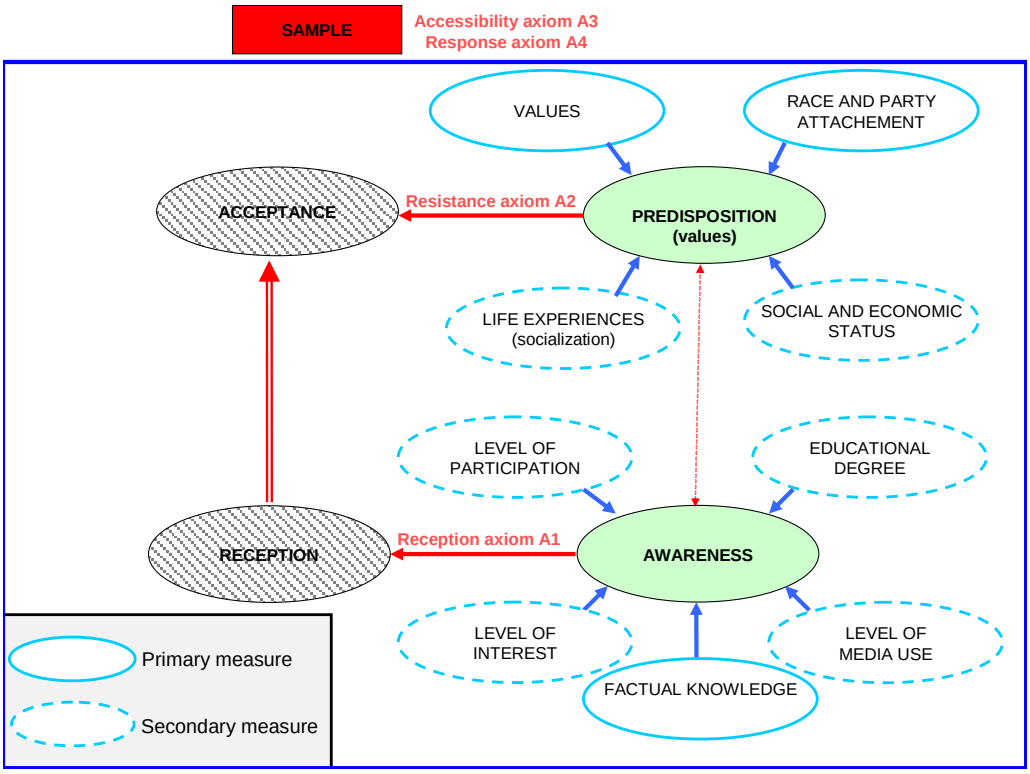

Figure 2.1: Graphical illustration of the Reception-acceptance model, adapted from Zaller (2006).

The *awareness* construct in Zaller's model suggests that people who are more aware will be exposed to, and thus 'receive', more information, but they will also be more selective in deciding which information to internalize as considerations (Zaller, 2006: 17-19). As a result, people that are more aware will be more likely to be able to voice their opinions, and these will generally be ideologically consistent with their *predispositions*. Awareness can be measured by more concepts: the level of participation, the level of interest and the level of media use (see Fig. 1). However, awareness is in most research usually measured by the specific knowledge (Zaller, 2006:333-339).

Predispositions are stable individual-level traits that regulate the acceptance or non-acceptance of the information a person receives. They are the critical intervening variables between the information that people encounter and their statements of issue preference. Predispositions are measured by values (Zaller, 2006:344, 22-28), life experiences, social and economic status or race and party attachment. As Zaller argues, "*Every opinion is a marriage of information and predisposition: information to form a mental picture of a given issue, and predisposition to motivate some conclusion about it*" (Zaller, 2006:6).

Empirical testing

Zaller's RAS model can be seen as a more advanced version of the memory-based models of Converse (1964), McGuire (1973), Iyengar and Kinder (1987). Even if Zaller is "*heavily cited"* and "*highly recognised"* in the literature (Bützer and Marquis, 2002; Dobrzynska and Blais, 2007; Goren, 2004; Krosnick and Brannon; Kulakovski, 2009; Liu, 2005), there is little empirical research validating the theoretical model. The entire RAS model has rarely been tested directly, due to a lack of data on the dynamic of mass opinion; for such a testing panel, data are necessary. The full model with a focus on the dynamics of opinion change was, however, tested by Lui (2005). Still, most empirical studies only tested the model in the acceptance stage (e.g. when voting decisions are made), as was for example the case with Goren (2004) or Bützer and Marquise (2002) and, more recently, Sciarini and Tresch (2011).

Some studies have already tested the model in both the reception and the acceptance stage, such as Dalton *et al.* (1996) and Dobrzynska and Blais (2007). All these studies provide a test of Zaller's Reception-acceptance model in the context of elections, but their results only confirm the model in some points. The authors suggest that "*when an issue is hotly debated in an election campaign voters who receive party messages are able to connect these messages to their values and predispositions whatever their level of political awareness*" (Dobrzynska and Blais, 2007: 259). The most aware people were more likely to receive messages, but did not necessarily learn more during the course of the election campaign. Most importantly, *"the highly aware were not more prone to form their opinion on the basis of their predispositions*"(Dobrzynska and Blais, 2007: 271). In the latter two studies, the familiarity with the message and its intensity are not taken into account. In an election campaign, the intensity and, consequently, the familiarity with the message is higher, so the awareness effect is, according to Zaller (2006: 155), weaker. This is confirmed by a study by Sciarini and Tresch (Sciarini and Tresch, 2011:333), who demonstrate that campaign effects are *"higher when the campaign is highly intense* ".

So far, all of the existing literature on the RAS model has addressed the field of political communication; what is new in our research is that the RAS model is applied in the field of risk communication.

Adaptation of the RAS model to risk Communication

The dependent variables, reception and acceptance, are taken from Zaller's construct. However, the adaptation of the independent variables of the RAS model to the context of risk communication required the redefinition of several concepts, among which *awareness* and *predisposition.* In the following paragraphs, the independent levels of this adapted RAS model are explained and the research hypotheses are formulated (see Figure 2.2).

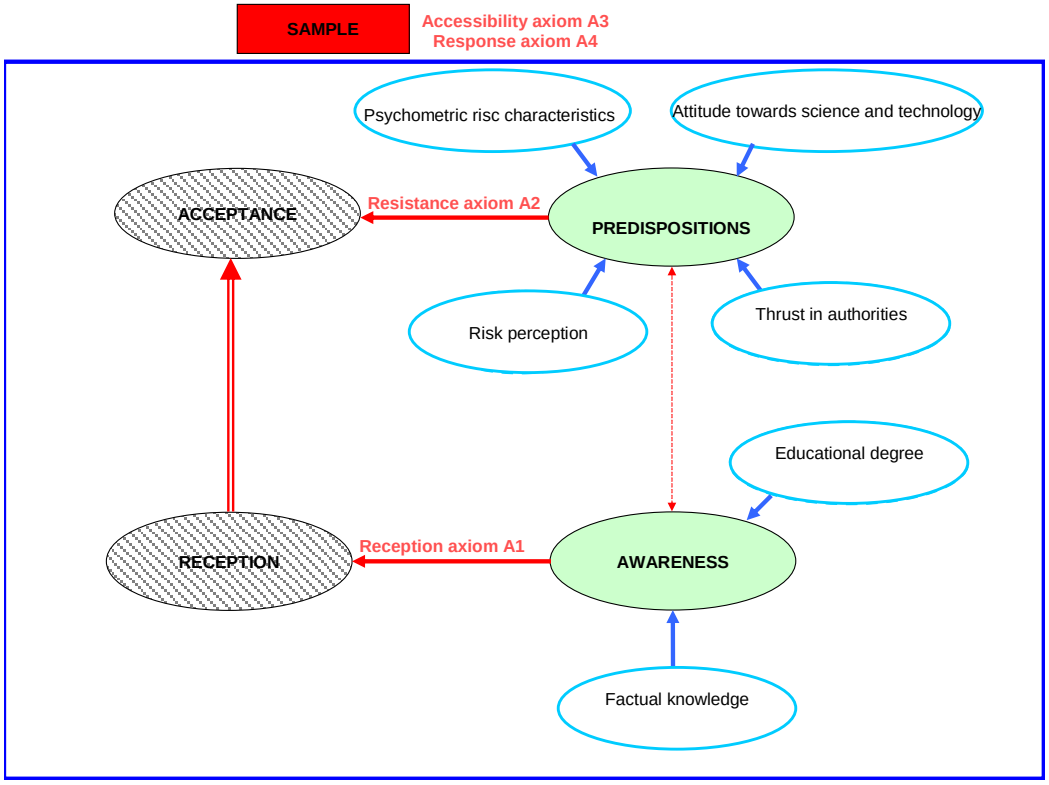

Figure 2.2: Hypothetical model; adaptation of political communication model to risk communication

Awareness

From the original construct of the latent variable political awareness, we only retained the education level and specific knowledge which we adapted to the domain of radiological risk.

Specific knowledge

H1a: *People with more specific knowledge about the nuclear field are more likely to receive messages about the radiological accident. In addition, the acceptance is an result of an interaction effect between specific knowledge and predispositions.*

As was recommended by Zaller (2006:333) and confirmed by Dobrzynska and Blais (2007), we only retained specific knowledge as a measure for awareness. The participants' prior knowledge was determined by a simple test of factual information related to the specific risk involved: "radioactivity". The information used to measure knowledge was not included in the risk communication, so that it was a good indicator of prior knowledge, independent from the risk communication.

The influence of specific knowledge on information processing is widely recognized by both political communication and risk communication scholars. Scholars in risk research, for example Griffin *et al.* (2008), Kahlor *et al.* (2006) and Huurne *et al.* (2009), have also found a positive direct relationship between knowledge and perceived information-gathering capacity. Political communication scholars such as Price and Zaller (1993), Dobrzynska and Blais (2007) have recognized specific knowledge as the most powerful

predictor for information *reception*. In other words, people who are well informed about a specific issue receive more information than people who are not as knowledgeable. However, Zaller observed that the impact of this knowledge depends significantly on the intensity and familiarity of the message (Zaller, 2006: 154-155). Therefore, if a message is very intense and familiar, or if people are extremely motivated by some reasons, such as personal relevance (Petty and Cacioppo, 1986), even the least knowledgeable would receive it. As a result, the following hypothesis could be formulated:

H1b: Specific knowledge is, due to higher familiarity with and intensity of the message, less influential as a predictor of reception for the affected population than for the general population.

In order to investigate the importance of familiarity with and intensity of the messages, two different populations were selected. First, we examined the general population, in which the intensity and familiarity of risk communication was not strong, and second, we studied the affected population, in which both factors were very strong (see Description of the communication case studied section).

Education level

H1c: *People with a higher level of education are more likely to receive messages about the radiological accident, which either deal with protective actions or are reassuring messages of risk communication.*

In a study byf Griffin *et al.* (1999), education was indicated as an important predictor of an individual's ability to seek, process and retain risk information. They found that people with a higher education are more likely to process the information and make a judgment afterwards. However, for the *reception* of "political" information, education is assumed to be a rather weak predictor (Price and Zaller, 1993; Zaller, 2006). To examine this contradiction further, we tested education as a possible predictor for the *reception* of risk messages.

Predispositions

We adapted the concept of *predispositions* to radiological risks (in political communication expressed e.g. as party orientation or political values). Based on the literature on risk research we identified the following variables that may act as predispositions for information processing: (1) attitude toward science and technology, (2) trust in the authorities to protect the population, (3) risk perception of nuclear accidents, and (4) psychometric characteristics of the nuclear accident (i.e. disaster potential, tampering with nature and unfamiliarity). We measured the influence of predispositions in both the reception and acceptance stage. The research hypotheses are summarized in the following paragraphs.

Attitude toward science and technology

An attitude is defined as a complex, multidimensional construct comprised of cognitive, affective or behavioral components (Rosenberg and Hovland, 1960). It is essentially a subjective judgment that one likes or dislikes an object, that it is good or bad, that one feels favorable or unfavorable toward it. Even if attitudes may play a limited role in predicting behavior, for certain individuals and certain situations they do come forward as important predictors of behavior. Fazio (1986), for example, showed that attitudes and behavior are correlated when (a) the attitude is based on direct experience with the attitude object, and (b) to the extent that the attitude is cognitively accessible.

Attitudes are considered key mental states relevant to information processing because of a presumed relationship between attitudes and actions (O'Keefe, 2002). Therefore, they are important determinants of persuasive communication, which risk communication often, but not always, aims to be (Krosnick and Petty, 1995).

In the context of a radiological accident, we assumed that people's attitude toward science and technology would be related to their acceptance of protective actions and reassuring messages, since a radiological accident can be seen as a risk arising from the development of science and technology. We tested the following hypothesis:

H2: *People with a positive attitude toward science and technology will accept risk-related messages more.*

Trust in authorities to protect the population against radiological risks

The variable "trust" attracts a growing interest in decision-making among risk perception scholars (e.g. Peters *et al.* (1997); Renn (2004); Chryssochoidis (2009); Sjöberg (2004). Trust is very often used as an explanation of risk perception and its acceptability. The components of trust are multidimensional: perceived competence, objectivity, fairness, consistency, sincerity, faith and empathy. Earlier research has identified trust as one of the key indicators for the acceptance of nuclear risks (Ibitayo and Pijawka, 1999; Sjöberg, 2004; Slovic *et al.*, 1991). Several researchers, such as (Earle, 1995; Slovic, 1993) have also identified trust as a key mediating factor in circumstances that require actions and subsequent information processing. However, none of these studies have so far identified at what particular stage of information processing trust actually becomes influential.

In our study we have explored this question by studying the relation between trust in authorities and the *reception/acceptance* of risk messages. With the increasing complexity of technological innovations, people find themselves in a position of not knowing much about highly complex and potentially dangerous technologies (Freudenburg, 1993; Gaskell *et al.*, 2004). Therefore, they have to rely on their own judgment about whom or what to trust.

H3: *People with more trust in the authorities to protect the population against radiological risks will accept a greater number of messages than people with less trust will.*

Risk perception of an accident in a nuclear installation

Risk perception is recognized as an essential social and psychological phenomenon, having an influence on decision-making (Beck, 2006; Renn, 2008; Sjöberg, 2006). A considerable amount of research on risk perception has been published and a variety of theoretical perspectives exist, including cultural (Dake, 1992), sociological (Beck, 2006) and psychological ones (Fischhoff *et al.*, 1978). Previous research on risk information by Griffin *et al.* (2008) has found that the response to a risk could be directly related to a person's information seeking. The research by Slovic and Weber (2002), Fischhoff (1993), Renn (2008) and others have found that risk perception influences the response to risk information as well. In this research following hypotheses was tested:

H4: *People that have a higher risk perception of an accident in a nuclear installation oppose more risk messages and formulate more negative opinions about actions taken to protect the population, in comparison with people with a lower perception of this risk.*

Psychometric risk characteristics

Huurne *et al.* (2009: 231) found that "*emotional reactions to risk are among the strongest predictors of individuals' risk information seeking behavior*". These specific emotions related to risk have been evaluated by several psychometric scholars. Fischhoff, Slovic and Lichtenstein (1978), who were the first to conduct such research, found that the characteristics of the risk influence its acceptability. For example, the more dreaded a risk is, the less people will accept the risk (Gregory and Mendelsohn, 1993). Slovic (1992) originally demonstrated 15 different risk characteristics, but most empirical research focuses on a limited number of characteristics, such as unfamiliarity, disaster potential (dread), the number of people exposed and controllability. The risk characteristics "unnatural and immoral", as well "tampering with nature", added by Sjöberg, considerably improved the psychometric model, so that it could predict people's acceptance of risk better (Fischhoff *et al.*, 1978; Sjöberg, 2000; Sjöberg and Wahlberg, 2002). Based on this, the following hypotheses was tested:

H4a: The acceptance of information is influenced by several risk characteristics, People that are more afraid of nuclear accidents and are more inclined to think that these accidents are a result of scientists tampering with nature or that they pose unfamiliar risks will reject more risk messages and formulate more negative opinions about protective actions.

Method

Description of the communication case studied

In August 22nd 2008, radioactive iodine was accidentally released in a facility producing radioisotopes for medical use, located in Fleurus, Belgium. After the accident, the Belgian authorities implemented restrictions on the use of local farming produce within 5 km of the release point. Due to the deposition of radioactive material, the population in the neighborhood was advised not to consume vegetables from their gardens, for a period of two weeks.

The European Commission sent out a warning using the ECURIE-alert system (The European Community Urgent Radiological Information Exchange) on the 29th of August. The event was covered by all Belgian mass media and it remained a daily news item for several weeks. The news items were mostly informative, based on the information provided by the Crisis Centre or interviews with important actors: crisis managers, experts, managers from the installation and local and national politicians (Carlé *et al.*, 2010). The national media focused their attention on the accident and then placed it within the context of lack of radioisotopes for medical use, which were produced in a facility and used for healing cancer. This framing didn't appear in the local media, however.

After reports of the incident in the press, the local population grew more concerned about possible health effects. As a consequence, the Belgian public health authorities organized a large-scale thyroid measurement campaign for the local population to check their thyroid uptake of radioactive iodine.

Public meetings with the local community were organized in a sports centre, and the accident was discussed with all stakeholders involved. The table below summarizes the main messages communicated by the authorities during the risk communication (Table 2.1).

Table 2.1: The messages of risk-communication that we analyzed in the research, aim and tools

Communicated message*	Basic information	Message about a protective action	Reassuring message	Main communication tool*
In the region of Fleurus there has been an accidental radiation release	✓			Local, national media
Release occurred in a facility producing isotopes for medical use	✓			National media
The influence of the radioactive release is only local.	✓		✓	Public meeting
The pollutant was radio-iodine	✓			Local media
Authorities advise not to consume vegetables from gardens for a period of 2 weeks		✓		Leaflets, public meeting
Radio-iodine can increase the risk of getting thyroid cancer	✓			Public meeting
The Belgian public health authorities organize a thyroid measurement campaign for the local population		✓		National media, leaflet
Evacuation of people is not needed			✓	Public meeting
Due to the accident there is a lack of isotopes for curing cancer patients in the hospitals	✓			National media

* We collected the published media news and public communication by authorities, and we selected the most relevant ones to test the RAS model for risk communication.

Description of the data collection and samples

The survey method employed was Computer Assisted Personal Interviewing (CAPI), which entailed face-to-face interviews at the home of the respondents. The survey was conducted in July and August 2009, on a large sample of the Belgian population (N=1031) in the language of their choice (French or Dutch). The sample was representative for the Belgian adult population with respect to the following variables: province, region, level of urbanization, gender, age and professionally active status. In the present study, this sample will be referred to as the 'general population'.

Next to the general population, this survey was also conducted on a (stratified) sample of the population living in the area neighboring the radiological accident location (N=104). This area was defined on the basis

of the postal code of the municipality in which the accident occurred. This sample will be referred to as the 'affected population'.[1]

Scales

Measurement of reception (dependent variable)

As suggested by Price and Zaller (1993), the dependent variable *reception* reflects the respondent's ability to correctly recall the information. Two analyses were carried out: one for the general population and a second for the affected population.

A first measurement of reception entailed remembering the place, year and month of the accident correctly. The respondents from the general population (N=1031) and the affected population (N=104) were asked if they "remembered an accident in a nuclear installation in Belgium involving a release of radioactivity". If so, did they remember " where and when it happened"[2].

One hundred and sixty-seven persons from the general population remembered the exact location and, from these, 163 (15 %) remembered the exact month and year in which the accident took place. From the sample of the affected population, 95 respondents (91 %) had heard about the event and also identified the place, year and month of the accident correctly. A binary variable was constructed based on the answers, coded as 1 (remembering correctly place and year) or 0 (otherwise). This variable was used as a first measurement of reception.

Next, the respondents that received the information about the event were asked five additional questions (see Table 2.2). These additional questions allowed us to further analyze the reception of specific messages from the risk communication. A second variable measuring reception was constructed as the number of correct answers on the five items. The values thus ranged from 0 to a maximum of 5 and formed a scale for the reception of risk messages (second dependent variable).

[1] A pilot study (N=32) was performed and, based on the results, the questionnaire was modified in order to improve its quality.

[2] In the area of Fleurus another incident involving radioactive release in the environment had happened just two months before the interviews were carried out. The additional filter questions were necessary to be sure that we were discussing the same accident.

Table 2.2: Reception of communicated messages: Items, frequencies and comparison of general and affected populations

Reception of risk communication; Radiological accident	Correct answer	General population % of correct answers (N=163)	Affected population % of correct answers (N=95)
Which was the main radioactive pollutant?	Radio-iodine	19	68
For what purpose is the radioactive element in Fleurus produced?	Medical purposes	58	34
What is the risk related to a large intake of radio-iodine? Can it increase the risk of getting...	Thyroid cancer	68	83
After the accident at IRE-Fleurus, the authorities decided on countermeasures. Do you remember what they advised the residents of some areas in Fleurus.	Not to eat fresh vegetables and fruit from the gardens.	67	76
There was also a campaign to measure radioactivity in the children. Do you remember what was done?	A measurement of radioiodine in the thyroid was set up.	19	3

Our results showed that one-third of the general population (33 %) who remembered the radiological accident was able to recall three specific messages from the communication and only 1 % could recall all messages. More than 7 % of the people who stated that they remembered the accident (and indicated the place and date correctly) were not able to recall any risk communication message.

More than half of the respondents from the affected population that remembered the accident were able to recall three messages from the communication (60 %), and only 1 % was able to recall all messages. Three percent of the affected population stated that they remembered the accident, but were not able to recall any message.

Acceptance scale (dependent variable)

We restricted the study of acceptance to those respondents who had received information about the radiological accident. Acceptance was measured as the acknowledgement of the messages communicated and received during the incident. For example, if the item measuring reception was *"a large intake of radio-iodine can increase the risk of getting thyroid cancer"*, the corresponding item measuring acceptance was

"even if the authorities responsible for the nuclear emergency management of the accident in IRE Fleurus reported differently, I believe that radio-iodine can also increase the risk of getting other cancers than thyroid cancer". The respondents recalling the accident were asked to indicate their agreement (on a 5-point scale, from strongly agreeing (1) to strongly disagreeing (5) with six statements regarding the information given during the crisis. These statements suggested that the situation was in reality more serious than the authorities claimed. The analysis of the two populations was based on the reactions of those who remembered the accident, who made up 15 % of the general population and 91 % of the affected population. An exploratory factor analysis using principal axis factoring and direct Oblimin rotation was performed to examine the scale for the acceptance of risk messages. The factor loading indicated that for the general population, the item "*evacuation of people in the 3 km radius would have been better*" had to be excluded from the scale. Finally, the confirmatory factor analysis verified the measurement model with Cronbach's alpha 0.78 for the general population and Cronbach's alpha 0.89 for the affected population as an estimate of the reliability of the scale. For the general population the factor with five items explained 54 % of the total variance (N=110 out of N=163) and for the affected population, the factor with six items explained 65 % of the variance (N=67 out of N=95). High scores on the factor scale suggested a high acceptance level of the communicated messages. The factor loadings are presented in Table 2.3. The number of respondents included in the factor analysis was relatively low, as we had to leave out the respondents who answered "don't know".

Table 2.3: Acceptance scale; factor loadings, principal axis factoring

Items	**General population Factor loadings Alpha=0.78 N=110**	**Affected population Factor loadings Alpha=0.89 N=67**
The influence of the radioactive release was not only local.	0.599	0.641
Besides radio-iodine there could also be other dangerous elements in the release.	0.780	0.886
All season vegetables and dairy products (e.g. milk) produced in the affected area could be polluted with radioactive elements.	0.681	0.785
The results from detectors used for the measurements of presence of radio-iodine in the thyroid are not completely trustworthy.	0.405	0.706
Evacuation of people in the 3 km radius would have been better.	NA	0.681
Radio-iodine can increase the risk of also getting other cancers than thyroid cancer.	0.769	0.848

Scales for independent variables

All independent variables were calculated for both the general population (N= 1031) and the affected population (N=104)[3].

Specific knowledge

Specific knowledge was operationalized as the number of correct answers given to a set of 19 exam-style questions about the protective actions in a nuclear/radiological emergency, the location of nuclear installations in Belgium and nuclear technology in general. The items measuring specific knowledge referred to issues that were not mentioned during the risk communication. Since the purpose of the "specific knowledge" variable was to comprise different levels of knowledge, it was not necessary for the items to measure the same latent construct. Responses were indexed and the resulting absolute scale ranged from 0 to a maximum of 19 correct answers. In the general population, specific knowledge was slightly lower than in the affected population (mean in affected pop. =10.6, mean in general pop. = 10.2), but the standard deviation was higher (std. in affected pop. = 3.4, std. in general pop. = 4.1).

Attitude toward science and technology

First, the respondents' attitude toward science and technology was assessed through a series of four items: *"Please indicate to what extent you agree or disagree with the following statements: "The development of science and technology brings more advantages than harm*", "*Science and technology makes our lives healthier, easier and more comfortable*", "*Future generations will have more opportunities as a result of science and technology*" and "*The risks of the development of science and technology outweigh the problems they solve*". Each item was measured on a 5-point Likert scale (ranging from strong disagreement to strong agreement. The answer "don't know/no answer" was treated as a missing value.

For the general population an analysis of the inter-item correlations reveals, however, that the last item could be excluded from the scale since it had low correlations (<0.3) with the other three items. This was confirmed when the reliability of the scale was calculated, which showed that the reliability (Cronbach's alpha) increased from 0.72 to 0.79 when the fourth item was deleted. The factor extracted with the remaining three items explained 71 % of the variance in the data. For the affected population the four items revealed only one factor, explaining 68 % of variances, the scale with four items having Cronbach's alpha 0.84 (N=96).

Trust in the authorities to protect the population against radiological risks

Seven items were used to measure trust in the authorities. The respondents were asked to state how much confidence they had in the authorities "*for the actions they undertake to protect the population against risks for each of the following items*": an accident in a nuclear installation, radioactive waste, radiation from mobile phones (cell phones), natural radiation (e.g. radon or radiation from space), medical X-rays, a terrorist attack with a radioactive source and residues of radioactivity in food. The possible answers ranged from "very low confidence" (1) to "very high confidence" (5). For both populations only one factor was extracted

[3] The correlation between specific knowledge and predispositions was calculated. No significant relationship was identified except for specific knowledge and psychometric risk characteristics (Pearson corr.< 0.2).

with all seven items, measuring trust in the authorities to protect the population against radiological risks. High scores on this scale indicated a strong confidence in the authorities. The scale attributes for the affected population were the following: 7 items, 67 % of the total variance explained, alpha 0.92, N= 99. For the general population, they were: 7 items, 57 % of total variance explained, alpha 0.86, N=845.

Risk perception of an accident in a nuclear installation

Respondents were asked to "*evaluate the risks of an accident in a nuclear installation"* with possible answers ranging from "very low" (1) to "very high" (5). In this respect, there were significant differences between the general population and the affected population. While only 15 % of the respondents in the general population evaluated the risks of a nuclear accident as high or very high, in the affected population this was the case for 41 % of the respondents.

Psychometric risk characteristics: disaster potential, tampering with nature, unfamiliar

Nine items corresponding to the risk characteristics, measured according to the psychometric paradigm (Fischhoff *et al.*, 1978; Slovic, 1987) as extended and modified by Sjöberg (2000), were used to assess the latent constructs behind the risk perception of an accident in a nuclear installation. Respondents were asked to "*give their perception of an accident in a nuclear installation"* (see Table 2.4). Statements were measured on a 5-point scale. High scores indicated a strong adherence to a psychometric characteristic of risk. The three main characteristics of risk were measured: "*Disaster potential (dread)*", "*Unfamiliar risk*" and "*Tampering with nature*", by three items each. Even if the scales were shortened from the original 22 items to 9 items, the loadings were still high and the Cronbach's alpha coefficients were larger than 0.75, suggesting strong scale reliability for both populations. It is interesting to note that the factor loadings for "Disaster potential" were negative for the affected population. After a close examination of the frequencies on the three items included in factor, suggest that there were substantial differences between the answers of the general population and the affected one when it came to items involving "large consequences of an accident". Almost half of the affected population agreed that a nuclear accident had large consequences (49 %), while in the general population less than 29 % of the respondents agreed with this statement.

Table 2.4: Risk characteristics; scales attributes

Risk perception of an accident in a nuclear installation	**General population Factor Loading Principal axis**	**Affected population Factor Loading Principal axis**	**General population Alpha, N (out of 1031)**	**Affected population Alpha, N (out of 104)**
Disaster potential				
An accident in a nuclear installation has large consequences.	0.79	-0.87	0.82 (N=974)	0.86 (N=95)
An accident in a nuclear installation has effects that cannot be reversed.	0.72	-0.72		
An accident in a nuclear installation is fatal.	0.81	-0.82		
Tampering with nature				
An accident in a nuclear installation shows that human tampering with nature has harmful consequences.	0.95	0.87	0.88 (N=980)	0.87 (N=95)
An accident in a nuclear installation shows that accidents may result if humans try to influence the basic processes and structures of nature.	0.89	0.87		
An accident in a nuclear installation is the result of humans disturbing the order of nature.	0.68	0.63		
Unfamiliar risk				
An accident in a nuclear installation is hard to understand for those who are exposed.	0.86	0.75	0.75 N=955	0.84 (N=93)
An accident in a nuclear installation is unfamiliar for those exposed	0.71	0.91		
An accident in a nuclear installation is hard to understand for science.	0.55	0.68		

Analysis and Results

Reception of the information

The reception of messages regarding the radiological accident was first investigated for both the general and the affected population by bivariate logistic regression. In the affected population, 91 % of the respondents recalled the information about the accident, while in the general population this was only the case for 15 % of the respondents. This result confirms our hypothesis (*H1b*) that a high intensity and familiarity of the message overrules the importance or specific knowledge as a predictor for reception.

In the regression models all potential predictor variables were included: specific knowledge, attitude toward science and technology, trust, risk perception, psychometric risk characteristics and socio-demographic variables. From the results (see Table 2.5), we can conclude that specific knowledge was the most significant predictor for the reception of information concerning the place and time of the accident. In the affected population specific knowledge was the only significant predictor of reception. In the general population, also the variable disaster potential and socio-demographic variables appeared to be statistically significant predictors. Therefore, our hypothesis (*H1c*) that "*people with a higher level of education are more likely to receive risk communication"* can be accepted for the general population. However, the pseudo-R^2 value of the model was weaker for the general population ($R^2 = 0.21$) than for the affected population ($R^2 = 0.34$).

Table 2.5: Model summary; Predictors of accident reception.

	Reception of radiological accident			
	General population		Affected population (all speak French)	
	B	**S. E.**	**B**	**S. E.**
Language	-1.427***	0.227	N.A.	N.A.
Gender	0.424*	0.209	-0.945	1.054
Education:				
Primary	-2.197***	0.583	1.508	1.898
Secondary	-0.753***	0.216	0.233	1.333
Higher and university	Ref. cat.	Ref. cat.	Ref. cat.	Ref. cat.
Age	0.020**	0.007	-0.013	0.036
Specific Knowledge	0.105***	0.030	0.310*	0.202
Attitude towards science and technology	-0.131	0.112	0.431	0.649
Trust in authorities	-0.073	0.115	-0.996	0.629
Risk perception of an accident	-0.152	0.104	1.188	0.654
Disaster potential	0.426*	0.183	0.135	0.852
Tampering with nature	-0.118	0.160	-0.121	0.700
Unfamiliar	-0.201	0.140	-0.032	0.739
Constant	-2.273***	0.557	-3.179	4.160
	N = 763 Nagelkerke Pseudo $R^2 = 0.21$ Percentage correctly classified 82.0		N = 80 Nagelkerke Pseudo $R^2 = 0.34$ Percentage correctly classified 91.3	

Note: Logistic regression analysis, Dependent variable: Reception of radiological accident,: Yes=1 and No=0;
Independent variables: language (ref.cat.: French), gender (ref.cat.: female), education (ref.cat: high and university degree), specific knowledge, attitude towards science and technology, trust in authorities, risk perception of a nuclear accident, disaster potential, tampering with nature, unfamiliar.
*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.

We continued by investigating the ability to recall specific messages from the risk communication. In this analysis only the respondents remembering the accident were included. The reception index was regressed with all hypothetical predictors. The dependent variable (index) was in this case assumed to satisfy an interval level of measurement.

The regression analysis of the full model is presented in Table 2.6 and confirms the previous results: the reception of the communicated messages is mainly driven by specific knowledge. Risk perception of an accident in a nuclear installation is also revealed as a statistically significant predictor for reception in the general population. The explanatory value of the full model is very different in the two populations: 10 % of the variation in reception was explained by the model for the general population and 41 % for the affected population. Specific knowledge was thus recognized as a significant predictor of reception in both

populations, while other hypothetical predictors (except the risk perception in general population) were, as expected, not significant for the reception of information.

Table 2.6: Model summary; reception of communicated messages

	Reception of communicated messages - index			
	General population		Affected population	
	β	S. E.	β	S. E.
Language	0.003	0.240	N.A.	N.A.
Gender	0.125	0.205	0.254	0.181
Education:				
Primary	0.990	0.618	-0.066	0.337
Secondary	0.002	0.209	-0.241	0.223
Higher and university	Ref. cat.	Ref. cat.	Ref. cat.	Ref. cat.
Age	-0.014	0.008	0.004	0.006
Specific Knowledge	0.075*	0.033	0.165***	0.038
Attitude towards science and technology	0.135	0.112	0.115	0.119
Trust in authorities	-0.086	0.115	0.014	0.112
Risk perception of an accident	0.236*	0.115	0.047	0.100
Disaster potential	-0.286	0.195	-0.207	0.142
Tampering with nature	0.107	0.163	0.099	0.129
Unfamiliar	-0.065	0.131	-0.146	0.129
Constant	1.383	0.849	0.288	0.775
N = 135 R^2(adj) (full model) = 0.10			N = 72 R^2(adj) (full model) = 0.41	

Note: Linear regression analysis, Dependent variable: Reception of risk communication messages;
Independent variables: language (ref.cat.: French), gender (ref.cat.: female), education (ref.cat: high and university degree), specific knowledge, attitude towards science and technology, trust in authorities, risk perception of nuclear accident, disaster, nature, unfamiliar, socio-demographic variables.
*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.

Conclusions on the reception of information

From the results of the logistic regression analysis (Table 2.5) and the linear regression analysis (Table 2.6), we can conclude that *specific knowledge* was most strongly related to the reception of risk communication. This confirms our expectations that (*H1a*) "*people with more specific knowledge about the nuclear field are more likely to receive messages about the radiological accident, which either deal with protective actions or are reassuring messages of risk communication*". The R^2 value of the model built for the affected population was strong ($R^2 = 0.41$), as opposed to the model for the general population, which exhibited a much lower R^2 ($R^2 = 0.10$). The following hypothetical predictors did not come out as significant predictors for reception in any of the two populations: attitude toward science and technology, trust in authorities to protect the population, education and psychometric characteristics of risks related to the nuclear accident. Risk perception of an accident in a nuclear installation was statistically significant as a predictor only for the

model with the general population. Specific knowledge was thus recognized as the most or even only influential predictor for both populations, but the proposed regression model for the reception of risk communication had more predictive power for the affected population.

Acceptance of the information

We expected the acceptance of protective actions and reassuring messages to be mainly influenced by predispositions. In order to test this, we studied the respondents who were aware of the accident (in other words, they received the message) and who had an opinion on the protective actions and reassuring messages (i.e. they either accepted or rejected them). The respondents who answered "don't know" were coded as "no opinion" and were excluded from this part of the analysis (similar to the study of Dobrzynska and Blais (2007)). We investigated the relationship between the potential predictors and the acceptance of messages in the two population samples. To this end, we estimated the linear regression model, with acceptance as the dependent variable and the following hypothetical predictors as independent variables: i) specific knowledge, ii) attitude toward science and technology, iii) trust in authorities to protect the population, iv) risk perception of nuclear accidents, v) psychometric risk characteristics of a nuclear accident (disaster potential, tampering with nature and unfamiliarity), and vi) socio-demographic variables. To analyse the joint effect of the specific knowledge and predispositions on acceptance, we also included the interaction variables (multiplicative terms) in the regression model. Finally, for the affected population, a stepwise selection method was used, due to the low number of respondents and high number of hypothetical predictors. A summary of the results is presented in Table 2.7.

Table 2.7: Model summary; acceptance of communicated messages

	Acceptance of communicated messages – factor scores			
	General population (enter method)		Affected population (stepwise method)	
	β	S. E.	β	S. E.
Language	0.075	0.183	N.A.	N.A.
Gender	0.296*	0.148	-0.131	-1.316
Education:				
Primary	1.553**	0.540	0.033	0.319
Secondary	0.201	0.152	0.116	1.170
Higher and university	Ref. cat.	Ref. cat.	Ref. cat.	Ref. cat.
Age	-0.007	0.005	0.092	0.894
Specific Knowledge	-0.077	0.072		
Attitude towards science and technology	-0.129	0.294	-1.077*	0.402
Trust in authorities	0.187	0.366	0.021*	0.043
Risk perception of an accident in a nuclear installation	-0.468	0.345	-0.241	-1.900
Disaster potential of nuclear accidents****	-1.656**	0.540	0.456***	0.108
Tampering with nature	-0.121	0.628	0.093	0.661
Unfamiliar risks	0.040	0.299	0.022	0.181
Attitude towards science and technology x Specific knowledge	0.028	0.024	0.130**	0.035
Trust in authorities x Specific knowledge	0.002	0.027	0.029**	0.009
Risk perception of an accident in a nuclear installation x Specific knowledge	0.037	0.026	-0.119	-0.881
Disaster potential of nuclear accidents x Specific knowledge	0.130**	0.042	-0.336	-1.146
Tampering with nature x Specific knowledge	-0.016	0.047	0.135	1.073
Unfamiliar risks x Specific knowledge	-0.006	0.025	0.026	0.221
Constant	0.775	1.090	0.120	0.097
	N = 95		N = 50	
	R^2(adj) (full model) = 0.49		R^2(adj) (full model) = 0.54	

Note: Linear regression analysis, Dependent variable: Acceptance of risk communication messages; Reference categories: language (French), gender (female), education (high and university degree),
**** Remember the different sign in factor loadings populations
*** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.

Conclusions on the acceptance of information

First, we only expected specific knowledge to indirectly facilitate the formation of an opinion (either acceptance or rejection) on protective actions, through the reception of information. Second, we assumed that individuals would form an opinion that confirmed their underlying values, also named predispositions. It was hypothesized that people with positive predispositions (e.g. more trust in authorities) are more likely to agree with the protective actions applied by authorities after the radiological accident, while those with negative predispositions (e.g. being more afraid of nuclear accidents) are more likely to oppose these actions.

As expected, some predispositions were revealed as important predictors for the acceptance of communicated risk messages. It was confirmed that there was a significant relationship between acceptance and psychometric risk characteristic disaster potential for both the affected population (β=0.46) and the general population (β=-1.66). These results show the same tendency in both populations (remember that factor scores for disaster potential are negative in the affected population). Respondents who believed that an accident in a nuclear installation has a high disaster potential accepted the communicated messages less than people who assumed a low disaster potential.

Specific knowledge was not significant to predict the acceptance of information. However, taking specific knowledge as a facilitating variable for acceptance, we noticed that the joint effect of disaster potential and specific knowledge was a significant predictor in the general population (β=0.13). Taking into account the interaction effect between specific knowledge on the one hand and perceiving an accident in a nuclear installation as having a high disaster potential on the other hand, we observed that the negative effect of 'disaster potential' on acceptance was smaller among respondents with more specific knowledge. Other psychometric risk characteristics were not significant. Therefore, our initial hypothesis (*H4a)* can be partly accepted.

Trust was a significant predictor for the acceptance of messages by the affected population. As expected, people with low confidence in the authorities to protect the population from radiological risks were more opposed to the communicated messages than people with a lot of confidence in the authorities (β in affected population=0.02). The higher acceptance of messages among the people with a lot of trust in the authorities was even more significant and consistent among the people with more specific knowledge (β=0.03), as *H3* was partly confirmed (i.e. only in the affected population).

Risk perception of an accident in a nuclear installation was not significant as a predictor for the acceptance of the communicated messages. The respondents' attitudes toward science and technology was only significant for the acceptance of information in the affected population (β = -1.077). People with a more positive attitude toward science and technology were more inclined to oppose the communicated messages. However, the people in this group who had with more specific knowledge about the nuclear domain were more inclined to accept the communicated messages. Thus, hypothesis (*H2) "People with a positive attitude toward science and technology will accept the communicated messages more"* can partly be rejected, since it is only confirmed for people with more specific knowledge.

The explanatory value of the full model for the general population was 49 % of the variation in acceptance. This value was 54 % for the affected population.

For the general population some background variables were also revealed as significant in the general population: man accepted the communicated messages more than women (β = 0.30). In addition, respondents

with primary education accepted the communicated messages more. However, these relationships were not significant in the affected population.

Discussion

The objective of this study was twofold. First, we aimed to investigate potential predictors for the reception and acceptance of risk information: education level, specific knowledge, attitude toward science and technology, trust in the authorities, risk perception and psychometric risk characteristics (disaster potential, tampering with nature and unfamiliarity) enter the information processing. The second objective was to adapt and empirically test the Reception-acceptance model in the context of risk communication. In the next paragraphs, the findings for each hypothetical predictor will be discussed separately.

People with profound **specific knowledge** were identified as especially able to receive risk communication messages, but their knowledge did not influence the acceptance of information directly (*H1a*). This is in accordance with a recent theory that recognizes specific knowledge as a filter for information processing (Dobrzynska and Blais, 2007; Price and Zaller, 1993; Zaller, 2006). The existing research on information gathering capacity by Griffin *et al.* (2008) confirms that the amount of knowledge people hold about a risk affects their capacity to gain new information about it. Moreover, our results suggest that people who are well informed about the risk environment receive more information than people who do not know much about the risk. In other words, if individuals have been able to understand risk information in the past, they should also be more capable of attending, comprehending and retaining risk information in the future. However, in our research specific knowledge didn't directly influence the "(dis)agreeing" with the communicated message. We can conclude that providing people with adequate information will not automatically ensure more agreement with risk communication. We obtained empirical evidence that the relationship between respondents' specific knowledge and their acceptance of communicated messages is not that significant.

According to Zaller (2006), the impact of specific knowledge depends significantly on the characteristics of the message, namely its intensity and people's familiarity with it. After comparing the reception levels in the affected and the general population and after examining the influence of knowledge, we can confirm that if the message is very intense and familiar, even the least aware people will receive it (*H1a*).

The presumption that there are correlations between people's **attitude toward science and technology** and their acceptance of risk messages was partly confirmed (*H2*). We demonstrated that attitude impacts on the interpretation and evaluation of information and that this interpretation and evaluation serves as the basis for the subsequent judgment. In particular, the acceptance levels of the affected population were shown to be influenced by their attitude toward science and technology. People with more knowledge about the nuclear domain were found to be more consistent with their attitudes toward science and technology than people with less knowledge. People with a positive attitude and more specific knowledge accepted the communicated messages more. However, people with a positive attitude and less knowledge opposed the communicated messages more. This result is consistent with Zaller's theory that more aware persons will be exposed to, and thus 'receive', more information, but they will also be more selective in deciding which information to internalize as considerations (Zaller, 2006: 17-19). Or, to put it the other words, people who don't know a lot about the risk will often be unaware of the implications of the risk communication they encounter, and will therefore often end up "mistakenly" opposing them.

Numerous researchers have already demonstrated that **trust** is an influential predictor of information processing, especially for risk tolerance or acceptability (Earle, 1995; Renn, 2008; Slovic, 1993). However, there are still no empirical studies on the exact stage of information processing in which trust becomes influential. In the current study we have explored this question by studying the relationship between trust and the *reception and acceptance* of radiological emergency messages. With the empirical results for the affected population, we can confirm that people's opinion about protective actions and reassuring messages (i.e. their acceptance) is influenced both by specific knowledge and trust in the authorities to protect the population (*H3*). People with more knowledge will receive more messages and those with more trust will accept more of them than people with lower knowledge and lower trust. Since trust was an influential predictor in the acceptance part of the model (but not in the reception part) for the affected population, we suggest using trust as a predisposition for the adaptation of the Reception-acceptance model to risk communication.

The perception of risk is usually studied in the literature as a dependent variable, to provide insight into how people respond to specific characteristics of various risks (Kasperson *et al.*, 1988). In our research risk perception is used as an independent variable, as a potential predictor of *reception and acceptance* of information related to a radiological accident. In empirical results of the research we observed large differences in the evaluation of *"the risks of an accident in a nuclear installation for you"* between the general population and the affected population. The affected population evaluated this risk much higher. As expected, the relationship between risk perception and *reception* was not statistically significant. Still, the relationship between the perception of an accident in a nuclear installation and the *acceptance* of messages communicated after the radiological accident was not statistically significant either. A significant relationship was expected for the affected population, where this risk was evaluated as high or very high by 41 % of the respondents (in comparison with 15 % of the respondents in the general population). A previous study on risk information processing by Griffin *et al.*(2008) found that the response to a risk could directly relate to a person's information processing. Our results do not confirm that being directly involved or affected by a radiological accident is likely to trigger such a response. We can conclude that the perception level of risk cannot be used as a predisposition for the reception or acceptance stage of information processing. Instead, we suggest using psychometric risk characteristics to this end.

As expected, our results confirmed that **psychometric risk characteristics** were influential predictors in the acceptance stage of information processing but not in the reception stage. This finding contradicts the results of Huurne *et al.* (2009: 231), who found that "*emotional reactions to risk are among the set of strongest predictors of individuals' risk information seeking behavior*". In our study, the respondents who perceive an accident in a nuclear installation as having a high disaster potential accepted the communicated messages less than people who assume a low disaster potential. Taking into account the interaction effect between perceiving an accident in a nuclear installation as having a high disaster potential and having specific knowledge, we observed that the negative effect of 'disaster potential' on acceptance was smaller among respondents with higher specific knowledge. The importance of disaster potential has been explored and confirmed by many risk perception scholars. Researchers working in the psychometric risk paradigm, for example Slovic (1987) and Fischhof (1993), have repeatedly shown that the disaster potential factor ("dread") explained most of the overall risk assessment (see Boholm (1998) for a review).

Even if the risk characteristic "*tampering by nature"* improved the psychometric risk perception model considerably and was a better predictor of peoples' assessment of the risks related to a nuclear accident (Fischhoff *et al.*, 1978; Sjöberg, 2000; Sjöberg and Wahlberg, 2002), this risk characteristic still didn't

improve the acceptance model. This may also be due to the significant correlation between factor disaster potential and tampering with nature (Pearson corr.=0.5). From this result, we could assume that the psychometric risk characteristic *tampering with nature* could also be used to explain the acceptance stage of information processing, only the measures of this factor should be more elaborated, as suggested by Sjöberg (2000). Based on these findings, we can state that some psychometric risk characteristics are influential predispositions for the *acceptance* part of the information processing, but that they are not influential for the *reception* of risk-related information.

In our research we noted some differences among the **general and affected populations**. From the extreme differences between the general population and the affected population in remembering the accident, as well as from the different significant levels (p-value) in logistic regression models, we can assume that (*H1*) specific knowledge is, due to a higher familiarity with and intensity of the message, less influential as a predictor of the reception for the affected population than for the general population.

In the general population, other predictors were also influential, namely **gender, education and age**. The same variables were influential for the acceptance stage for the general population. In risk research, **education** is commonly recognized as a predisposition for seeking out risk information and as an influencing factor for the extent to which a person will spend time and effort analyzing the risk information critically. Griffin *et al.*(1999), for example, found that people with a higher level of education are more likely to process the information and make a judgment afterwards. This can be confirmed only for general population in our study. Based on our findings, we can conclude that the more involved in risk communication one is (for example, if one is affected by risk), the less important classical personal dimensions such as gender or education are for the information processing stages.

Conclusions

To conclude, this study has shown that the application of the Reception-acceptance model from political communication to risk communication can provide a better insight into the processing of risk information, by highlighting which predictors are related to the different stages of the process. The results clearly demonstrate that specific knowledge is only dominant at the level of the reception of risk messages, while predictors such as psychometric risk characteristics, trust in risk management by the authorities and attitudes toward science and technologies are most influential at the level of the acceptance of risk messages. Several differences were identified among information processing in the general population and the affected population. The more one is affected by the risk, the less important factors such as gender, age or education will be for information processing. This finding is useful for risk communicators in general and to design more focused risk communication strategies for nuclear emergency communication in particular. Future research will apply the Reception-acceptance model to long-term risk communication, including panel data.

References

Beck, U., 2006. Living in the world risk society. *Economy and Society*, 35, 329-345.

Boholm, A., 1998. Comparative Studies of Risk Perception: A Review of Twenty Years of Research. *Journal of Risk Research*, 1, 135-163.

Bützer, M., Marquis, L., 2002. Public Opinion Formation in Swiss Federal Referendums. in: D. Farrell, S.-B. R. (Eds.), Do Political Campaigns Metter? Campaign effects in elactions and referendums. Rutledge, London.

Carlé, B., Perko, T., Turcanu, C., Schröder, J., 2010. Individual response to communication about the August 2008 131I release in Fleurus: results from a large scale survey with the Belgian population. Third European IRPA Congress on Radiation Protection, Helsinki.

Chryssochoidis, G., Strada, A., Krystallis, A., 2009. Public trust in institutions and information sources regarding risk management and communication: towards integrating extant knowledge. *Journal of Risk Research*, 12, 137-185.

Converse, P.E., 1964. The Nature of Belief Systems in Mass Publics.

Dake, K., 1992. Myths of Nature - Culture and the Social Construction of Risk. *J.of Social Issues*, 48, 21-37.

Dalton, R.J., Beck, P.A., Huckfeldt, R., 1996. Partisan cues and the media: Information flows in the 1992 presidential election American Political Science Review. Amer political science assoc, San Francisco, California, pp. 111-126.

Dobrzynska, A., Blais, A., 2007. Testing Zaller's Reception and Acceptance Model in an Intense Election Campaign. *Polit. Behav*, 30, 259-276.

Earle, T.C., Cvetkovich, G.T., 1995. Social Trust: Toward a Cosmopolitan Society. C. T. Praeger, Westpoint.

Fazio, R.H., 1986. How do Attitudes Guide Behavior? in: R.M. Sorrentino, Higgins, E. T. (Ed.) Handbook of motivation and cognition: Foundations of social behavior Guilford Press, New York, pp. 204 - 243.

Fischhoff, B., Bostrom, A., Quadrel, M.J., 1993. Risk Perception and Communication. *Annual Review of Public Health*, 14, 183-203.

Fischhoff, B., Slovic, P., Lichtenstein, S., Read, S., Combs, B., 1978. How Safe is Safe Enough - Psychometric Study of Attitudes Towards Technological Risks and Benefits. *Policy Sciences*, 9, 127-152.

Freudenburg, W.R., 1993. Risk and Recreancy - Weber, the Division of Labour and the Rationality of Risk Perception. *Social Forces*, 71, 909-932.

Gaskell, G., Allum, N., Wagner, W., Kronberger, N., Torgersen, H., Hampel, J., Bardes, J., 2004. GM foods and the misperception of risk perception. *Risk Analysis*, 24, 185-194.

Goren, P., 2004. Political Sophistication and Policy Reasoning: A Reconsideration. *American Journal of Political Science*, 48, 462-478.

Gregory, R., Mendelsohn, R., 1993. Perceived Risk, Dread, and Benefits. *Risk Analysis*, 13, 259-264.

Griffin, R.J., Dunwoody, S., Neuwirth, K., 1999. Proposed Model of the Relationship of Risk Information Seeking and Processing to the Development of Preventive Behaviors. *Environmental research*, A80, 230-245.

Griffin, R.J., Yang, J., Huurne, E., 2008. After the Flood: Anger, Attribution, and the Seeking of Information. *Science Communication*, 29, 285-315.

Huurne, E., Griffin, R.J., Gutteling, J.M., 2009. Risk Information Seeking Among U. S. and Dutch Residents: An Application of the Model of Risk Information Seeking and Processing. *Science Communication*, 31, 215-237.

Ibitayo, O.O., Pijawka, K.D., 1999. Reversing NIMBY: an assessment of state strategies for siting hazardous-waste facilities. *Environment and Planning C-Government and Policy*, 17, 379-389.

Iyengar, S., Kinder, D. R., 1987. News that Matters: Television and American Opinion. University of Chicago Press, Chicago.

Jones, B., Baumgartner, F., 2005. The Politics of Attention. How Government Prioritizes Attention. University of Chicago Press, Chicago.

Jooyoung, K., Hye-Jin, P., 2009. Information Processing of Genetically Modified Food Messages Under Different Motives: An Adaptation of the Multiple-Motive Heuristic-Systematic Model. *Risk Analysis*, 29, 1793-1806.

Kahlor, L.A., Dunwoody, S., Griffin, R.J., Neuwirth, K., 2006. Seeking and Processing Information About Impersonal risk. *Science Communication*, 28, 163-194.

Kasperson, R.E., Renn, O., Slovic, P., Brown, H.S., Emel, J., Goble, R., Kasperson, J.X., Ratick, S., 1988. The Social Amplification of Risk - A Conceptual Framework. *Risk Analysis*, 8, 177-187.

Krosnick, J.A., Brannon, L.A., 1993. The impact of the Gulf War on the ingredients of presidential evaluations: Multidimensional effects of political involvement. *Amer. Polit. Sci. Rev.*, 87, 963-978.

Krosnick, J.A., Petty, E.R., 1995. Attitude strenght: An overview. in: E.R. Petty, J.A. Krosnick (Eds.), Attitude strenght: Antecednets and consequences. Lawrence Erlbaum, Mahwah, NJ, pp. 1-24.

Kulakovski, K., 2009. Opinion Polarization in the Receipt-Accept-Sample Model Physica A. Elsevier, pp. 469-476.

Liu, C.-S.F., 2005. "The Nature and Origin of Mass Opinion" Revisted/ Exploring Zalle's RAS Model with the Agent-Based Modeling Approach Annual Meeting of the American Political Science Association. American Political Science Association, Kansas.

McGuire, W.J., 1973. Persuasion, Resistance, and Attitude Change. in: I.D.S. Pool (Ed.) Handbook of Communication. IL:Rand McNally, Chicago.

O'Keefe, D.J., 2002. Persuasion; Theory and Research. Sage Publications, London.

Peters, R.G., Covello, V.T., McCallum, D.B., 1997. The determinants of trust and credibility in environmental risk communication: An empirical study. *Risk Analysis*, 17, 43-54.

Petty, E.R., Cacioppo, J.T., 1986. The Elaboration Likehood Model of Persuasion. in: A.D. Berkowitz (Ed.) Advances in Experimental Social Psychology. Academic Press, New York, pp. 124-192.

Price, V., Zaller, J., 1993. Who Gets the News? Alternative Measures of News Reception and their Implications for Research. *Public Opinion Quarterly*, 57, 133-164.

Renn, O., 2004. The role of stakeholder involvement in risk communication. *Atw-International Journal for Nuclear Power*, 49, 602-+.

Renn, O., 2008. Risk Governance; Coping with Uncertainty in a Complex World. Earthscan, London.

Rosenberg, M.J., Hovland, C.I., 1960. Cognitive, affective and behavioral components of attitudes. in: C.I. Hovland, M.J. Rosenberg (Eds.), Attitude organization and change. Yale University Press, New Haven, pp. 1 -14.

Sciarini, P., Tresch, A., 2011. Campaign Effects in Direct-Democratic Votes in Switzerland. *Journal of Elections, Public Opinion and Parties*, 21, 333-357.

Sjöberg, L., 2000. Perceived risk and tampering with nature. *Journal of Risk Research*, 3, 353-367.

Sjöberg, L., 2004. Local acceptance of a high-level nuclear waste repository. *Risk Analysis*, 24, 737-749.

Sjöberg, L., 2006. Myths of the Psychometric Paradigm and How they can Misinform Risk Communication. Center for Risk Research, Stockholm, pp. 20.

Sjöberg, L., Wahlberg, A., 2002. Risk perception and new age beliefs. *Risk Analysis*, 22, 751-764.

Slovic, P., 1987. Perception of Risk. *Science*, 236, 280-285.

Slovic, P., 1992. Perception of Risk: Reflections on the Pshyometric Paradigm in: S. Krimsky, D. Golding (Eds.), Social Theories of Risk. Praeger, Westport, CT.

Slovic, P., 1993. Perceived Risk, Trust and Democracy. *Risk Analysis*, 13, 675-682.

Slovic, P., Finucane, M.L., Peters, E., MacGregor, D.G., 2004. Risk as analysis and risk as feelings: Some thoughts about affect, reason, risk, and rationality. *Risk Analysis*, 24, 311-322.

Slovic, P., Flynn, J.H., Layman, M., 1991. Perceived Risk, Trust and the Politics or Nuclear waste. *Science*, 254, 1603-1607.

Slovic, P., Weber, U., 2002. Perception of Risk Posed by Extreme Events Risk Management strategies in an Uncertain World" Palisades, New York.

Trumbo, W.C., 2002. Information Processing and Risk Perception: An Adaption of the Heuristic-Systematic Model. *Journal of Communication*, 52, 367-382.

Zaller, J., 2006. The Nature and Origins of Mass Opinion. Cambridge university press New York.

3. Communication in nuclear emergency preparedness: A closer look at the information reception

Manuscript in the second review before publication as:

Perko T.,Van Gorp B., Thijssen P., Carlé B., Turcanu C.,: "Communication in nuclear emergency preparedness: A closer look at the information reception".- In: Risk Analysis

Abstract

Along the entire cycle of preparedness-response-recovery, communication is the cornerstone of successful emergency management. This study aims at providing a better understanding of the way people process communicated messages and the factors that may influence how they do this. In particular, it investigates *reception*, as part of the information processing in pre-crisis communication (i.e. preparedness) and intends to determine whether heuristic predictors also play a role in the reception phase of information processing, alongside systematic predictors, and, if so, which of the two are most influential. As a case study, the pre-crisis communication context was chosen, as it has been tackled to a lesser extent in the literature.

The empirical data used for this study originated from a large-scale public opinion survey in Belgium. One topic in this survey addressed the information campaign for the distribution of iodine tablets, in the context of preparedness for nuclear emergencies.

The findings of this study demonstrate that systematic predictors have a stronger influence compared to heuristic predictors. The latter are only to a minor extent involved in the *reception* of emergency preparedness information. The hypothesized pattern - that more prior knowledge about the field relates to a higher *reception* of information - was confirmed for pre-crisis communication. Contrary to expectations, results showed that people with a high perception of radiological risks were less attentive to information about protective actions. People with little trust in authorities were also more likely to have a low reception of information.

Introduction

Whether a risk information campaign is intensive or not, there will always be people who do not get the information. Who are these people and what influences their resistance to information? An average individual in today's society is exposed to a large amount of risk related information, definitely much more than one can absorb (Renn, 2008). If the information does not carry certain symbolic cues or does not match the receiver's interests, it is likely that it will not grab the receiver's attention or that s/he will not involve him/herself in the communication (Chaiken and Stangor, 1987; Lang, 2000; Ohman, 1994; Trumbo, 2002; Visschers *et al.*, 2009). Therefore, in risk communication, the primary goal of communicator is to make the message interesting enough to attract the attention of receivers so that will stay in people's memory for as long as is needed to recall the message or involve the recipient in the communication and, finally, make a decision about a given risk. This substantiates the need for studying the *reception* stage of risk information processing. Hence, the aim of this study was to investigate potential predictors and patterns in audience *reception* of pre-crisis risk communication. Based on these predictors and patterns, we subsequently sought to identify subgroups of respondents expected to be particularly (un)attentive to communication about emergencies. This aspect is of paramount importance in the preparedness phase of emergency management, when people are in general less attentive toward the issue.

The *reception* of information refers to the extent to which an individual pays attention to and understands what s/he has encountered. It is usually studied as an integrated part of information processing, which also includes a decision-making part. The latter part, called "*acceptance"* by Zaller (Zaller, 2006), refers to the "probability of resisting or accepting the information". Together, *reception* and *acceptance* make up information processing. Although the literature has seen a growing interest in information processing as a whole (Huurne *et al.*, 2009; Jooyoung and Hye-Jin, 2009; Petty and Cacioppo, 1986; Trumbo, 2002), there has been little empirical research on directly testing the *reception* part of pre-crisis information processing.

In this study, we will evaluate *reception* separately from decision-making. According to the definition of Price and Zaller (1993: 134), *reception* entails a sequence of information processing steps: (1) attending to the information, (2) comprehending it, and (3) retaining it. This is mostly a cognitive process which involves individuals' selectively reprocessing and storing information, and thus affecting their recall. However, until now *reception* has for the most part been empirically studied in a political communication context (Dalton *et al.*, 1996; Dobrzynska and Blais, 2007; Zaller, 2006) or in risk research in the context of information seeking (Griffin *et al.*, 1999). In this paper, we will extend the study of *reception* to pre-crisis risk communication in nuclear emergency management.

Nuclear emergency management is often presented as a cycle composed of risk assessment, planning, response, recovery and evaluation (Turcanu *et al.*, 2008). Communication should be integrated into all parts of this cycle (Sohier, 2002). The first two stages, risk assessment and emergency planning, are associated with pre-crisis communication; the third stage, emergency response, is related to crisis communication itself; and the fourth and fifth stage, recovery and evaluation, are part of post-crisis communication. The focus of communication should be on the preparedness phase, since it influences all other emergency stages. This communication involves acquiring a good understanding of how people process given information, which is exactly what this study deals with.

Pre-crisis communication is crucial in emergency planning and preparedness, which are two key determinants in the effective management of nuclear emergencies (IAEA, 2006). Still, the existing research does not focus on the empirical study of pre-crisis communication (Elliot, 2006; Strack and Deutsch, 2004; Visschers, 2007; Zajonc, 1980). Yet, this does not change the fact that there is a clear need to get the population more involved in preparedness for nuclear emergencies (IAEA, 2006), as their knowledge about the nuclear domain is rather limited (Eurobarometer, 2007; Eurobarometer, 2008) and do not have any direct contact with the nuclear risk, but mainly learn about it through the media and the politicians (Blando *et al.*, 2008).

The purpose of this study was to determine influential predictors for pre-crisis information reception and to test in which part of the information processing stage the predictors (i.e. education, specific knowledge, hazard experience, trust, risk perception and affective response - fear) start to affect the decision. An additional aim was to empirically test whether the variables that have been traditionally used in risk research have a different effect in the *reception* stage of information processing. Therefore, we propose a set of predictors that may influence people's attention to pre-crisis information, as well as their motivation and ability to process it.

The operationalization of several hypothetical predictors was driven by risk research theory, as developed by Griffin *et al.* (1999), Slovic *et al.* (2004), Sjöberg (2006), Renn (2008) and others. However, the basic dependent concept, *reception*, was taken from the Receive-Accept-Sample model (RAS) developed by Zaller in the context of political communication (2006). The reasons for this are fourfold. The first reason why the RAS model was chosen is that it is particularly suited for our research since it makes an empirical distinction between the two stages of opinion formation: *reception* of the message and *acceptance*, that is, agreeing or disagreeing with it. Second, the application of the RAS model to risk communication allowed us to empirically test influential predictors for the *reception*, thus highlighting the exact stage of information processing in which the different variables started to have an influence. Third, the context of pre-crisis communication is similar to political communication, since the risk (for example, a nuclear accident) is typically intensively communicated, but the attentiveness and familiarity with the messages among the

population is usually low. Finally, risk related discussions frequently appear in political agendas, therefore politicians often draw public attention to a particular risk (Beck, 2006; Jones and Baumgartner, 2005).

The independent concepts (predictors) used in this study draw on two modelling paradigms encountered in information processing theory (Eagly and Chaiken, 1993): heuristic and systematic information processing (see Hastie and Park (1986) for a detailed comparison). The heuristic paradigm describes the mental shortcut individuals use to judge the quality of information, whereas the systematic part is deeper and more effort-intensive. Both may give us insight into who the people are that will or will not receive the information from risk communication. Even if the two modes are competing, the heuristic and systematic information processing modes are not necessarily exclusive. There is evidence in the literature that people may use both these modes simultaneously to make a judgment in specific situations or contexts (Eagly, 1993; Hastie and Park, 1986; Petty and Cacioppo, 1986; Trumbo, 2002; Tversky and Kahneman, 1974). However, although people may use both modes to perceive the same risk, one mode will dominate the other (Loewenstein *et al.*, 2001).

The main contribution for this part of the research is taken from the Risk information seeking and processing model developed by Griffin (1999) which was designed for risk-related information, and the Elaboration Likelihood Model (ELM) (Petty and Cacioppo, 1986), which explains both systematic and heuristic processing.

Each of the three models that are used in this study have a specific focus and hence also particular advantages. The RAS model defines a certain number of independent variables as potential predictors for reception, whereas the ELM highlights the information processing mode that independent variables may stimulate. The Risk information seeking and processing model of Griffin *et al.* proposes the specific predictors of risk-related information processing, for example the affective response to risk (e.g. worry, anxiety, fear). Through the use of these three models, we seek to highlight two types of predictors: (1) those that may stimulate heuristic information processing in a pre-crisis communication, such as trust, hazard experience, risk perception and affective response or most likely fear, and (2) predictors that are likely to stimulate systematic processing (e.g., specific knowledge and education).

Theoretical concepts

Most information processing models describe reception as a result of attention, ability and motivation (Chaiken and Stangor, 1987; Eagly, 1992; Eysenck and Keane, 2005; Lang, 2006; Lang *et al.*, 1999; McGuire, 1973; Shiffrin and Schneider, 1984; Trumbo, 2002; Zaller, 2006). The first, attention, refers to signals for getting the message out of the environment and starting the information processing. The second one, ability, involves the physical ability of the receiver to follow the information without any distractions. Finally, motivation is considered as the willingness and interest of the receiver to process information or, at a later stage, to actively get involved in the communication. A comparison of the three information processing models employed in this study with respect to basic *reception* elements is presented in Table 3.1..

In pre-crisis communication, *reception* is more complex than during the crisis itself and may stimulate either a systematic or a heuristic mode. Before a crisis, the motivation for information processing is lower, since the information may or may not be useful sometime in the future. In crisis communication, however, the message might be received after a mostly heuristic information processing of risk. This process is stimulated by messages such as "ATTENTION" or "DANGER" (Elliot, 2006; Strack and Deutsch, 2004; Visschers,

2007; Zajonc, 1980). Crisis communication addresses situations requiring immediate reactions, such as seeing a barrel marked with the radioactivity sign. In such cases, individuals should be able to decide quickly whether something or somebody is dangerous. It should therefore not be based on systematic or deliberative conscious processing, as the systematic mode is more elaborate, extensive and time consuming. Nevertheless, also in heuristic processing a certain interaction with already existing knowledge is necessary, for example the sign of radioactivity has to be recognized as such.

Table 3.1: Information reception in different models: attention, ability and motivation

Model	**RAS**	**ELM**	**Risk information seeking and processing model**
Information processing mode	Systematic approach (also called analytical, central, primary or memory based processing)	Two exclusive modes: First named peripheral, heuristic or on-line processing and second mode named systematic or central.	Systematic-Heuristic: modes can be simultaneously exchanged
Factors influencing attention	Awareness, prior specific knowledge, media use, education	Heuristic: trust, impression, stereotype, moral evaluation, number of arguments, emotions Systematic: strong arguments, engagement	Exposure, respondent's self-reported elaboration of the messages
Factors influencing ability	Cognitive engagement	Notion of capacity: distraction, repetition, prior knowledge, message comprehensibility	Perceived information gathering capacity: ability and nonroutine gathering
Factors influencing motivation	Intensity, familiarity of message	Personal relevance, need for cognition, personal responsibility	Information sufficiency: Affective response to a risk (e.g. worry, anger), informational subjective norms and hazard characteristics

As seen in Table 3.1, in the RAS model for systematic information processing motivation, attention and ability are assumed to depend on the cognitive engagement with the communicated subject. According to Zaller, *"The greater a person's level of cognitive engagement with an issue, the more likely he or she is to be exposed to and comprehend – in a word, to receive messages concerning that issue"* (Zaller, 2006, p. 42). In other words, the impact of cognitive engagement depends on the message characteristics. In this respect, Zaller identifies two possible characteristics of a message: intensity and familiarity. The weaker the intensity of the message and the receiver's familiarity with it, the stronger the effect of cognitive engagement is.

In the heuristic or peripheral processing mode as described in the ELM of Petty and Cacioppo (1986), motivation is believed to depend on three factors: the personal relevance of the risk information, the need for cognition and personal responsibility. The ability to process the information depends, among other things, on distraction, repetition, prior knowledge and message comprehensibility.

In the risk information seeking and processing model developed by Griffin *et al.* (1999) the motivation is influenced by information sufficiency: affective response to a risk (e.g., worry, anger) and informational subjective norms (e.g., desire for information). The ability in this model reflects one's perceived capacity to perform the information processing steps and the nonroutine gathering of information (e.g., additional effort to get the information).

Attention, ability and motivation construct the *reception.* Zaller has operationalized *reception* as a dependent variable (Price and Zaller, 1993; Zaller, 2006). In his model, reception is mainly influenced by specific factual knowledge but can also be affected by the level of participation, interest and media use (Zaller, 2006, p. 333-339). The *reception* part of the information processing has also recently been tested by Dobrzynska and Blais (2007). Similar to Zaller, the authors observed that people with greater specific knowledge are more likely to receive messages. In contrast, the research by Dalton *et al.*(1996) suggests that the *reception* of messages is not most accurate among the most knowledgeable people. In their study, predictors such as education, self-reported rates of media use and prior levels of specific knowledge were tested mainly for political messages (Eagly, 1993; Zaller, 2006). In the present research, education and specific knowledge were tested as predictors for the *reception* of risk messages.

Since risk communication is often related to heuristic information processing, we also tested predictors that may stimulate heuristic processing for *reception*: hazard experience (Trumbo, 2002), trust (Petty and Cacioppo, 1986), risk perception and affective response (Griffin *et al.*, 1999). The first predictor, past experience, has also been used as a measurement of heuristic processing by Trumbo (2002). The second one, social and institutional trust, has been demonstrated to serve as a cognitive heuristic for the individual, by for example Earle and Cvetkovich (1995), Freudenburg (1993), Kasperson and Kasperson (2005), Renn (2008), Slovic (2000), Siegrist *et al.* (2000) and others. More evidence that risk perception is related to heuristic processing comes from the "risk-as-a-feeling" theory (Loewenstein *et al.*, 2001), which suggests that people respond to risk based on direct emotional influence. Reliance on feelings has been called the "affect heuristic" by Slovic *et al.* (2004), who explained that individuals' risk perception is also based on what individuals feel about the risk and not only on what they know about it. Finally, fear as an affective response to the risk is assumed to affect the intensity of information seeking and suggests that it may stimulate systematic or heuristic processing. Negative emotions stimulate the systematic mode according to Bohner *et al.* (1994). However, extremely negative emotions like strong fear stimulate heuristic processing (Jepson and Chaiken, 1990).

Hypotheses

In the study by Griffin *et al.* (1999), *education* was indicated as an important predictor of an individual's ability to seek, process and retain risk information. They found that people with a higher level of education are more likely to process the information and make a judgment afterwards. On the other hand, socio-demographic measures such as age or gender were not confirmed as predictors of *reception* in studies by Price *et al.* (1993), whereas education was recognized as a rather weak predictor for the *reception* of "political" information (Zaller, 2006). Due to these different findings, we tested education as a possible predictor for the *reception* of nuclear emergency messages; our first hypothesis could be formulated as follows:

H1 = The *reception* of pre-crisis messages is not more accurate among people with a higher *education level than among people with lower education*.

Griffin *et al.* (2008), Kahlor *et al.* (2006) and Huurne *et al.* (2009) have found a positive direct relationship between self-reported knowledge and perceived information-gathering capacity, which could also be seen as reception of the message. According to the RAS model, specific knowledge is the most powerful predictor for the reception part of information processing (Dobrzynska and Blais, 2007; Price and Zaller, 1993; Zaller, 2006). In the context of *reception* research, specific knowledge can also be seen as prior knowledge. In other words, people who are well informed about a certain specific issue receive more information about the communicated issue than people who are not knowledgeable. Therefore, the next hypothesis was formulated as follows:

H2 = People with more *specific knowledge* about nuclear topics are more likely to *receive* nuclear emergency messages related to preparedness for nuclear accidents than people with less knowledge.

People tend to apply past experience as an initial steer of judgment. Grunig (1983) claims that past experience serves the individual as a guide for deciding how to think, behave or react in a new situation. Although Johnson and Tversky (1983) discovered that an individual's experience with one risk can indeed determine his/her responses to other risks, they did not study the *hazard experience* as a predictor of the *reception* of a certain message.

In our research, we tested experience in the radiological/nuclear field as a predictor for the *reception* of nuclear emergency information. We expected that having direct or indirect personal experience in the nuclear field, for instance by having visited a nuclear installation, would largely contribute to recalling communication messages. Therefore, the third hypothesis is the following:

H3 = People with radiological *hazard experience* are more likely to *receive* emergency messages related to preparedness for nuclear accidents.

Despite ample research on the "trust–risk" relation, the question of whether trust influences a person's *reception* of certain pre-crisis communication messages has not been tackled. *Trust* is very often emphasized as an explanation of risk perception and its tolerance. The components of trust are multidimensional: perceived competence, objectivity, fairness, consistency, sincerity, faith and empathy. Earlier research has identified trust as one of the key indicators for the acceptance of nuclear risks (Ibitayo and Pijawka, 1999; Sjöberg, 2004; Slovic *et al.*, 1991). In our study, we explored the relation between trust (expressed as confidence in the authorities) and the reception of emergency messages. We started from the finding that with the increasing complexity of technological innovations, people find themselves in a position of not knowing much about highly complex and potentially dangerous technologies (Freudenburg, 1993; Gaskell *et al.*, 2004). People must therefore rely on their own judgments about whom to trust or what activities to trust. The fourth hypothesis was formulated as follows:

H4 = People with more *trust* in nuclear activities will receive fewer messages related to preparedness for nuclear accidents in comparison with people with low trust.

A considerable amount of research on risk perception has been published and a variety of theoretical perspectives exist, including cultural (Dake, 1992), sociological (Beck, 2006) and psychological (Fischhoff *et al.*, 1978) ones. Risk perception is recognized as an essential social and psychological phenomenon, influencing and driving decision-making at various levels, from individual to societal decision-making (Beck, 2006; Renn, 2008; Sjöberg, 2006). In all these studies, risk perception is mainly used as a dependent variable, while in our research it is employed as an independent variable. For example research on risk

information by Griffin *et al.* (2008) established that response to a risk could be directly related to a person's information seeking. Huurne *et al.*, too, found that "emotional reactions to risk are among the set of strongest predictors of individuals' risk information seeking behavior" (Huurne *et al.*, 2009), p. 231. Since a person's high risk perception could lead to a higher level of cognitive engagement with a hazard and since the risk communication messages is perceived to be more personally relevant to them, we hypothesized that such a person would be more likely to receive messages concerning that issue:

H5 = Recipients with higher *perception of nuclear risks* will *receive* more nuclear emergency messages than people with lower perception of nuclear risks.

Fear is recognized as an affective response to a risk by Griffin *et al.*(1999), as a stimulator of risk information seeking. It is a strong emotional reaction that influences information processing (Bohner and Apostolidou, 1994). In the literature the influence of emotions like fear, worry or anger on information processing is mainly studied in general, applied to complete information processing (Bohner *et al.*, 1994). However, the influence of strong emotions on different stages of information processing, for instance, *reception*, is empirically still a relatively unexamined area. Therefore, we formulated a sixth hypothesis:

H6 = People that are more *afraid* of nuclear accidents will *receive* more nuclear emergency messages than recipients who are less afraid.

Method

Description of pre-crisis communication as part of emergency preparedness: The Iodine distribution campaign

The distribution of stable iodine is one of the possible ways to protect the population in case of an accidental radioactive release of radioactive iodine[4]. Iodine saturates and subsequently protects the thyroid gland against the potential harm caused by radio-iodines. In 14 European countries, stable iodine tablets are also distributed to people living in the vicinity of nuclear installations as preparation for a possible accident. The area for pre-distribution varies from a 5 km radius around the nuclear installations in Switzerland to 50 km in Lithuania. In most cases, stable iodine is delivered to the entire population in the selected area (Jourdain *et al.*, 2010).

In Belgium such a campaign was conducted prior to this study in 1999 and 2002. In 1999, the target population of the campaign were the inhabitants of the Belgian municipalities located in the vicinity of Belgian or near-border nuclear sites. They were invited to collect free stable iodine tablets from their local pharmacy. In 2002, the iodine distribution campaign was repeated for the inhabitants of the municipalities located within a 20 km radius from Belgian or near-border nuclear installations. The stable iodine pre-distribution was complemented with a nuclear emergency information campaign directed at the entire Belgian population.

[4] Depending upon the severity of accidental release of radioactivity into the environment, a number of protective measures are considered to avoid public exposure to ionizing radiation. Beside the administration of stable iodine, other means such as sheltering, evacuation, or a change of diet can be recommended.

The tablets delivered in 1999 expired in 2008, but new tablets were not ordered until June 2010. After the expiration, the topic regularly appeared in the media as well in the agenda of local communities. The Federal Crisis Centre continued to release information that the tablets were still good to use even if they were expired (Belgian Federal Crisis Centre, 2010). However, the tablets were officially expired medical product. The last information before the collection of the empirical data for this research started was published at the beginning of 2009, approximately two months before the field work. A new information campaign and distribution of the stable iodine tablets took place in 2011.

In relation to the communication means used, we can make a distinction between, on the one hand, the intensive communication to the people living in the vicinity of the nuclear installations and, on the other, the less intensive communication to the general population in Belgium. In 1999, the inhabitants of the Belgian municipalities located within a 10 km radius from Belgian or near–border nuclear sites received information leaflets explaining nuclear emergency preparedness. In 2002, this radius was extended to 20 km, and the mayors of some municipalities sent additional personal invitations for residents to collect their iodine tablets. A voucher was distributed to community centers, schools, leisure centers and senior citizens' centers and could be exchanged at the local pharmacy for packs of iodine tablets.

The broader information campaign (for the whole of Belgium) communicated information about (1) the nuclear installations, (2) protective actions in case of a nuclear accident, (3) information about radioactivity, and (4) the distribution and use of the stable iodine tablets. There were two main objectives: to inform and educate the public on nuclear emergency preparedness and to invite people to collect iodine tablets. The campaign was conducted nationwide in media, advertisements and communication material such as posters and leaflets. In 2008, after the radiological incident in Fleurus (Belgium), the topic of stable iodine tablets reappeared in the national media. One year later, stories on expired tablets caught the media's attention and elite discourse on a national level. In response, the Federal Crisis Centre released information about the possible effects of consuming the tablets on its website and sent this information to local authorities (Belgian Federal Crisis Centre, 2010). Consequently, the negative press subsided and the local and national media started to frame the issue more neutrally. Some local authorities also sent personal letters to residents. The new information and pre-distribution campaign was announced in the media in 2009.

The communication tools used in the campaign were; personal letters, meetings with a local communities, leaflets, advertisements published on TV, radio and in newspapers, press conferences, internet pages, posters, participation of experts at informative meetings e.g. schools.

Based on the context and objectives of the campaign, intensity of the communication and tools used we assume that pre-distribution campaign of iodine tablets satisfies the RAS model's conditions to test the predictors for the *reception* stage of pre-crisis information processing.

Description of the data collection and sample

The survey method employed in this study was Computer Assisted Personal Interviewing (CAPI), which entailed face-to-face interviews at the respondents' homes, the answers being directly recoded and stored on a portable hard disk. The survey was conducted by professional company on a large sample of the Belgian population (N=1031) in a chosen language (French or Dutch) in July and August 2009. A pilot study (N=32) was performed and, based on the results, some modifications were made to improve the quality of the questionnaire.

A stratified sample was applied to obtain a sample of respondents representative for the Belgian adult population with respect to the following variables: province, region, level of urbanization, gender, age and professional status.

Measurements

Reception (dependent variable)

Reception was measured by the ability to recall the information, as suggested by Price and Zaller. Two analyses were carried out. For the first measurement, the respondents (n = 1031) were asked if they knew about the distribution of iodine tablets (i.e. self-evaluation): *"Some years ago, the authorities organized a distribution of iodine tablets as part of the nuclear emergency plan; do you know about the distribution of iodine tablets?"*. Answers were given as "Yes" (coded 1) or "No" (coded 0), with "don't know" recoded as 0. Half of the respondents (519) remembered the campaign. In addition to this first general question, all respondents (N=1031) were given a question related to the use of a stable iodine tablet in case of a nuclear accident: "*In case of a nuclear accident, a stable iodine tablet would protect against thyroid cancer.* A correct answer was coded as 1, an incorrect one as 0.

In the second analysis, we selected the respondents who remembered the campaign (N= 519). In this way it was possible to analyze the reception of specific messages from the campaign in depth. This subsample of respondents answered an additional set of four questions related to the campaign. Among the people who were familiar with the iodine campaign, 53 % were men and 47 % were women, while 44 % spoke French and 56 % spoke Dutch. In this respect, the subsample was similar to the representative sample for the Belgian population (in which 48 % were men, 52 % women, 42 % French speaking and 58 % Dutch speaking).

Dobrzynska and Blais (2007) and Price and Zaller (1993) measured reception by determining whether the respondent remembered an explicit story. If they did, they needed to give some specific information connected to the story. In contrast to this method, we measured the reception of one story (communication-iodine campaign) using nine items in an exam style format. This approach allowed us to gain insight into what people recalled from the communication. The factor analysis carried out on these nine items identified a single dominant factor (Cronbach's α=0.64), suggesting that the *reception* of pre-crisis communication is one-dimensional. For further analysis, the number of correct answers out of the nine items was used (Table 3.2). The values thus range from 0 to a maximum of 9 and form a scale on which to assess the *reception* of pre-crisis messages from the iodine campaign.

Table 3.2: Reception of communicated messages

Reception of preparedness communication – Iodine campaign	Correct answer	1st analysis Percent of correct answers (from N=1031) Alpha = 0.85	2nd analysis Percent of correct answers (from N=519) Alpha = 0.64
A stable iodine tablet would protect against: … lung cancer	No	41	54
… bone cancer	No	43	53
… skin burns	No	51	67
… leukaemia	No	38	48
… thyroid cancer	Yes	53	68
Do you know about the distribution of iodine tablets?	Yes / I have heard something about it	50	100
Do you know who was invited to collect these iodine tablets?	The people living in the radius of 20 km of a nuclear installation	NA	71
In case of nuclear alarm, should you take the tablets immediately or should you wait.	Wait for instructions	NA	54
Where can you get these iodine tablets?	At the local pharmacy	NA	69
Are these iodine tablets free or to be paid for?	Free	NA	53

Most of the people (48 %) who remember the Iodine campaign were able to recall 6 to 8 messages from the campaign, and 4 % were able to recall all messages. Only few (1 %) stated that they remembered the iodine campaign, but were not able to recall any messages.

Specific knowledge

In his model, Zaller (2006) recommended measuring *specific knowledge* by a simple test of specific factual information, while scholars in risk research (Griffin *et al.*, 2008; Huurne *et al.*, 2009; Kahlor *et al.*, 2006) have measured it as a self-reported item. In our study *specific knowledge* was operationalized as the number of correct answers given to a set of 14 exam-style questions about protective actions in a nuclear emergency, the location of nuclear installations in Belgium and nuclear technology (see Table 3.3). Since the purpose of the specific knowledge variable was to comprise different levels of knowledge, the items did not measure one latent construct. Responses were indexed and the resulting absolute scale ranged from 0 to a maximum of 14 correct answers. While less than 1 % of the respondents answered all 14 items correctly, most respondents had seven to eleven correct answers ($\tilde{x}$=8, *SD* = 2.9).

Table 3.3: Specific knowledge

Specific knowledge scale N=1031	Correct answer	Percent of correct answers
Indicate whether the following towns have a nuclear power plant:		
Hasselt	No	65
Lier	No	63
Liege	No	54
Doel	Yes	70
Tihange	Yes	73
Is a radiological dispersal device (also known as dirty bomb) the same as an atomic bomb?	No	47
Will exposure to radiation necessarily lead to a contamination with radioactive material?	No	26
Which percentage of electric power in Belgium is produced in nuclear plants?	Between 45 – 65 %	29
Which of the following sectors make use of nuclear technology:		
Production of electricity	Yes	95
Medical sector	Yes	87
Food industry	Yes	25
Textile industry	Yes	50
Belgium has decided to phase out nuclear energy.	Yes	43
There exists a plan to ensure the protection of the population in case of a nuclear accident.	Yes	71

Experience with the hazard

Four questions on *personal experience with the hazard* were used in this survey (see Table 3.4). The response was "yes" (1) or "no" (0) and the response "don't know" was recoded as a missing value. Hazard experience was calculated as a summation of the four recoded items. The results showed that the majority of the Belgian population (80 %) has no personal experience with nuclear technology or installations: about 5 % have or had a job that involved radioactivity, about 12 % have visited a nuclear installation and the same percentage has close friends or relatives working in the field.

Table 3.4: Radiological hazard experience

Alpha=0.50, N=1031	Percent of experienced
Had a job that involved the use of radioactivity (nuclear power plant, industry or hospital using the radioactive sources, …)	5
Had a family member or close friend with a job that involved the use of radioactivity?	12
Visited a nuclear power plant or research reactor	13
Lived in an area close (within a 20 km radius) to a nuclear installation (power plant, nuclear research institute …)	20

Trust and risk perception

To examine the scales for *trust* and *risk perception*, an exploratory factor analysis was performed using principal axis factoring and direct Oblimin rotation. The confirmatory factor analysis results indicated that the factor loadings for each of the scales were adequate (greater than 0.5) and were typically very strong, indicating a high construct validity.

Seven items were used to measure how much *confidence* the respondents have in the authorities for the actions they undertake to protect the population (see Table 3.5). The answers ranged from "very low confidence" (1) to "very high confidence" (5). Only one scale was extracted with all seven items measuring confidence in the authorities to protect the population from radiological risks. High scores in this scale indicated a strong trust in authorities.

Table 3.5: Factor loadings and other scales attributes for trust

Confidence in authorities for the actions undertaken against radiological risks	Factor Loading Principal axis	CFA Loadings	Alpha	N out of 1031
Radioactivity in food	0.799	0.83	0.87	835
Accident nuclear installation	0.725	0.77		
Radioactive waste	0.714	0.74		
Natural radiation	0.700	0.76		
Terrorist attack radioactive source	0.698	0.75		
Medical x-rays	0.668	0.72		
Radiation GSM	0.593	0.75		

Respondents were asked to evaluate the risks of seven different radiological risks for an ordinary Belgian citizen (see Table 3.6). Responses ranged from "very low" (1) to "very high" (5). Two risk perception scales were extracted. The "risks related to the nuclear industry" referred to the perceived level of risk for an accident in a nuclear installation, radioactive waste, radioactivity in food and a terrorist attack with a radioactive source. "Risks unrelated to the nuclear industry" were medical X-rays, radiation from mobile phones and natural radiation. Low factor scores on both scales denoted a low perception of radiological risks.

Table 3.6: Factor loadings and other scales attributes for radiological risks

Perception of nuclear industry related radiological risks	Factor Loading Principal axis	CFA Loadings	Alpha	N out of 1031
Accident nuclear installation	0.849	0.83	0.85	958
Radioactive waste	0.804	0.80		
Radioactivity in food	0.715	0.77		
Terrorist attack radioactive source	0.704	0.77		
Perception of non-nuclear industry related radiological risks	**Factor Loading Principal axis**	**CFA Loadings**	**Alpha**	**N out of 1031**
Medical x-rays	0.621	0.49	0.63	912
Radiation GSM	0.569	0.40		
Natural radiation	0.454	0.92		

Affective response

Respondents' fear of an accident in a nuclear installation was measured by their level of agreement with the statement "An accident in a nuclear installation is strongly feared" on a 5-point scale, ranging from 1 "strongly disagree" to 5 "strongly agree".

Bivariate relationships

We investigated the relationships between the reception measures and each of the following predictor variables: education, specific knowledge, hazard experience, trust, the perception of radiological risks unrelated to the nuclear industry, the perception of radiological risks related to the nuclear industry and affective response.

Potential predictors for reception: the complete sample

As introduced in the previous section, reception was first measured at the level of the whole population by two reception items. Each of the two reception items was investigated separately for all predictor variables by binary logistic regression.

Table 3.7: Summary Comparison: Predictors of pre-crisis communication recall

		1. model Recall of iodine campaign		**2. model Recall of iodine tablets' purpose**	
Predictor, Scale attributes		**B**	**S. E.**	**B**	**S. E.**
Education					
Primary		0.113	0.404	-0.870*	0.423
Lower secondary		-0.237	0.349	-0.686	0.366
Higher secondary		0.077	0.320	-0.693*	0.343
Higher		0.204	0.334	-0.341	0.358
Specific Knowledge	Additive scale 14 items N = 1031	0.272***	0.035	0.255***	0.033
Visited a nuclear power plant or research reactor		0.057	0.262	-0.071	0.257
Living or having lived close to a nuclear installation		-1.830***	0.249	-0.521*	0.213
Had a job that involved the use of radioactivity		-0.326	0.405	-0.169	0.374
Had a family member or close friend with a job that involved the use of radioactivity		-0.695*	0.274	-0.084	0.254
Trust	α = 0.87 7 items N = 835	-0.306**	0.092	-0.179*	0.087
Risk perception not industry related radiation	α = 0.63 3 items N = 912	-0.033	0.115	0.396***	0.114
Risk perception industry related radiation	α = 0.85 4 items N = 958	0.094	0.104	-0.339***	0.102
Affective response (fear)		0.115	0.077	-0.078	0.075
Constant		2.471	1.056	0.570	0.963
		N = 758 Percentage correctly classified=70 Nagelkerke Pseudo $R^2 = 0.27$		N = 758 Percentage correctly classified=65 Nagelkerke Pseudo $R^2 = 0.20$	

Note: Binary logistic regression analysis, Dependent variables: Recall of Iodine campaign, Recall of iodine tablets use: Yes=1 and No=0; *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.

From Table 3.7 we can conclude that the predictors *specific knowledge* and *hazard experience* ("*living or having lived close to a nuclear installation*") were most strongly related to recalling the iodine campaign and the purpose of the iodine tablets, as was to be expected. The predictor risk perception of radiological risks was strongly related to recall of iodine tablet's purpose. Respondents with less trust in the authorities to protect the population against radiological risks recalled better the campaign and the purpose of the iodine tablets than respondents with more trust. The first regression model revealed a significant relationship with hazard experience for the group of respondents that "*had a family member or close friend with a job that involved the use of radioactivity*". This relationship was not significant for the second model. The hypothetical predictors education and affective response were not significant for any reception item.

However, the pseudo-R^2 value of the first model was moderately strong ($R^2 = 0.27$) whereas in the second model was lower ($R^2 = 0.20$).

Potential predictors for reception: the sample of people remembering the campaign

We continued by investigating the relationships between each of the potential predictors and the ability to recall specific messages from the iodine distribution campaign.

The *reception* index calculated as a sum of the nine items measuring the recollection of the iodine distribution campaign was regressed separately on each of the predictors items. The dependent variable was assumed in this case to satisfy an interval level of measurement. For the scales on trust, perception of risks related to the nuclear industry, and perception of risks unrelated to the nuclear industry, the factor scores were recalculated only for the people recalling the iodine distribution campaign. The results are summarized in Table 3.8 which presents the linear regression coefficients for each alternative predictor.

Table 3.8: Summary Comparison: Predictors of Iodine distribution campaign recall

Predictor scale	**Scale attributes N=519**	**Preparedness communication**		
		β	**R^2**	**Significance**
Education	One item N=519	0.12	0.01	0.008
Specific knowledge	Additive scale No of items = 14 N=519	0.46	0.21	0.001
Hazard experience	Additive scale No of items = 4 N=519	0.12	0.02	0.005
Trust	Alpha = 0.86 No of items = 7 N = 431	0.14	0.02	0.003
Perception of nuclear industry related radiological risks	Alpha = 0.82 No of items = 4 N = 479	-0.18	0.03	0.001
Perception of non-nuclear industry related radiological risks	Alpha = 0.70 No of items = 3 N = 442	Not significant	Not significant	Not significant
Affective response (fear)	One item	-0.12	0.02	0.008

As reported in Table 3.8, specific knowledge was again most strongly related to the reception of the iodine campaign. According to our expectations, specific knowledge tended to produce the strongest regression coefficients ($\beta = 0.46$), up to three times larger than the ones obtained for the other predictors. The R^2 value showed that specific knowledge explains about 20 % of the variation in *reception*.

In order to compare the relationships between the predictors and the dependent variable reception we standardized the predictor values to a five-level scale. Plotting the average percentages of respondents recalling messages (from communication) across an increasing level of specific knowledge clearly demonstrated the expected pattern – higher specific knowledge is related to higher reception of pre-crisis messages (see Figure 2.2).

The predictors of heuristic information processing revealed a significant relationship with *reception*, but they were recognized only as weak predictors. For example, the perception of radiological risks related to the nuclear industry was negatively correlated with reception, but the explanatory value of the model was only 3 %. Trust, fear and perception of radiological risks related to the nuclear industry were also significant, but weak predictors.

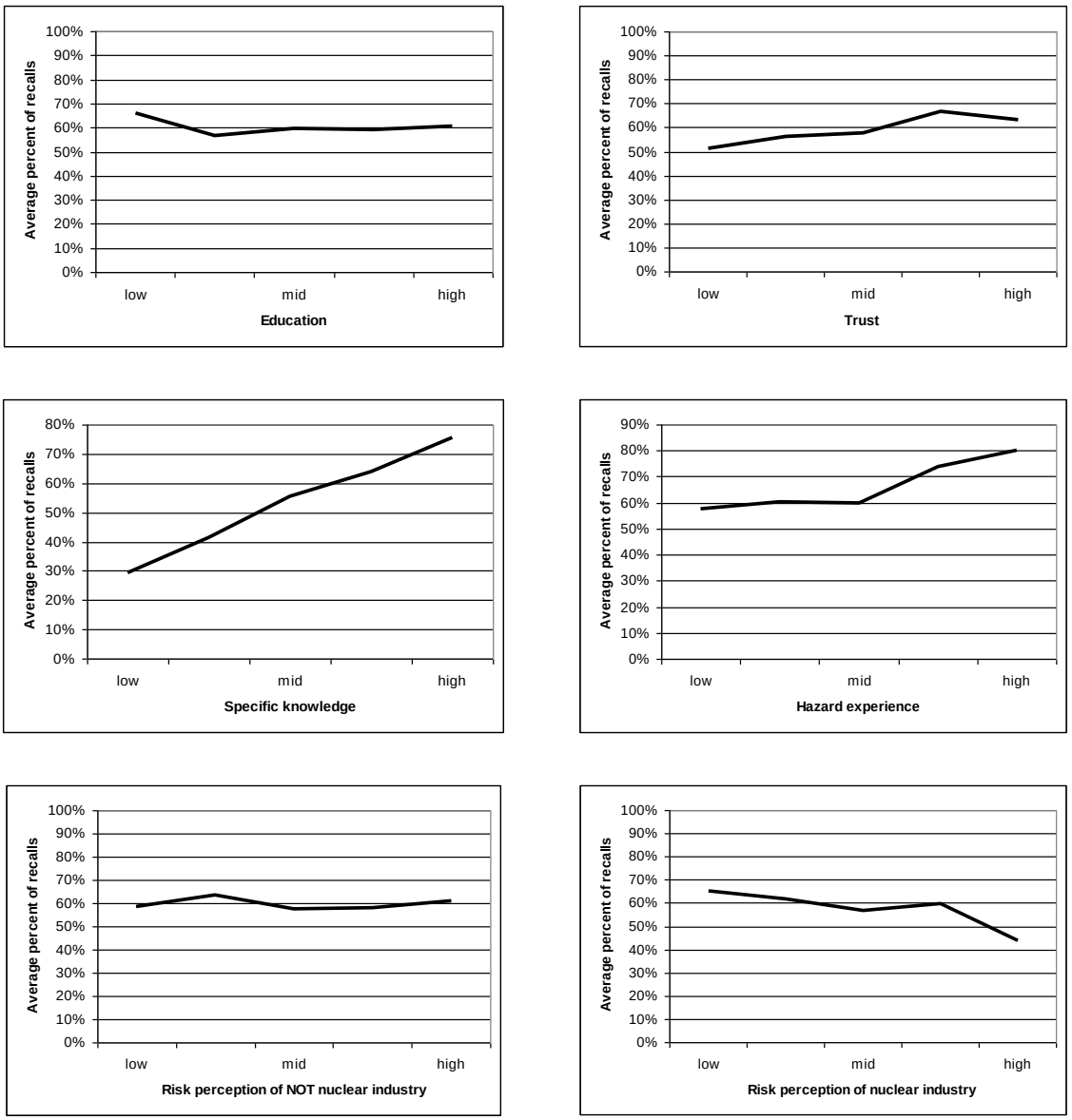

Figure 3.1: Communication reception by different predictors

To explore the full model with all hypothetical predictors, a linear regression analysis was performed (see Table 3.9).

Table 3.9: The regression model for recall of iodine campaign messages

	Recall of iodine campaign messages	
Predictor	**β**	**S.E.**
Education		
Primary	0.045	0.378
Lower secondary	-0.020	0.281
Higher secondary	0.052	0.241
Higher	0.055	0.358
Specific knowledge	0.348***	0.041
Hazard experience	0.035	0.103
Trust	0.125**	0.109
Perception of nuclear industry related radiological risks	-0.130*	0.123
Perception of non-nuclear industry related radiological risks	0.042	0.138
Affective response (fear)	-0.065	0.093
Constant		0.581
	N= 447 R^2(adj) (full model) = 0.18	

Note: Linear regression analysis, Dependent variable: Recall of iodine campaign messages; *** p < 0.001; ** p < 0.01; * p < 0.05.

The regression analysis of the full model confirmed the previous results: the *reception* of communicated messages is mainly driven by specific knowledge. Trust and risk perception of the nuclear industry were revealed as significant, but risk perception had a negative β coefficient (-0.13). The explanatory value of the full model was 18 % of the variation in reception, with specific knowledge three times stronger than any other predictor. The other hypothetical predictors were not significant for the reception of pre-crisis communication messages.

Findings for specific groups of respondents

Even though most of the predictors tested were recognized as rather weak predictors, we report about some specific findings in the interest of nuclear emergency communication. We developed a three-level scale for reception in which 1 meant that the respondents recollected 0-4 messages, 2 that they remembered 5-6 messages and 3 level meant recollection of 7-9 messages. The first group was labelled "low" reception and contained 36.8 % of the respondents, the second group (“medium”) included 26.4 %, and the third group (“high”) took up 36.8 % of all the respondents. This division was made in order to identify a subgroup of respondents who would be particularly attentive to a specific nuclear emergency message.

For example, we expected people with a high perception of nuclear risks to be especially interested in receiving instructions about what to do in case of a nuclear accident. Hence, we assumed that these people would be interested to learn about iodine tablets and the information campaign (H5). However, the results of cross tabulation, χ^2=10.92, *df*=4, *p*=0.03, with the three levels of the dependent variable showed exactly the opposite effect. A low recollection of information was related to a high perception of radiological risks related to the nuclear industry and a high recall correlated with a low perception of this risk. While 44 % of

all the people with a high risk perception recalled few messages from communication, only 33 % people with a low perception of this risk also had a poor recollection.

Our results showed that there is a significant association between the recollection of messages and the education level (H1); χ^2=16.85, *df*=8, *p*=0.04. A lower level of education was associated with a lower reception of information: 36 % of everyone who held a university degree had a high recall of information, whereas this was the case for 24 % of the respondents with only primary education. However, this pattern was not consistent at all education levels and the association with education turned out to be rather weak after all.

It was expected that recipients with more specific knowledge about nuclear topics would be more likely to receive nuclear emergency messages on preparedness than people with less knowledge (H2). The results confirmed this expectation: 20 % of the respondents with a low degree of specific knowledge had a high recollection of information, compared to 63 % in the group of people with a high degree of specific knowledge, χ^2=84.27, *df*=4, *p*=0.00.

Concerning hazard experience, we assumed that the recipients with hazard experience would be more likely to receive emergency messages in the preparedness phase of a nuclear emergency (H3). However, our results cannot confirm this expectation, since the association between the recollection of preparedness communication and the hazard experience was not significant, χ^2=14.49, *df*=8, *p*=0.07. Still, we observed that more than half of the respondents (52 %) had no hazard experience. It is interesting to note that "living or having lived in an area close to a nuclear installation (within a 20km radius)" is not significantly associated with the reception of messages from the information and the iodine distribution campaign.

Finally, we assumed that trust in the authorities would influence attention to emergency communication in the preparedness phase, and that people with a higher degree of trust would recall fewer messages (H4). The association is indeed significant, χ^2 =12.25, df=4, p=0.02, but the influence is not in the expected direction. People with a lot of trust in the authorities were more likely to have high reception; 31 % of the respondents with little trust were able to recall most of the information, while this accounted for 38 % of the respondents with medium levels of trust and 47 % of those with a lot of trust.

Discussion

The goal of the present study was twofold. The first objective was to explore at what point of the process heuristic or systematic predictors become relevant for information processing. We focused on the patterns in people's *reception* of pre-crisis (i.e., preparedness) communication. Education, prior knowledge, trust, risk perception and affective response (fear) were assumed to be important at the *reception* level of information processing. Taking these predictors into account, our second objective was to identify subgroups of respondents who were expected to be particularly attentive to communication about emergencies.

An adaptation of Zaller's model offered the opportunity to take a closer look at reception as a distinctive part of risk information processing, and allowed us to define who the people are that will (not) receive risk information. In general we confirmed that the reception of the information is determined by the awareness.

The findings of this study demonstrate the stronger influence of systematic predictors over heuristic predictors at the *reception* level. People with a lot of specific knowledge were identified as especially

attentive toward emergency preparedness communication, while people with a high risk perception were mainly negligent.

This study evaluated reception as a stage of information processing, separate from the acceptance stage. Prior research by Price *et al.* (1993), Zaller (2006), Dobrzynska and Blais (2007) on reception as a stage of information processing has suggested the importance of prior knowledge. Our analysis confirms this view and suggests, in addition, that people's likelihood of learning about preparedness for emergency is best predicted by their pre-existing knowledge of risk.

Education was recognized as a rather weak predictor for the *reception* of pre-crisis communication. This result is similar to the studies from the field of political communication by Price et al (1993), Zaller (2006) , Dobrzynska and Blais (2007). However, in risk research education is recognized as a predisposition for seeking out risk information and as an influencing factor for the extent to which a person will spend time and effort analyzing the risk information critically. In the risk related literature - for example, the study of Griffin *et al.* (1999) - information processing is studied as a complete process, and *reception* and *acceptance* are not separated as in our research. This may explain why in our research education was not found to be a significant factor for the *reception* of information, as it could become more influential in the *acceptance* part of information processing. The hypothesis (H1) that the *reception* of pre-crisis messages is not most accurate among people with a higher education level can be partly accepted. It was also confirmed that a lower education level is correlated with lower recollection of information.

The low correlation between education and specific knowledge suggests that in the education system, people do not get any specific knowledge about nuclear emergencies or the location of nuclear installations. This is important for the development of preparedness communication, since people with more **specific knowledge** about the nuclear domain are more likely to receive nuclear emergency messages than people with less knowledge (H2). Therefore, it would be recommended to include more risk-related topics already in the education systems. These findings are in line with a recent theory, which recognizes specific knowledge as a filter for information processing (Dobrzynska and Blais, 2007; Price and Zaller, 1993; Zaller, 2006). The research on information gathering capacity by Griffin *et al.* (2008) confirms that the amount of knowledge people hold about a risk affects their capacity to gain new information about it. Moreover, our results suggest that people who are well-informed about the risk environment receive more information about emergency preparedness than people who do not know much about the risk. In other words, if people succeeded in understanding risk information in the past, this should enhance their ability to be attentive, comprehend and retain risk information in the future.

Risk has become a prevalent element in our daily life as we live in "a risk society" (Beck, 1992; Beck, 2006). Past experience may serve the individual as a guide for deciding how to think, behave or react in a new situation (Grunig, 1983) and it may trigger heuristic information processing (Trumbo, 2002). One of our research questions was to determine whether directly measured hazard experience becomes influential for the information processing at the reception stage. Our results showed that hazard experience did not have a significant influence on the reception of emergency preparedness communication (H3). It is interesting that hazard experience and specific knowledge did not correlate, meaning that people who have personal experience related to the nuclear domain do not always have a higher level of actual knowledge of the topic. In other words, living close to a nuclear installation or having visited a nuclear installation did not help people in gaining additional knowledge. This is not in line with Eurobarometer study (2007), in which a link

between nuclear experience (living in a state with a nuclear power plant) and specific knowledge is recognized.

The influence of **trust** in the *reception* part of risk information processing is negligible. People's confidence in the authorities to protect the population against radiological risks has a weak influence on the attention they pay to emergency communication in the preparedness phase (H4). It might, however, become influential later on in the information processing. For instance, recent research by Whitfield (2009, p. 425) suggests that "increased trust in the nuclear governance institutions reduces the perceived risk of nuclear power and together higher trust and lower risk perceptions predict positive attitudes toward nuclear power". However, current literature suggests that risk regulators have problems with the low level of public trust and that they face difficulties in mobilizing the necessary social support for nuclear activities or decision-making. In most cases, the public assesses regulators on the basis of their past decisions (Renn, 2008). Our research showed that people with a lot of trust in the authorities recalled less nuclear emergency information.

Perception of risk in the literature is usually studied as a dependent variable, to provide insight into how people respond to specific characteristics of various risks (Kasperson *et al.*, 1988). In our research, though, risk perception is used as an independent variable, as a potential (heuristic) predictor of *reception*. Our hypothesis was that people with a higher perception of radiological risks are more attentive to a nuclear emergency message (H5). The relationship between risk perception and *reception* indeed appeared to be statistically significant. However, linear regression revealed the low explanatory power of this predictor. Contrary to our expectations, a high perception of radiological risks related to the nuclear industry was negatively correlated with the recollection of information about iodine tablets. This might be explained based on previous risk perception research (Renn, 2008; Sjöberg, 2002; Slovic *et al.*, 2004) and media research (Clark and Harvey, 2002), according to which risk perception is lower for familiar/known risks. In other words, people's familiarity or ability to be personalized with a media topic increases their degree of attentiveness to communicated messages related to these risks, and thus it stimulates reception.

A growing body of research indicates that emotional reactions and moods influence information processing (Bohner and Apostolidou, 1994; Griffin *et al.*, 1999; Griffin *et al.*, 2008). We investigated if fear as a measurement of an **effective response** influences the *reception* stage of processing. The results of our empirical testing indicated that fear of an accident at a nuclear installation did not predict the respondent's reception of pre-crisis information related to protection measures (H6).

Conclusion

To conclude, this study showed that heuristic predictors have a limited influence in the *reception* stage of information processing. Among the information processing predictors studied, specific knowledge plays a dominant role in the *reception* of pre-crisis communication. People with a lot of specific knowledge were identified as particularly attentive, motivated, and able to recollect the information related to nuclear emergency preparedness communication. The reception is determined by the awareness. Education, hazard experience, trust, risk perception and affective response (fear) - although statistically significant - do not play an important role in the reception of pre-crisis information.

Future research will need to address the *acceptance* part of information processing. It is likely that in this part, heuristic predictors prove to be more influential than systematic ones. Finally, further research on crisis and post-crisis (recovery) communication would also be advisable.

Technical note: Heuristic vs. Systematic Information Processing of the Information from the Iodine Campaign

People process information in two central information processing modes: heuristic and systematic. Heuristic processing is most strongly characterized by low effort and reliance on existing knowledge. Systematic processing is most strongly characterized by greater effort and the desire to evaluate information formally (e.g. scientifically) (Trumbo, 1999).

In this section we investigated if the information processing in case of the iodine campaign was heuristic (instinctive or emotion driven) or systematic (based on rationality), e.g. taking more effort to process and check the information and to make a decision.

The research questions are the following:

• Is processing of information related to stable iodine tablets heuristic (instinctive or emotion driven) or systematic (based on rationality, e.g. taking more effort to process and check the information and to make a decision)?

• Which are predictors of information processing related to stable iodine tablets?

• What is the relation with nuclear energy or radiological risks?

The questions measuring information processing mode were adapted from existing literature related to systematic and heuristic measurements (Griffin, Dunwoody and Neuwirth 1999; Jooyoung and Hye-Jin 2009; Trumbo 1999; Trumbo 2002). These questions target the individual's effort to acquire and compare information (See Table 3.10).

Table 3.10: Items on heuristic and systematic information processing

(ITEMS RANDOMIZED & FILTERED WITH only for those who know about the campaign)

Information processing mode	**Please tell me how much you agree or disagree with the following statements:**	
Systematic	In order to be completely informed about the use of iodine tablets, I think that the more viewpoints I get, the better off I will be.	1. Strongly Disagree 2. Disagree 3. Neither agree, nor disagree 4. Agree 5. Strongly Agree 9. Don't know / no answer
Systematic	I have been very attentive to the information presented in the information campaign on iodine tablets.	
Systematic	When the topic of iodine tablets came up, I tried to learn more about it.	
Systematic	It was important for me to clarify how I should use the iodine tablets.	
Systematic	When I encountered information about iodine tablets, I carefully considered it.	
Heuristic	On issues like that I just go with my gut feeling.	
Heuristic	Past experiences with health related issues have made it easier for me to make an opinion about the use of iodine tablets.	
Heuristic	On the use of iodine tablets I shall simply place my trust in the experts and respect their recommendations.	
Heuristic	Related to decisions concerning the iodine tablets, I follow the people from my environment, e.g. family, neighbours.	
Heuristic	I could easily make an opinion about the use of iodine tablets without seeking additional information, based on my existing knowledge.	

The answers for each item are presented in the Figure 3.2 below.

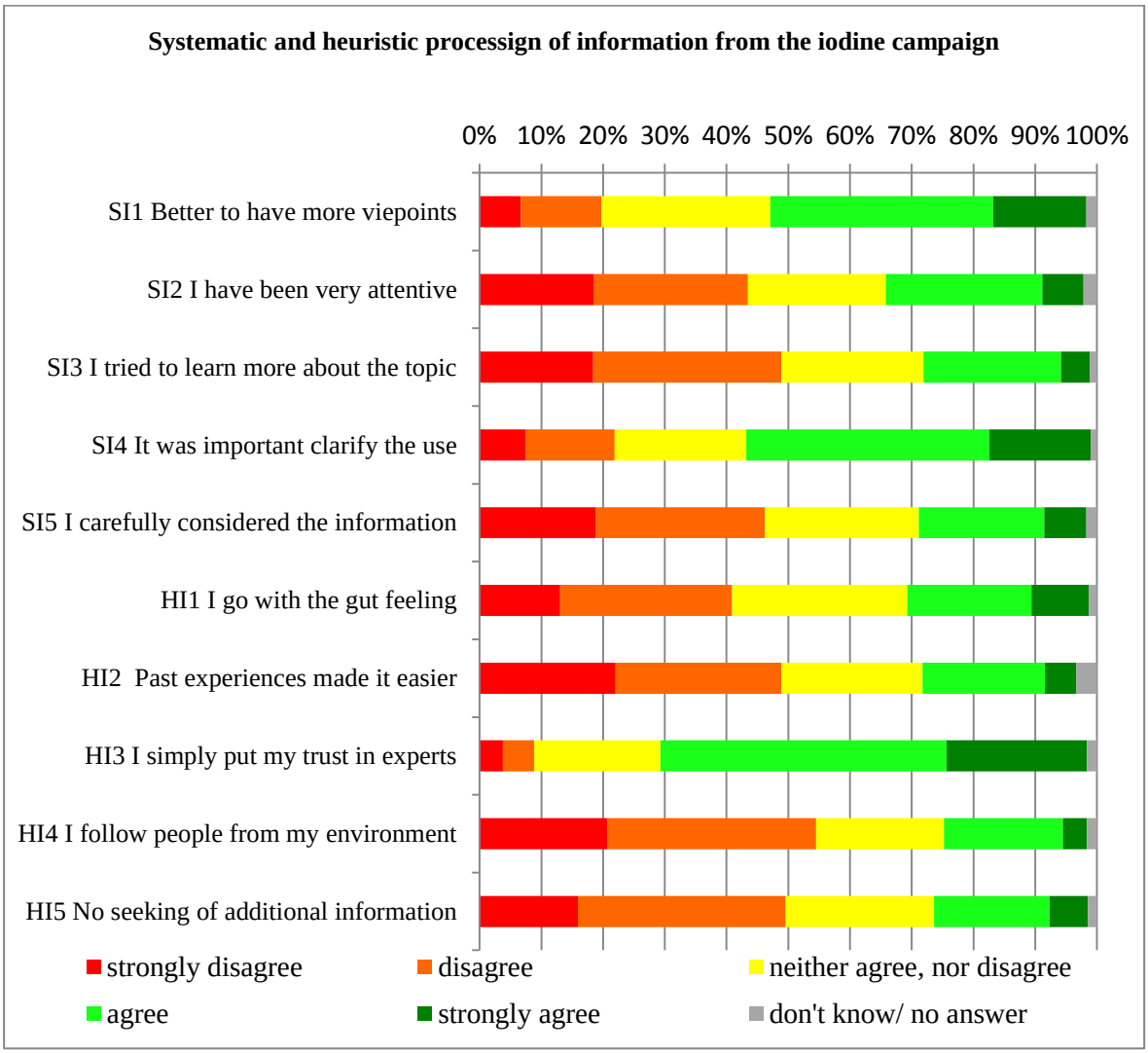

Figure 3.2: Frequency on systematic and heuristic processing items on information related to iodine tablets

To identify the strength of the predictors for information processing, the following latent constructs and items were used: *Systematic mode, Heuristic mode, Perception of radiological risks, Confidence in authorities to protect population for radiological risks, Specific knowledge, Knowledge related to use of iodine tablets, Acceptance of iodine campaign and Acceptance of communicated message (see* Table 3.11*).*

Table 3.11: Latent constructs and scale attributes used to study predictors for information processing

Latent variable	Measures	Alpha	Factor loading
Systematic mode	In order to be completely informed about the use of iodine tablets, I think that the more viewpoints I get, the better off I will be.	0.79	0.48
	I have been very attentive to the information presented in the information campaign on iodine tablets.		0.74
	When the topic of iodine tablets came up, I tried to learn more about it.		0.69
	It was important for me to clarify how I should use the iodine tablets.		0.60
	When I encountered information about iodine tablets, I carefully considered it.		0.76
Heuristic mode	Past experiences with health related issues have made it easier for me to make an opinion about the use of iodine tablets.	0.55	0.76
	Related to decisions concerning the iodine tablets, I follow the people from my environment, e.g. family, neighbours.		0.66
	I could easily make an opinion about the use of iodine tablets without seeking additional information, based on my existing knowledge.		0.76
Trust in the experts	On the use of iodine tablets I shall simply place my trust in the experts and respect their recommendations.		
Perception of radiological risks	Radioactive waste.	0.82	0.73
	An accident in a nuclear installation.		0.87
	A terrorist attack with a radioactive source.		0.75
Confidence in authorities to protect population for	Radioactive waste.	0.86	0.87
	An accident in a nuclear installation.		0.86
	A terrorist attack with a radioactive source.		0.74
Specific knowledge	Index (17 items)		
Knowledge: Use of iodine tablets	Index (5 items)		
Acceptance of iodine campaign	The authorities assure that the iodine tablets can reduce health consequences in case of a nuclear accident. Do you agree?	0.75	0.64
	Do you agree with the distribution of iodine tablets		0.60

Latent variable	Measures	Alpha	Factor loading
	for people living with a certain radius from a nuclear installation?		
	The distribution of iodine tablets is a good idea.		0.84
	Iodine tablets are waste of money. (inverted)		0.55
Acceptance of communicated message	Iodine tablets would protect against thyroid cancer.		

Results in Table 3.12 show that a higher degree of systematic information processing generally led to more acceptance of communicated messages. If we compare for instance the respondents agreeing that "iodine tablets would protect against thyroid cancer" with those who didn't agree, we notice that the latter processed the information significantly less systematic than the former, and slightly more heuristic.

Table 3.12: Group statistics for systematic and heuristic processing (factor scores)

Iodine tablets would protect against thyroid cancer		N	Mean	Std. Deviation	Std. Error Mean
Systematic processing mode	Not agreeing	81	-0.310	1.027	0.114
	Agreeing	586	0.043	0.873	0.036
Heuristic processing mode	Not agreeing	77	0.093	1.135	0.129
	Agreeing	584	-0.012	0.981	0.041

As a statistical test comparing the distributions across the two groups (agreeing and not agreeing with the communicated message) we used the independent-samples nonparametric tests Mann-Whitney U. The results show that the systematic information processing was significantly different in the two groups (asymptotic significance value p=0.001). For the heuristic information processing mode, the differences between the group categories did not appear as statistically significant.

To identify the strength of information processing predictors for accepting the communicated message related to iodine tablets a binary logistic regression analysis with following hypothetical predictors was used: specific knowledge, systematic and heuristic information processing mode, confidence in authorities, radiation risk perception and trust in the experts.

Table 3.13: Binary logistic regression for Iodine tablets would protect against thyroid cancer

Iodine tablets would protect against thyroid cancer	B	S.E.	Sig.
Specific knowledge	0.243	0.050	0.000
Systematic mode	0.413	0.202	0.041
Heuristic mode	-0.337	0.175	0.054
Confidence in authorities	0.365	0.152	0.016
Radiation risk perception	-0.236	0.157	0.132
Trust in the experts	0.389	0.138	0.005
Constant	-1.939	0.773	0.012

R^2= 0.21
Respondents included in the model: N = 621 out of 690 knowing about the communication campaign related to iodine tablets.
Grey shaded fields indicate significant predictors

A higher acceptance of communicated information related to iodine tablets is mostly driven by systematic information processing (B=0.41*), followed by higher trust in the experts (B=0.39**), higher confidence in authorities (B=0.37*) and higher specific knowledge (B=0.24***). Respondents that processed the information related to iodine tablets more heuristically seemed less inclined to agree with the protection use of the iodine tablets; however, the significance level of the heuristic mode was on the limit (p=0.05).

To analyse the general acceptance of the information distributed in the iodine campaign, a linear regression was carried out, using as a dependent variable a latent construct measured with four communicated messages (see Table 3.14).

Table 3.14: Acceptance of information from the iodine campaign

Acceptance of iodine campaign	Unstandardized Coefficients		Standardized Coefficients	
	B	Std. Error	Beta	Sig.
(Constant)	-1.127	0.220		0.000
Heuristic mode	-0.016	0.037	-0.019	0.661
Systematic mode	0.103	0.043	0.108	0.016
Confidence in authorities	0.065	0.037	0.070	0.077
Radiation risk perception	-0.026	0.037	-0.028	0.469
Trust in the experts	0.302	0.036	0.335	0.000
Specific knowledge	0.015	0.014	0.044	0.273
Knowledge; use of iodine tablets	-0.025	0.020	-0.049	0.218

R2 = 0.15 , N=600
Grey shaded fields indicate significant predictors

Results in Table 3.14 show that trust in the expert is the strongest predictor for the acceptance of iodine campaign. The higher trust in the experts one has, the more he/she accepted the communicated messages. Another influential predictor is the systematic information processing mode. The persons who made a decision related to iodine tablets based on rationality, e.g. taking more effort to process and check the information and to make a decision, accepted the messages from the iodine campaign to a greater extent.

From the results we can conclude that an information campaign related to protective actions will be successful, if it stimulates systematic information processing, for instance by stimulating stakeholder engagement, including experts in the communication and stimulating critical thinking (e.g. presenting positive and negative sides of iodine tablets).

References

Beck, U., 1992. The Risk Society: Toward a New Modernity. Sage, London, UK.

Beck, U., 2006. Living in the world risk society. *Economy and Society*, 35, 329-345.

Belgian Federal Crisis Centre, 2010. Efficacité des comprimés d'iode confirmée http://www.crisiscentrum.be/index.php?option=com_content&task=view&id=257&Itemid=1.

Blando, J.D., Robertson, C., Bresnitz, E., 2008. Communicating information in an emergency preparedness pill distribution campaign. *Biosecurity and Bioterrorism-Biodefense Strategy Practice and Science*, 6, 57-65.

Bohner, G., Apostolidou, W., 1994. Mood and Persuasion - Indepandent effects of Affect Before and After Message Processing. *Journal of Social Psychology*, 134, 707-709.

Bohner, G., Chaiken, S., Hunyadi, P., 1994. The Role of Mood and Message Ambiguity in the Interplay of Heuristic and Systamatic Processing. *European Journal of Social Psychology*, 24, 207-221.

Chaiken, S., Stangor, C., 1987. Attitudes and Attitude Change. *Annual Review of Psychology*, 38, 575-630.

Clark, V., Harvey, R., 2002. Media Studies. Longman.

Dake, K., 1992. Myths of Nature - Culture and the Social Construction of Risk. *Journal of Social Issues*, 48, 21-37.

Dalton, R.J., Beck, P.A., Huckfeldt, R., 1996. Partisan cues and the media: Information flows in the 1992 presidential election American Political Science Review. Amer political science assoc, San Francisco, California, pp. 111-126.

Dobrzynska, A., Blais, A., 2007. Testing Zaller's Reception and Acceptance Model in an Intense Election Campaign. *Polit. Behav*, 30, 259-276.

Eagly, A.H., 1992. Uneven Progress - Social Psychology and the Study of Attitudes. *Journal of Personality and Social Psychology*, 63, 693-710.

Eagly, A.H., Chaiken, S., 1993. The Psychology of Attitudes Harcourt Brace Jovanovich College Publishers

Earle, T.C., Cvetkovich, G.T., 1995. Social Trust: Toward a Cosmopolitan Society. C. T. Praeger, Westpoint.

Elliot, A.J., 2006. The Hierarhical Model of Approach-avoidance motivation. *Motivation and Emotion*, 30, 111-116.

Eurobarometer, 2007. Eurobarometer; Europeans and Nuclear Safety. European Commission, , pp. 112.

Eurobarometer, 2008. Eurobarometer: Attitudes Towards Radioactive Waste. European Commission.

Eysenck, M.W., Keane, M. T. , 2005. Cognitive psychology. 5 ed. Psychology Press, London.

Fischhoff, B., Slovic, P., Lichtenstein, S., Read, S., Combs, B., 1978. How Safe is Safe Enough - Psychometric Study of Attitudes Towards Technological Risks and Benefits. *Policy Sciences*, 9, 127-152.

Freudenburg, W.R., 1993. Risk and Recreancy - Weber, the Division of Labour and the Rationality of Risk Perception. *Social Forces*, 71, 909-932.

Gaskell, G., Allum, N., Wagner, W., Kronberger, N., Torgersen, H., Hampel, J., Bardes, J., 2004. GM foods and the misperception of risk perception. *Risk Analysis*, 24, 185-194.

Griffin, R.J., Dunwoody, S., Neuwirth, K., 1999. Proposed Model of the Relationship of Risk Information Seeking and Processing to the Development of Preventive Behaviors. *Environmental research*, A80, 230-245.

Griffin, R.J., Yang, J., Huurne, E., 2008. After the Flood: Anger, Attribution, and the Seeking of Information. *Science Communication*, 29, 285-315.

Grunig, J.E., 1983. Communication Behaviors and Attitudes Of Environmental Publics: Two Studies. *Journalism Monographs*, 81, 1-47.

Hastie, R., Park, B., 1986. The Relationship Between Memory and Judgement Depends on Whether the Judgement Task is Memory-Based or Online. *Psychological Review*, 93, 258-268.

Huurne, E., Griffin, R.J., Gutteling, J.M., 2009. Risk Information Seeking Among U. S. and Dutch Residents: An Application of the Model of Risk Information Seeking and Processing. *Science Communication*, 31, 215-237.

IAEA, 2006. Manual for first Responders to a Radiological Emergency. in: I.A.E. Agency (Ed.) Emergency Preparedness and Response, Vienna.

Ibitayo, O.O., Pijawka, K.D., 1999. Reversing NIMBY: an assessment of state strategies for siting hazardous-waste facilities. *Environment and Planning C-Government and Policy*, 17, 379-389.

Jepson, C., Chaiken, S., 1990. Chronic Issue-Specific Fear Inhibits Systematic Processing of Persuasive Communications. *Journal of Social Behavior and Personality*, 5, 61-84.

Johnson, E.J., Tversky, A., 1983. Affect, Generalization, and the Perception of Risk. *Journal of Personality and Social Psychology*, 45, 20-31.

Jones, B., Baumgartner, F., 2005. The Politics of Attention. How Government Prioritizes Attention. University of Chicago Press, Chicago.

Jooyoung, K., Hye-Jin, P., 2009. Information Processing of Genetically Modified Food Messages Under Different Motives: An Adaptation of the Multiple-Motive Heuristic-Systematic Model. *Risk Analysis*, 29, 1793-1806.

Jourdain, J.R., Herviou, K., Bertrand, R., Clemente, M., Petry, A., 2010. Medical Effectiveness of Iodine Prophylaxis in a Nuclear Reactor Emergency Situation and Overview of European Practices. RISKAUDIT IRSN/GRS International, France, pp. 66.

Kahlor, L.A., Dunwoody, S., Griffin, R.J., Neuwirth, K., 2006. Seeking and Processing Information About Impersonal risk. *Science Communication*, 28, 163-194.

Kasperson, J.X., Kasperson E. R., 2005. The Social Contours of Risk. Earthscan, Virginia.

Kasperson, R.E., Renn, O., Slovic, P., Brown, H.S., Emel, J., Goble, R., Kasperson, J.X., Ratick, S., 1988. The Social Amplification of Risk - A Conceptual Framework. *Risk Analysis*, 8, 177-187.

Lang, A., 2000. The limited capacity model of mediated message processing. *Journal of Communication*, 50, 46-70.

Lang, A., 2006. Using the Limited Capacity Model of Motivated Mediated Message Processing to Design Effective Cancer Communication Messages. *Journal of Communication*, 56, S57-S80.

Lang, A., Bolls, P., Potter, R.F., Kawahara, K., 1999. The Effects of Production Pacing and Arousing Content on the Information Processing of Television Messages. *Journal of Broadcasting & Electronic Media*, 43, 451-475.

Loewenstein, G.F., Weber, U.E., Hsee, C.K., Welch, N., 2001. Risk as feelings. *Psychological Bulletin*, 127, 267-286.

McGuire, W.J., 1973. Persuasion, Resistance, and Attitude Change. in: I.D.S. Pool (Ed.) Handbook of Communication. IL:Rand McNally, Chicago.

Ohman, A., 1994. As fast as the blink of an eye: Evolutionary preparedness for preattentive processing of threat. Trans. A.P.S.U.D.N.C.S.E. Spr, Attent. in: P.J. Lang, R.F. Simons, M.T. Balaban (Eds.), Conference in Honor of Frances Keesler Graham - Attention and Orienting: Sensory and Motivational Processes. Lawrence Erlbaum Assoc Publ, Atlanta, Ga, pp. 165-184.

Petty, E.R., Cacioppo, J.T., 1986. The Elaboration Likehood Model of Persuasion. in: A.D. Berkowitz (Ed.) Advances in Experimental Social Psychology. Academic Press, New York, pp. 124-192.

Price, V., Zaller, J., 1993. Who Gets the News? Alternative Measures of News Reception and their Implications for Research. *Public Opinion Quarterly*, 57, 133-164.

Renn, O., 2008. Risk Governance; Coping with Uncertainty in a Complex World. Earthscan, London.

Shiffrin, R.M., Schneider, W., 1984. Automatic and Controlled Processing Revisited. *Psychological Review*, 91, 269-276.

Siegrist, M., Cvetkovich, G., Roth, C., 2000. Salient Value Similarity, Social Trust, and Risk/benefit perception. *Risk Analysis*, 20, 311-322.

Sjöberg, L., 2002. Are received risk perception models alive and well? *Risk Analysis*, 22, 665-669.

Sjöberg, L., 2004. Local acceptance of a high-level nuclear waste repository. *Risk Analysis*, 24, 737-749.

Sjöberg, L., 2006. Myths of the Psychometric Paradigm and How they can Misinform Risk Communication. Center for Risk Research, Stockholm, pp. 20.

Slovic, P., 2000. The perception of Risk. Earthscan Publications, London.

Slovic, P., Finucane, M.L., Peters, E., MacGregor, D.G., 2004. Risk as analysis and risk as feelings: Some thoughts about affect, reason, risk, and rationality. *Risk Analysis*, 24, 311-322.

Slovic, P., Flynn, J.H., Layman, M., 1991. Perceived Risk, Trust and the Politics or Nuclear waste. *Science*, 254, 1603-1607.

Sohier, A., 2002. A European Manual for OFF-site Emergency Planning and Response to Nuclear Accidents. December, 2002 ed. Belgian Nuclear Research Centre, SCK CEN, pp. 339.

Strack, F., Deutsch, R., 2004. Reflective and Impulsive Determinants of Social Behavior. , 8, 220-247.

Trumbo, W.C. 1999. "Heuristic-Systematic Information Processing and Risk Judgement." Risk Analysis 19:391-400.

Trumbo, W.C., 2002. Information Processing and Risk Perception: An Adaption of the Heuristic-Systematic Model. *Journal of Communication*, 52, 367-382.

Turcanu, C.O., Carlé, B., Paridaens, J., Hardeman, F., 2008. On the constructive role of multi-criteria analysis in complex decision-making: An application in radiological emergency management. Trans. S. European, S.R.A.E. Reliabil Assoc. in: S. Martorell, C.G. Soares, J. Barnett (Eds.), European Safety and Reliability Conference (ESREL)/17th Annual Meeting of the Society-for-Risk-Analysis-Europe (SRA-Europe). Crc Press-Taylor & Francis Group, Valencia, SPAIN, pp. 89-96.

Tversky, A., Kahneman, D., 1974. Judgement Under Uncertainty - Heuristics and Biases Science, pp. 1124-1131.

Visschers, V., Meertens RM, Passchier WW, de Vries NN., 2009 Probability information in risk communication: a review of the research literature. *Risk Anal.*, 29, 267-87.

Visschers, V.H.M., 2007. Gut Feeling versus Common Sense; The Role of Associative and Cognitive Processes in Risk Perception and Communication The Nutrition and Taxology Research Institute Maastricht. Rojal Netherlands Academy or Arts and Sciences, Maastricht, Nederlands, pp. 152.

Whitfield, S.C., Rosa, E.A., Dan, A., Dietz, T., 2009. The Future of Nuclear Power: Value Orientations and Risk Perception. *Risk Analysis*, 29, 425-437.

Zajonc, R.B., 1980. Feeling and thinking: Preferences need no inferences. *American Psychologist*, 35, 151-175.

Zaller, J., 2006. The Nature and Origins of Mass Opinion. Cambridge university press New York.

4. Is knowledge important? Empirical research on nuclear risk communication in two countries

Manuscript published as:

Perko, T., Zeleznik, N., Turcanu, C., Thijssen, P. 2012."*Is Knowledge Important? Empirical Research on Nuclear Risk Communication in Two Countries"*. Health Physics, 102, 614-625.

Abstract

Increasing audience knowledge is often set as a primary objective of risk communication efforts. But is it worthwhile focusing risk communication strategies solely on enhancing specific knowledge? The main research questions tackled in this paper were: i) if prior audience knowledge related to specific radiological risks is influential for the perception of these risks and the acceptance of communicated messages and ii) if gender, attitudes, risk perception of other radiological risks, confidence in authorities and living in the vicinity of nuclear/radiological installations may also play an important role in this matter. The goal of this study was to test empirically the mentioned predictors in two independent case studies in different countries. The first case study was an information campaign for iodine pre-distribution in Belgium (N=1035). The second was the information campaign on long-term radioactive waste disposal in Slovenia (N=1200). In both cases, recurrent and intensive communication campaigns were carried out by the authorities aiming, among other, at increasing specific audience knowledge. Results show that higher prior audience knowledge leads to more willingness to accept communicated messages, but it does not affect people's perception of the specific risk communicated. In addition, the influence of prior audience knowledge on the acceptance of communicated messages is shown to be not stronger than that of general radiation risk perception. The results in both case studies suggest that effective risk communication has to focus not only on knowledge, but also on other, more heuristic predictors such as risk perception or attitudes towards communicated risks.

Introduction

Communication related to radiological risks touches on multiple societal aspects. Communicators have to take into account not only health risks for the population (e.g. radiation-related diseases), but also social attitudes (e.g. stigma), psychological effects (e.g. distress, depression), protective measures (e.g. stable iodine tablets) and economic threats (e.g. decrease of property value). A considerable amount of literature investigated the effects of communication on radiological risks (or lack of it), especially in the aftermath of the accidents with severe radiological consequences (Abbott *et al.*, 2006; Bertell, 2008; Dubreuil *et al.*, 1999; Havenaar *et al.*, 2003; Jackson *et al.*, 2002; Sjöberg and Drottz, 1987; Wakeford, 2007), in emergency preparedness (Bergmans and Mortelmans, 2001; Blando *et al.*, 2008; Le Guen *et al.*, 2002) or related to the management of radioactive waste (Sjöberg, 2004; Železnik, 2010). In most cases, the main objective of the communication strategies applied was increasing specific audience knowledge , i.e. educate the public.

The aim of this paper was to provide an answer to a basic question: is it worthwhile focusing the risk communication strategy only on increasing specific audience knowledge, or should other factors, such as trust or attitudes be also taken into consideration? For this purpose we had a close look at two information campaigns related to radiological risks carried out in Belgium and Slovenia, respectively. We investigated the influence of prior audience knowledge on the acceptance of communicated messages (e.g. "no health risks") and the perception of communicated risks (e.g. risks from radioactive waste disposal).

Many risk communicators mistakenly measure the success of risk communication by what the population knows about the risk, and whether it believes it knows enough to make a decision. But knowledge may not always play a role in determining people's behavior. Knowledge about radon, for example, is uncorrelated with actually doing a home radon test (Sandman and Eblen, 1994). People who take risks are not necessarily less knowledgeable than those who do not take risks (Sjöberg and Drottz-Sjöberg, 1991).

In this paper an extended empirical investigation was performed to test the hypothesis (*H1*) that low prior knowledge is related to high risk perception and low acceptance of the communicated messages. A second

hypothesis tested (*H2*) was that the influence of prior knowledge on the perception and the acceptance of communicated radiological risks is stronger than the influence of attitudes, risk perception of other radiological risks or confidence in authorities. The analysis of case studies in two different countries, Belgium and Slovenia, allowed in addition to study the importance of knowledge for risk communication in diverse societal and cultural environments. A third hypothesis tested (*H3*) was that the main predictors of successful communication are similar in the two different contexts analyzed.

Two case studies were analyzed: the campaign for distribution of stable iodine tablets in Belgium and the campaign for long-term radioactive waste disposal in Slovenia.

In the next section we explain the theoretical background of the dependent and independent variables. In the methodology section are described the communication campaigns and the measurement scales. The results are presented in separate section, followed by the discussion and the conclusions.

Theoretical background

Theoretical research related to human attentiveness to information and the ability to acquire, comprehend, remember and recall the information (also called information processing) mainly addresses people as individuals, rather than as members of the society. The information processing models are seen as applicable for each individual, regardless of the societal or cultural bias (Chaiken and Stangor, 1987; Eagly, 1992; Eysenck, 2005; Lang, 2006; Lang *et al.*, 1999; McGuire, 1973; Shiffrin and Schneider, 1984; Trumbo, 2002; Zaller, 2006). Empirical research in this domain identified predictors of information processing and recognized the importance of prior audience knowledge (Dobrzynska and Blais, 2007; Price and Zaller, 1993), of perception of radiological risks (Huurne *et al.*, 2009), confidence in authorities (Freudenburg, 1993) and of attitudes (O'Keefe, 2002).

However, the process of risk communication can not be isolated from the broader social and cultural context in which it occurs, since individuals adapt to risky situations predisposed by the society or the country (Fisher, 1991; Otway, 1990; Vaughan, 1995). Countries may differ in beliefs, cultural values, past social and risk experiences, the saliency of particular aspects of a policy issue, the socio-economic profile and the trust in regulatory agencies.

In this study the main predictors of information processing were tested in the context of communication related to radiological risks in two different countries.

In the next section the dependent and independent variables used in the analysis are explained. Since communication about radiological risks is influenced by a number of unique characteristics, the specifics of the radiation domain are discussed.

Prior knowledge

Knowledge has been recognized as a mediator between a person and the effect of communication already in 1970 (Tichenor *et al.*, 1970). It was found that knowledge is relevant for an individual's communication skills. Those with a better reading ability, for example, should be able to comprehend information more easily. Since then, the influence of prior audience knowledge on the outcome of communication has been highlighted by both political communication and risk communication scholars. In risk communication research Griffin *et al.*(2008), Kahlor *et al.*(2006) and Huurne *et al.*(2009) have found a positive direct

relationship between knowledge and the perceived information-gathering capacity. Political communication scholars such as Price and Zaller (1993), Dobrzynska and Blais (2007) found that prior audience knowledge was the most powerful predictor for information reception. In other words, people who are a priori well informed about an issue will be exposed to, comprehend, remember and recall more of the related information than people who are less knowledgeable.

Zaller (2006: 154-155) found that the impact of knowledge depends significantly on the intensity of and the familiarity with the message. If a message is very intense and familiar, or if the person is extremely motivated by some reasons such as personal relevance (Petty and Cacioppo, 1986), even the least knowledgeable would receive it. However, in the nuclear field it is known that the public lacks knowledge and has only rarely (acknowledged) experiences with radioactivity (Kuklinski *et al.*, 1982; Miller, 1998; Perko *et al.*, 2010; Van Aeken *et al.*, 2007). For instance, the results of a survey in Belgium showed in 2009 that less than 25 % of the people knew that ionising radiation is also used by the food industry, and the majority of the respondents (80 %) had no personal experience with nuclear technologies or installations (Perko *et al.*, 2010).

Perception of radiological risks

Understanding risk perception plays a key role in developing risk communication. Risk perception is an essential social and psychological phenomenon, influencing and driving decision-making at individual, societal and cultural level (Beck, 2006; Douglas, 1982; Renn, 2008; Sjöberg, 2006). Previous research on risk communication by Griffin *et al.* (2008) and Huurne *et al.* (2009,p.231) found that the exposure to a risk could directly stimulate a person to find more information. The perception of radiological risks is often linked to the catastrophic potential of a nuclear accident. Such an event is unpredictable and uncontrollable, it can affect a large number of people and may create long-lasting and wide-spread consequences (Dubreuil *et al.*, 1999; Slovic *et al.*, 1979). Typical for radiological risks is also the difference between expert and lay public perception, e.g. with respect to the consequences of exposure to radiation, safety of nuclear power plants or nuclear waste (Purvis-Roberts *et al.*, 2007; Slovic *et al.*, 2004). Many surveys have been conducted to better understand these differences (Sjöberg and Drottz-Sjöberg, 1991). Such studies suggest that, very often, lay people exhibit higher perceptions of radiological risks than the experts, who are more knowledgeable.

Trust and confidence

The limited effectiveness of risk communication efforts can be attributed to the public's lack of trust in responsible institutions (Slovic, 1999). Trust is very often emphasized as an explanation of risk perception and tolerance. The components of trust are multidimensional: perceived competence, objectivity, fairness, consistency, sincerity, faith and empathy. The credibility of the spokesperson or authority delivering the message has been shown to be an overwhelming contributor to acceptance of messages (e.g. Peters (1992) on the credibility of nuclear industry). Due to the increasing complexity of technological innovations, people often find themselves in the position of not knowing much about highly complex and potentially dangerous technologies (Freudenburg, 1993; Gaskell *et al.*, 2004). They must therefore rely on their own judgments when deciding whom or which activities to trust. Holding less trust in managing agencies appears to lead people to have stronger negative feelings toward the risks (Huurne *et al.*, 2009).

In what regards the nuclear field, some particularities are worth mentioning. Past contamination episodes such as the Chernobyl fallout or the Fukushima nuclear accident have caused a lot of uncertainty and public

distrust (Ipsos MORI 2011; Carlé *et al.*, 2007; Van Aeken *et al.*, 2007). Earlier research identifies trust as one of the key indicators also for the acceptance of nuclear risks (Ibitayo and Pijawka, 1999; Sjöberg, 2004; Slovic *et al.*, 1991). Due to the low transparency of the information communicated by governments or nuclear authorities, the general population has little confidence in the public information pertaining to the nuclear field. People typically distrust those that manage the nuclear facilities, their competence being evaluated as higher than their trustworthiness (Perko *et al.*, 2010).

Attitudes

An attitude is a complex, multidimensional construct comprised of cognitive, affective or behavioral components (Krech, 1962; McGuire, 1962; Rosenberg and Hovland, 1960). It is essentially a subjective judgment that one likes or dislikes an object, that it is good or bad, or that one feels favorable or unfavorable towards it. Attitudes are considered key mental states relevant to information processing because of a presumed relationship between attitudes and actions (O'Keefe, 2002). Therefore they are important determinants of persuasive communication (Krosnick and Petty, 1995). Persuasion will often, but not always, be a risk communication goal.

Attitudes towards radiological risks have some particularities, one of the reasons being the scientific uncertainty about the effects of radiation (e.g. for low doses), which hinders clear information. As a result, one has to deal with conflicting information (e.g. dangerous or not) when communicating about radiological risks. Furthermore, the general public is usually inattentive to information related to the nuclear domain, except in the case of an emergency or other "bad news" (Rowe *et al.*, 2000). Radiological risks are often used as powerful, yet flexible, rhetorical tools for articulating political positions, for assigning or denying authority and legitimacy. The attitude towards nuclear energy appears frequently in the political agenda before the elections or in the case of an emergency (Abbott *et al.*, 2006; Beck, 2006; Cantone *et al.*, 2007; Paine, 1992; Peters, 1992; Schmid, 2001).

Methodology

Description of the case studies

The iodine campaign in Belgium

Administration of stable iodine is one of the possible measures that can be taken to protect the population in the case of an accidental release of radioactive iodine. This action is essential for the saturation and subsequent protection of the thyroid gland against the potential harm caused by radio-iodine (Le Guen *et al.*, 2002). Preventive distribution of stable iodine tablets to people living in the vicinity of nuclear installations has been organized in 14 European countries, in the framework of preparedness for nuclear accidents. The area for pre-distribution varies from a 5 km radius around the nuclear installations in Switzerland to 50 km in Lithuania. In most cases, stable iodine has been delivered to the entire population living in the selected area, regardless of age (Jourdain *et al.*, 2010).

The survey data used for the Belgian case-study were collected in 2009. Prior to data collection, the iodine campaign had been conducted in Belgium 1999 and 2002 (in 2011 a new campaign was launched, but this took place two years after our survey). In 1999, a large-scale campaign on nuclear emergency preparedness took place in Belgium (Van Bladel *et al.*, 2000). At the same time, the inhabitants of Belgian municipalities located within 10 km from major Belgian or near-border nuclear installations (with the exception of the IRE site in Fleurus for which the radius was limited to 5 km) were invited to collect free stable iodine tablets from

their local pharmacy. A follow-up campaign took place in 2002, when the area of preventive stable iodine distribution was extended to 20 km (10 km for IRE, Fleurus) from Belgian or near-border nuclear installations.

The tablets delivered in 1999 expired in 2008, but new tablets were not ordered until June 2010. After the expiration of the stable iodine tablets, the topic appeared constantly in the media and in the agenda of local communities. The Federal Crisis Centre continued to release the information that even if the tablets are expired they are still good to use (Belgian Federal Crisis Centre, 2010). The last public information before the collection of the empirical data for this research was published at the beginning of 2009, approximately two months before the field work.

The main objectives of the communication campaigns were to increase knowledge (educate) the public on nuclear emergency preparedness and to invite the target population to collect the iodine tablets.

The long-term radioactive waste disposal campaign in Slovenia

After the failure of site selection for low and intermediate radioactive waste disposal (LILW) in 1990 and 1993, the Slovenian National Agency for radioactive waste management (ARAO) was urged in 1996 to start a new site selection process. Special emphasis was to be given to public involvement and participation since the very beginning of the process. A so-called combined approach to site selection was chosen, which incorporated besides technical screening and investigations, also public participation (especially from local citizens) in the form of local partnerships. Very intensive information and communication activities related to radioactive waste were carried out. At the end, the communication campaign targeted two local municipalities which had volunteered to host the LILW disposal. To enhance the knowledge and to stimulate citizens' participation, local partnerships were established in the two communities; these constituted the frame for all subsequent communication activities.

The main objectives of the communication campaign were in this case to increase knowledge (educate) the public on nuclear waste and to improve the public acceptance of the LILW repository.

Description of the data collection and samples

The Belgian case study

The survey method employed was Computer Assisted Personal Interviewing (CAPI), which entailed face-to-face interviews at the home of the respondents. The survey was conducted in July and August 2009, on a large sample of the Belgian population (N=1031) in the language of their choice (French or Dutch). The sample was representative for the Belgian adult population with respect to the following variables: province, region, level of urbanization, gender, age and professionally active status. Out of the 1031 interviews, 778 (75 %) of the encounters were random, whereas 253 (25 %) were meetings with subjects referred by other people. A pilot study (N=32) was performed and based on the results some modifications were done to improve the quality of the questionnaire.

Among the 1031 respondents from the general population, 207 (20 %) indicated that they *"lived or have lived in an area close (within a 20 km radius) to a nuclear installation (power plant, nuclear research institute ...)"*.

The Slovenian case study

For this case study, Computer Assisted Telephone Interviewing (CATI) was employed, i.e. telephone interviews with respondents. The telephone interviewing was performed by a professional company and a pilot study was conducted in advance of the field work in order to improve the questionnaire.

The sample of the general population (N=983) was representative for the Slovenian adult population with respect to the following variables: gender, age, education, level of urbanization and region.

An additional sample of the local population (N=217) was taken from two municipalities, Brežice and Krško, where participation in the form of local partnerships with citizens was established from 2006 on, and where the Slovenian Nuclear power plant Krško is operating for almost 30 years.

Measurements of dependent variables

Acceptance of communicated messages

For the Belgian case, the dependent variable acceptance of communicated messages was measured by the level of agreement with the statement "In case of a nuclear accident, a stable iodine tablet would protect against thyroid cancer". The disagreement with the communicated statement was coded as 1, the "don't know" answer was coded as 2 and the agreement with the statement was coded as 3.

Significant differences in the acceptance of communication related to iodine tablets were observed between the general population and the population living in vicinity of nuclear installations. Only half of the respondents in the general population agreed with the communicated statement, whereas in the population living in a radius of 20 km from a nuclear installation 65 % of the respondents agreed with the statement. An interesting difference was observed in the "don't know" answers. It seems that people living in the vicinity of a nuclear installation made their opinion related to iodine tablets easier than the general population. In the general population, 36 % did not form an opinion related to the tablets, while in the local population only 24 % respondents chose the answer "I don't know".

For the Slovenian case, the acceptance of communicated messages was measured by the respondent's level of agreement with the statement: "The low and intermediate radioactive waste disposal will have negative health effects". Answering categories ranged from "completely disagree" (1) to "completely agree (5). The item was reverse coded such that high values correspond to high acceptance of the communicated message.

Differences were observed also in this second case study between the general population and the population living in selected municipalities. In the general population, 67 % of people agreed that the disposal will not have negative health effects; in the local population 59 % of people agreed with this communicated message.

Perception of communicated risks

Perception of communicated risk was measured in both countries by one direct question.

In Belgium, the respondents were asked: "*evaluate the risks of an accident in a nuclear installation for you"*, with answering categories ranging from "very low" (1) to "very high" (5). Some differences were observed between the general population and the population living in the vicinity of nuclear installations. Only 12 % of the respondents in the population living in vicinity of nuclear installations evaluated the risks of a nuclear

accident as very low, whereas in the general population this risk was evaluated very low by 21 % of the respondents.

In Slovenia, the respondents were asked to "*evaluate the risk of a radioactive waste disposal"* with answering categories ranging from *"not risky"* (1) *to "very risky"* (5). In this case only minor differences were observed between the general population in Slovenia and the local population living in two selected municipalities for radioactive waste disposal. More than half of the respondents in both populations evaluated the waste disposal as risky or very risky (52 % of the respondents in the local population and 56 % of the respondents in the general population).

Scales for independent variables

For some of the variables used in the study, a scale was constructed to measure latent constructs such as attitudes or risk perception. An exploratory factor analysis using principal axis factoring was performed to examine the scales used as independent variables. Cronbach's alpha coefficient was used to test the reliability of the scales (a value of ~0.7 or larger for this coefficient corresponds to a reliable scale). As presented in the tables below, the results of the confirmatory factor analysis indicated that the factor loadings for each of the scales were adequate and in most cases very strong, which suggests a high construct validity. For the scale "prior knowledge" each item was recoded as 0/1 and the index of correct answers was then calculated. We discuss the content of each scale in the following.

Prior knowledge

Prior audience knowledge was operationalized as the number of correct answers given to a set of 13 exam-style questions in Belgium (Table 4.1) and in Slovenia (Table 4.2). These questions measured prior audience knowledge related to radioactivity and the nuclear field. The questions were selected and adapted from: i) Eurobarometer studies – special surveys related to nuclear and radiological topics conducted in all European countries (2007; Eurobarometer, 2008); ii) the SCK•CEN Risk Perception Barometer (Van Aeken *et al.*, 2007) and iii) discussion with experts, as advised by Zaller (2006). An important remark is that the information used in the concept of prior audience knowledge had not been communicated during the communication campaigns. Since the purpose of the "prior knowledge" variable was to comprise different levels of knowledge, it was not necessary for the items to measure the same latent construct. Responses were indexed and the resulting absolute scale ranged from 0 to a maximum of 13 correct answers.

Table 4.1: Prior knowledge in the general population and the local population in Belgium

Prior knowledge scale in Belgium	Correct answer	Percentage (%) of correct answers (Belgium, general) N=1031	Percentage (%) of correct answers (Belgium, local) N=207
Indicate whether the following towns have a nuclear power plant:			
Hasselt	No	65	62
Lier	No	63	66
Liege	No	54	59
Doel	Yes	70	68
Tihange	Yes	73	76
Is a radiological dispersal device (also known as dirty bomb) the same as an atomic bomb	No	47	47
Will exposure to radiation necessarily lead to a contamination with radioactive material	No	26	27
Which percentage of electric power in Belgium is produced in nuclear plants	Between 45 – 65 %	29	33
Which of the following sectors make use of nuclear technology:			
Production of electricity	Yes	95	99
Medical sector	Yes	87	95
Food industry	Yes	25	29
Textile industry	Yes	21	20
Belgium has decided to phase out nuclear energy	Yes	43	55

In Belgium less than 1 % of the respondents answered correctly on all 13 items; most respondents had seven to ten correct answers (in the general sample: mean = 6.9 st. dev. = 2.6; in the local population: mean=7.4; st. dev=2.3). It is interesting that the correlation between education and prior audience knowledge was statistically significant, but low (0.26 in the general population; 0.17 in the local population).

Table 4.2: Prior knowledge in the general population and the local population in Slovenia

Prior knowledge scale in Slovenia	Correct answer	Percentage (%) of correct answers (Slovenia, general) (N=983)	Percentage (%) of correct answers (Slovenia, local) (N=217)
Natural radioactivity is not dangerous for people, because we are used and adapted to it	No	36	37
Strawberries growing in the vicinity of a NPP are not good for eating because of radioactivity	No	32	51
Radiation causes changes in cells and these cells contaminate other cells. After a time the whole body becomes contaminated	No	21	22
If a person is exposed to radioactivity, he/she becomes radioactive as well	No	19	26
Radioactive sources are used in many factories for various measurements, e.g. fluid density, quality of welding, etc	Yes	58	64
The human body is naturally radioactive	Yes	31	44
Children of parents that were exposed to radioactivity, will become radioactive as well	No	31	32
With time, every radioactive substance becomes more and more radioactive because radioactivity accumulates	No	32	36
Humans can sense radioactivity	No	73	76
The duration and power of radioactivity is the same in all radioactive substances	No	72	77
The vicinity of fresh nuclear fuel is deadly dangerous for people	No	12	16
If a human would be in close proximity of spent nuclear fuel, he would get inflamed and burn	Yes	17	19
Gamma radiation is by nature similar to light or radio waves	Yes	29	33

In Slovenia nobody answered correctly on all the 13 items and most respondents had four to seven correct answers (in the national sample mean = 4.6, st. dev. = 2; in the local population mean=5.3, st.dev.=2.1). Prior audience knowledge was slightly higher in the local population than in the general population.

Perception of radiological risks (other risks than communicated in the campaign)

Respondents in Belgium were asked to "*evaluate the risks for an ordinary citizen of Belgium"* for different radiological risks that were not related to radiological accidents. Answering categories ranged from "very low" (1) to "very high" (5). The risk perception scale finally consisted of the perceived level of risk for natural radiation, radioactive waste, radioactivity in food and a terrorist attack with a radioactive source (Table 4.3). Low scores on this scale indicate that radiological risks were perceived as low. The factor

analysis revealed that medical X-rays and radiation from mobile phones could not be included in this constructed scale, since the factor loadings were too low, suggesting that these two risks belong to another latent construct.

Table 4.3: Factor loadings and other scale attributes for other radiological risks (Belgium)

Perception of radiological risks (other than accident in a nuclear installation)	Factor Loading Principal axis	Alpha	N out of 1031
Natural radiation	0.605	0.81	921
Radioactive waste	0.759		
Radioactivity in food	0.826		
Terrorist attack with radioactive source	0.685		

The respondents in Slovenia were asked to evaluate five different radiological risks: medical X-rays, radon in the houses, nuclear power plants, radiation from mobile phones and natural radioactivity (Table 4.4). Answering categories ranged from "*not at all dangerous*" (1) to "*extremely dangerous*"(5). Low scores on the scale formed with these items indicate low perception of radiological risks.

Table 4.4: Factor loadings and other scale attributes for other radiological risks (Slovenia)

Perception of radiological risks (other than radioactive waste)	Factor Loading Principal axis	Alpha	N out of 1200
Medical X-rays	0.649	0.67	1200
Radon in houses	0.551		
Nuclear power plant	0.711		
Mobile phone	0.633		
Natural radioactivity	0.722		

Confidence in authorities

For the Belgian case study, confidence in authorities was measured by four items introduced with the following question "*how much confidence do you have in authorities for the actions they undertake to protect the population against risks from the following items"*: nuclear accident, radioactive waste, a terrorist attack with a radioactive source and residues of radioactivity in food. The answering categories ranged from "very low confidence" (1) to "very high confidence" (5) (Table 4.5). High scores on the scale constructed with these four items indicate strong confidence in authorities.

Table 4.5: Factor loadings and other scale attributes for confidence (Belgium)

Confidence in authorities to protect the population against radiological risks	Factor Loading Principal axis	Alpha	N out of 1031
Nuclear accident	0.830	0.83	947
Radioactive waste	0.752		
Terrorist attack radioactive source	0.728		
Radioactivity in food	0.721		

In Slovenia three items were used to measure how much confidence the respondents have in authorities related to the management of radioactive waste. The respondents were asked to express the level of agreement with the following statements: "The g*overnment cares for the people", "The city council cares for the people", "The Slovenian radioactive waste agency cares for the people".* The answers ranged from "very low" (1) to "very high" agreement (5). High scores on this scale in Table 4.6 indicate strong confidence in authorities.

Table 4.6: Factor loadings and other scales attributes for confidence (Slovenia)

Confidence in authorities (related to radwaste management) to care for the people	Factor Loading Principal axis	Alpha	N out of 1200
Government	0.661	0.67	1200
City council	0.736		
Slovenian radioactive waste agency	0.511		

Attitude towards science or scientific information

In Belgium, the attitude towards science and technology was assessed through a series of three items. The respondents had to *"indicate to what extent they agreed or disagreed"* with the related statements using a 5-point Likert scale (from strongly disagree to strongly agree) (Table 4.7). The reliability (Cronbach's alpha) of the scale formed with these items was 0.79. High scores on this three-item scale indicate a positive attitude towards science and technology.

Table 4.7: Factor loadings and other scale attributes for the attitude toward science and technology (Belgium)

Attitude toward science and technology	Factor Loading Principal axis	Alpha	N out of 1031
The development of science and technology brings more advantages than harm.	0.932	0.79	981
Future generations will have more opportunities as a result of science and technology.	0.694		
Science and technology makes our lives healthier, easier and more comfortable	0.619		

In Slovenia the respondents were asked to express their attitude towards scientific information: "*If you need to make a decision whether the LILW would be in your residential area, how much would you trust the scientific information given by: the government, the Slovenian agency for radioactive waste, the mayor or the Ministry for environment and spatial planning*", with answering categories from "*not at all*" (1) to "*completely"*(5) to each of listed institutions (Table 4.8).

Table 4.8: Factor loadings and other scale attributes for the attitude toward scientific information (Slovenia)

Attitude toward scientific information	Factor Loading Principal axis	Alpha	N out of 1200
Government	0.779	0.75	1200
Slovenian agency for radioactive waste	0.591		
Mayor	0.530		
Ministry for environment and spatial planning	0.735		

Attitude towards nuclear energy or waste management

In the Belgian population the attitude towards nuclear energy was hypothesized as a potential predictor for the acceptance of communicated messages. The attitude towards nuclear energy was first assessed by three general questions on which the respondents had to state their agreement or disagreement using a 5-point scale, with 1 = *"strongly disagree"* to 5 = *"strongly agree"* (Table 4.9). High scores on the scale formed with these four items indicate a high acceptance of nuclear energy.

Table 4.9: Factor loadings and other scale attributes for attitude toward nuclear energy (Belgium)

Attitude toward nuclear energy	Factor Loading Principal axis	Alpha	N out of 1031
(Favourable) opinion about nuclear energy	0.829	0.84	892
Benefits of nuclear energy outweigh disadvantages	0.804		
NPPs open necessary for secure energy supply	0.759		
Reduction of NPPs is a good cause (reverse coded)	0.626		

The Slovenian respondents were asked to express their attitude towards the management of radioactive waste as performed by the national agency ARAO (Table 4.10): "*ARAO explains the reasons for decisions"*, "*ARAO tells the truth about important facts", "ARAO keeps the promises" and "ARAO is competent"*. The respondents had to state their agreement or disagreement with these statements using a five-point scale, from 1 = *"strongly disagree"* to 5 = *"strongly agree"*. High scores on this scale in Table 4.10 indicate a positive attitude towards the management of radioactive waste, as performed by ARAO.

Table 4.10: Factor loadings and other scale attributes for attitude toward radioactive waste management (Slovenia)

Attitude toward radioactive waste management	Factor Loading Principal axis	Alpha	N out of 1200
ARAO explains the reasons for decisions	0.628	0.76	1200
ARAO tells the truth about important facts	0.785		
ARAO keeps the promises	0.741		
ARAO is competent	0.522		

Analysis and Results

Two separate analyses were conducted to test the hypotheses *H1*, *H2* and *H3*. We first investigated the relationship between the predictor variables and the acceptance of communicated messages: in Belgium acceptance of the fact that iodine tablets offer protection against thyroid cancer; in Slovenia that the LILW will not cause health consequences. Next, the relationship between the perception of communicated risks (in Belgium the risk of an accident in a nuclear installation, in Slovenia the risk of a radioactive waste disposal) and the potential predictor variables was analyzed. These variables were: gender, prior knowledge, perception of other radiological risks, confidence in authorities, attitudes and living close to a nuclear installation (in Belgium) or living in the selected local community for radioactive waste disposal (in Slovenia). The results are discussed for each of the two dependent variables separately.

Acceptance of communicated messages

For the Slovenian case study, linear regression analysis was employed to identify influential predictors for the acceptance of communicated messages. For the Belgian case study, given that the dependent variable was categorical with three levels, we used multinomial logistic regression. The level of acceptance, calculated as described in section 3.3.1 was regressed by the hypothetical predictors. The results are summarized in Table 4.11 which shows the regression coefficients and the significance level for each potential predictor.

From the results in Table 4.11 we can conclude that for the acceptance of communicated messages the *perception of other radiological risks* (β=-0.3) and *prior knowledge* (β= 0.2) were the most influential predictors in Slovenia. People with higher prior knowledge and those who perceived radiological risks as low were more inclined to accept that the LILW disposal will not lead to health consequences for the population.

In Belgium, prior audience knowledge, attitude towards science and technology, perception of other radiological risks and living close to nuclear/radiological installations were the most significant predictors for the acceptance of communicated messages. People with low prior knowledge were more likely to disagree or to refrain from form an opinion, rather than agree with the usefulness of iodine tablets. This effect is especially strong (B=-0.4) when we compare the group of people in the middle category ("don't know" answers) with those who accepted the message (the reference category). A negative attitude toward science and technology led to higher likelihood to disagree, rather than agree with the communicated message. It is interesting to notice that respondents with high perception of other radiological risks or a positive attitude toward science and technology were more likely to not form an opinion, rather than agree with the message. A possible explanation could be the fact that in the group of respondents who answered "I don't know", less than 30 % remembered the distribution of iodine tablets.

While *gender* was strongly significant in the Slovenian case study, it was not significant in the Belgian case study. In Slovenia, the female population had a higher acceptance of communicated messages than the male population.

Table 4.11: Predictors of acceptance of communicated messages

Acceptance of communicated messages	Slovenia "LILW will not cause health consequences"		Belgium "Iodine tablets offer protection against thyroid cancer"	
	β	S.E.	B[a]	S.E.
Gender[b]	0.111***	0.078	-0.274 (0.166)	0.227 (0.186)
Prior knowledge	0.202***	0.020	0.102* (-0.357***)	0.052 (0.042)
Perception of other radiological risks	-0.310***	0.040	0.118 (0.264**)	0.126 (0.100)
Confidence in auth. to protect against radiological risks	-0.055	0.052	0.117 (0.129)	0.134 (0.108)
Attitude B - toward science and technology SI - toward (scientific) information	0.068	0.049	-0.350** (0.343**)	0.116 (0.110)
Attitude B - toward nuclear energy SI -radwaste management	0.116***	0.049	-0.035 (0.002)	0.132 (0.107)
Living close[c]	0.052*	0.097	0.360 (0.739**)	0.269 (0.242)
	Linear regression R^2(adj) (full model)= 0.26 N=1200		Multinomial regression with reference category "agree" Nagelkerke Pseudo R^2 = 0.2 N = 753	

[a] The values reported refer to the regression coefficients for category "disagree" and "don't know" (in parentheses), respectively, with respect to reference category "agree".
[b] Reference category: woman B, man Si
[c] Reference category: living close
Note: Regression analysis.*** p < 0.001; ** p < 0.01; * p < 0.05.

It is interesting that the *confidence in authorities* was not significant for the acceptance of communicated messages. The *attitude towards radioactive waste management (as performed by ARAO)* was a significant predictor for the Slovenian study, where a more positive attitude led to a slightly higher acceptance of communicated messages (β=0.12). Other attitudes did not influence significantly the acceptance of communicated messages neither in Slovenia, nor in Belgium.

Both communication campaigns were more intensive for people living in vicinity of nuclear/radiological installations or living in the selected local communities for LILW. The results of the regression analysis confirmed in both case studies the differences in the acceptance of communicated messages between the respondents living farther from the nuclear installations and the local population. Local respondents in Slovenia agreed that "*LILW will not cause health consequences"* more than the rest of the respondents (β= 0.1). In Belgium living close to nuclear installations led to higher likelihood (B=0.7) to agree with, rather than not forming an opinion about the communicated message that "*iodine tablets offer protection against thyroid cancer*".

Perception of communicated risks

We continued by investigating which predictors are influential for the perception of communicated risks. Although the dependent variable: risk perception of an accident in a nuclear installation (Belgium) and risk perception of a radioactive waste disposal (Slovenia), respectively, was measured as a Likert scale, we assumed that the scale is an interval scale.

Table 4.12 presents the linear regression coefficients and the significance level of each alternative predictor for the perception of the communicated risk.

Table 4.12: Predictors of perception of communicated risk

Perception of communicated risks	**Slovenia "Risk perception of a radioactive waste disposal"**		**Belgium "Risk perception of an accident in a nuclear installation"**	
	β	**S.E.**	**B[a]**	**S.E.**
Gender	-0.104***	0.059	0.024	0.059
Prior knowledge	-0.090***	0.015	-0.028	0.013
Perception of other radiological risks	0.448***	0.030	0.695***	0.033
Confidence in auth. to protect against radiological risks	0.010	0.040	-0.046	0.035
Attitude B - towards science and technology SI - towards (scientific) information	-0.051	0.037	0.064*	0.033
Attitude B - towards nuclear energy SI - rad. waste management	-0.079**	0.037	-0.045	0.034
Living close	-0.038	0.073	0.035	0.070
	R^2(adj) (full model)= 0.31 N=1200		R^2(adj) (full model)= 0.51 N=752	

Note: Linear regression analysis, *** p < 0.001; ** p < 0.01; * p < 0.05.

The most significant and most influential predictor for the perception of communicated risks was in both countries the same: perception of other radiological risks. This confirmed that people with higher risk perception for radiological risks in general perceived also the communicated risks as high. Some attitudes were revealed as significant and influential for the perception of communicated risks: in Belgium, the respondents having a more positive *attitude towards nuclear energy* perceived an accident in a nuclear installation as less risky. In Slovenia, the respondents with a positive *attitude toward radioactive waste management* perceived the risk of a LILW disposal less risky than respondents with a negative attitude toward radioactive waste management.

Gender was a significant predictor only for the Slovenian case study where the male population had a slightly lower risk perception of the LILW disposal.

Prior audience knowledge was not a significant predictor for the perception of the communicated risk in the Belgian case study and had only a weak influence (β= -0.1) in the Slovenian case study.

Discussion

In this paper we performed an extended empirical investigation to compare the strength and influence of various predictors on the acceptance of communicated messages and the perception of related risks. Since increasing specific audience knowledge is often set as a primary objective of risk communication efforts, special attention was given to audience knowledge as a hypothetical predictor. By empirical research in two different countries we found that (H1) *people with higher prior knowledge accepted communicated messages more than people with low prior knowledge*. This goes in line with other results in the literature, that revealed a positive direct relationship between knowledge and information processing (Griffin *et al.*(2008), Kahlor *et al.*(2006) and Huurne *et al.*(2009)). However, prior audience knowledge was not significant for the perception of communicated risks. In other words, a high knowledge about the nuclear field doesn't necessarily lead to lower risk perception of radiological risks.

Further on, we tested the influence of the "*risk perception for other radiological risks"* on the acceptance of communicated messages. This factor included radiological risks that were not communicated in the campaigns, e.g. natural radiation. The *perception of other radiological risks* was strongly significant and influential for *the acceptance of communicated messages i*n Slovenia and partly in Belgium. This confirms our expectation that people with low perception of other radiological risks might accept the communicated messages more than people having a high risk perception. In addition, the influence of this predictor on the perception of communicated risk was confirmed in both populations in Slovenia and Belgium. People who perceived other radiological risks as high, perceived the communicated risks as high, as well. These findings are in line with existing literature, e.g. the research related to hazardous industrial chemicals (Huurne *et al.*, 2009).

This suggests that risk communication strategies should not seek to isolate one radiation risk from the other. When risk communicators communicate about one radiation risk, they should also communicate about radiation in general.

The hypothesis (*H2*), that the *influence of prior knowledge on the perception and the acceptance of communicated risks is stronger than the influence of attitudes, risk perception of other radiological risks or confidence,* can be accepted only partially. Prior audience knowledge appears important for successful risk communication (acceptance of communicated messages), but the perception of other radiological risks may be an even more important predictor.

This study set out with the objective of providing empirical evidence that (*H3*) the *main predictors of successful communication are similar in different cultural and societal contexts.* Although the measurement scales for the various predictors were not completely the same and the communication campaigns were different, the predictors for acceptance of risk information and perception of communicated risk were similar in the two case studies. It is interesting that the confidence in authorities did not emerge as a significant predictor, neither for the acceptance of risk messages, nor for the perception of related risks. Having less confidence in authorities did not seem to lead people in either case study to have stronger negative feelings towards a nuclear accident or a radioactive waste disposal.

Conclusions

To conclude, this study showed that although enhancing prior audience knowledge remains an important objective, effective risk communication strategies have to consider also other, more heuristic predictors such as risk perception. In risk communication campaigns it is not possible to isolate one radiation risk from the other. Results suggest that recipients of communicated messages link one radiation risk to other radiological risks, therefore communicators in different fields involving radiation have to work together.

Audience knowledge about radiological risks gained before the communication campaigns proves important for the effectiveness of communication. It would be thus recommended to involve risk topics in public systems, for example educational, more intensively than actually done.

Finally the results of this research confirm the expectations that the predictors of risk information processing are the same or similar in different countries.

References

Ipsos MORI 2011. Global Citizen Reaction to the Fukushima Nuclear Plant Disaster. Global @dvisor, http://www.ipsos-mori.com/Assets/Docs/Polls/ipsos-global-advisor-nuclear-power-june-2011.pdf.

Abbott, P., Wallace, C., Beck, M., 2006. Chernobyl: Living with Risk and Uncertainty. *Health Risk & Society*, 8, 105-121.

Beck, U., 2006. Living in the world risk society. *Economy and Society*, 35, 329-345.

Belgian Federal Crisis Centre, 2010. Efficacité des comprimés d'iode confirmée http://www.crisiscentrum.be/index.php?option=com_content&task=view&id=257&Itemid=1.

Bergmans, A., Mortelmans, D., 2001. Evaluatieonderzoek van de Jodiumcampagne 1999. Uneversitiet Antwerpen, Antwerpen, pp. 235.

Bertell, R., 2008. Chernobyl: An Unbelievable Failure to Help. *International Journal of Health Services*, 38, 543-560.

Blando, J.D., Robertson, C., Bresnitz, E., 2008. Communicating information in an emergency preparedness pill distribution campaign. *Biosecurity and Bioterrorism-Biodefense Strategy Practice and Science*, 6, 57-65.

Cantone, M.C., Sturloni, G., Brunelli, G., 2007. The Role Played by Stakeholders in the Public Debate that Brought Italy out of the Club of Nuclear Energy Producers. *Health Physics*, 93, 261-266.

Carlé, B., Turcanu, C.O., Van Aeken, K., Hardeman, F., 2007. Nuclear emergency preparedness: Study of the risk perception and the consequences for emergency planning in Belgium. Trans. I. Comm. in: B. VandeWalle, X. Li, S. Zhang (Eds.), 2nd International Workshop on Information Systems for Crisis Response and Management. Harbin Engineering Univ, Harbin, PEOPLES R CHINA, pp. 445-450.

Chaiken, S., Stangor, C., 1987. Attitudes and Attitude Change. *Annual Review of Psychology*, 38, 575-630.

Dobrzynska, A., Blais, A., 2007. Testing Zaller's Reception and Acceptance Model in an Intense Election Campaign. *Polit. Behav*, 30, 259-276.

Douglas, M., Wildavsky, A., 1982. Risk and Culture. University of California Press, Berkely.

Dubreuil, G.H., Lochard, J., Girard, P., Guyonnet, J.F., Le Cardinal, G., Lepicard, S., Livolsi, P., Monroy, M., Ollagnon, H., Pena-Vega, A., Pupin, V., Rigby, J., Rolevitch, I., Schneider, T., 1999. Chernobyl post-accident management: The ETHOS project. *Health Physics*, 77, 361-372.

Eagly, A.H., 1992. Uneven Progress - Social Psychology and the Study of Attitudes. *Journal of Personality and Social Psychology*, 63, 693-710.

Eurobarometer, 2007. Eurobarometer; Europeans and Nuclear Safety. European Commission, , pp. 112.

Eurobarometer, 2008. Eurobarometer: Attitudes Towards Radioactive Waste. European Commission.

Eysenck, M.W., Keane, M. T. , 2005. Cognitive psychology. 5 ed. Psychology Press, London.

Fisher, A., 1991. Risk Communication Challenges. *Risk Analysis*, 11, 173-179.

Freudenburg, W.R., 1993. Risk and Recreancy - Weber, the Division of Labour and the Rationality of Risk Perception. *Social Forces*, 71, 909-932.

Gaskell, G., Allum, N., Wagner, W., Kronberger, N., Torgersen, H., Hampel, J., Bardes, J., 2004. GM foods and the misperception of risk perception. *Risk Analysis*, 24, 185-194.

Griffin, R.J., Yang, J., Huurne, E., 2008. After the Flood: Anger, Attribution, and the Seeking of Information. *Science Communication*, 29, 285-315.

Havenaar, J.M., de Wilde, E.J., van den Bout, J., Drottz-Sjöberg, B.M., van den Brink, W., 2003. Perception of risk and subjective health among victims of the Chernobyl disaster. *Social Science & Medicine*, 56, 569-572.

Huurne, E., Griffin, R.J., Gutteling, J.M., 2009. Risk Information Seeking Among U. S. and Dutch Residents: An Application of the Model of Risk Information Seeking and Processing. *Science Communication*, 31, 215-237.

Ibitayo, O.O., Pijawka, K.D., 1999. Reversing NIMBY: an assessment of state strategies for siting hazardous-waste facilities. *Environment and Planning C-Government and Policy*, 17, 379-389.

Jackson, R.J., DeLozier, D.M., Gerasimov, G., Borisova, O., Garbe, P.L., Goultchenko, L., Shakarishvili, G., Hollowell, J.G., Miller, D.T., 2002. Chernobyl and iodine deficiency in the Russian Federation: An environmental disaster leading to a public health opportunity. *Journal of Public Health Policy*, 23, 453-470.

Jourdain, J.R., Herviou, K., Bertrand, R., Clemente, M., Petry, A., 2010. Medical Effectiveness of Iodine Prophylaxis in a Nuclear Reactor Emergency Situation and Overview of European Practices. RISKAUDIT IRSN/GRS International, France, pp. 66.

Kahlor, L.A., Dunwoody, S., Griffin, R.J., Neuwirth, K., 2006. Seeking and Processing Information About Impersonal risk. *Science Communication*, 28, 163-194.

Krech, D., Crutchfield, B. , 1962. Individual in society McGraw-Hill Book Company, New York.

Krosnick, J.A., Petty, E.R., 1995. Attitude strenght: An overview. in: E.R. Petty, J.A. Krosnick (Eds.), Attitude strenght: Antecednets and consequences. Lawrence Erlbaum, Mahwah, NJ, pp. 1-24.

Kuklinski, J.H., Metlay, D.S., Kay, W.D., 1982. Citizen Knowledge and Choices on the Complex Issue of Nuclear Energy. *American Journal of Political Science*, 26, 615-642.

Lang, A., 2006. Using the Limited Capacity Model of Motivated Mediated Message Processing to Design Effective Cancer Communication Messages. *Journal of Communication*, 56, S57-S80.

Lang, A., Bolls, P., Potter, R.F., Kawahara, K., 1999. The Effects of Production Pacing and Arousing Content on the Information Processing of Television Messages. *Journal of Broadcasting & Electronic Media*, 43, 451-475.

Le Guen, B., Hemidy, P.Y., Garcier, Y., 2002. French approach for the distribution of iodine tablets in the vicinity of nuclear power plants. *Health Physics*, 83, 293-300.

McGuire, W.J., 1962. Social Judgement - Assimilation and Contrast Effects in Communication and Attitude Change. *Contemporary Psychology*, 7, 320-322.

McGuire, W.J., 1973. Persuasion, Resistance, and Attitude Change. in: I.D.S. Pool (Ed.) Handbook of Communication. IL:Rand McNally, Chicago.

Miller, J.D., 1998. The Measurement of Civic Scientific Literacy. *Public understanding of science*, 7, 203 - 223.

O'Keefe, D.J., 2002. Persuasion; Theory and Research. Sage Publications, London.

Otway, H., 1990. Communicating with the Public about Major Hazards:Challenges for European Research. in: H.B.F. Gow, H. Otway (Eds.), Communicating with the Public about Major Accident Hazards. Elsevier, London.

Paine, R., 1992. `Chernobyl' reaches Norway: the accident, science, and the threat to cultural knowledge. *Public Understanding of Science*, 1, 261-280.

Perko, T., Turcanu, C., Schröder, J., B., C., 2010. Risk Perception of the Belgian Population; Results of the Public Opinion Survey in 2009. SCK CEN, Mol, pp. 202.

Peters, P.H., 1992. The Credibility of Information Sources in West Germany after the Chernobyl Disaster. *Public Understanding of Science*, 1, 325-343

Petty, E.R., Cacioppo, J.T., 1986. The Elaboration Likehood Model of Persuasion. in: A.D. Berkowitz (Ed.) Advances in Experimental Social Psychology. Academic Press, New York, pp. 124-192.

Price, V., Zaller, J., 1993. Who Gets the News? Alternative Measures of News Reception and their Implications for Research. *Public Opinion Quarterly*, 57, 133-164.

Purvis-Roberts, K.L., Werner, C.A., Frank, I., 2007. Perceived risks from radiation and nuclear testing near Semipalatinsk, Kazakhstan: A comparison between physicians, scientists, and the public. *Risk Analysis*, 27, 291-302.

Renn, O., 2008. Risk Governance; Coping with Uncertainty in a Complex World. Earthscan, London.

Rosenberg, M.J., Hovland, C.I., 1960. Cognitive, affective and behavioral components of attitudes. in: C.I. Hovland, M.J. Rosenberg (Eds.), Attitude organization and change. Yale University Press, New Haven, pp. 1 -14.

Rowe, G., Frewer, L., Sjöberg, L., 2000. Newspaper reporting to hazard in the UK and Sweden. *Public Understanding of Science*, 9, 59-78.

Sandman, P.M., Eblen, R.A., 1994. Risk Communication in: R.W. Eblen (Ed.) Encyclopedia of the Environment Houghton Mifflin, Boston, pp. 620–623.

Schmid, S.D., 2001. Transformation discourse: Nuclear risk as a strategic tool in late Soviet politics of expertise Workshop on Technologies of Uncertainty - Reconstructing Order through Rethorics of Risk. Sage Publications Inc, Ithaca, NY, pp. 353-376.

Shiffrin, R.M., Schneider, W., 1984. Automatic and Controlled Processing Revisited. *Psychological Review*, 91, 269-276.

Sjöberg, L., 2004. Local acceptance of a high-level nuclear waste repository. *Risk Analysis*, 24, 737-749.

Sjöberg, L., 2006. Myths of the Psychometric Paradigm and How they can Misinform Risk Communication. Center for Risk Research, Stockholm, pp. 20.

Sjöberg, L., Drottz-Sjöberg, B.M., 1991. Knowledge and Risk Perception Among Nuclear Power Plant Employees. *Risk Analysis*, 11, 607 -18.

Sjöberg, L., Drottz, B.M., 1987. Psychological Reactions to Cancer Risks after the Chernobyl Accident. *Medical Oncology and Tumor Pharmacotherapy*, 4, 259-271.

Slovic, P., 1999. Trust, emotion, sex, politics, and science: Surveying the risk-assessment battlefield (Reprinted from Environment, ethics, and behavior, pg 277-313, 1997). *Risk Analysis*, 19, 689-701.

Slovic, P., Finucane, M.L., Peters, E., MacGregor, D.G., 2004. Risk as analysis and risk as feelings: Some thoughts about affect, reason, risk, and rationality. *Risk Analysis*, 24, 311-322.

Slovic, P., Fischhoff, B., Lichtenstein, S., 1979. Rating the Risks. *Environment*, 21, 14-20, 36-9.

Slovic, P., Flynn, J.H., Layman, M., 1991. Perceived Risk, Trust and the Politics or Nuclear waste. *Science*, 254, 1603-1607.

Tichenor, P.J., Donohue, G.A., Olien, C.N., 1970. Tichenor, P. J., Donohue, G. A. & Olien, C. N. (1970). Mass media flow and differential growth in knowledge. *Public Opinion Quarterly*, 34, 159–70.

Trumbo, W.C., 2002. Information Processing and Risk Perception: An Adaption of the Heuristic-Systematic Model. *Journal of Communication*, 52, 367-382.

Van Aeken, K., Turcanu, C.O., Bombaerts, G., Carlé, B., Hardeman, F., 2007. Risk perception of the Belgian population. Results of the public opinion survey in 2006. . Belgian Nuclear Research Centre SCK•CEN BLG-1038, Mol, Belgium.

Van Bladel, L., Pauwels, A., Smeesters, P., 2000. The challenge of interacting with the public on nuclear emergency preparedness and iodine prophylaxis. in: O. NEA (Ed.) OECD-NEA Workshop Investing in Trust: Nuclear Regulators and the Public. OECD, Paris, France, pp. 141-147.

Vaughan, E., 1995. The Significance of Socioeconomic and Ethnic Diversity for the Risk Communication Process. *Risk Analysis*, 15, 169-180.

Wakeford, R., 2007. The Windscale Reactor Accident—50 Years on. *Journal of Radiological Protection*, 27, 211–215.

Zaller, J., 2006. The Nature and Origins of Mass Opinion. Cambridge university press New York.

Železnik, N., 2010. Mental Models of Radioactivity and Attitudes towards Radioactive Waste. http://nuklearno-drustvo.hr/hr/skupovi/konferencije.html ed 8th International Conference on Nuclear Option in Countries with Small and Medium Electricity Grids Dubrovnik, Croatia.

5. Media reporting and changes in public opinion after Fukushima nuclear accident: Belgium as case study

Manuscript accepted for publication as:

Perko T., Turcanu C., Gennen D., 2012. "*Media reporting and changes in public opinion after Fukushima nuclear accident: Belgium as case study*". International Journal of Nuclear Governance, Economy and Ecology

Full report about the media content analysis published as:

Perko T., Turcanu C., Geenen D., Mamane N., Van Rooy L., 2011 *"Media content analysis of the Fukushima accident in two Belgian newspapers"* Mol, Belgium: SCK•CEN, - 127 p.- (Open Report of the Belgian Nuclear Research Centre; BLG-1084).- ISSN 1379-2407

Manuscript partly based on this chapter published in proceedings:

Cantone M., Perko T., Turcanu C., Prezelj I., Tavola F., Sturloni G., e.a.- *Content analysis of the media reporting on the Fukushima nuclear accident in three European countries.*- In: Proceedings of the 13th International Congress of the International Radiation Protection Association (on internet: http://www.irpa13glasgow.com/information/downloads/), Glasgow, United Kingdom, 13-18 May 2012 / Society for Radiological Protection (SRP), Glasgow, United Kingdom, Society for Radiological Protection (SRP), 2012, p. 1-8

Abstract

This study examines the Belgian press coverage related to the Fukushima nuclear accident, and investigates the changes in the public opinion related to nuclear energy. Two research methodologies were applied. The first method conducted was a content analysis of two quality newspapers in Belgium, covering the first two months after the accident. The second method was a public opinion survey, based on more than 1000 personal interviews conducted in Belgium in the third month after the accident. The results show that the accident induced enormous media coverage in the first weeks after the accident with focus on many different topics; yet, attention decreased with time and became limited to the "future of nuclear energy" and "safety and crisis management aspects". The Chernobyl nuclear accident has been recognised as part of the collective memory, influencing media reporting and public opinion. As expected, the Fukushima nuclear accident has also induced some changes in the public opinion about nuclear energy.

Introduction

Nuclear accidents have a strong impact on the public opinion and often lead to political discussions about the use of nuclear energy for power generation. In this context, media play an influential role in shaping public opinion about nuclear energy. Media do not only report about public issues, but they also have the power to influence people's opinion. This influence was pointed out already in 1922 by Walter Lippmann (1922). Further studies suggest that the salience of issues in the media reporting influences public opinion and even the behavior of the people (Barnes *et al.*, 2008). When mass media intensively report about a certain topic, the people receiving the media information consider this topic as important (Cohen, 1985; McCombs and Shaw, 1972). Moreover, numerous studies from political and risk research established strong correlations between media and public priorities (For overview: McCombs and Shaw, 1993).

Some particularities can be mentioned as regards media reporting and public opinion about the nuclear accidents and nuclear energy.

Information about the nuclear domain is not directly experienced, but rather learned through elite discourse and communication in the media (Boomgaarden and de Vreese, 2007; Perko *et al.*, 2012). Elite discourse is in turn driven by public opinion. For instance, the experience after the accident in Chernobyl showed that nuclear accidents cause significant changes in the public opinion and frequently lead to political decisions related to nuclear programs (Cantone *et al.*, 2007)

Media are usually more interested in politics than risk, in simplicity than complexity, and in danger rather than safety issues (Covello, 1988). A nuclear accident is extremely newsworthy, since it is strongly feared, it has catastrophic potential and it can have long term consequences, which usually exceed the geographical boundaries of the radioactive contamination. At the same time, it is an event that can be personalized, and for which politicians are used as a main source of information (Perko, 2011; Perko *et al.*, 2012). Dramatic and extraordinary real-world events are reported in the media and by themselves have the power to influence the public opinion and to cause shifts in public attitudes (Boomgaarden and de Vreese, 2007).

The nuclear accidents at Chernobyl or Three Mile Island became part of the collective memory and as such, linked to media reporting about any nuclear event (Boomgaarden and de Vreese, 2007; Greenberg and Truelove, 2011; Triandafyllidou, 1995; van der Brug, 2001; Zorkaja, 2006). Lindner (2000) compared the perception of the Chernobyl accident with other, non-nuclear disasters and found that other human-made or

natural disasters "*tend to be accepted by the public much more readily"* and are relatively faster forgotten in the media coverage (Lindner, 2000, p. 282).

Most of the scholars exploring media reporting about nuclear accidents report, directly or indirectly, about the changes in the public opinion and in the public acceptability of nuclear energy after the accidents. It is confirmed that nuclear accidents reduce public support for nuclear energy and increase opposition (Boomgaarden and de Vreese, 2007; Greenberg and Truelove, 2011; Lindner, 2000; McDermott, 1982; Perko *et al.*, 2010; Zorkaja, 2006).

Opinion polls show that public support for nuclear power has declined after the Fukushima nuclear accident, not only in Japan but also in other nations around the world (Ipsos MORI 2011; Asahi, 2011; Ramana, 2011). People may oppose nuclear power for a variety of reasons, for example perception of nuclear technology as too dangerous.

This paper does not investigate the causal relationships between the nuclear accident, media reporting and public opinion, but it restricts to the analysis of the media and journalism regarding the Fukushima nuclear accident and of the changes in the public opinion on several issues related to the accident itself and to nuclear energy in general. We also highlight the implications for emergency management.

Since the media play a major role in communicating with the public in case of a nuclear emergency, it is important to know what messages do the media deliver and how do they frame the event. The analysis of media reporting on a nuclear event can be beneficial for nuclear emergency management in two major aspects. On the one hand, such an analysis shows how to deliver risk messages effectively through the media and, on the other hand, it brings insight into the information that has to be communicated by the emergency managers to the mass media. Since media have a power to make, shape or terminate the crisis, they do not only reflect the public opinion, but they also create it. Therefore, the changes in the public opinion after the high media attentiveness to the Fukushima nuclear accident partly reflect also the media framing of the accident.

The media analysis reported here concerned Belgian media reporting about the Fukushima nuclear accident in the first two months after the accident, while the public opinion in Belgium was measured in the month following this media exposure. The next section gives an overview of the research on media reporting about nuclear accidents. This is followed by a methodological section. Section four reports on selected results and the final one summarises the conclusions.

Media reporting about nuclear accidents: an overview.

A number of studies have investigated media reporting on the Chernobyl accident. A classical study on nuclear discourse was provided by Gamson and Modigliani (1989) showing how "*media packages*" or "*frames*" have to incorporate events such as Chernobyl and provide them "*with a meaning that is plausible and consistent with the frame*"(Gamson and Modigliani, 1989, p.4). Rowe *et al* (2000) showed how newspapers from Sweden and the United Kingdom characterized a variety of risks (including nuclear hazards) around the 10th anniversary of the Chernobyl accident. They found an increase in media attention to nuclear hazards in Sweden after this anniversary, suggesting a "*generalization of media concern*" (Rowe *et al.*, 2000, p. 59).

Triandafyllidou (1995) analyzed the framing of the Chernobyl event in the Italian press during the period from 1987 to 1991. She discovered that the nuclear accident of Chernobyl acquired "*a prominent position in the collective memory"* (Triandafyllidou, 1995, p. 532). Another media content analysis done for Italian press is the research of Cantone *et al.* (2007), which focused on the media reporting about the political debate related to the nuclear energy program and the results of the referendum as a direct measurement of public opinion. They found that media reporting was "*polarized to a "yes/no choice," which eventually caused Italy to abandon the production of nuclear power for civilian use*" (Cantone *et al.*, 2007, p. 261).

Recent research by Perko *et al* (2012) on media reporting about an event at the Krsko nuclear power plant in Slovenia points out that even if the event was minor from the radiological point of view, it triggered a high intensity of media coverage. The results of this study showed that the frequency of the media articles was higher in the countries where nuclear energy was in the public agenda, compared to the countries where it was not a salient topic of discussion: "*The states where the future of nuclear energy was under the political discussion (e.g., a planned referendum in Italy and strong opposition from environmental organizations in Germany) reporting even more than in Slovenia"* (Perko *et al.*, 2012, p. 52).

Scholars testify that media reporting about nuclear accidents does not increase knowledge and understanding of radiological risks, but rather increase negative feelings and risk perception. For instance, the findings from the research by Brown and White (1987) exploring how the public in UK defines radiation, radioactive waste and the impact of significant nuclear events revealed that, "*knowledge is not increased by mass media coverage of an accident, but emotional reactions are significantly affected"* (Brown and White, 1987). Another study among the American population about the nuclear accident at Three Mile Island accentuates again this potential influence of the media, showing that: "*sensation-hungry news media contributed to panic based on unwarranted fear"* (McDermott, 1982). A study related to the 20th anniversary of the Chernobyl accident in the Russian media indicated that; "*a proper appraisal of Chernobyl has yet to take place, and instead of providing penetrating analysis, the Russian media offers unimaginative catastrophe scenarios." (Zorkaja, 2006, p.235).*

Methodology

Media content analysis

The newspapers included in the analysis (Perko *et al.*, 2011) were the Belgian newspapers "Le Soir" (French language) and "De Standaard" (Dutch language). The news articles were obtained from press clippings from the "Media data base at University Antwerp - MEDIARGUS" for the period between the 11th of March and the 11th of May, 2011. This time sampling of two months was focused on the *"critical discourse moments"*, which made the nuclear energy issue visible in the mass media.

The articles coded were either directly or indirectly related to the Fukushima nuclear accident and were collected by the following keywords: "Fukushima" and "nuclear*".

Once the articles were selected according to these rules, each article was assigned a number of codes as prescribed in a codebook in annex. Every article was coded by two independent coders for each of the two languages (French and Dutch). In case of disagreement, the master-coder decided the final code based on a discussion. Krippendorf's coefficient (Krippendorf, 2004) was calculated to assess the inter-coder reliability.

The public opinion survey

The results presented in this paper are based on a large scale public opinion survey in the Belgian population.

The data collection method employed was *"Computer Assisted Personal Interviewing"*, consisting of personal interviews of about 45 minutes carried out at the home of the respondents, the answers being directly recorded on a portable hard disk. The field work was performed by a market research company with professional interviewers.

The survey (Turcanu *et al.*, 2011) included, among others, questions on the general attitude towards nuclear energy and the relevance of the accident in Fukushima for Belgium. The field work was carried out between 25/05/2011 and 24/06/2011.

The population sample consists of 1020 respondents and is representative for the Belgian adult population (18+) with respect to sex, age, region, province, habitat and social class.

Most questions in the survey were formulated as statements, to which the respondent could answer using a five point Likert-scale (e.g. <strong disagreement, disagreement, undecided, agreement, strong agreement>), plus a sixth category (<no answer/don't know>). The latter answering option was allowed, but not encouraged.

Results

Media reporting about the Fukushima nuclear accident

Media attentiveness to the Fukushima nuclear accident

One of the first goals in the media content analysis was to identify the accident as a topic on the media agenda and to determine for how long was the Fukushima nuclear accident part of the media agenda. An analysis of the number of articles published per week revealed the immediate outburst of media attention and the subsequent decay in the rate of attention.

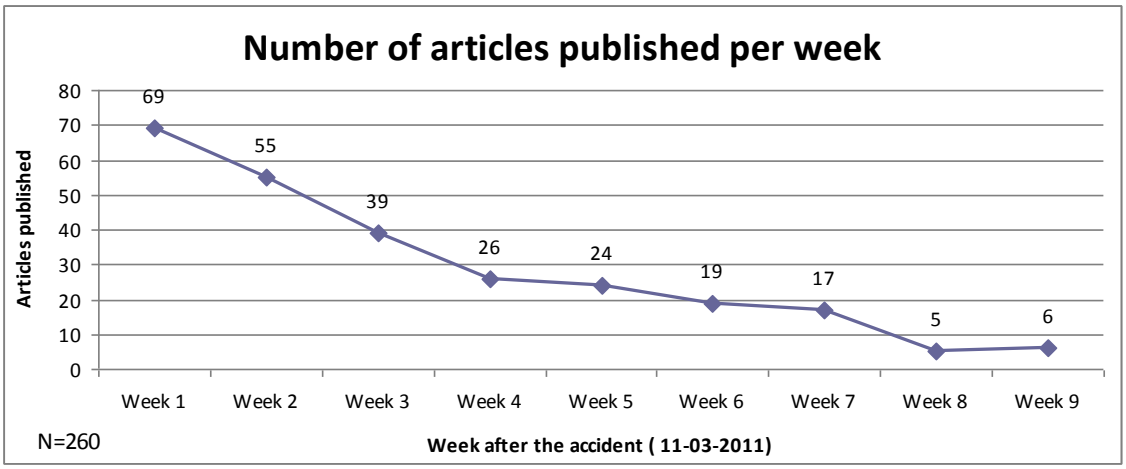

Figure 5.1: Number of articles published per week in *De Standard* and in *Le Soir*

To exclude the drops in media attention on Sundays and public holidays the frequency of published articles was calculated per week. Figure 5.1 clearly shows the explosion of media attention in the first week: the two newspapers published in total 69 articles, with 55 articles related to the accident following in the second week.

The Fukushima nuclear accident was a newsworthy topic of information for the media since it was an extraordinary event, presenting new or unusual information, conflict was very much present, as well as drama, tragedy, and presence of experts, elite persons or celebrities. The situation could be personalized and it evoked emotional response. In addition, media have also to fulfill the economic aspects of publishing or broadcasting, with the *"bad news is good news"* slogan being a well-known phenomenon in journalism; from this point of view the Fukushima nuclear accident was also newsworthy. Although the nuclear accident attracted a lot of media attention in the first weeks, the attention monotonously decreased as weeks passed by. The rate of attention dropped to 6 articles in the ninth week after the accident. Such a drop in attention indicates that long-term media communication might be a challenge for environmental remediation processes.

Objective or subjective type of the articles related to the accident

The question in this part of the analysis was if the news articles and their authors kept to the facts and the objective information or they published mostly subjective opinions related to the nuclear accident.

The following articles were considered as subjective articles: editorials, columns, letters and interviews. Such articles were usually written by one person and presented the author's opinion related to the nuclear accident.

Objective articles presented different views and facts about the nuclear accident. The journalist's or author's opinion was not presented in such articles. News and features were considered as objective types of media articles. The articles that could not belong to any of these two groups, for instance a quiz question, were coded as "other".

The inter-coder reliability for the coding of *"type of article"* was 0.96 for the French articles from "Le Soir" and 0.92 for the Dutch articles from "De Standaard".

Figure 5.2 shows that the majority of articles related to the nuclear accident could be categorized as objective. 41 % up to 100 % of the articles related to the accident and published in the weeks following the accident were news or feature articles. Most of the media texts were concise reports of a news item, usually consisting of a few short paragraphs which dealt with the factual information or gave a summary of an event, e.g. information about an explosion at one of the nuclear reactors.

The media also had an in-depth look at what was going on. They often included a detailed description and analysis of the nuclear accident and its consequences. They accompanied the information with an interview or quotes from various emergency actors, local population and victims. They published full-page articles, with photos and sometimes illustrations from field reporting.

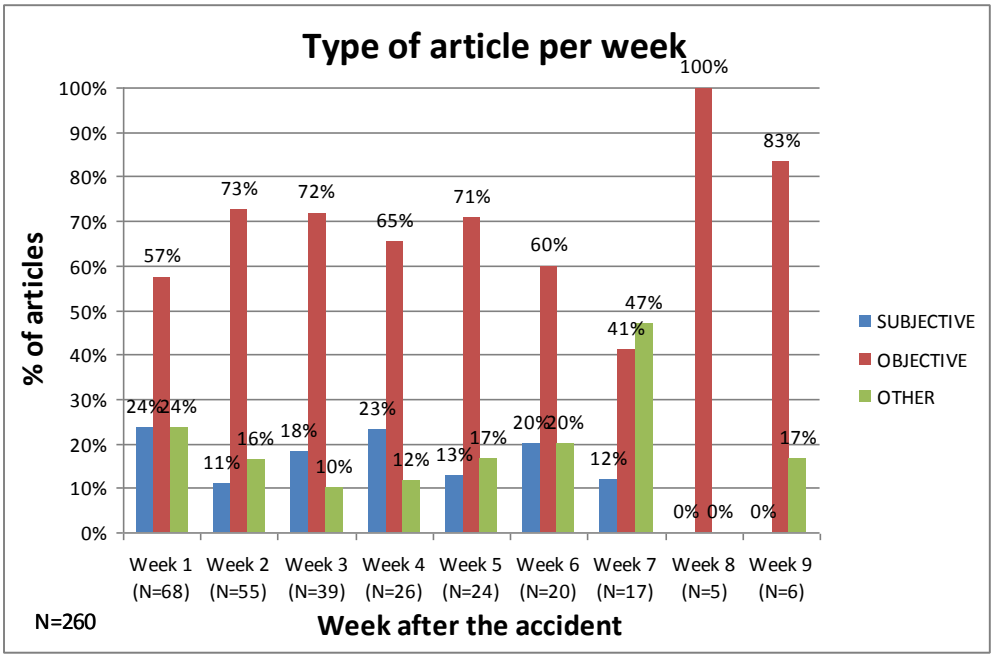

Figure 5.2: Type of the article per week

In the first seven weeks after the nuclear accident, 12 % to 24 % of the weekly published articles could be coded as "subjective". Most subjective articles were published in the first week, when every fourth article was an editorial, a column, a letter or an interview. The authors of this type of article published their own point of view, which involved a critical analysis of the news item (subjective opinion supported by facts). The nuclear accident was often framed in its broader context, for instance the context of international information exchange in case of emergency, nuclear safety, energy needs or international (political) discussion about the nuclear energy. The newspapers also published letters addressed to the editor or the newspaper, written by an individual from the general public or a representative of an organization, for instance Greenpeace. The type of articles published in the seventh week after the accident is significantly different from all the previous weeks. During this week, the world commemorated the 25th anniversary of the accident in Chernobyl (1986). The highest frequency in the 7th week was of 'other' articles (47 %), followed by objective ones (41 %).

To conclude, news and features prevail in the reporting about this nuclear accident. However, in the first week every fourth article was a subjective opinion.

Focus of the media articles related to the accident

The analysis of the "*main focus of the article*" allowed identifying the main challenges of media communication in case of a nuclear accident, as well as the focal point of the media. Media may address an event from different perspectives and interests. The categories used to describe the focus of the articles are summarised in the following.

The category *'Technical aspects'* contained all articles that dealt with the technical aspects of the accident, e.g. technical data about the state of the reactors or the spent fuel ponds. All articles about emergency management and protective actions for people, the food chain or the environment were categorized as *'Crisis management'*. *'Affected inhabitants'* contained all articles that described the situation of people that were victims of the accident. *'International reaction'* presented all articles that described an international reaction on the Fukushima nuclear disaster. Articles on the *'Safety/Risk aspect'* described the possibility of an accident, the probabilistic estimations of risks and accidents in NPP's or referred to the stress tests. *'Information exchange'* contained all articles that described the problems with the information exchange during and after the accident, in specifically the top-down information flow towards the general public and the outside world. The category *'Future of nuclear energy'* included all articles reporting about decisions or discussions of (international) governments towards the choice of nuclear energy in the future. *'Energy consumption or supply'* addressed the articles talking about the energy consumption and/or energy supply, including discussions about the policy of electricity suppliers or operators. The articles that discussed whether there is someone to blame belonged to *'Blame'*. *'Economic impact'* contained all the articles that discussed the effects of the Fukushima accident on the (international) economy.

The inter-coder reliability for the coding of *"focus of the article"* was 0.93 for the French articles from "Le Soir" and 0.82 for the Dutch articles from "De Standaard". Figure 5.3 depicts the percentage of articles (from the total articles published in *Le Soir* and *De Standaard*) reporting on these focus points.

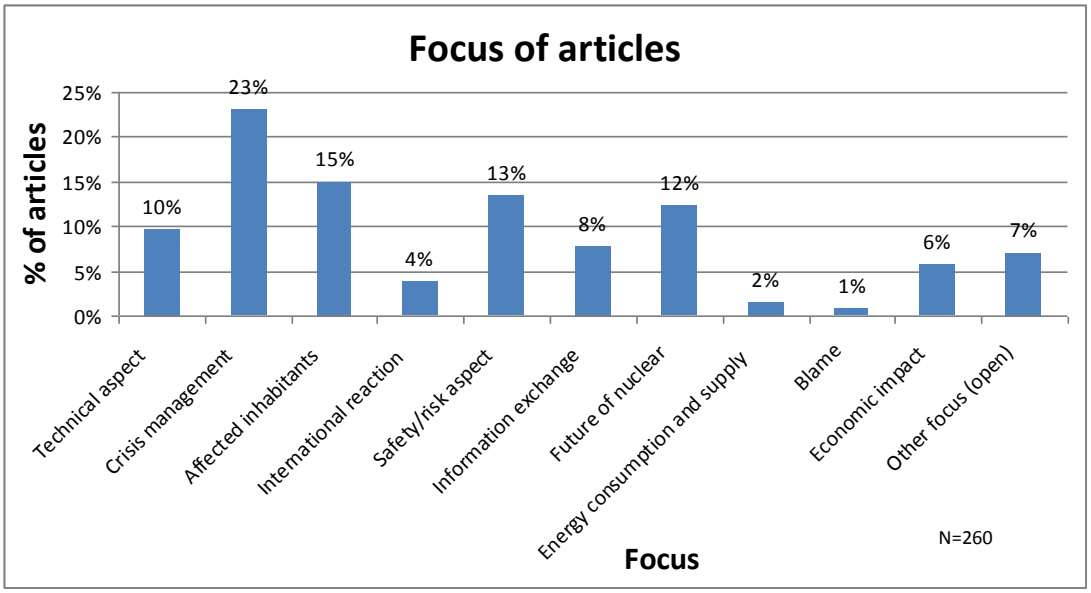

Figure 5.3: Focus of the articles

We can conclude that the main focal point of the articles concerned the crisis management of the Fukushima nuclear accident (see Figure 5.3). 23 % of the newspaper articles focused their attention on the emergency management and the protective actions for the people, food chain or environment. 15 % of the articles

described the situation of people who were victims of the nuclear accident. Interestingly, there were only a few articles that focused on '*blame*' (1 %), '*international reaction*' (4 %) and '*energy consumption and supply*' (2 %). One of the main challenges of emergency communicators is thus to separate the technical and emergency management aspects from the political discussions related to the nuclear energy.

The detailed analysis of the focal interest of the media revealed shifts in media reports and its attention towards different subjects through time, in the weeks after the accident. In the first weeks, the news media focused on many different topics, from technical aspects, crisis management, and safety and risk aspects to energy consumption and supply. Eight weeks after, the media focused their attention to a limited number of topics. In the ninth week after the accident half of the articles focused on the future of nuclear energy, 33 % on safety and risk aspects and 17 % on crisis management.

Conflict and disagreement related to the accident

We further investigated whether the news media reported about conflicts or disagreements between people/groups/parties/countries related to nuclear emergency. Such stories contained an explicit mention of the fact that there was disagreement about the issue (e.g. nuclear energy, emergency management, monitoring). This disagreement had to be expressed in words (e.g. contradictory positions or claims) or in deeds (e.g. protest, stigmatization).

The inter-coder reliability for the coding of *"conflict or disagreement"* expressed in the articles was 0.91 for both articles in French and Dutch language.

The results presented in Figure 5.4 show that the number of articles reporting conflict or disagreement issues has an erratic course: it fluctuates in the weeks after the accident between 20 % and 41 %. One remarkable peak occurs in week 7, the same week in which the accident in Chernobyl was remembered all over the world. More than 40 % of the articles published in this week reported a conflict or disagreement.

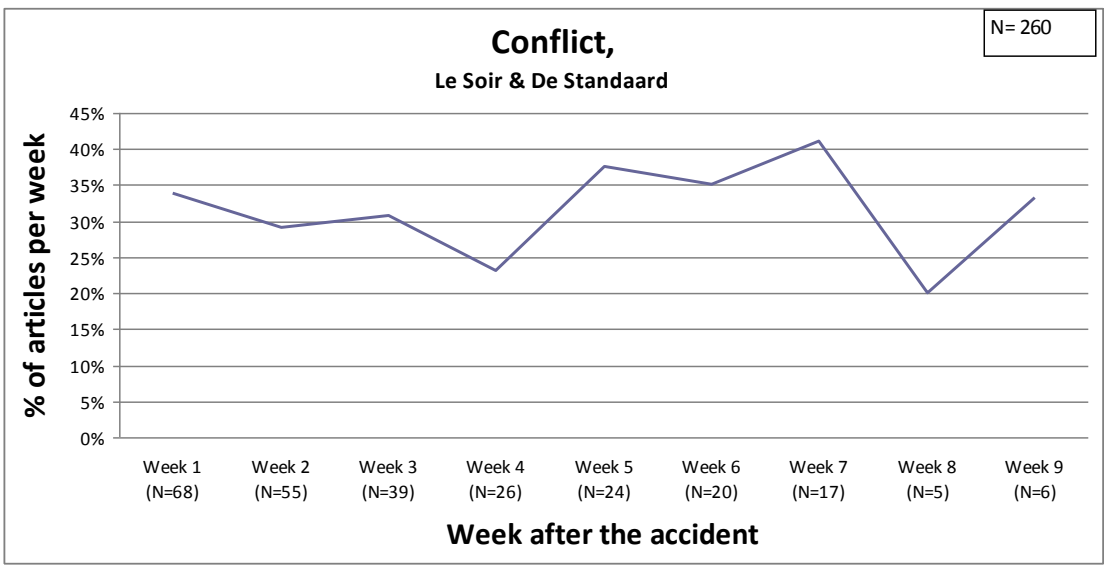

Figure 5.4: Conflict or disagreement in the articles per week for both newspapers (cumulated).

Article orientation toward nuclear energy

The variable concerning the orientation of the article towards nuclear energy explored the way of journalistic reporting about nuclear energy and the arguments used. This referred to the subjective intention of the author or the newspaper policy to expose arguments in favour or against nuclear energy. The articles that presented an opinion towards nuclear energy were therefore categorised as 'positive' (pro), 'negative' (against) or 'balanced'. To classify a media text as "balanced" required that pro and contra arguments and statements concerning the nuclear energy were equally presented in the article, without a clear tendency towards one of these sides. Note the difference from articles that did not express any orientation towards nuclear energy at all; these were coded as 'neutral' (see Figure 5.5).

The inter-coder reliability for the coding of the *'orientation'* of the articles towards nuclear energy was 0.97 for French articles and 0.84 for the Dutch articles in the sample.

The results of our media analysis show that the overall orientation of the published articles towards nuclear energy was neutral. This means that most articles did not really address the topic of 'good or bad' and that they did not express a normative opinion with regards to nuclear energy.

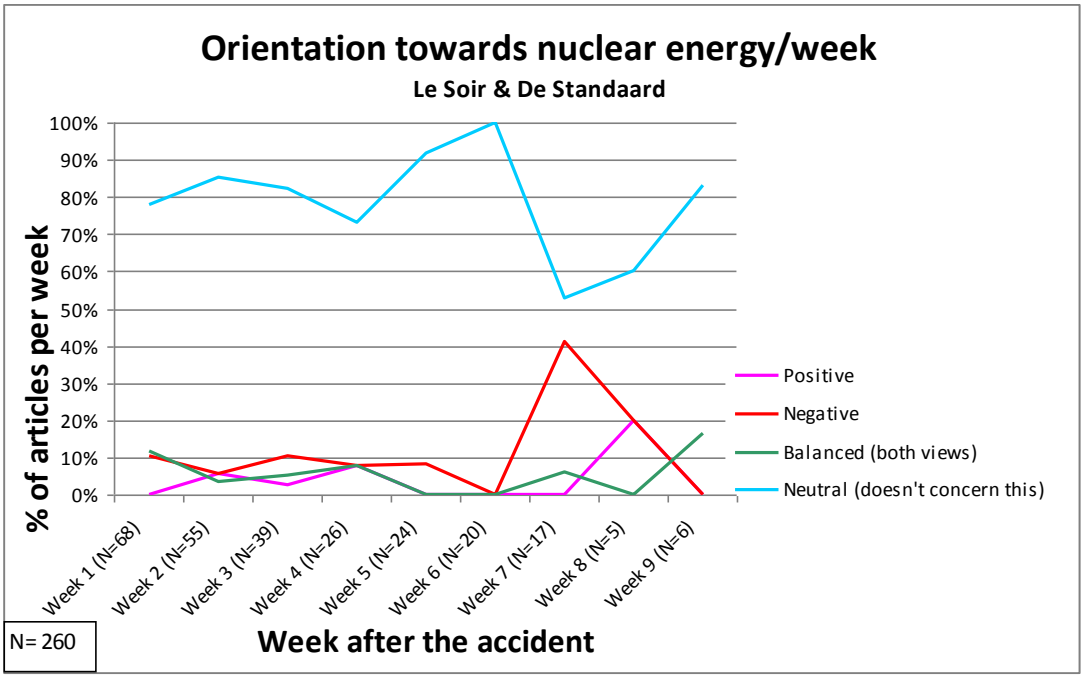

Figure 5.5: Orientation of the article towards nuclear energy per week

The comparison of the orientation of the articles towards nuclear energy in the weeks after the nuclear accident suggests that the increase in negatively orientated articles in the week 7 is not only due to the accident in Fukushima, given that the overall trend shows a a fairly low and balanced number of normatively oriented articles. During the period of analysis, in the 7th week after the accident, the world commemorated the 25th anniversary of the accident in Chernobyl (1986), still the worst nuclear accident in history. It is in

this week that we observed a significant increase of articles negatively orientated towards nuclear energy and a significant decrease of neutral articles.

The word "Chernobyl" in the media articles

Another interesting point of research was to highlight if and how the media coverage of the Fukushima nuclear accident was presented to the public through the memories of the Chernobyl accident from 1986. While the journalists are producing a news story, they present in general the news within a meaningful frame that guides the public on how this news should be understood. Since Chernobyl is part of the collective memory, we explored how many times the two newspapers made a reference to this past nuclear accident when reporting on the nuclear accident in Fukushima. We found out that although the nuclear accident in Chernobyl had completely different characteristics than the one in Fukushima, the media frequently referred to it. The word "Chernobyl" appeared in the articles almost every day. On the fourth day after the accident in Fukushima the reference to Chernobyl was even made ten times in the articles of the two newspapers.

The graph below presents the percentage of articles per week related to the Fukushima nuclear accident and mentioning the word “Chernobyl”, for the two newspapers taken together (see Figure 5.6).

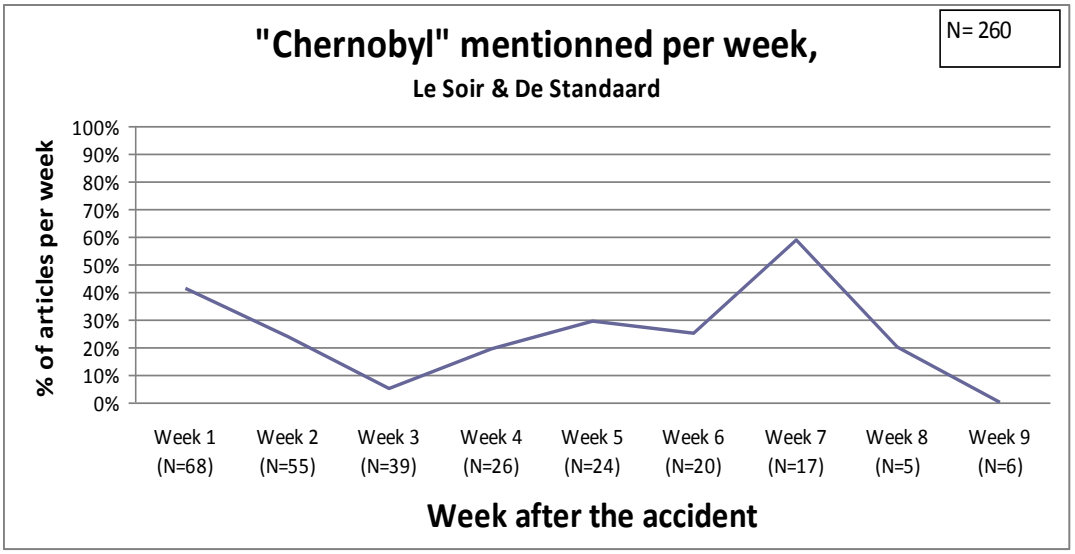

Figure 5.6: Presence of "Chernobyl" keyword in the articles published, per week, both newspapers

Public opinion after Fukushima nuclear accident

The relevance of the accident in Fukushima for Belgium

Even if the accident in Fukushima occurred far away from Belgium and due to a combination of specific natural hazards, the topic was salient in the Belgian context. It was thus important to find out how was the accident perceived by the population in terms of its relevance and the feelings triggered by this accident. Results show that the public opinion in Belgium was divided as regards the relevance of the accident for Belgium (see Figure 5.7).

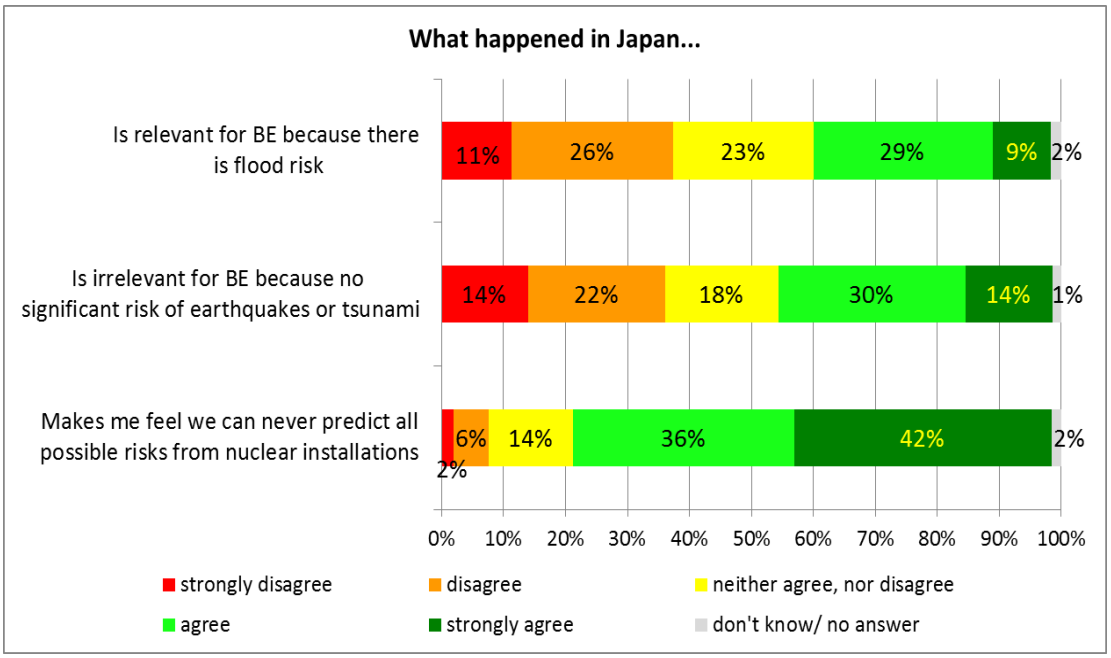

Figure 5.7: Opinions and feelings triggered by the accident at Fukushima (part 1), N=967

From the 967 respondents who had heard about the accident (out of 1020 interviewed), 38 % of the respondents thought that the accident in Japan is relevant for Belgium because there are flood risks, but almost the same percentage (37 %) did not agree with this statement. 44 % of the respondents (out of the 967) expressed the opinion that the accident in Fukushima is not relevant for Belgium, since there are no significant risks of earthquakes or tsunami, while 36 % disagreed with this statement. Whether they found it relevant or not, it is clear that for the big majority (78 % out of 967) the accident in Fukushima induced a feeling of uncertainty over how well we can predict the potential risks from nuclear installations.

We also enquired about the management of nuclear installations in Belgium. About 36 % of the 967 respondents who had heard about the accident felt relieved that the nuclear installations in Belgium are well managed, while 30 % disagreed with this (Figure 5.8). What is somewhat striking is that 49 % (out of 967) worry about dangers from Belgian nuclear installations, but only 31 % want to know how to protect themselves in case of a nuclear emergency.

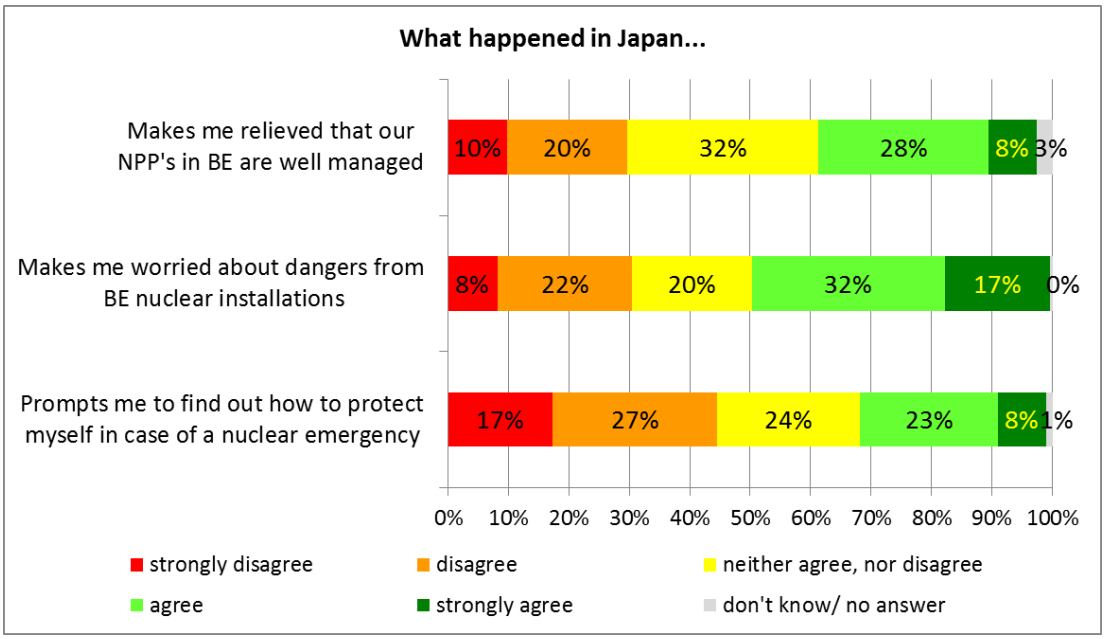

Figure 5.8: Opinions and feelings triggered by the accident at Fukushima (part 2), N=967

Changes in the attitude towards nuclear

The attitude towards nuclear energy was first assessed through a number of general questions on which the respondents had to state their degree of agreement or disagreement.

The opinion on whether *"the reduction of the number of nuclear power plants in Europe is a good cause"* has been measured in all SCK•CEN Barometers since 2002 (see Figure 5.9). The percentage of respondents agreeing with this statement decreased from 66 % in 2002 to 51 % in 2006, and 47 % in 2009. In 2011 the trend has changed: 61 % of respondents agreed with this statement, which is comparable to the year 2002, before what is sometimes referred to as the "nuclear renaissance". The year 2002 is also the year in which the Belgian government decided on a (gradual) nuclear phase-out.

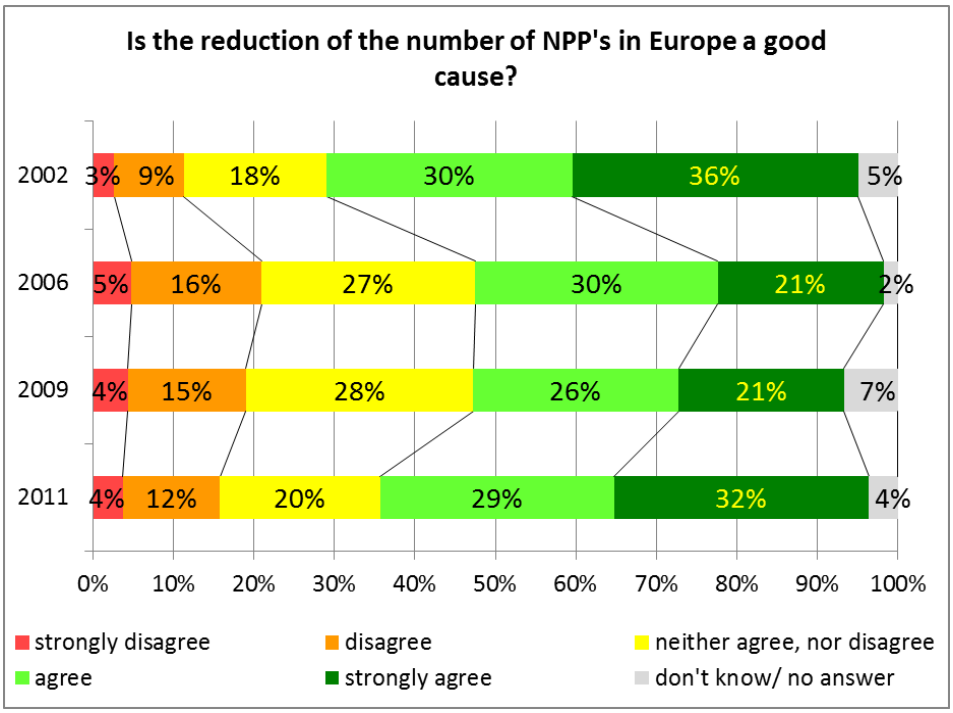

Figure 5.9: On the reduction of NPP's in Europe, N=1020

The negative switch in the attitude towards nuclear energy was observed also with the statement *"in general, the benefits of nuclear energy outweigh the disadvantages"*. In 2011, 30 % of the respondents agreed or strongly agreed with this statement, compared to 44 % in 2009, and 39 % disagreed in 2011, compared to 26 % in 2009. This shift is illustrated in Figure 5.10.

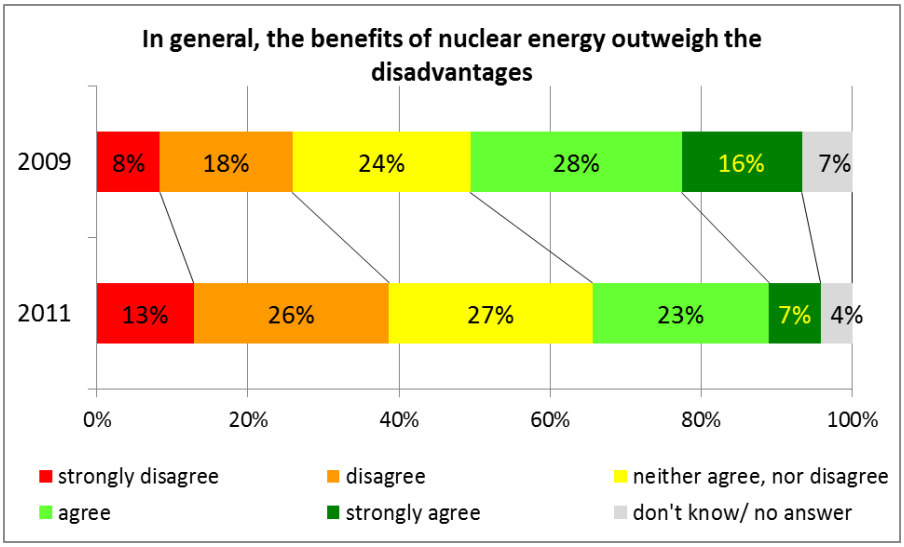

Figure 5.10: On the benefits vs. disadvantages of nuclear energy, N=1020

Another issue studied since 2002 was whether the respondents thought that the "*nuclear power plants endanger the future of our children*". For this item, the results in 2011 were very similar to those obtained in 2009 (and 2002). Only a minor increase in the percentage of respondents agreeing or strongly agreeing with this statement could be observed as compared to 2009 (Figure 5.11).

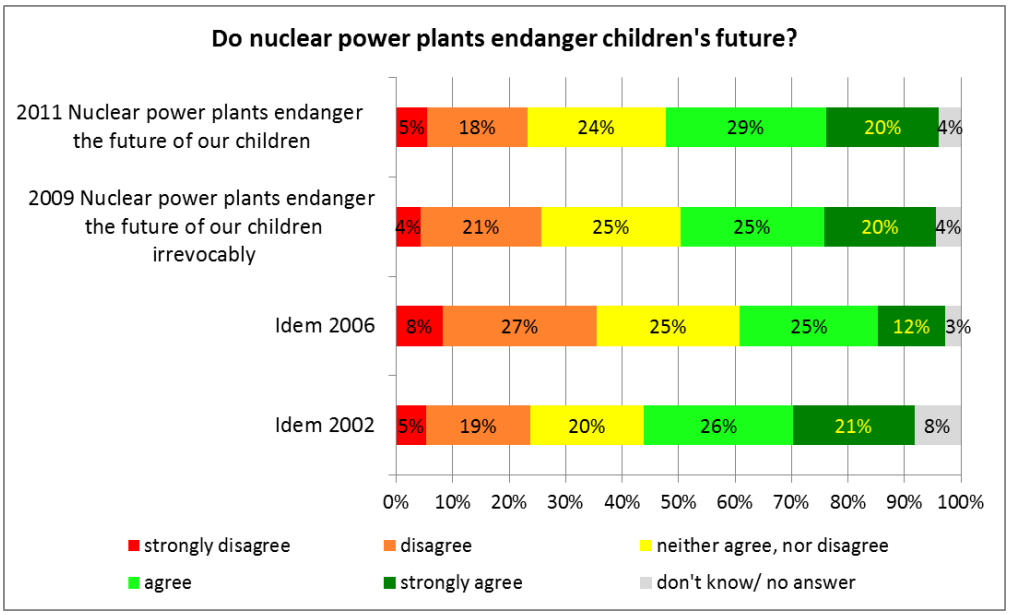

Figure 5.11: Nuclear power plants and children's future, N=1020

Next, opinion about nuclear energy was measured by a direct question on whether the respondent was in favour of nuclear energy or not.

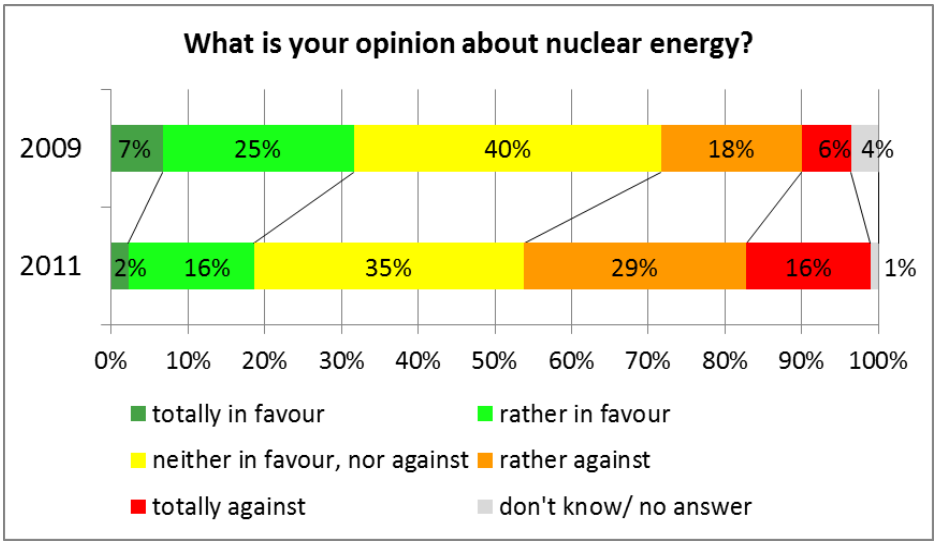

Figure 5.12: Opinion about nuclear energy, N=1020

A change towards a more negative opinion about nuclear energy could be clearly noticed in 2011 compared to 2009 (see Figure 5.12). In 2009, the opinions about nuclear energy were rather balanced, with a slightly higher number of respondents in favour of nuclear energy (32 % pro, 24 % against nuclear energy) and a large number of people undecided. In 2011, only 18 % of the respondents were in favour of nuclear energy, whereas 45 % were against. It can also be noticed that, similarly to 2009, more than one third of the population does not take a clear stand as regards nuclear energy.

The results therefore show that the Fuksuhima nuclear accident led to changes in the public opinion related to nuclear energy, which could be clearly measured in the third month after the accident. There is more concern about safety of nuclear installations, and there is more tendency to evaluate the risks from nuclear energy as higher than the benefits it brings.

Conclusions

Risk communication during Fukushima nuclear accident was one among the most challenging aspects for emergency management even in other states than Japan. On the one side, a high media attention helped as a communication tool for communicators; on the other side, a media information-hunger could cause information mistakes and over- or under-statements. The Fukushima accident induced enormous media coverage in the first weeks after the accident but attention decreased with time. This can be of concern for a long term communication, for instance related to the environmental remediation process. Conflicts and disagreements were highly presented in the media articles.

The journalists presented the Fukushima nuclear accident through the collective memory of the Chernobyl accident during the first two months after the incident. The word "Chernobyl" appeared in the articles almost every day. Although the results of media analysis show that the overall orientation of the published articles towards nuclear energy was neutral and the type of the articles was objective, the articles' orientation towards nuclear energy displayed a clear emphasis on the negative aspects in April 2011, at the time of the 25th aniversary of the Chernobyl accident. This goes in parallel to the observed change in the public opinion which has shifted towards more negative opinions and attitudes towards nuclear energy as compared to previous years.

References

Ipsos MORI 2011. Global Citizen Reaction to the Fukushima Nuclear Plant Disaster. Global @dvisor, http://www.ipsos-mori.com/Assets/Docs/Polls/ipsos-global-advisor-nuclear-power-june-2011.pdf.

Asahi, S., 2011. Asahi poll in December 2011: 57 % of Japanese say no to nuclear power http://ajw.asahi.com/article/behind_news/social_affairs/AJ201112130013. Asahi Shibun.

Barnes, M.D., Hanson, C.L., Novilla, L.M.B., Meacham, A.I., McIntyre, E., Erickson, B.C., 2008. Analysis of media agenda setting during and after Hurricane Katrina: Implications for emergency preparedness, disaster response, and disaster policy. *American Journal of Public Health*, 98, 604-610.

Boomgaarden, H.G., de Vreese, C.H., 2007. Dramatic real-world events and public opinion dynamics: Media coverage and its impact on public reactions to an assassination. *International Journal of Public Opinion Research*, 19, 354-366.

Brown, J.M., White, H.M., 1987. The public's understanding of radiation and nuclear waste. *Journal of the Society for Radiological Protection*, 7, 61-7070.

Cantone, M.C., Sturloni, G., Brunelli, G., 2007. The Role Played by Stakeholders in the Public Debate that Brought Italy out of the Club of Nuclear Energy Producers. *Health Physics*, 93, 261-266.

Cohen, B.L., 1985. A Simple Probabilistic Risk Analysis for High-Level Waste Repositories. *Nuclear Technology*, 68, 73-76.

Covello, V.T., 1988. Seven cardinal rules of risk communication. in: O.o.P.A. US Environmental Protection Agency (Ed.), Washington, DC.

Gamson, W.A., Modigliani, A., 1989. Media discourse and public opinion on nuclear power: a constructionist approach. *The American Journal of Sociology* 95, 1 - 37.

Greenberg, M., Truelove, H.B., 2011. Energy Choices and Risk Beliefs: Is It Just Global Warming and Fear of a Nuclear Power Plant Accident? *Risk Analysis*, 31, 819-831.

Lindner, L., 2000. Chernobyl today and compared to other disasters. *Atw-Internationale Zeitschrift Fur Kernenergie*, 45, 282-+.

Lippmann, W., 1922. Public opinion. Macmillan,, New York.

McCombs, M.E., Shaw, D., 1972. The agenda-setting function of the mass media. *Public Opinion Quarterly*, 689, 813-824.

McCombs, M.E., Shaw, D.L., 1993. The Evolution of Agenda-stetting Research - 25 Years in the Marketplace of Ideas. *Journal of Communication*, 43, 58-67.

McDermott, J.J., 1982. Three Mile Island. (The malfunction and its effects on American public opinion). *Fizikai Szemle*, 32.

Perko, T., 2011. Importance of Risk Communication During and After a Nuclear Accident. *Integrated Environmental Assesement and Management*, 7, 388–392.

Perko, T., Turcanu, C., Carlé, B., 2012. Media Reporting of Nuclear Emergencies: The Effects of Transparent Communication in a Minor Nuclear Event. *Journal of Contingencies and Crisis Management*, 20, 52-56.

Perko, T., Turcanu, C., Geenen, D., Mamane, N., Van Rooy, L., 2011. Media content analysis of the Fukushima accident in two Belgian newspapers Open Report Belgian Nuclear Research Centre SCK•CEN, Mol; Belgium, pp. 127.

Perko, T., Turcanu, C., Schröder, J., B., C., 2010. Risk Perception of the Belgian Population; Results of the Public Opinion Survey in 2009. SCK CEN, Mol, pp. 202.

Ramana, M.V., 2011. Nuclear power and the public. *Bulletin of the Atomic Scientists*, 67, 43-51.

Rowe, G., Frewer, L., Sjöberg, L., 2000. Newspaper reporting to hazard in the UK and Sweden. *Public Understanding of Science*, 9, 59-78.

Triandafyllidou, A., 1995. The Chernobyl Aaccident in the Italian Press - A Media Story-Line. *Discourse & Society*, 6, 517-536.

Turcanu, C., Perko, T., Schröder, J., 2011. The SCK•CEN Barometer 2011 - Perception and attitudes towards nuclear technologies in the Belgian population Open Report. Belgian Nuclear Research Centre SCK•CEN, Mol; Belgium, pp. 150.

van der Brug, W., 2001. Perceptions, opinions and party preferences in the face of a real world event - Chernobyl as a natural experiment in political psychology. *Journal of Theoretical Politics*, 13, 53-80.

Zorkaja, N., 2006. Radiant disinterest - Chernobyl in Russian public opinion. *Osteuropa*, 56, 235-+.

6. Media reporting of nuclear emergencies: The effects of transparent communication in a minor nuclear event

Manuscript published as:

Perko T., Turcanu C., Carlé B., 2012. "*Media Reporting of Nuclear Emergencies: The Effects of Transparent Communication in a Minor Nuclear Event*". Journal of Contingencies and Crisis Management, 20, 52-56.

Manuscript partly based on this chapter published in proceedings:

Perko T., Turcanu C., Carlé B., Vidmar T.- *How transparent is transparent enough? A case study of a minor nuclear event*.- In: Nuclear Energy - Global Trends and Perspectives in South East Europe, Podgorica, Montenegro, 10-12 May 2011, Podgorica, Montenegro, The Montenegrin Academy of Sciences and Arts, 2011, p. 75-89

Abstract

On the 4th of June, 2008, a nuclear event occurred at the Krško NPP in Slovenia. Even though it was classified as level zero on the INES scale, the transparency policy of the Slovenian nuclear safety authorities prompted it to notify the international community. This was the first time that the European ECURIE notification system was used outside the exercise framework. The event was reported in all major European media, the news content varying from country to country.

In this contribution we report on a content analysis of the media articles related to this event. The main research question we tackled was if a nuclear emergency generates significant media coverage, even in the case of a minor event and a transparent communication policy. We also investigated if the distance from the event's location and the general nuclear policy of a country influence related media coverage. The analysis included more than 200 published articles from printed and spoken media in Slovenia, the neighbouring countries, other EU member states and ECURIE members. The analysis revealed that even a transparent communication policy in a minor nuclear event by the affected country may still trigger a high intensity media coverage, emotional reactions and heated political discussion The main media sources in countries with open political questions related to nuclear energy tend to end up being the politicians, rather than the resident experts.

Introduction

Transparent communication of nuclear authorities and operators is recognized in international documents as essential for effective emergency management, therefore advised or even mandatory (IAEA, 1994; IAEA, 2006; IAEA, 2007; *ICRP*, 1991; ICPR, 2007; UNEC, 1998). However, in practice transparent communication is a challenging task due to at least three reasons. Firstly, a transparent and sound communication from the nuclear authorities towards the public is often hindered by divergence of experts' opinions related to scientific uncertainties (e.g. health effects of low doses), different perceptions of radiological risks (Slovic *et al.*, 2004), and past experiences with low transparency of nuclear activities by operators and authorities (Whitfield *et al.*, 2009). Secondly, a compromise has to be reached between the transparency of communication and the security requirements in the nuclear field (e.g. possibility of a terrorist attack at a nuclear installation). Finally, there may be a conflict of interests among the industry, the regulators, action groups, general public, emergency actors on how much transparency is really needed in nuclear risk and crisis communication. Related to this, different levels of transparency could be:

- "public has the right to know" (UNEC, 1998),
- "specific information is privileged", to ensure safety of a nuclear infrastructure and its functioning, e. g. safe transport (Rojas-Palma *et al.*, 2009)
- the practice of "restricted information", due to fear of misinterpretation (Visschers *et al.*, 2009) or abuse of the information by general public and/or groups of pressure.

To ensure a transparent communication, nuclear emergency actors need the mass media to reach the general public. In order to manage an emergency, nuclear actors must communicate on basic questions such as: What may happen? What happened? Is there a hazard for the population? Is there a danger now, in the near future or later? What do we need to do: immediately, soon, later? (Brunner, 2002). But a control over the distribution of the type of information or what information that mass media will distribute can not be assured (Freedom of the press).

Nuclear events predictably induce enormous media coverage (Gamson and Modigliani, 1989). This is mainly due to the specifics of nuclear events which mostly trigger the newsworthiness. Nuclear accidents have a high catastrophic potential, they can involve high exposures and may create long lasting consequences (Dubreuil *et al.*, 1999). High media attention to a nuclear events is also due to past contamination episodes such as the Chernobyl fallout which, even after decades, continues to induce a lot of uncertainty and distrust (Carlé *et al.*, 2007). In general, mass media play a dominant role at all levels of communication on nuclear emergency issues (IAEA, 2006). They are the prominent information channel for the general public, being used for communication by different stakeholders and acting as the "watchdog" of society. However, media also have to fulfil the economic aspects of publishing or broadcasting, with "bad news is good news" being a well-known phenomenon in journalism. Mass media play a progressively more important role in contemporary crisis situations. They help to create, shape and terminate a crisis (Wien and Elmelund-Praesteker, 2009).

The journalists not only report about the reality but they also influence it. Journalists represent, interpret, and construct reality (Rupar, 2010). Gamson and Modigliani (1989) point out that journalists have an active role in reporting about an event (crisis). Political and public salience of issues is partly driven by media coverage of these issues. When media increase their attention to a given issue, the political elites jump on the bandwagon as well by stating their opinion, asking parliamentary questions about the issue, tabling law proposals, or issuing executive orders (McCombs and Shaw, 1972; Walgrave and Van Aelst, 2006).

In the literature there are several examples related to the content of mass media (e.g. printed press) in a radiological or nuclear crisis (Rowe *et al.*, 2000). Cantone et al (2007) analysed the role of mass media, the reasons for the decision to phase out nuclear energy in Italy and the communication strategies of the stakeholders that took part in the public debate on nuclear energy during the weeks following the Chernobyl accident. They found that media acted as a discussion forum, presenting the values and interests of various social actors in the political debate related to future of nuclear energy. More general, the research on the media agenda, including the studies of Vasterman (2005) and Wien & Elmelund-Præstekær (2009) shows that extended media attention can prompt important changes in public perceptions and governmental action toward underlying policy issues (Baumgartner *et al.*, 2008).

In this study we explored the role of mass media in shaping the crisis after transparent and open communication of the main nuclear actor, in the case of minor nuclear event. What did they publish and how did they focus the information?

We analysed media response on the nuclear event at the Krško NPP in Slovenia, which occurred on the 4th of June, 2008. Even though the event was classified as level zero on the INES scale, the transparency policy of the Slovenian nuclear safety authorities prompted it to notify the international community. The plant was initially in an emergency state due to an unidentified leak, which in turn triggered the activation of the National Response Plan. This was the first time that the European ECURIE notification system was used outside the exercise framework. Consequently, this event was considered newsworthy and thus reported in the media all around Europe (informative and daily press). The content of the news varied from country to country.

The analysis included more than 200 published articles from printed and spoken media in Slovenia, the neighbouring countries (Austria, Italy, Croatia and Hungary), other EU member states, and/or ECURIE members or IAEA members.

New media channels (e.g. mobile phones, e-mail) can replace interpersonal interactions in what is called an exploding crisis event, as people call friends and family to obtain information (Bracken *et al.*, 2005). However, we focused our attention on the traditional mass media since – in the case of a major crisis event - the new media channels have been found in past studies no more important in news diffusion than the traditional ones (Krippendorff, 2004),(Bracken *et al.*, 2005), (Spence *et al.*, 2007; Spence *et al.*, 2007). For analysis we have used a combined quantitative-qualitative approach. The quantitative part was the analysis of the number of articles, their size, the page where they were published, the sources of information referred to and the presence of specific words in the articles. In the qualitative part, the coders identified of the focus of the articles, according to their subjective judgment, as detailed in methodology section. The coding was done using standard methods for content analysis (Krippendorff, 2004; Neuendorff, 2002).

The main research goal of the study was to determine the effects of a transparent communication policy on the media coverage of a minor nuclear event. In addition we aimed at highlighting the influence of the general nuclear policy in a country and the distance from the event's location on the related media attentiveness. For this purpose we addressed the following issues:

1.) Which countries, among which the country where the event occurred, the states having a common border with it and some other ECURIE members, reported about the nuclear event and what was the frequency of published media news?
2.) Did the media sources differ among the countries?
3.) What was the focus of the articles?
4.) Did the media reports include messages with negative connotation?

The remainder of this chapter is organized as follows. In the next section we describe more in detail the nuclear emergency event used as a case study, as well as the methodology used for media analysis and coding. The results and discussion are presented in section 3, followed by the conclusions.

Methodology

Description of the nuclear emergency event

On the 4th of June 2008 an event occurred at the nuclear power plant Krško (NPP) in Slovenia. Operators of the NPP detected an increased leakage of water from the primary system inside the containment at 15:07. For such cases adequate procedures are in place and they required that emergency of the lowest level - *unusual event* was declared at 15:56. According to the procedures, the plant started to decrease power at a steady rate. The reactor was shut down at 19:50 and the plant was cooled down after that until the following day. It was found out that the seal degraded on a valve on one of the smaller pipes which were connected to the primary system. When the working conditions were reached, the valve was replaced and the fault was eliminated. At 16.07, 11 minutes after declaring the emergency, the operator of the NPP informed about the problem the Slovenian Nuclear Safety Administration (SNSA), which is as an independent nuclear safety authority.

Activation of National Nuclear Emergency Response Plan in Slovenia is not necessary for an event of such minor level, but the SNSA decided to partially activate the emergency response organization. The head of the SNSA latter argued that *"Leakage from the primary system was relatively small and stable, but at that moment the reason for leakage was not known and possible increase of leakage could lead to a more serious event of the loss of primary coolant"* (Stritar, 2009).

SNSA informed the public in Slovenia and abroad in the first hour. Slovenia is a signatory of the Convention on Early Notification of a Nuclear Accident and also of bilateral agreements with neighbouring countries, which refer to the early notification in case of a radiological emergency. As an EU Member State, Slovenia is as well liable to report to the European Commission and through this to all member states in the EU in the framework of ECURIE system. All these agreements prescribe an early notification when it comes to a situation when the state should take measures for the protection of its citizens. Table 6.1: Timeline of the nuclear emergency event in Slovenia, 2008 summarises the timeline of events.

Table 6.1: Timeline of the nuclear emergency event in Slovenia, 2008

4. 6. 2008:
➢ 15.07 Operators observed leakage in the reactor building (~3 m3/h) ➢ 15.56 "Unusual event" declared - Level 0 emergency ➢ Controlled shutdown initiated - 5 MW/min ➢ 16:09 Slovenian Nuclear Safety Agency was informed by NPP Krško ➢ 16:27 Emergency response team was activated ➢ 17:38 Alert message was sent to ECURIE, indicating that the leak is inside containment ➢ 18:17 First message for domestic media was distributed ➢ 18:35 to 19:00 EMERCON messages to IAEA, Austria, Hungary, Croatia and Italy (Word EXCERCISE from the template was not deleted – IAEA called immediately and corrected) ➢ 18:39 ECURIE system distributed message to other countries ➢ 19:00 EC issued media statement about the event in Slovenia ➢ 19:50 Reactor shut down, cool down and depressurization continued ➢ 21:20 SNSA notified ECURIE: reactor is shut down ➢ 21:20 ECURIE second media update – "End of event" ➢ 21.36 European Commission issued media statement about "End of event".
5.6.2008
➢ Morning : According to director of SNSA approx. 50 media vans in front of the NPP ➢ 10: 00 Report of Slovenian minister for environment and spatial planning at EU Meeting of (environment) ministers in Luxemburg, ➢ 11:00 SNSA , press conference ➢ 12:00 NPP, press conference ➢ Afternoon: Greenpeace at SNSA
9.6.2008
➢ Slovenia report at OECD/NEA CNRA, Oslo, 9. 6. 2008 about the event ➢ 15.30 NPP Krško back in full operation and back in electricity supplying system

Media news collection and coding

Media analysis was performed with the content analysis method. This method follows explicit rules of coding and enables large quantities of data to be categorized. The coding was performed by two independent coders plus a master coder that decided in case of disagreements in the coding of the same media news.

The media news used for this analysis have been obtained from press clippings "Daily press clipping book of Slovenian and international media", compiled by the Slovenian government communication office, from the period between June 4th to 13th , 2008. The European press newspapers included in the analysis were: Sűddeutsche Ztg., Le Monde, Le Figaro, International Herald Tribune, El Pais, Il Sole 24 Ore, Il Corriere della Sera, FT, FAZ, The Economist, European Voice, Der Standard, Neue Zuericher Zeitung, Le Soir, Il

Piccolo, Die Presse, Večernji list, Vjesnik, Globus, Politika, Večernje novosti, Vreme. The Slovenian mass media included in the analysis consisted of all national and regional daily and weekly press, as well the informative program of two TV stations (TVS and POP-TV) and the public Radio station. The press folders were collected by the following key words: "Krško nuclear power plant" and "Slovenia". Articles not related to the investigated topic were excluded from the research. Finally we have analysed 207 media texts, published or broadcasted between 4 - 14 June 2008 in 43 different media from 14 countries.

Results and discussion

Which countries reported about the nuclear event and what was the frequency of published media news?

Even though the nuclear emergency event at Krško NPP was classified as level zero on the INES scale (i.e. no safety significance), the media response was enormous. The news frequency varied from country to country however. The average frequency of published news in media for each state (Figure 6.1) allowed to identify the countries with high attentiveness to this nuclear event.

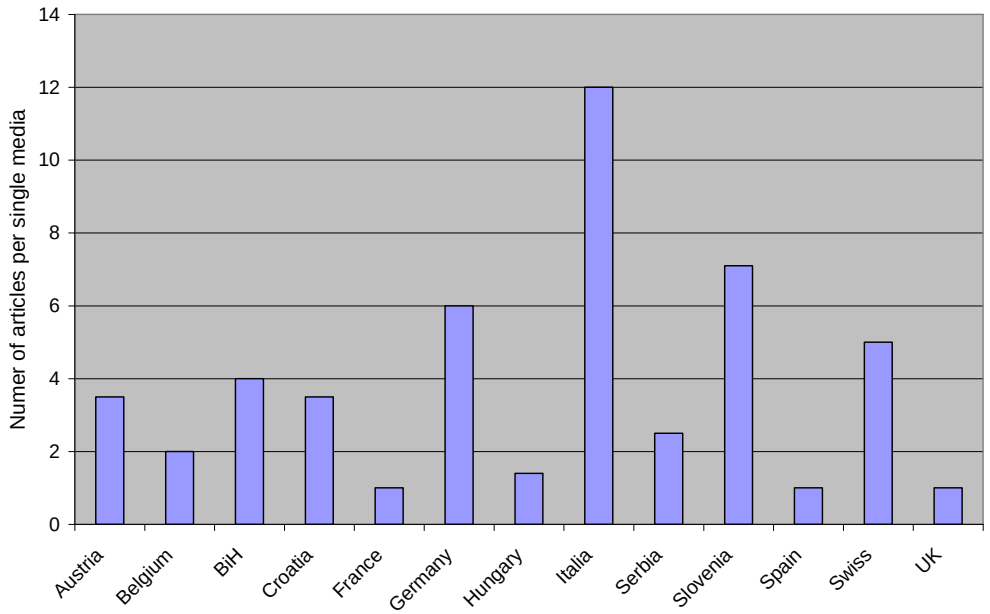

Figure 6.1: Average frequency of media news in single media per country

The event was most frequently reported in Italian newspapers (12 articles per newspaper) followed by Slovenia (7 articles per one mass medium), Germany (6 articles per newspaper) and Switzerland (5 articles per newspaper). The states with the lowest frequency of the published articles related to event in Krško (one per newspaper) were France, United Kingdom and Spain.

Table 6.2: Public opinion, nuclear program and number of media articles related to Krško NPP in countries

Country*	Favourable public opinion** (Eurobarometer, 2005)	Favourable public opinion** (Eurobarometer, 2008)	Change** 2005-2008	Number of articles related to Krško event in one media***	Status of nuclear before Krško event
Austria	8 %	14 %	+6	3	Nuclear program forbidden by law in 1978, prolonged in 1997.
Belgium	50 %	50 %	0	2	Phase-out law in 2003; recommendation from energy commission in 2007 to extend operating life of existing reactors to meet CO_2 requirements.
Croatia	NA	NA	NA	3	Co-owns the Krško NPP together with Slovenia.
France	52 %	52 %	0	1	Law in 2005 requiring that nuclear power be central to energy policy and security.
Germany	38 %	46 %	+8	6	Continuing political and public debates about when the nuclear should be phased out.
Hungary	65 %	63 %	-2	1	Government committed to nuclear power to serve its future electricity needs.
Italy	30 %	43 %	+13	12	After referendum in 1987 all NPP's closed; in 2007 the government, intended to restart the nuclear program.
Slovenia	44 %	51 %	+7	7	In 2006, the Government held internal discussions on adding a new block to Krško NPP.
Spain	16 %	24 %	+8	1	Existing nuclear program, no nuclear restriction policy.
Switzerland	NA	NA	NA	5	Extended nuclear program and many referendums on nuclear energy.
United Kingdom	44 %	50 %	+6	1	In 2008, the government gave the go-ahead for building new NPP's.

* For Bosnia-Herzegovina and Serbia no data available
** Question formulated as: "Are you totally in favour, fairly in favour, fairly opposed or totally opposed to energy production by nuclear power stations?" Only percentage "in favour" compared.
***Correlation between the change and the number of articles is 0.74.

Italy, Slovenia and Germany have different nuclear status, as the public debate related to nuclear program is also quite specific as shown in Table 6.2.

The political and public debate in Italy was at the time of the Krško event very vivid, focused on the possibility to reopen the nuclear programme. In Italy the nuclear power was phased out with the legislation introduced in 1987 after the Chernobyl accident, the last power reactor being closed in 1990. The nuclear power debate was restarted by the government in 2005 with the intention to re-open the state nuclear

program and to build new NPP's in Italy. The political discussion, as well as the public attitude towards nuclear energy, were in 2008 extremely polarized. Although Italy was without nuclear reactors in operation in 2008, 43 % of the Italian population was -before the nuclear event in Slovenia- strongly in favour of energy production by NPP's (Eurobarometer, 2008).

At first glance it might seem surprising that the German media reported about the event with such high frequency (average of six articles per newspaper). Germany had at the time of nuclear event in Krško 15 reactors in operation, but had adopted a "Nuclear exit law" in 2000. The political discussion over nuclear energy was in the years 2002 – 2008 vibrant: it was set to be a key issue in coalition talks. The elections campaigns were focused on the phase-out of the nuclear program (pro and contra) and the population was divided among people being in favor or against nuclear energy. In the month before the nuclear event in Slovenia, a public opinion poll in Germany showed that 46 % of Germans wanted the country to continue using nuclear energy, another 46 % said they supported the nuclear phase-out policy and 8 % were undecided (WNO, 2008).

The states with the lowest frequency of published articles related to event in Krško were those for which at the time of the nuclear event in Slovenia the discussion related to the nuclear program was neither in the political agenda, neither in the public agenda. Those states were France, United Kingdom and Spain. It is interesting that among this category of states appeared also Hungary. Hungary is Slovenian neighbouring state and the Krško NPP is less than 100 km from the common border. Hungary has one nuclear power plant with four units and the government of Hungary remains committed to nuclear power in order to serve its future electricity needs. The public opinion in 2008 was in general positive towards nuclear energy (Eurobarometer, 2008) and there was no public or political discussion related to the future of nuclear energy.

The results support the assumption that the frequency of the media articles related to nuclear event in Krško NPP will be higher in the states with the nuclear program under public and political discussion than in the states where the existence of NPP's is not considered as a future question.

As regards the distance from the nuclear emergency event the results show that media coverage was not consequently higher in the neighbouring countries than in more distant states. This can be noticed especially for Croatia and Hungary.

Did the media sources differ among the countries?

As a rule of thumb, especially when reporting on crisis, reporters are expected to use multiple sources (Kovach and Rosenstiel, 2007; Wilson, 1996). The primary sources of the information related to problems in NPP Krško were three different notification systems used for notifying different groups of countries. The first one was the National response plan used in Slovenia, in the framework of which Slovenian citizens should be informed about radiological or nuclear emergencies. The second system was the bilateral agreement between Slovenia and the neighbouring countries (Italy, Austria, Hungary and Croatia). The third system was the European Community Urgent Radiological Information Exchange (ECURIE), used to inform all European countries and Switzerland and Croatia. In all three notification and information exchange systems the original source of information was the Slovenian Nuclear Safety Administration (SNSA) as the responsible regulatory body. For other ECURIE states than the neighbouring countries, the European Commission has distributed the information, therefore acted as primary source of information (press release).

With the content media analysis we explored the sources of information for published media news related to the nuclear emergency event at Krško NPP. The aim was to find out which sources were referred in mass media and whose information was the most quoted. The code of journalism assumes that a media article must refer to different sources of information, in order to present several views and depict the event taking different aspects into consideration. We analysed the media sources for each of the following groups of countries separately: Slovenia, neighbouring countries and other ECURIE members (distant countries).

In Slovenia the most quoted media source was the Slovenian Nuclear Safety Authority as the origin of information according to the national response plan. As expected, more than 40 % of media news in Slovenia referred to SNSA. Second most quoted source was the operator of the NPP at Krško (quoted in 34 % of news), followed by unidentified sources of information. Almost 30 % of media news distributed information about the nuclear event without referring to any identified source.

Figure 6.2 summarises the media sources for the Slovenian media. It would normally be expected that the local government or the local population from the municipality with the Krško NPP will be highly present in the media, since they are likely to be most affected by a radiological release. Surprisingly, this source of otherwise important journalistic information was in Slovenian media quoted in only few articles (1 % of news).

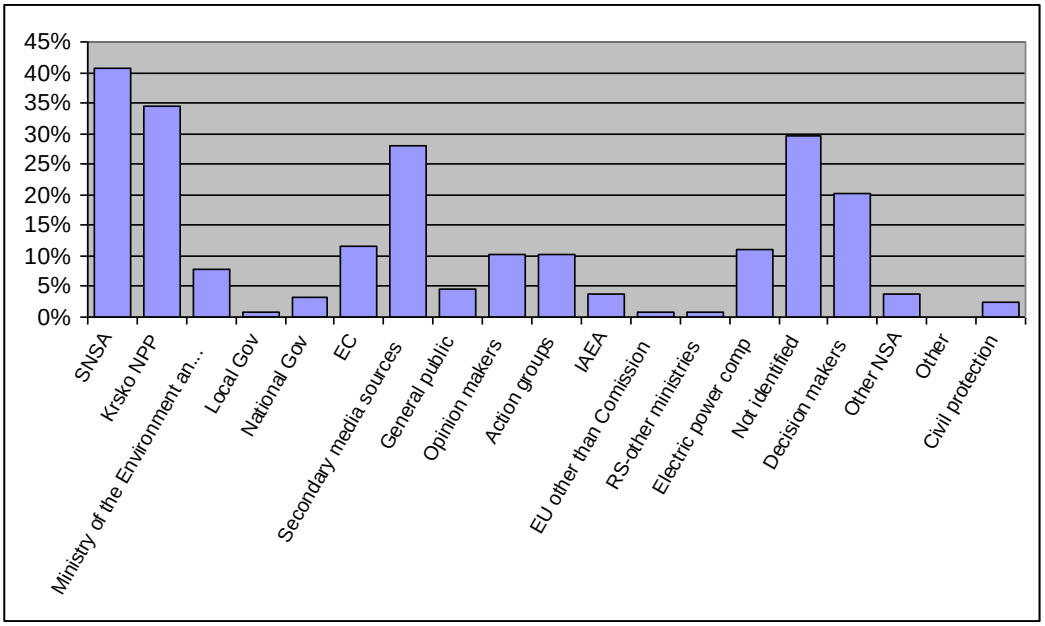

Figure 6.2: Media sources in Slovenia

In the neighbouring countries Italy, Austria, Hungary and Croatia the most quoted source were by far the decision makers (see

Figure 6.3). This category of actors includes politicians and representatives of governments other than Slovenian. 44 % of articles published in the neighbouring countries presented the statements of the decision makers. The information or opinion given in the news was usually the opinion of a government or political

party, e.g. the E.U. green parliament party. Decision makers were followed by secondary media sources. Secondary sources of information are reports of other media houses, press agencies or correspondents abroad: *"As reported by ..."*.

The original information of SNSA related to the nuclear emergency was presented only in 15 % of the articles in these neighbouring states. This is, surprisingly, the same frequency as for the information presented by opinion makers. The category opinion makers includes well-known personalities and politicians, scientists whose opinion is considered important enough to be represented separately, either in a full-fledged interview or via quotes. The actors grouped in this category represent themselves rather than an institution or a role attributed to them (the opinion given is that of an individual and not of a group). People from academic institutions also fall into this category when the opinion provided is theirs and not that of the department or division they belong to.

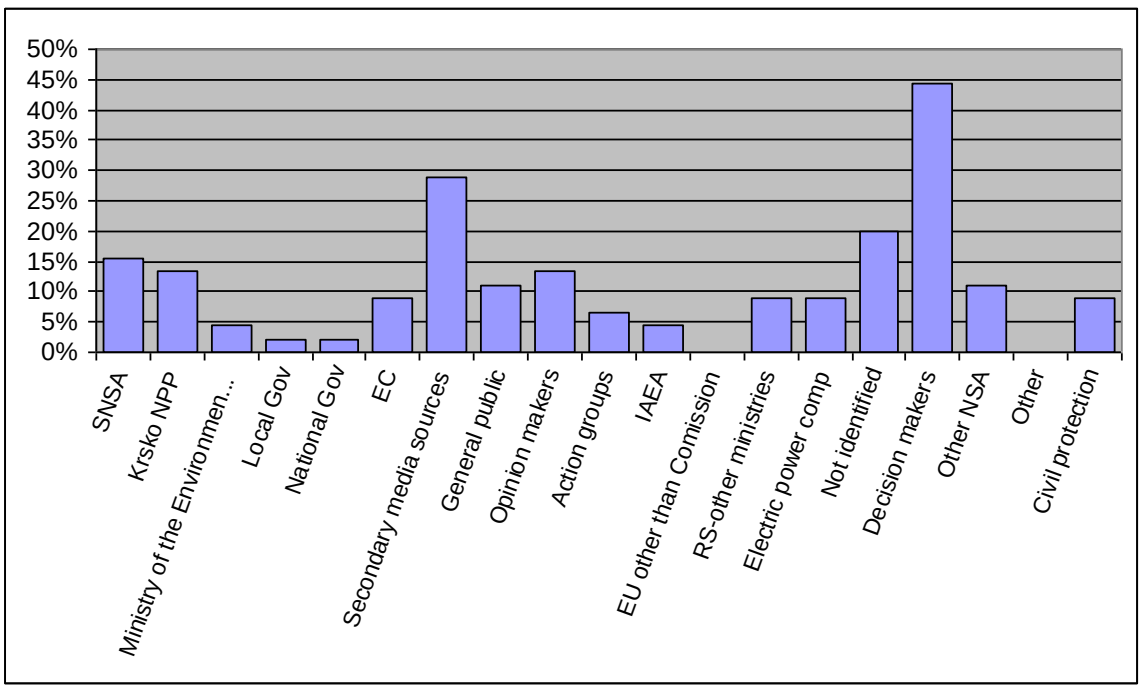

Figure 6.3: Media sources in neighbouring countries (Italy, Austria, Hungary and Croatia)

In more distant countries the frequency of the most quoted sources was different to those in Slovenia or neighbouring countries. The most quoted sources of information were other media. This source of information is the leading source in almost 60 % of the articles related to the nuclear emergency event. In other words, media around Europe reported other media stories related to the nuclear emergency at NPP in Slovenia. This source of information for media in distant countries was followed by the operator of the NPP (39 % of articles referred also to the NPP Krško). According to the journalism rule that the journalist has to go to the origin of the information (problem), this frequency of the NPP Krško appearance as source of information was to be expected. This was possible due to the transparent communication policy where also

an operator (NPP) was allowed by the authorities to organise a press conference. The European Commission, which distributed the information to ECURIE members and published press release, ended with less than 30 % of references on the fourth place of media source frequency as shown in Figure 6.4. This may be due to poor and technically orientated information in the first press release published by the European Commission.

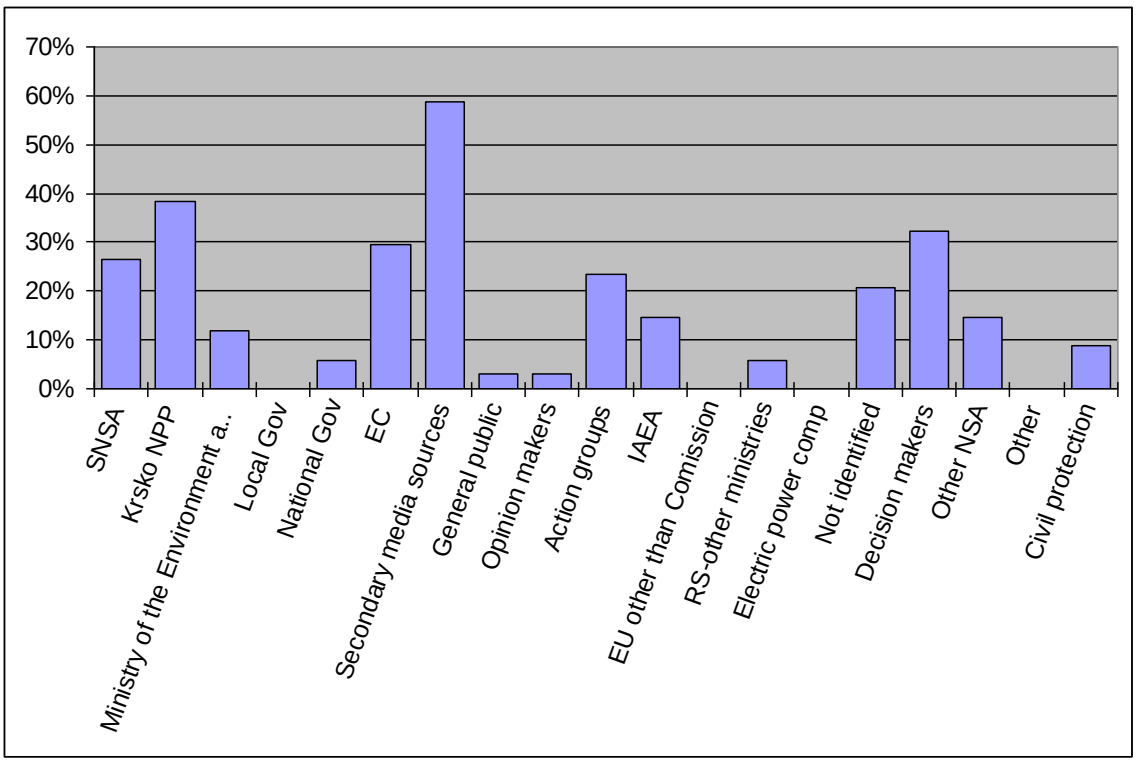

Figure 6.4: Media sources in other ECURIE countries (distant countries)

The results support the conclusion that, despite the existence of primary sources of information related to the nuclear emergency, the media around Europe preferred to refer to secondary sources of information and sometimes even omitted the primary one (SNSA or European Commission). While the most quoted source was the Slovenian Nuclear Safety Agency as the regulatory body in Slovenia, the most quoted sources of information in the neighbouring states were politicians and representatives of governments. A strong influence of published information in mass media can be recognised by the high frequency of secondary media sources. When the information about the nuclear emergency at the Slovenian NPP was published, mass media in Europe mostly took it over from other media, instead of making their story based on the information from the primary sources. This is in line with previous research showing that media coverage is affected by strong inter-media agenda-setting mechanisms leading to parallel increases and decreases in the attention of various media to the same issue (Vliegenthart and Walgrave, 2008). Media outlets (e.g first pages) generally follow the same track (e.g. presenting an event as a crisis) and let their attention for the issue in a similar manner (Vasterman, 2005; Wolfsfeld and Sheafer, 2006).

What was the focus of the articles?

The analysis of the main focus of the articles allowed to identify the main challenge and the focal point of the crisis and post crisis communication. The codes used to describe the focus of the articles were: "technical aspect", "inhabitants", "international reaction", "safety/risk aspect", "ECURIE" (European Community Urgent Radiological Information Exchange). Figure 6.5 depicts the percentage of articles (from total articles published in the country or country group) reporting on these focus points. Up to three focus points were allowed for each article.

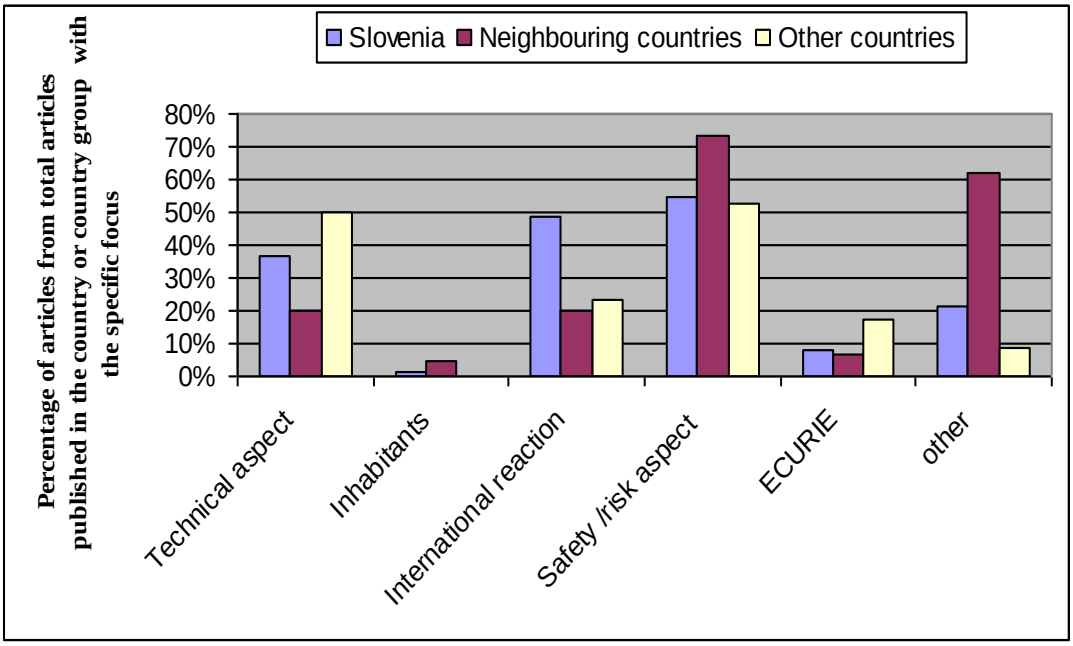

Figure 6.5: Focus of the articles in Slovenia, neighbouring countries and other ECURIE members

The most important focal point of the published media news in all country groups (see Figure 6.5) was the safety/risk aspect. For Slovenia, the second most frequent focal point was the international reaction. For the neighbouring states, the second most discussed focal point was "other", mainly consisting of political problems, ownership issues, ideological discussions etc. For other ECURIE countries the second most discussed focal point was technical aspects.

Did the media reports include messages with negative connotation?

To assess whether the event at Krško NPP was reported with a negative connotation that might stimulate public's emotions we analyzed the keywords used in the articles. For this purpose the frequency of the following keywords was calculated: Chernobyl, panic, alarm nuclear accident, catastrophe, danger, dread, alert (in the sense of warning). Synonyms, antonyms and homonyms were included in accordance to linguistic properties (e.g. "dread" also expressed with the words "fear" and "threat").

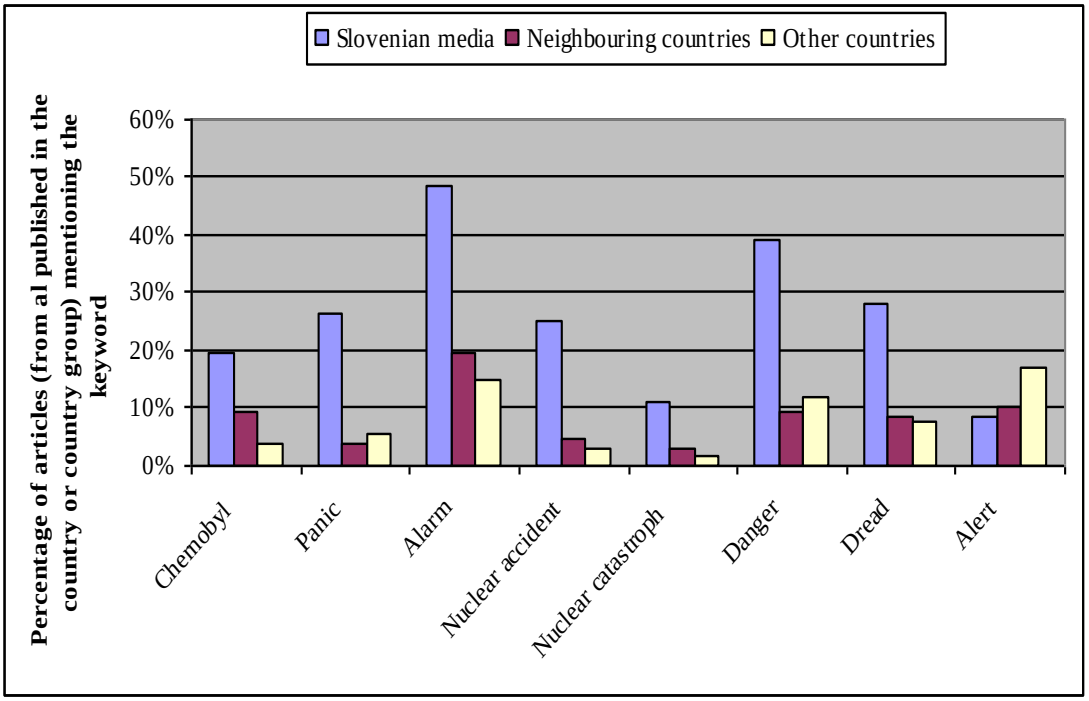

Figure 6.6: Keywords in articles published in Slovenia, neighbouring countries and other ECURIE members

The results presented in Figure 6.6 show that words with negative connotation were present in the mass media, while they were not present (except for the word 'alert') in communications by the primary information sources.

It is interesting to notice that "alert" was one of the messages delivered in the press release of the European Commission. The analysis revealed however that "alert" was translated to "alarm" (which has a more negative connotation) in almost 50 % of Slovenian articles, 20 % of articles in neighbouring countries and 15 % of article from more distant countries. The connotation of alert and alarm differs quite significantly: while alert refers to a warning, alarm relates to a fear resulting from the awareness of an imminent danger.

That a nuclear emergency is linked to a high catastrophic potential is proven by the frequency of the word "Chernobyl". It was used in almost 20 % of the Slovenian news and 10 % of the articles published in neighbouring countries. If we compare the different groups of countries, we can confirm that with the distance from the affected site, the use of words with negative connotation decreased.

Conclusions

This study analysed the media content after the minor nuclear event at the Slovenian NPP. The analysis revealed that despite a transparent communication policy by the affected country and low level of emergency, this event triggered a high intensity of media coverage. The results showed that the frequency of the media articles was higher in the countries where the nuclear energy was in the public agenda. The states where the future of nuclear energy was under the political discussion (e.g. a planned referendum in Italy and a strong opposition from environmental organisations in Germany) reported even more than Slovenia.

Important differences as regards the information sources were noticed between different country groups. In Slovenia the most frequently referred source of information was the nuclear safety authority. In the neighbouring countries decision makers (politicians) were the most important information source. In more distant countries media mostly took over other media reports. Overall secondary media were an important source of information.

The safety and the risk aspects were the main focal point in the media reports for all country groups. In Slovenia however, the international reaction on this event received almost equal attention. The results clearly demonstrated that the media reports often included messages with negative connotation. Even if the event had no safety significance, the media linked the event with the nuclear accident at Chernobyl and used emotion triggering words such as panic and danger.

The operators and the nuclear safety authorities are obliged by law to be transparent from and to openly communicate about nuclear safety issues, regardless of the possibility of (ab)using the emergency for political purposes. With constant and transparent communication, the communicators can avoid misunderstandings. However, emotional reactions and heated political discussions may arise when this is not accompanied by an adequate and transparent response in communication by international organisations, because the main media sources in countries with open political questions related to nuclear energy tend to end up being politicians, rather than the resident experts.

References

Baumgartner, F., De Boef, S., Boydstun, A., 2008. The Decline of the Death Penalty and the Discovery of Innocence. Cambridge University Press, New York (NY).

Bracken, C.C., Jeffres, L., Neuendorf, K.A., Kopfman, J., Moulla, F., 2005. How cosmopolites react to messages: America under attack. *Communication Research Reports*, 22, 47-58.

Brunner, H.H., 2002. The Emergency Plan: Organization and Requirements. in: A. Sohier (Ed.) A European Manual for Off-site Emergency Planning and Response to Nuclear Accidents. SCK CEN, Mol, Belgium, pp. 257-278.

Cantone, M.C., Sturloni, G., Brunelli, G., 2007. The Role Played by Stakeholders in the Public Debate that Brought Italy out of the Club of Nuclear Energy Producers. *Health Physics*, 93, 261-266.

Carlé, B., Turcanu, C.O., Van Aeken, K., Hardeman, F., 2007. Nuclear emergency preparedness: Study of the risk perception and the consequences for emergency planning in Belgium. Trans. I. Comm. in: B. VandeWalle, X. Li, S. Zhang (Eds.), 2nd International Workshop on Information Systems for Crisis Response and Management. Harbin Engineering Univ, Harbin, PEOPLES R CHINA, pp. 445-450.

Dubreuil, G.H., Lochard, J., Girard, P., Guyonnet, J.F., Le Cardinal, G., Lepicard, S., Livolsi, P., Monroy, M., Ollagnon, H., Pena-Vega, A., Pupin, V., Rigby, J., Rolevitch, I., Schneider, T., 1999. Chernobyl post-accident management: The ETHOS project. *Health Physics*, 77, 361-372.

Eurobarometer, 2005. Public opinion in the European Union, EB65.

Eurobarometer, 2008. Eurobarometer: Attitudes Towards Radioactive Waste. European Commission.

Eurobarometer, 2008. Values of Europeans, EB69.

Gamson, W.A., Modigliani, A., 1989. Media discourse and public opinion on nuclear power: a constructionist approach. *The American Journal of Sociology* 95, 1 - 37.

IAEA, 1994. Guidelines for Agricultural Countermeasures Following an Accidental Release of Radionuclides Technical report series No. 363. IAEA, Vienna.

IAEA, 2006. Manual for first Responders to a Radiological Emergency. in: I.A.E. Agency (Ed.) Emergency Preparedness and Response, Vienna.

IAEA, 2007. Safety Glossary; Terminology Used in Nuclear Safety and Radiation Protection. IAEA, Vienna, pp. 238.

ICRP, 1991. Recommendation of the International Commission on Radiological Protection. in: I.C.o.R. Protection (Ed.). Pergamon Press, Oxford, New York, Frankfurt, Seoul, Sydney, Tokyo.

ICRP, 2007. Annals of the ICRP: The 2007 Recommendation of the International Commission on Radiological Protection. in: Publication 103, Valentin J. (ed.). Elsevier.

Kovach, B., Rosenstiel, T., 2007. The Elements of Journalism: What Newspeople Should Know and The Public Should Expect Three Rivers Press, New York.

Krippendorff, K., 2004. Reliability in Content Analysis. *Human Communication Research*, 30, 411-433.

McCombs, M.E., Shaw, D., 1972. The agenda-setting function of the mass media. *Public Opinion Quarterly*, 689, 813-824.

Neuendorff, K., 2002. The Content Analysis Gueidebook. Sage Publication, Thusand Oaks, California.

Rojas-Palma, C., Liland, A., Jerstad, A.N., Etherington, G., Perez, M.R., Rahola, T., Smith, K., 2009. TMT Handbook; Triage, Monitoring and Treatment of people exposed to ionising radiation following malevolent act. Lobo Media AS, Norway.

Rowe, G., Frewer, L., Sjöberg, L., 2000. Newspaper reporting to hazard in the UK and Sweden. *Public Understanding of Science*, 9, 59-78.

Rupar, V., 2010. Journalism and Meaning-Making; Reading the Newspaper. Hampton Press.

Slovic, P., Finucane, M.L., Peters, E., MacGregor, D.G., 2004. Risk as analysis and risk as feelings: Some thoughts about affect, reason, risk, and rationality. *Risk Analysis*, 24, 311-322.

Spence, P.R., Burke, J.M., Lachlan, K.L., Seeger, M.W., 2007. Media use and information needs of the disabled during a natural disaster. *Journal of Health Care for the Poor and Undeserved*, 18, 394–404.

Spence, P.R., Lachlan, K.L., Griffin, D.R., 2007. Crisis Communication, race, and natural Disasters. *The Journal of Black Studies*, 37, 539–554.

Stritar, A., 2009. Incident at Krško NPP and panic in Europe. in: ENS (Ed.) PIME, Edinburgh.

UNEC, 1998. Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters: Aarhus Convention. in: U.N.E.C. Europe (Ed.), Aarhus.

Vasterman, P., 2005. Media-Hype. Self-reinforcing News Waves. Journalistic Standards and the Construction of Social Problems. *European Journal of Communication*, 20, 508-530.

Visschers, V., Meertens RM, Passchier WW, de Vries NN., 2009 Probability information in risk communication: a review of the research literature. *Risk Anal.*, 29, 267-87.

Vliegenthart R, Walgrave S. The Contingency of Intermedia Agenda-Setting. A Longitudinal Study in Belgium. *Journalism and Mass Communication Quarterly* 85: 860-877; 2008.

Walgrave, S., Van Aelst, P., 2006. The Contingency of the Mass Media's Political Agenda Setting Power: Towards A Preliminary Theory. *Journal of Communication*, 56, 88-109.

Whitfield, S.C., Rosa, E.A., Dan, A., Dietz, T., 2009. The Future of Nuclear Power: Value Orientations and Risk Perception. *Risk Analysis*, 29, 425-437.

Wien, C., Elmelund-Praesteker, C., 2009. An Anatomy of Media Hypes:Developing a Model for the Dynamics and Structure of Intense Media Coverage of Single Issues. *European Journal of Communication*, 24, 183-201.

Wilson, J., 1996. Understanding Journalism. Routledge, London and New York.

WNO, W.N.O., 2008. Nuclear Power in Germany http://www.world-nuclear.org/info/inf43.html.

Wolfsfeld G, Sheafer T. Competing Actors and the Construction of Political News: The Contest Over Waves in Israel. *Political Communication* 23: 333-354; 2006.

7. Importance of Risk Communication During and After a Nuclear Accident

Manuscript published as:

Perko T.- ***Importance of Risk Communication During and After a Nuclear Accident*****.- In: Integrated Environmental Assessment and Management, 7:3(2011), p. 388-392.- ISSN 1551-3777**

Abstract

Past nuclear accidents highlight communication as one of the most important challenges in emergency management. In the early phase, communication increases awareness and understanding of protective actions and improves the population response. In the medium and long term, risk communication can facilitate the remediation process and the return to normal life. Mass media play a central role in risk communication. The recent nuclear accident in Japan, as expected, induced massive media coverage. Mass media were employed to communicate with the public during the contamination phase and they will play the same important role in the clean-up and recovery phase. However, media also have to fulfil the economic aspects of publishing or broadcasting, with the "bad news is good news" slogan being a well-known phenomenon in journalism. This study addresses the main communication challenges and suggests possible risk communication approaches to adopt in the case of a nuclear accident.

Challenges of Risk Communication During Nuclear Emergencies

Past major nuclear emergencies include those from Windscale (UK, 1957), Three Mile Island (Harrisburg, Pa., USA, 1979), Chernobyl (USSR, now Ukraine, 1986) and Tokai Mura (Japan, 2000), with important lessons related to risk communication.

The communication approach taken during and after the Windscale accident drastically reduced the public acceptance of nuclear installations. It raised public discussion about nuclear energy and *"had profound political effects"(Wakeford, 2007, p. 212).*

Poor risk communication during and after the Three Mile Island accident induced uncertainty and panic, in addition to a spontaneous and unnecessary evacuation of more than 100 000 persons (Sohier, 2002). Due to lack of public information, the evacuation was mainly driven by hearsay. The communication process went wrong in many aspects. It is reported (Boiarsky, 2004) that the writers did not include necessary information, they omitted necessary details, placed important information in inappropriate locations, used qualifiers to reduce perceptions of the consequences of actions, and failed to follow organizational conventions related to the transmission of information. The emergency management communicators lacked knowledge of rhetorical strategies.

Decades after the Chernobyl accident, non-technical issues in the mitigation of consequences were highlighted as one of the greatest challenges. Psychological, sociological, political and other impacts on the public perception were long-lasting due to poor risk communication (Abbott *et al.*, 2006; Bertell, 2008; Cantone *et al.*, 2007; Dubreuil *et al.*, 1999; Havenaar *et al.*, 2003; Jackson *et al.*, 2002; Oughton, 2008; Poumadere, 1995; Schmid, 2001; Sjöberg and Drottz, 1987).

The Chernobyl accident is still remembered by the lay public 25 years after the event. Opinion polls about this accident within Europe still demonstrate large uncertainty in the population as regards its consequences and, due to opaque communication, distrust towards the authorities, along with fear of its consequences (Van Aeken *et al.*, 2007). The communication of the various aspects of the Chernobyl accident *"became increasingly politicized with regard to related policy agendas*" (Abbott *et al.*, 2006, p. 105). The Chernobyl accident is a dramatic example of an event requiring good and transparent risk communication with the public affected, either directly or indirectly, long after the acute phase of the crisis.

Risk Communication as a Management Aid to the Fukushima Nuclear Emergency

Nuclear emergency management is often presented as a cycle composed of risk assessment, planning, response, recovery and evaluation (Turcanu *et al.*, 2008). Communication should be integrated into all parts of this cycle (see Figure 7.1). Good communication in nuclear emergencies such as the Fukushima accident leads to increased awareness and understanding of emergency response measures and improves population response. It helps to adjust behavioural intentions that may intuitively seem correct, but may actually cause additional negative health effects and safety consequences (Hunt, 1994; Palenchar and Heath, 2005). In this way, risk communication helps making nuclear emergency management fully functional.

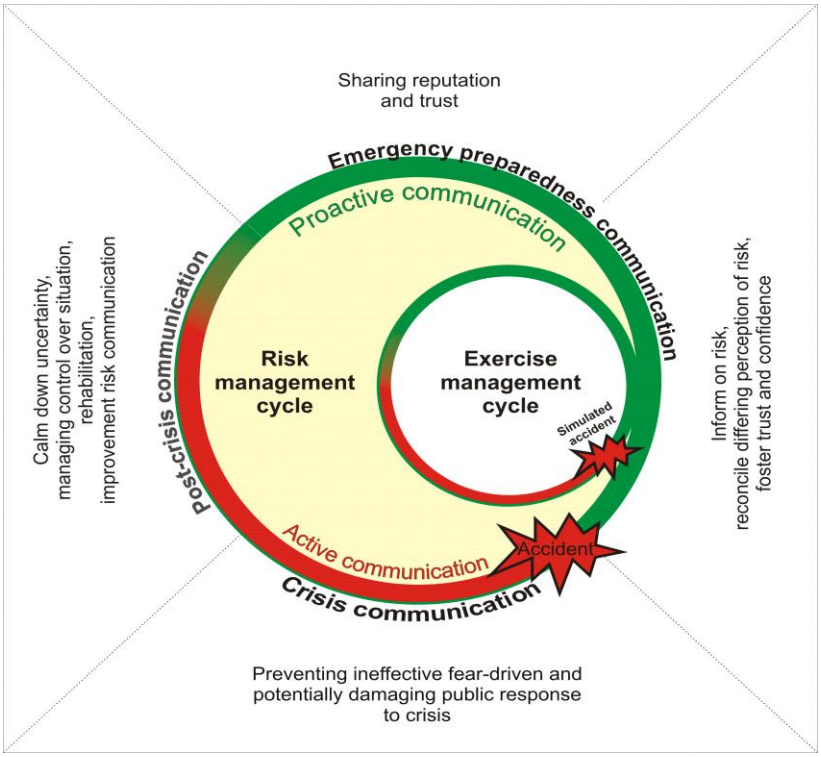

Figure 7.1: Risk communication in the nuclear emergency management cycle.

In nuclear crisis communication, the main goal is preventing ineffective, fear-driven and potentially damaging public response to the crisis. In post-crisis communication the goals are highly dependent on the situation: addressing the uncertainty felt by the population, informing about the situation, building trust and working towards a widely accepted and supported rehabilitation project by developing stakeholder involvement and partnerships. Two-way communication among all stakeholders (e.g. operators, regulators, directly and indirectly affected population, NGO's, international community: IAEA, WHO etc.) is essential. There are various methods, tools and procedures that could be applied in nuclear emergency management communication and stakeholder involvement, in early (crisis) communication as well as in long-term (post-crisis) communication, as summarised in Table 7.1.

Table 7.1: Practical recommendations for crisis and post-crisis communication in case of a nuclear accident

Nuclear emergency management communication	Early (crisis) communication	Long-term (post-crisis) communication
Goals	Prevent ineffective, fear-driven and potentially damaging public response to crisis.	Reduce uncertainty; maintain control of the situation; facilitate rehabilitation.
How to reach the goals	- Rapid and continuous communication to the general public and to affected groups - Express empathy and address people's concerns about radiological risks. - Provide information about how can people protect themselves, e.g. wash vegetables, stay indoors. - Designate crisis spokespersons and formal channels and methods of communication. - Make sure that communicators have a good understanding of the crisis circumstances and potential outcomes. - Admit uncertainties, e.g; health effects of low doses.	- Explain potential risks (e.g. living in a contaminated area) - Communicate both risks and benefits of remediation options - Assess radiation risk perception of the population - Inform the general public about ongoing risks (e.g. safety of nuclear installations) and related decision-making - Get feedback on the risk management from affected publics and clarify misunderstandings and rumours. - Ensure open and transparent communication between the environmental remediation actors and the population - Initiate stakeholder engagement about ongoing clean-up, remediation, recovery, and rebuilding efforts. - Facilitate broad, honest, and open discussions and resolutions of issues regarding cause, blame, responsibility, and adequacy of response. - Document, formalize, and communicate lessons learned. - Determine specific actions to improve nuclear crisis communication and crisis response capability.
Method	Active communication, balanced emotions and facts	Proactive communication, two way communication and consultation; participatory methods
Tool/ communication channel (selected)	- mass media: TV, radio, newspaper, internet - personal appearance (e.g. visit of governmental representative at the contaminated site) - face to face communication (e.g. discuss with affected family) - meetings - leaflets, posters, letters - web sites, e-mail, blogging, photo sharing - SMS short message service	- mass media: TV, radio, newspaper, internet - stakeholders meetings, - excursions, - opinion exchange, - working groups, - consultancy, - focus groups - personal appearance - face to face communication
Procedure	-Establish a multidisciplinary communication team (lawyer, doctor, psychologist, person to follow media response live, radiological experts) - Develop short messages. - Develop a written public statement. - Prepare possible questions and answers. - Control information flow and feedback (e.g. centralise contacts with media). - Form alliances (retired nuclear engineers, academicians, family doctors, priests, etc) - Open information sources: e.g. call centre, info point - Analyze at least every 24 h - Control rumours: follow and respond to rumours.	- Information follow-up - Feedback follow-up - Analyze and improve communication: collect media clips, open FAQ - Involve scientific research (social science) - Use stakeholder involvement methods

Communication in a nuclear accident situation should reflect and respond to the specifics of the emergency, society and the culture. Therefore, there is no general 'recipe' for sound communication in nuclear accident situations. The Fukushima nuclear accident involved unique circumstances, including multiple infrastructure failures and competing public priorities, such as providing for the basic human needs of earthquake and tsunami victims. The circumstances of the accident haven't yet been fully clarified and the situation may still evolve, due to earthquake aftershocks or changes in the affected units.

Role of the News Media During Nuclear Accidents

The nuclear accident in Japan has predictably induced enormous media coverage. In general, mass media play a dominant role at all levels of communication on nuclear emergency issues. They are the prominent information channel for the general public, being used for communication by different stakeholders and acting as the “watchdog” of society. They monitor the nuclear emergency management and the subsequent remediation process. Media form a link between the emergency actors and the risk perception among the population. However, media also have to fulfil the economic aspects of publishing or broadcasting, with "bad news is good news" being a well-known phenomenon in journalism. Due to this, some broad and perhaps even exaggerated coverage of the Fukushima nuclear accident by the mass media is to be expected (see Table 7.2).

Table 7.2: Reasons for media attention to the Fukushima nuclear accident

What is newsworthy for media in general?	Specifics of newsworthiness of the Fukushima nuclear accident?
Extraordinary event	Nuclear accident as a consequence of earthquake and tsunami of large magnitude. None or rare past experiences with radiological risks .
New or unusual information	Combination of natural disaster and manmade risk.
Conflict	Questioning of transparency and decision making. Humans tampering with nature.
Drama	Radiation is continuously being released into the environment. Will they be able to solve the problem?
Tragedy	Dread, catastrophe, link to Chernobyl, …
Presence of elite or celebrities	Politicians, superstars, pop idols, NGOs, presidents of the countries, etc, … comment on the accident.
The situation (event) can be personalized	Can radiation affect me and my family? (Wide-spread concerns)
The event evokes emotional response	Evacuation, frightened people, ruins of nuclear installations

Communication Strategies

In the early phase of the Fukushima nuclear accident, public messages needed to contain information about: 1) the hazard associated with emergency event; 2) instructions on a proper course of action during an emergency; and 3) instructions for the post-event phase, in order to prevent harmful effects. The most common questions addressed to the nuclear emergency management in this early phase are presented in Table 7.3 which is based on best judgment. Those questions need to be followed later by technical questions, as well as clarification on who is responsible for the different actions, including the role of public authorities.

Table 7.3: Questions to be addressed in early phase of nuclear emergency

Questions to be addressed in early phase of nuclear emergency
- How does radioactivity travel (e.g. wind, air, water, plume dispersion, etc.)? - How can radioactivity be spread (other people, animals, etc.)? - How far can radioactivity travel? - Will radioactivity contaminate the water and food? - How long will the contamination last? - How much radioactivity is safe? - How are radioactivity levels determined? - How are radioactivity levels monitored? - What are the symptoms of exposure? - How do individuals know if they have been contaminated or not, as symptoms might not show-up immediately? - What can individuals do to protect themselves? - What are the short- and long-term effects of contamination? - How will the sick and injured be treated? - Are the hospitals able to cope? - What is the likelihood of becoming contaminated? - What are the sources of information? - How can I obtain further information related to the event?

Conclusions

Risk communication is one of the cornerstones of successful emergency management. In the nuclear field, crisis communication that restricts itself to facts, but fails to account for peoples' knowledge (or lack of it), their perception of risks and their relative inexperience, is incomplete and ineffective. There is also a risk of panic or abuse of a nuclear emergency situation for political purposes. In contrast, proper and transparent communication will strengthen trust in the nuclear actors and ensure a good response to protective measures for the population. Risk communication can help people return to normal life.

The Fukushima nuclear accident will undoubtedly provide another lesson on the importance of risk communication. It is too early to evaluate how successful the applied communication strategy has been until now. We can only hope that nuclear emergency actors worldwide continue to learn from previous experiences and will not repeat the mistakes committed in historical nuclear accidents.

References

Abbott, P., Wallace, C., Beck, M., 2006. Chernobyl: Living with Risk and Uncertainty. *Health Risk & Society*, 8, 105-121.

Bertell, R., 2008. Chernobyl: An Unbelievable Failure to Help. *International Journal of Health Services*, 38, 543-560.

Boiarsky, C., 2004. Avoiding disasters with better communication. Trans. C. Soc Tech 51st Annual Conference of the Society-for-Technical-Communication. Soc. Technical Communication, Baltimore, MD, pp. 387-391.

Cantone, M.C., Sturloni, G., Brunelli, G., 2007. The Role Played by Stakeholders in the Public Debate that Brought Italy out of the Club of Nuclear Energy Producers. *Health Physics*, 93, 261-266.

Dubreuil, G.H., Lochard, J., Girard, P., Guyonnet, J.F., Le Cardinal, G., Lepicard, S., Livolsi, P., Monroy, M., Ollagnon, H., Pena-Vega, A., Pupin, V., Rigby, J., Rolevitch, I., Schneider, T., 1999. Chernobyl post-accident management: The ETHOS project. *Health Physics*, 77, 361-372.

Havenaar, J.M., de Wilde, E.J., van den Bout, J., Drottz-Sjöberg, B.M., van den Brink, W., 2003. Perception of risk and subjective health among victims of the Chernobyl disaster. *Social Science & Medicine*, 56, 569-572.

Hunt, T., Grunig, J., 1994. Public Relations Techniques. Fort Worth, TX: Harcourt, Brace.

Jackson, R.J., DeLozier, D.M., Gerasimov, G., Borisova, O., Garbe, P.L., Goultchenko, L., Shakarishvili, G., Hollowell, J.G., Miller, D.T., 2002. Chernobyl and iodine deficiency in the Russian Federation: An environmental disaster leading to a public health opportunity. *Journal of Public Health Policy*, 23, 453-470.

Oughton, D.H., 2008. The Social, Economic and Ethical Consequences of the Chernobyl Accident. in: R. Mrabet El (Ed.) 4th International Symposium on in Situ Nuclear Metrology as a Tool for Radioecology, Morocco, pp. 18.

Palenchar, M.J., Heath, R.L., 2005. Strategic risk communication: Adding value to society Conference on New Perspectives on Crisis Communication. Elsevier Science Inc, Washington, DC, pp. 120-129.

Poumadere, M., 1995. Issues in Communication with the Public on Health and Environmental Risk. *European Review of Applied Psychology-Revue Europeenne De Psychologie Appliquee*, 45, 7-16.

Schmid, S.D., 2001. Transformation discourse: Nuclear risk as a strategic tool in late Soviet politics of expertise Workshop on Technologies of Uncertainty - Reconstructing Order through Rethorics of Risk. Sage Publications Inc, Ithaca, NY, pp. 353-376.

Sjöberg, L., Drottz, B.M., 1987. Psychological Reactions to Cancer Risks after the Chernobyl Accident. *Medical Oncology and Tumor Pharmacotherapy*, 4, 259-271.

Sohier, A., 2002. A European Manual for OFF-site Emergency Planning and Response to Nuclear Accidents. December, 2002 ed. Belgian Nuclear Research Centre, SCK CEN, pp. 339.

Turcanu, C.O., Carlé, B., Paridaens, J., Hardeman, F., 2008. On the constructive role of multi-criteria analysis in complex decision-making: An application in radiological emergency management. Trans. S. European, S.R.A.E. Reliabil Assoc. in: S. Martorell, C.G. Soares, J. Barnett (Eds.), European Safety and Reliability Conference (ESREL)/17th Annual Meeting of the Society-for-Risk-Analysis-Europe (SRA-Europe). Crc Press-Taylor & Francis Group, Valencia, SPAIN, pp. 89-96.

Van Aeken, K., Turcanu, C.O., Bombaerts, G., Carlé, B., Hardeman, F., 2007. Risk perception of the Belgian population. Results of the public opinion survey in 2006. . Belgian Nuclear Research Centre SCK•CEN BLG-1038, Mol, Belgium.

Wakeford, R., 2007. The Windscale Reactor Accident - 50 Years on. *Journal of Radiological Protection*, 27, 211-215.

8. Conclusions

"When distant and unfamiliar and complex things are communicated to great masses of people, the truth suffers a considerable and often a radical distortion. The complex is made over into the simple, the hypothetical into the dogmatic, and the relative into an absolute."
Walter Lippman, 1922

How can we improve communication in nuclear emergency management? What can we learn from the study of predictors influencing the different stages of information processing to better communicate about radiological risks? Moreover, what lessons can be drawn from investigating the information provided to the public by the mass media in a case of a nuclear emergency? This dissertation aims at supporting the efforts to provide an effective public communication before, during and after a nuclear emergency. It provides evidence that for information processing not all predictors recognised in the theory of risk research have the same influence on the reception and/or the acceptance of information. In addition, this dissertation sheds some light on some of the mechanisms underlying media reporting about nuclear emergencies during or after an emergency.

We have modelled risk perception and risk communication in the context of different nuclear events and communication campaigns; for this purpose we have used an interdisciplinary approach, touching on several fields of research: risk communication, political communication, risk perception, emergency management, radiation protection and opinion formation. The case studies investigated range from communication in the framework of nuclear emergency preparedness, to crisis communication and post crisis communication of radiological risks. The research is not entirely focused on major nuclear accidents, which is a common practice in the literature; it also addresses minor nuclear events which do not get enough attention from researchers, although they occur frequently[5] and the public should be (at least) informed about them.

The conclusions emerging from the preceding chapters and the main answers pertaining to the above mentioned questions are summarised and discussed below. In the closing parts some practical directions stemming from our research are proposed for sound risk communication in nuclear emergency management.

Which predictors influence the different stages of information processing during a nuclear crisis, post-crisis or nuclear emergency preparedness?

We started our investigation with one of the central questions in this dissertation: at which stage of information processing do predictors such as risk perception, trust, knowledge and other predictors traditionally used in risk research, start to influence opinion formation? In order to address this question, the basic concepts used as dependent variables (reception and acceptance) are taken from Zaller (2006), but the operationalization of several concepts used as independent variables was driven by the risk research theory developed by Griffin (1999), Slovic (2004), Sjöberg (2006), Renn (2008) and others.

We thus introduced a new approach for the analysis of risk communication by adapting the Reception-Acceptance information processing model of Zaller (2006) from political communication to risk communication. This new approach was then tested in various contexts related to nuclear emergency management. The rationale for choosing Zaller's model as a starting point in our investigation is that it highlights the stage of information processing in which the different predictors start to influence opinion formation. In addition, this model makes it possible to easily determine and test empirically (e.g. by opinion surveys) the influential predictors for the *reception* and *acceptance* of risk-related information.

[5] Daily information on nuclear and radiological events happening in IAEA member states is published on http://www-news.iaea.org/EventList.aspx. For instance, two emergency events were posted in January 2012, and four emergencies in February 2012.

Based on the early research by the memory-based models of Converse (1964), McGuire (1973), Iyengar and Kinder (1987), Zaller postulated the importance of the awareness (measured by, among others, specific knowledge and education) for the reception of the information (Price and Zaller 1993) and the importance of predispositions (e.g. values, attitudes and world view) for the acceptance of the communicated message (Zaller 2006). In political communication, the Reception-Acceptance model was tested and confirmed by several scholars (Bützer and Marquis 2002; Dobrzynska and Blais 2007; Goren 2004; Krosnick and Brannon 1993; Kulakovski 2009; Liu 2005).

Based on the literature on risk research, we have tested, in addition to the predictors postulated by Zaller, the influence of the following variables for the different stages of the information processing: attitudes (O'Keefe, 2002); trust in the authorities to protect the population (Chryssochoidis, Strada and Krystallis 2009; Peters, Covello and McCallum 1997; Renn 2004; Renn 2008; Sjöberg 2004); risk perception of nuclear accidents and psychometric characteristics of a nuclear accident, i.e. disaster potential, tampering with nature and unfamiliarity (Fischhoff *et al.* 1978; Sjöberg 2000; Sjöberg and Wahlberg 2002; Slovic, Flynn and Layman 1991). We measured the influence of these variables for both the reception and the acceptance of information.

Our empirical studies show that the application of the Reception-Acceptance model (Zaller 2006) from political communication to risk communication gives additional insights in processing of risk-related information.

In Chapter 2 we tested the Reception-Acceptance model in the context of crisis communication triggered by a radiological accident in Fleurus (Belgium). Our results confirmed Zaller's findings (Price and Zaller 1993; Zaller 2006) that: i) specific knowledge is the dominant predictor for the reception of risk messages (here operationalized by recall) and ii) that knowledge is not significant at the level of acceptance, but can act as a facilitating variable. For instance, people who were more knowledgeable about nuclear issues in general were more likely to know when and where did the accident happen and what kind of protective actions were taken by the authorities; however, they didn't necessarily agree with these actions.

For the acceptance of protective actions communicated to the broader public we demonstrated that the perceived disaster potential of a nuclear accident was the most influential predictor. Specific knowledge could not predict the acceptance of information. However, taking specific knowledge as a facilitating variable for information acceptance in the general population, we noticed the joint effect with some predispositions (dread).

In addition, we investigated if and how did the predictors and the strength of these predictors vary among two population groups: the population that has been directly affected by a radiological accident, respectively the population that had neither been exposed to protective actions, nor has it been target population for risk communication. Several differences in what concerns information processing were identified between the general population and the affected population. As opposed to the general population, in the affected population, socio-demographic variables such as gender or education were revealed as not important for information processing. This could be due to the higher intensity of the communication campaign in the affected population and a higher saliency of the issue. Based on the findings, we can conclude that the more affected one is by an emergency, the less important socio-demographic characteristics are for the information processing. In addition, specific knowledge (indicator of systematic information processing) was revealed as more influential for the reception of information in the affected population than in the general population. At

the same time, risk perception (indicator of heuristic information processing) was revealed as the most significant predictor for information reception in the group of the general population that remembered the accident: respondents with higher risk perception were more likely to remember more details about the accident. Risk perception was however not significant for information reception in the affected population.

In Chapter 3 we looked at pre-crisis communication (preventive distribution of iodine tablets) in order to answer the following question: what makes people attentive to emergency preparedness information, given that this relates to a hypothetical situation that may never happen? Thus, the dependent variable studied in this chapter was reception of risk communication. Furthermore, we identified subgroups of population who are expected to be particularly inattentive to communication about protective actions in case of a nuclear emergency.

Since people process information in two central information processing modes: heuristic and systematic, we tested the influence of both systematic and heuristic information processing indicators. Heuristic processing is most strongly characterized by low effort and reliance on existing knowledge and simple cues, while systematic processing is most strongly characterized by greater effort and the desire to evaluate information formally (Trumbo 1999). Our findings suggest that indicators of systematic information processing have a stronger influence on the reception of information than the indicators of the heuristic mode. The latter are only to a minor extent involved in the reception of emergency preparedness information. The hypothesized pattern—that more prior knowledge about the field relates to a higher reception of information—was thus confirmed also for pre-crisis communication. Contrary to expectations, results showed that among the people who were aware of the iodine campaign, those having a high perception of industry-related radiological risks were less attentive to information about protective actions than people with low risk perception. This poses challenges for nuclear emergency communicators since one third of the population has a high or very high perception of a nuclear accident.

In addition, our results suggest that people with higher trust in authorities were more likely to have a low reception of information, i.e. they recalled less details about the communication campaign for preventive distribution of iodine tablets.

Our results (in technical note) have also confirmed the importance of systematic information processing for the acceptance of communicated messages related to the iodine campaign. Respondents that processed the information related to iodine tablets more heuristically seemed less inclined to agree with the communicated messages than respondents that processed the information more systematically. A higher acceptance of the communication campaign related to iodine tablets as whole seems to be mostly driven by systematic information processing and the trust in experts. However, specific knowledge was also significant in predicting the acceptance of a particular message related to iodine tablets, namely that these protect against thyroid cancer.

In Chapter 4, we provide further evidence for the importance of prior knowledge for the acceptance of risk-related communication and for the perception of the communicated risk. Thus, the dependent variables studied in this chapter were information acceptance and risk perception. The goal of this chapter was to test empirically the predictors of information processing (identified in the first two chapters) in two independent case studies in different countries. The communication context of both studies is related to long term communication, but one of them addressed emergency preparedness actions, whereas the other focused on risk assessment for a radioactive waste disposal. This chapter provides empirical evidence that the main

predictors for the acceptance of communicated messages are similar in different cultural and societal contexts. Although the measurement scales for the various predictors were not completely the same and the communication campaigns were different, the predictors for the acceptance of risk-related information and for the perception of communicated risk were similar in the two case studies. It is interesting that confidence in authorities did not emerge as a significant predictor, neither for the acceptance of risk messages, nor for the perception of related risks. This confirms our results related to the crisis communication in the general population sample discussed in Chapter 2, where trust in authorities was a weak predictor for the acceptance of information only in the affected population, but not in the general population.

Having less confidence in authorities did not seem to lead people in either case study (Belgium and Slovenia) to have stronger negative feelings towards the communicated risk. As opposed to the crisis communication context described in Chapter 2, specific knowledge was a significant predictor of information acceptance in the non-crisis communication context. A higher specific knowledge leads to more willingness to accept the communicated messages, but it does not affect people's perception of the specific risk communicated. Specific knowledge appears important for the acceptance of communicated messages, but the perception of other radiological risks (for instance medical X-rays or natural radiation) may be an even more important predictor.

To conclude, the Reception-Acceptance model was adapted and tested in a pre-crisis and crisis risk communication context. Our results confirm the influence of awareness on the reception of information and of predispositions (in particular risk perception) on the acceptance of information. The results are in line with e.g. Griffin *et al.* (2008), Kahlor *et al.* (2006) and Huurne *et al.* (2009), have also found a positive direct relationship between knowledge and perceived information-gathering capacity, which confirms that the amount of knowledge people hold about a risk affects their capacity to gain new information about it.

However, differences were observed between the crisis and pre-crisis communication contexts. For instance, specific knowledge acted as a facilitating variable in the crisis context, but had a direct, significant influence on information acceptance in pre-crisis communication.

Since the research by Slovic (2002), Fischhoff (1993), Renn (2008) and others have found that these variables influence the response to risk information, we identified that this variables are influential mainly for the acceptance part of the information processing and not for the reception part.

What kind of information do people get from mass media in a case of a nuclear emergency?

The traditional approach to studying and analysing risk communication is based on the communication model of information transfer among sources, transmitters and final receivers. The original model was developed by Lasswell in 1948. In this model everybody (re)codes the information or, in other words, everybody converts the original message into a new message. In our study we focused on the mass media as transmitters. The transmitter receives and processes information, e.g. related to nuclear emergency management, and subsequently, it acts as an information source for the population affected by nuclear emergency management and for the general population.

Mass media are main the information transmitter (channel) related to nuclear event.

In Chapter 5, we turn to the question concerning the type of information people receive from the media in case of a nuclear event. In particular, we investigated how and what media reported about a severe nuclear accident (Fukushima, 2011), what was in the focus and for how long was the accident newsworthy. The changes in public opinion related to nuclear issues are addressed and the influence of the past nuclear accidents on media framing is identified.

The results of our media content analysis show that the Fukushima accident induced enormous media coverage in the first weeks after the accident. The accident in Japan contained most of the factors that are assumed to determine the attractiveness of risk-related messages for media. For instance drama and conflict, technologically induced hazard, uncertainty and controversy. However, media attention to the accident decreased over time, despite the fact that emergency management continued to remain a challenge at the nuclear power plant and was expected to have broad radiological, social and economic consequences. In a previous study related to media attentiveness to different disasters, Linder (2000) compared the perception of the Chernobyl accident with other, non-nuclear disasters and found that other human-made or natural disasters are relatively faster forgotten in the media coverage (Lindner 2000, p.282).

At the outset of the accident, media focused their attention on multiple topics; yet, attention decreased with time and became limited to the future of nuclear energy and the safety and crisis management aspects. In many cases, the nuclear accident was (ab)used in the media coverage as a frame for discussions about the national future of nuclear energy.

The results of the media content analysis showed that the overall orientation of the published articles towards nuclear energy was neutral and the articles were mostly objective. However, the articles' orientation towards nuclear energy displayed a clear emphasis on the negative aspects in April 2011, at the time of the 25th aniversary of the Chernobyl accident. This result is in line with the findings of the previous studies related to the nuclear accidents at Chernobyl or Three Mile Island which became part of the collective memory and as such, linked to media reporting about any nuclear event (Boomgaarden and de Vreese 2007; Greenberg and Truelove 2011; Triandafyllidou 1995; van der Brug 2001; Zorkaja 2006).

The fact that the word "Chernobyl" appeared in the articles almost every day and that comparisons were made repeatedly between the two accidents, allows us to infer that the journalists presented the Fukushima disaster through the frame of the Chernobyl accident. This goes in parallel to the observed change in the public opinion which has shifted towards more negative opinions and attitudes towards nuclear energy as compared to previous years. For instance, in 2009 the opinions about nuclear energy were rather balanced, with a slightly higher number of respondents in favour (32 % pro, respectively 24 % against nuclear energy) and a large number undecided. In 2011, after the Fukushima nuclear accident, there is a clear switch: only 18 % of the respondents are in favour of nuclear energy and 45 % are against it. In addition, there is more concern about safety of nuclear installations, and there is an increased tendency to evaluate the risks from nuclear energy as higher than the benefits it brings. The results therefore show that the Fukushima nuclear accident led to changes in the public opinion related to nuclear energy, which could be clearly measured in the third month after the accident, thus after the high media attention to the Fukushima nuclear accident.

In Chapter 6, we focused on media coverage of a minor nuclear event occurring at the Krško NPP in Slovenia in 2008. We explored the role of mass media in shaping the crisis after transparent and open communication from the main nuclear actor and in the different national contexts.

While the main focus of the published media news was on the safety/risk aspects, other highly reported topics were the discussion related to political problems, ownership issues, ideological discussions and the nuclear program. Results show that media coverage is not systematically higher in countries geographically closer to the affected country than in more distant ones. Moreover, the results support the assumption that the frequency of media articles related to the nuclear event was higher in states where the nuclear program was under public and political discussion, than in the other states. In the states with vivid political discussions related to the nuclear energy program, the information or opinion given in the news was usually the opinion of the government or a political party. Despite the existence of primary sources of information for the nuclear emergency, the media often referred to secondary sources of information and sometimes even omitted the primary one. The study highlighted that even a minor nuclear event is linked to a high catastrophic potential and the collective memory of Chernobyl. The word "Chernobyl" appeared regularly in the media reports analysed.

The results from both media content analyses support the conclusion that the magnitude and the probability of a nuclear event seem to play only a minor role in the media coverage of nuclear emergencies. The media are not mere transmitters of the nuclear event, but they report also on the nuclear emergency management and other issues that are of concern for the society, for instance the future of nuclear energy in the country (which confirms e.g. Cantone, Sturloni and Brunelli, 2007). It seems that media construct the reality of a nuclear event. In general, the media coverage of nuclear emergences reflects the organizational rules, the external expectations - for instance public opinion - and the memory of the past nuclear experiences (including accidents). The political salience of the issue dominates the transformation process related to nuclear emergency management and influences media reporting. The degree of social (political) conflict related to the nuclear energy program correlates strongly with media coverage. The media content related to nuclear events (either minor event or nuclear accident) is a mix of original messages describing the event and re-coded messages (e.g. the health effects of the event as estimated by different experts). Thus, media leave it to the final receiver (affected population or general population) to understand what is the original information and what is the broader framework hinted at by various (other) transmitters reported in the media. These other transmitters were revealed to be politicians, pressure groups, independent researchers or independent experts. Signals relating to conflicts, disagreements and contradicting information between the different sources of information are intensified in media reporting about nuclear events.

To conclude, we addressed shortcomings in previous research on media reporting about nuclear events by developing strict scientific and coding protocols, measurement methods, code books and calculating inter-coder reliabilities and by the study of minor nuclear events. Our study shows that in the case of nuclear events, even minor incidents may pose great challenges for nuclear emergency communicators.

Practical implications for nuclear emergency communication

On the basis of our analytical approach distinguishing between information reception and acceptance, we propose a set of suggestions for increasing the number of people that will be attentive to, comprehend and recall the information, as well as for increasing the acceptance of risk-related messages. These can be considered as preconditions for risk communication and provide orientations for designing nuclear risk communication strategies.

Our findings support the idea that pre-crisis communication has to account for the way people feel about a risk, with sufficient attention given to different risk perceptions. Specific communication has to be designed

for people having a high risk perception, since they seem to have a lower reception of preparedness related information.

In general, public understanding of nuclear risk-related information is hindered by the complexity of the risk concept. This concept includes not only the probability and consequences of a nuclear event, but also the specific risk characteristics. For nuclear hazards such characteristics are, among others, the strong link to a high catastrophic potential, the fear and the unfamiliarity. These and other characteristics of the nuclear risk have to be addressed by risk communicators. For instance, in the preparedness plan for nuclear emergencies it would be advisable to communicate information about how a catastrophic event can be avoided. The nuclear emergency authorities could develop a program for educating people about the radiation concept and moreover to involve them in nuclear risk governance (e.g. make experiments in the schools, prepare open door days, make science cafes, use stakeholder engagement tools).

Trust in experts is one of the most important preconditions for sound risk communication. The nuclear emergency authorities would benefit from involving experts in communication about nuclear emergencies. They have to select also a trustworthy communicator. It is worth to mention that trust building is a long-term process which has to address the following components of trust: competence, objectivity, fairness, consistency, sincerity, faith and empathy. It requires a full engagement of the whole nuclear emergency management and not only good communicators.

The most important lesson from the first part of the study brings into attention the importance of prior (or specific) knowledge: the communicated message may not be received, if the audience has insufficient knowledge. If people do not possess a certain level of prior knowledge, the communicated messages will not trigger enough attention to be heard or recalled. In other words, hazards and risks have to be communicated openly long before a crisis in the context of preparedness for nuclear emergencies. Moreover, our results related to long term communication (in Chapter 4) suggest that risk communication strategies should not seek to isolate one radiation risk from the other. When risk communicators communicate about one radiation risk, they should also communicate about radiation in general. For instance, the nuclear waste agency has to communicate not only about nuclear waste, but also about natural radiation, radiation from medical exposures or radiation from mobile phones.

The empirical results obtained support the justification of long-term communication programs, through which people can increase their specific knowledge related to the risk. In addition, in order to increase the reception of communicated messages, the communicators have to develop a specific communication strategy for the people with high risk perception. For the communication campaigns in the preparedness phase of nuclear emergency management it would be advised to use an approach that stimulates systematic information processing (rather than heuristic). The regulators could, for instance, stimulate stakeholder engagement processes, include technical experts in their communication and stimulate critical thinking by, e.g. presenting both positive and negative sides of protective actions. The people who make decisions related to risk messages based on rationality, taking more effort to process and check the information and to arrive at a decision, accept the messages to a greater extent than those who process the information in a heuristic way. Thus, effective risk communication in nuclear emergency preparedness must firstly contain sufficient rational argumentation to satisfy the audience with the interest in the nuclear risk-related message.

The analysis of media reporting on a nuclear event can be beneficial for nuclear emergency management in two major aspects. On the one hand, such an analysis shows how to deliver risk messages effectively through

the media and, on the other hand, it brings insight into the information that has to be communicated to the mass media.

The nuclear emergency communicators have to be aware that the media are interested to report about the events and not the processes or the continuous development, for instance long releases and long environmental remediation works afterwards. They are more interested about the risk related to the immediate consequences than about the safety standards. Communicators have to be prepared for the media (over)pressure at the beginning of the event and for the decrease of media attention in the later stage. This bears consequences especially for the process of environmental remediation or the long term communication during risk assessment of nuclear installations. In such situations, communicators have to prepare pseudo-events to attract the media attention, for instance organised excursions to a contaminated site or visits to well-designed waste disposals.

An important result from our media content analysis relates to the nuclear emergency management in the affected zones. It is clear that journalists tend to report as close to the event as possible. The media seek to collect information both from the affected population (they report personal stories) and from the nuclear emergency authorities. This means that even if a zone is evacuated, there will be journalists willing to enter the zone regardless of risks in order to be able to eyewitness the consequences of a nuclear event. The nuclear management authorities have to protect the victims from being photographed or taped during decontamination, evacuation or collecting personal data in order to avoid stigmatisation, although there will be a high pressure of the media. Moreover, the nuclear emergency communicator although occupied with standard procedures of emergency management, has to express concern and care for the affected people.

In addition, although the nuclear emergency authorities tend to centralize communication during and after a nuclear event, they face a diversity of incoming messages caused by different perspectives on the nature of the risk. For instance the scientific uncertainty related to the health effects of low doses of radiation causes different views and argumentations presented in the media and in public or scientific debates. Thus, establishing a relation with other possible sources of information (independent experts, research institutes, local population, NGO's) in the preparedness phase of emergency management would be highly beneficial for the nuclear emergency authorities.

In the early phase of a nuclear accident, media are interested to transmit messages about the hazard associated with the emergency event, about the instructions on protective actions during an emergency and instructions for the post-event phase, in order to prevent harmful effects. The most common questions addressed to the nuclear emergency management during the event by media should be assessed in advance. Public relation officers have to be well prepared for communication of technical aspects of nuclear installation and radiological risks. For this they can develop in advance different visuals, for instance a picture with human exposure pathways that may be published in the case of an event also in the mass media.

The nuclear emergency communicators have to be well informed about all major nuclear accidents, since media memory, as well as collective memory makes links between any nuclear event with major nuclear accidents; Chernobyl or Three Miles Island. The nuclear accidents are intensively re-discussed in the media coverage, especially during the yearly commemoration of such accidents.

It is clear that sooner or later in the discussion there will be a high pressure on nuclear emergency authorities to take a side related to a nuclear energy. A good communicator should stay impartial related to this topic,

since the objective of a communication by nuclear emergency management should be to warn people, to inform about radiological risks, to prevent panic and outrage, to support the stakeholders to make informed decisions related to radiological risks, and to establish two-way communication and joint problem solving.

Limitations of the study and directions for future research

The particular limitations for each of the empirical studies carried out have been discussed in the respective chapters. A number of more general limitations is mentioned here.

We investigated risk perception and risk communication in nuclear emergency management in a number of particular cases. Naturally, it is difficult to generalize any of the findings above beyond the respective contexts from which they are derived. It can be recognized that different states have specific needs and procedures. Generalisation of the findings from this study should therefore always take into account the local and national communication culture and practices, the past experiences, the legal background, the function, trustworthiness and responsibility of communicators, as well as the role of regulators and operators when planning and communicating with the public. These particularities have to be taken into account when interpreting our findings, in order to assess to what extent they might apply to other nuclear emergency contexts. For this reason we thoroughly described the specific context for each of the case studies addressed and provided detailed information on the scales and measurement methods used.

As we pointed out, the reception of emergency management communication has been measured by the recall of information. The mechanisms and mental processes of individual information processing have been one of the most studied topics in risk or communication psychology, mostly by means of experiments. In our research we applied the survey method in order to increase the population sample and the ability to generalise the findings. Thereafter we have used the recall as a measurement for the reception, as suggested for instance by Price and Zaller (1993) or by studies in the field of risk research. As an example, the reception of risk information on genetically modified organisms by Peters (2000) was measured by inquiring about the arguments for or against GMO's that the respondents remembered after exposure to newspaper and TV stories. We are however aware that with this kind of measurement we were not able to capture the information related to some levels of reception, for instance attentiveness, ability and motivation.

Furthermore, prior knowledge or specific knowledge is used in our research as an independent variable. Due to this, the knowledge items were carefully considered in order to check if the related information had not been communicated in the information campaign. The knowledge index thus represents the level of awareness and not the level of reception. However, we were able to thoroughly analyse only the official communication, but were not able to capture an overview of the personal communication which was probably stimulated by the information campaign. Thus, it could be that some of the measurement items were indirectly reflected by the information campaign studied. Nevertheless, the comprehensive measurement of prior knowledge carried out in our study represents a multi-dimensional construct and not a unique scale. We thus avoided addressing only one level of knowledge, which could have been influenced by personal communication.

We acknowledge another limitation of our investigation. Our exclusive focus was on the acceptance construct being expressed as an attitude or opinion about protective actions. It would be very useful for nuclear emergency communicators if behaviour would be measured or modelled, as well. An attitude reflects

a person's inner thoughts and feelings, while behaviour is usually an outward expression of attitude, thus a future research can address this challenge.

This dissertation has provided what we regard as a potentially promising path for future research on risk perception and risk communication in nuclear emergencies. It has introduced new ways of looking at the reception and acceptance of risk communication campaigns and has provided explanations for the mechanisms and conditions behind media reporting about nuclear emergency management.

References

Boomgaarden, Hajo G., and Claes H. de Vreese. 2007. "Dramatic real-world events and public opinion dynamics: Media coverage and its impact on public reactions to an assassination." International Journal of Public Opinion Research 19:354-366.

Cantone, M. C., G. Sturloni, and G. Brunelli. 2007. "The Role Played by Stakeholders in the Public Debate that Brought Italy out of the Club of Nuclear Energy Producers." Health Physics 93:261-266.

Chryssochoidis, G., A. Strada, and A. Krystallis. 2009. "Public trust in institutions and information sources regarding risk management and communication: towards integrating extant knowledge." Journal of Risk Research 12:137-185.

Converse, P. E. 1964. The Nature of Belief Systems in Mass Publics.

Fischhoff, B., A. Bostrom, and M. J. Quadrel. 1993. "Risk Perception and Communication." Annual Review of Public Health 14:183-203.

Fischhoff, B., P. Slovic, S. Lichtenstein, S. Read, and B. Combs. 1978. "How Safe is Safe Enough - Psychometric Study of Attitudes Towards Technological Risks and Benefits." Policy Sciences 9:127-152.

Gamson, William A., and A. Modigliani. 1989. "Media discourse and public opinion on nuclear power: a constructionist approach." The American Journal of Sociology 95:1 - 37.

Greenberg, Michael, and Heather Barnes Truelove. 2011. "Energy Choices and Risk Beliefs: Is It Just Global Warming and Fear of a Nuclear Power Plant Accident?" Risk Analysis 31:819-831.

Griffin, R.J., J. Yang, and E. Huurne. 2008. "After the Flood: Anger, Attribution, and the Seeking of Information." Science Communication 29:285-315.

Huurne, E., R.J. Griffin, and J. M. Gutteling. 2009. "Risk Information Seeking Among U. S. and Dutch Residents: An Application of the Model of Risk Information Seeking and Processing." Science Communication 31:215-237.

Iyengar, S., Kinder, D. R. 1987. News that Matters: Television and American Opinion. Chicago: University of Chicago Press.

Kahlor, L. A., S. Dunwoody, R.J. Griffin, and K. Neuwirth. 2006. "Seeking and Processing Information About Impersonal risk." Science Communication 28:163-194.

Lindner, L. 2000. "Chernobyl today and compared to other disasters." Atw-Internationale Zeitschrift Fur Kernenergie 45:282-+.

Lippmann W. Public opinion. New York: Macmillan; 1922.

McDermott, J. J. 1982. "Three Mile Island. (The malfunction and its effects on American public opinion)." Fizikai Szemle 32.

McGuire, W. J. (Ed.). 1973. Persuasion, Resistance, and Attitude Change. Chicago: IL:Rand McNally.

Peters, P.H. 2000. "The committed are hard to persuade: Recipients' thoughts during exposure to newspaper and TV stories on genetic engeneering and their effect on attitudes." New Genetics Society 19:367-383.

Peters, R. G., V. T. Covello, and D. B. McCallum. 1997. "The determinants of trust and credibility in environmental risk communication: An empirical study." Risk Analysis 17:43-54.

Price, V., and J. Zaller. 1993. "Who Gets the News? Alternative Measures of News Reception and their Implications for Research." Public Opinion Quarterly 57:133-164.

Renn, O. 2004. "The role of stakeholder involvement in risk communication." Atw-International Journal for Nuclear Power 49:602-+.

—. 2008. Risk Governance; Coping with Uncertainty in a Complex World. London: Earthscan.

Rowe, G., L. Frewer, and L. Sjöberg. 2000. "Newspaper reporting to hazard in the UK and Sweden." Public Understanding of Science 9:59-78.

Sjöberg, L. 2000. "Perceived risk and tampering with nature." Journal of Risk Research 3:353-367.

—. 2004. "Local acceptance of a high-level nuclear waste repository." Risk Analysis 24:737-749.

Sjöberg, L., and A. Wahlberg. 2002. "Risk perception and new age beliefs." Risk Analysis 22:751-764.

Slovic, P., J. H. Flynn, and M. Layman. 1991. "Perceived Risk, Trust and the Politics or Nuclear waste." Science 254:1603-1607.

Slovic, P., and U. Weber. 2002. "Perception of Risk Posed by Extreme Events." in Risk Management strategies in an Uncertain World" Palisades, New York.

Triandafyllidou, A. 1995. "The Chernobyl Aaccident in the Italian Press - A Media Story-Line." Discourse & Society 6:517-536.

Trumbo, W.C. 1999. "Heuristic-Systematic Information Processing and Risk Judgement." Risk Analysis 19:391-400.

van der Brug, W. 2001. "Perceptions, opinions and party preferences in the face of a real world event - Chernobyl as a natural experiment in political psychology." Journal of Theoretical Politics 13:53-80.

Zaller, J. 2006. The Nature and Origins of Mass Opinion. New York: Cambridge university press

Zorkaja, N. 2006. "Radiant disinterest - Chernobyl in Russian public opinion." Osteuropa 56:235-+.

Annex 1: Code Book

The code book was developed in Belgium and later applied also in Italy and in Slovenia. Thus the codes correspond also to the different nuclear emergency contexts in the three countries.

Meta Data

1) **ID** - Article ID
2) **Validity** - level of validity of the article
3) **Title** - Transcribe literally in the original language of the article
4) **TitleEN** - Translation of the original title in English
5) **Date** - Date of appearance in the newspaper
6) **Source** - Name of the newspaper
7) **STATE** - Country of publishing
8) **PGNUM** - Page Number
9) **WCOUNT** - Word Count
10) **VISUALS** - Visuals (photo, graph, map…) (yes/no)
11) **DATELN** - Dateline (text, e.g. "Tokyo")
12) **TAKENFROM** - Is the article taken from a press agency or other newspaper? (yes/no)

For each article, we need some descriptive material that allows us to identify the story. Each article should be assigned a specific identification number "*ID*", consisting of 5 digits, from which the first two are the country code. All Belgian articles thus will start with 32, all Slovenian with 36 and all Italian with 39. For instance, the first Belgian article will have the ID 32001 (Belgian article, country code 32, article 001). In Belgium, for the French articles the last 3 digits will start from 001 (e.g. 32001, 32002,..), the Dutch articles will start from 501 (32501, 32502,..).

The validity of the article has four levels: 0 is not valid at all, we will not code it. E.g. a metaphor like: "he's like the Fukushima nuclear reactor". Level 1 contains the articles that we will code and they are completely related to the Fukushima nuclear accident. Also TV guides are coded as level 1. Level 2 are articles that are doubled in our database. We keep them in our database, but we don't code them. Level 3 are articles that only mention the Fukushima nuclear accident, but they don't discuss it e.g. cancelation of sport events in Japan that are followed by the discussion related to particular sport. Another example of the article with validity 3 would be article related to Khadafi mentioning that the focus of media attention is more orientated towards Fukushima, but the article discusses the events in Libya. **The coders code only the paragraph or sentence related to Fukushima, not entire article.**

After the validity, we shall record the original title or the article ("*title"*), the English translation of the title ("*TitleEN*"), the "*date"* of the issue, and the "*source"* of the article (the name of the newspaper). Because of the dynamic media agenda, the page number should also be mentioned.

The articles that are covered in newspapers may vary significantly in size. Some cover significant parts of a page, while others consist of fewer than 50 words and are tucked away in a corner. One way of determining the size of an article is by counting the "*words"*.

The size of an article can be part of the agenda setting capabilities of the media, as newspapers can accentuate stories by making them larger and putting them front and center. Is this agenda different in different countries?

Do other aspects of format, such as visuals also matter in the importance attributed to the content of an article or an issue in a newspaper? The "*visuals"* category is a binary variable that we shall use to distinguish between articles with or without visuals. The purpose of this dummy is to distinguish between the stories in

which the reporter is supported by visuals in order to have more effect and ordinary articles. If visuals are not obtainable, then mark it as such.

We are also interested in where the article was written, which is stated in the "*dateline"*. Was the reporter in Japan, in the region from which he/she was reporting or was he or she writing from a different country or region? It is for example possible that the newspaper did not have a journalist on location, and because of the conditions or costs, the reporter was not able to get there. The dateline can usually be found in front of the body of the article. If there is no dateline, the site of the media house must be written, e.g. Brussels. For the type of article 'letters' you write the place of the author.

Finally, we shall record if the article was taken from a press agency (e.g. Associated Press). In this case the variable TAKENFROM will get a value 1, otherwise 0. This is useful for instance in case of a dateline 'Tokyo" to distinguish the case when the journalist himself has been at the reported location (e.g. Tokyo) or whether the reporting by another press agency (e.g. AP) has been done from Tokyo.

From this point onward all variables are binary: Yes/No, unless otherwise specified.

Type of the article

100) Type of article

1001 - News

1002 - Interview

1003 - Editorial

1004 - Column

1005 - Letter

1006 - Feature

1007 - Mixed

1008 - Other

exactly one of these will be coded **1**, the rest: 0

News: Concise report of a news item, usually just a short paragraph which sticks to factual information or a summary of an event, e.g. an information about explosion on nuclear reactor.

Interview: An article largely based on an interview, which can be preceded by a brief introduction and/or followed by a conclusion. Interviews often tend to represent one point-of-view i.e. that of the actor interviewed, unless two or more actors have been interviewed. There are different types of interview e.g. studio interview or long statements in article.

Editorial: Editor's viewpoint implies a critical analysis of the news item (subjective opinion supported by facts). The issue is often framed in its broader context. For the Fukushima nuclear accident, this can be the wider context of international information exchange in case of emergency, nuclear safety, energy needs or international (political) discussion on nuclear energy.

Column: A regular piece in a publication by the same author providing an opinion or different perspectives on the news item, but not labelled as editorial. A column is always written by opinion-maker.

Letter**:** A letter to the editor or newspaper, written by an individual from the general public or representing an organization. E.g. Letter from Greenpeace.

Feature**:** An in-depth look at what's going on behind the news. This type of article tends to include a detailed description and the analysis of the issue involved and is often accompanied by an interview or quotes from various actors. A feature invariably implies full-page articles, with photos and sometimes illustrations reporting from the field with all possible sources included (e.g. reportage).

Mixed**:** An article with analysis and quotes/ small interview, a one-off article by an expert(s)/well-known personality(ies), a longer analysis article where a description or analyses is interspersed with quotes from actors referred to in the news item. This category is added to classify articles that do not fall into any of the above categories, but have a common thread running through them – quotes from actors. The size of the article can therefore vary from short (a few statements with quotes, and therefore not just a brief news where there are no quotes), to longer articles (a more detailed description with quotes from actor(s), but not long enough to fall into any of the other categories).

Other: *O*ther publications which do not belong to any of mentioned categories, e. g. comics, cartoons… In this category enter also the articles that are the text below the photo's e.g. subtitles and TV-guide related to Fukushima. Also the definitions or general explanations can be coded as other; e.g. radioactivity, fusion, iodine.

Narrative codes (four digits)

21) DOMISSUE – does the article concern a domestic issue, an issue of EU, Japan, another country or international?

2101 – domestic
2102 – European
2103 – Japan
2104 – Another country
2105 – International or global

exactly one of these will be coded **1** (the most important), the rest: 0

22) EMPHASE - Emergency management phase

2201 – preparedness
2202 – response
2203 – recovery and evaluation

exactly one of these will be coded **1**, the rest: 0

The coder has to determine "**DOMISSUE**", i.e. whether the article considers:

- a domestic issue;
- a European issue (e.g. food restrictions inside the EU);
- an issue **only in** Japan (e.g. lack of trust in the Japanese government by the population). Remark: all articles will mention Japan; in order to code 2103 as 1, the article has to focus on the situation in Japan.
- an issue related to some other state or region (e.g. USA or South Korea);
- international issue broader than EU (e.g. recommendations or comments of international organisations, such as IAEA) or global issue (e.g. energy in general or future of energy worldwide).

Coders may find an indication on assigning the DOMISSUE by looking at the particular newspaper section where the article was published, e.g. domestic issues, external affairs, etc.

Example for **DOMISSUE**: if *the article clearly mentions* that this accident posed a threat to Belgium as the radiation will increase because of the nuclear accident in Japan, the value 1 should be given to the dummy variable **2101**. If the article addresses a domestic topic, but this topic is a result of e.g. international norms it has to be coded as domestic as well. For instance, if the article reports about sushi rejection in many states as well in Belgium, the coders in Belgium have to code the article as dummy variable **2101** with the value 1.

The "**EMPHASE**" aims to identify which phase of the emergency management is the article mainly addressing. Nuclear/radiological emergency management is nowadays often presented as a cycle (Turcanu *et al.* 2008) composed of preparedness for possible nuclear accidents (**2201**), response (**2202**), recovery actions and evaluation of the technical, political, economic, societal consequences of the accident (**2203**).

Example for **EMPHASE**: Preparedness: **2201** = 1 if the article concerns any aspect of emergency planning, e.g. stress tests on nuclear installations, pre-distribution of iodine tablets in Belgium, articles related to possibilities of earthquake in the countries. Response: **2202** =1 if the article concerns crisis response (e.g. cost or number of people evacuated, monitoring, information distribution e.g. INES, food restrictions), i.e. immediate actions and decisions but not the future, not long term plans etc. Recovery: **2203** = 1 for all articles related to long term recovery actions (e.g. decontamination of buildings, removing the surface layer of contaminated soil, waste management) or to societal, political, economic, or other effects (e.g. discussions of the future of nuclear energy, German decision to phase out nuclear energy, protest against nuclear energy, global costs of the accident, drop in the public opinion support of nuclear energy).

Issue Codes (four digits)

The coder should establish the major topic category (usually discussed in the first two paragraphs of the article and/or the title of the article): is it about energy, health, food, nuclear technology, radiation effects, protective actions, tsunami or earthquake, nuclear waste, etc.? After that, the coder shall decide on the more specific subtopic code. Codes should be assigned at the most detailed level that is feasible. If the article deals with two or more topics, but one is clearly dominant, the article should be classified according to the dominant topic.

23) Energy,

2301 – energy supply (e.g. shortage)
2302 – future of nuclear energy (overview of the nuclear issues in the past and the present - influencing the future of nuclear)
2303 – energy production
2304 – climate change
2305 – waste (integrated in a broader debate about nuclear energy)
2399 – about another issue related to energy

Each of these may be coded **1** or 0 (it is possible to have multiple 1's)

24) Health,

2401 – cancer
2402 – next generations
2403 – other diseases than c
2404 – psychological consequences
2499 – about another issue related to health

Each of these may be coded **1** or 0 (it is possible to have multiple 1's)

25) Protective actions related to food (related to radiation),

2501 – drinking water
2502 - farming products
2503 - sea food, including fish
2505 – food import /export
2506 - restrictions on food products (consumption, producing, etc)
2507 – food control
2599 – another issue related to food

Each of these may be coded **1** or 0 (it is possible to have multiple 1's)

26) Nuclear technologies,

2601 – technical aspects of reactors Japan
2602 – technical aspects other reactors (outside Japan)
2603 – stress tests for nuclear installations
2604 – new types of nuclear reactors (Gen III or IV mentioned by name)
2605 – other nuclear technology (e.g. research reactor, use of nuclear technology)

27) Accident effects other than health & food,

2701 – contamination of the land
2702 – contamination of the see
2703 – contamination of inhabited area (e.g. houses, playground)
2704 – contamination of goods from Japan (e.g. products, clothes, luggage)
2705 – other effects e.g. radioactivity, material damage, disturbance of daily life (schools, transport) and compensation.
2706 – radioactivity in air (cloud)
2707 – economic impact

Each of these may be coded **1** or 0 (it is possible to have multiple 1's)

28) Other protective actions (not food),

2801 – decontamination
2802 – monitoring the environment
2803 – evacuation of people
2804 – sheltering of people
2805 – iodine tablets (stable iodine)
2806 – measurement of contamination of people (internal or external)

Each of these may be coded **1** or 0 (it is possible to have multiple 1's)

29) Tsunami or earthquake,

2901 – consequences
2902 – probability
2903 – specifics (general things)

Each of these may be coded **1** or 0 (it is possible to have multiple 1's)

30) Nuclear/radioactive waste (the word "waste" specifically mentioned),

3001 – management of Fukushima waste (other than sea water)
3002- management of nuclear waste (general): siting, storage (interim/temporary), disposal (permanent), spent fuel
3003 – amount (expressed with the measurement unit, e.g. m^3, litres, etc.)

31) Emergency management issues

3101 - public information (e.g. information system, informing public, INES scale, censorship …)
3102 - emergency workers + actions: direct involved at the plant (Fukushima 50, kamikaze …) actions on the plant (cooling, extinguishing the fire, explosions …
3103 - other emergency actors (e. g. military, fire brigade, police, civil protections, volunteers…) + actions on the plant (cooling, extinguishing the fire, explosions …
Examples! E.g. monitoring environment: measurement of the contamination of the inhabited areas, using the specific equipment(detectors).

DOUBTCAT – doubt category

3100 – doubt? Yes=1; no=0

Let's take as example an article on the evacuation of people from a certain area as one of the protective measures to protect against health consequences from radiation. This article has to be coded as being mainly about a protective action and only secondarily about health.

If the coder cannot decide, counting the paragraphs belonging to the different issue codes can help to determine the dominant issue code.

In case the coder has serious doubts about which issue code to assign, he/she should mark the doubt variable **(3100)**. In this case, the coder should briefly state between which codes he/she is hesitating. This area is reserved for the most contentious issues. If a coder feels 90 % confident about the issue code, this 10 % doubt is not enough to use this doubt variable.

Tendency of the Article

In addition to the issue codes, we include a number of variables affecting the way in which an article is presented or can be interpreted. Coders will be asked to code variables that capture whether the article mentioned a conflict and whether there were any emotions expressed.

32) CONFLICT: Does the article mention a conflict or strong disagreement?
3200 – Conflict or disagreement? Yes=1, No=0

"**CONFLICT**" Conflict stories involve a conflict between people/groups/parties/countries. The story contains an explicit mention of the fact that there is disagreement about the issue (e.g. nuclear energy, emergency management, monitoring). This disagreement can be in words (e.g. contradiction positions or claims) or in deeds (e.g. protest, stigmatisation,). If the article includes conflict, code as =1.

The purpose of the conflict variable is to identify stories in which there is an explicit mentioning of some sort of disagreement about a nuclear emergency management or nuclear energy in general. This can be in the form of a disagreement in words. For example, politicians disagree about future or nuclear reactors, unions disagree with the restrictions on farming products, the environmental organisations disagree with (not) evacuation etc. A conflict can also be in the form of deeds. This can for example be in the form of protests, protest against nuclear energy, and rejection of food products from Japan. Examples of this are: Greenpeace activists chain themselves to trees to stop logging. The article needs to explicitly mention a conflict or disagreement, but the words or deeds do not need to be the primary topic of the story. For example in Belgium, an article mentioned that there was no significant increase in radiation levels in the country,

measured by an advanced monitoring network in the country, but then further the article stated that there was a disagreement between the environmentalists and the nuclear safety authorities related to the measured concentration of radioactivity. Another example is a march to show unity against nuclear energy. The primary topic here is definitely not conflict. However, the article can state that this march was organized because of the growing tensions between pro- and –con nuclear groups, demonstrating conflict.

If the author of the article expresses an internal conflict mentioning arguments pro– and contra- this should not be coded as a conflict (usually this is expressed in subjective types of the articles e.g. letter or editorial).

33) KEYWORD: Does the article mention words triggering or expressing emotions? (synonyms will be included in accordance to linguistic properties)

3301 – Chernobyl
3302 – panic
3303 – nuclear accident
3304 – nuclear disaster (also apocalypse)
3305 – distrust (no or low trust)
3306 – danger / dangerous
3307 – dread (fear, anxiety)
3308 – anger
3309 – victim (casualties, including deaths)
3310 – sympathy
3311 – compassion
3312 – solidarity (e.g. raising funds to help people in Japan)
3313 – assistance (from international organisation such as IAEA, experts, states)
3314 – blame (who is responsible?)
3315 – chaos

Each of these may be coded **1** or 0 (it is possible to have multiple 1's)

Nuclear accidents are linked to a high catastrophic potential and emotional reactions, but, with the distance from the affected site, the use of emotions decreases (Perko *et al.* 2009). With the "**KEYWORD**" variable we will assess whether the nuclear accident at Fukushima was reported in the direction of a negative insinuation that could stimulate public's emotions and we shall evaluate public emotional response to the event. For this purpose the frequency of appearance in the media of a number of keywords with positive or negative connotation will be calculated. Synonyms (e.g. "dread" also expressed with the words "fear" and "anxiety" or "worry") and words having the same root (e.g. danger-dangerous – endangered) will be accounted for in accordance with linguistic properties. The keyword has to be explicitly mentioned in the article, one or more times. For example, if the word Chernobyl is mentioned one or more times, the variable 3301 has to receive the value 1 (3301 = 1).

Sources of information

34) SOURCEINT: All domestic information sources included in the article

3401 – Domestic Nuclear safety authority (FANC in Belgium, ASN in Italy and SNSA in Slovenia)
3402 – The Nuclear Power Plant in the country – operator, owner, distributor (In Belgium NPP Doel & Tihange, Electrabel Suez; in Italy ENEL and EDISON; and in Slovenia NPP Krško or Electro Slovenije)
3403 – Domestic nuclear research institute in country (SCK•CEN in Belgium, INFN in Italy and Institut Jozef Stefan in Slovenia)

3404 – Waste management agency (NIRAS in Belgium, xxx in Italy, ARAO in Slovenia)
3405 **–** Domestic Ministry of the Environment and Spatial Planning
3406 **–** Domestic Ministry of Health
3407 **–** Domestic Ministry of External Affairs
3408 – Domestic Ministry of Energy
3409 – National government
3410 – General public/inhabitants
3411 – Domestic opinion makers/givers
3412 – Domestic action groups
3413 – Secondary media sources from the country
3414 –Another national agency (only Italy: ENEA)
3499 – Other

Each of these may be coded **1** or 0 (it is possible to have multiple 1's)

35) SOURCEEXT: All information sources included in the article other than domestic or Japanese

3501 – Nuclear safety authority
3502 – The Nuclear Power Plant– operator, owner, distributor
3503 – Nuclear research institute
3504 –Ministry of the Environment and Spatial Planning
3505 –Ministry of health
3506 –Ministry of external affairs
3507 – Ministry of energy
3508 – National government
3509 – General public/inhabitants
3510 - Opinion makers/givers
3511 - Action groups
3512 – Secondary media sources
3513 – IAEA – UN International Atomic Energy Agency
3514 – European Union
3515 –World health organisation WHO
3516 - United Nations Food and Agricultural Organization FAO
3517 – USA department of energy (DoE)
3518 – OECD
3519 – ISPRA (Italy) or IRMM (Belgium)
3599 - Other

Each of these may be coded **1** or 0 (it is possible to have multiple 1's)

36) SOURCEJAP: All sources from **Japan** included in the article

3601 – operator TEPCO
3602 – government
3603 – inhabitants
3604 – opinion makers/givers
3605 – non-governmental organisations
3606 – health organisation
3607 – emergency management actors
3608 – Ministry of Education, culture, sports, science & technology in Japan (MEXT)
3609 - Ministry of Health, labour and welfare (MHWL)
3610 – mass media from Japan
3611- commercial companies from Japan (Toyota, Sony, Nissan…)

Each of these may be coded **1** or 0 (it is possible to have multiple 1's)

37) **SOURCENOTKNOWN:** source not known
3701 – is the source unknown? 1=yes, 0=no

38) **PRIMACTO :** primary actor in the article

Identifying sources of information is an important part of defining the communication flow, by pinpointing the actors that have been communicating in order to send their message through media channels to the general public. With the content media analysis we will explore the sources of information for media news related to the nuclear accident at Fukushima nuclear power plant. The aim is to find out which sources were referred in mass media and whose information was the most quoted? The code of journalism assumes that a media article must refer to different sources of information, in order to present several views and depict the event taking different aspects into consideration. According to this, we expect that every article will have more than one positive value (1) at dummy variable related to sources.

The sources are divided in three categories: domestic "**SOURCEINT" (34-**), international or external source "**SOURCEEXT" (35-**) and sources from Japan "**SOURCEJAP" (36-**). Every article has to have at least one identified source - code value 1. The coder should always try to establish the main category first: is it the source domestic, from international environment or from Japan. Only then does the coder decide on the more specific code of the source. Only in the case that there is no possibility for source identification he/she should use the dummy variable "**SOURCENOTKNOWN**" value =1. The coder will assign also the primary actor in the article "**PRIMACTO**" **(38-)**, using the codes from 34- to 36-.

39) **PRIMACTO :** If one or more actors have been identified, who is the primary actor discussed in the article?

*Identification of "**SOURCEINT**" domestic information sources:*

The domestic Nuclear safety authority (**3401**) is the national nuclear safety administration whose scope of competence includes carrying out administrative and professional tasks. Among these are regulation of the nuclear and radiological safety of nuclear facilities, transport and handling of nuclear and radioactive materials, accountability and control of nuclear materials, physical protection of nuclear facilities and nuclear materials, professional qualifications of personnel operating nuclear facilities and their training, quality assurance in the nuclear field, radiological monitoring of the environment, early notification in case of nuclear or radiological accidents, international co-operation in the field of competence, nuclear emergency communication. The nuclear safety authority in Belgium is FANC, in Italy ASN and in Slovenia is SNSA.

The Nuclear Power Plant in the country – operator, owner or distributor (**3402**). The source in this case may be different between the countries since Italy doesn't have an NPP, but has a distributor of electricity, using the nuclear energy bought abroad. In Belgium, the operators are Doel and Tihange NPP's, the owner of NPP's and distributor is Electrabel (GdF-SUEZ), in Italy ENEL or EDISON and in Slovenia NPP Krško or Electro Slovenije.

The category Nuclear research institute (**3403**) includes scientific institutions carrying out nuclear research: SCK•CEN in Belgium, INFN in Italy and Institut Jozef Stefan in Slovenia. If the information in the article is coming from a research institute or from an expert presented as affiliated to the research institute, the

variable 3403 has to receive the code 1. If the article only reports the activities at the research institute and the source of this information is not clearly the institute itself (e.g. spokesperson or press conference) it should NOT be coded under this code.

The waste management agency (**3404**) is in charge with the short and long term management of radioactive waste management. In Belgium it is NIRAS, in Slovenia ARAO, in Italy.

Domestic Ministry of the Environment and Spatial Planning (**3405**) – or the ministry that covers the issue of environment.

Domestic Ministry of Health (**3406**) – or the ministry that covers the issue of health.

Domestic Ministry of external affairs (**3407**) – or the ministry that covers the international relationships and the issues related to citizens abroad.

Domestic Ministry of energy (**3408**) – or the ministry that covers the issues of energy.

National Government (**3409**): This term is used to denote a number of political actors; the president or prime minister, ministers in national government (except for the minister of environment and spatial planning, health and external affairs, which are assigned with own codes). This category is meant for the Federal cabinet ministers and also includes the prime minister. In some cases, a country might have a federal as well as regional governments (Belgium), which means that there are multiple sets of governments that each have their own ministers. If a minister at the Federal level or regional ministers is present, the code 1 should be assigned. The crisis cell also belongs to this category.

General public/inhabitants (**3410**): Refers to the lay persons, usually mentioned in the context of the inhabitants and concerned citizens.

Domestic opinion makers/givers (**3411**): This category of actors includes scientists, well-known personalities and politicians, whose opinion is considered important enough to be represented separately, either in a full-fledged interview or via quotes. The actors grouped in this category represent themselves rather than an institution or a role attributed to them (the opinion given is that of an individual and not of a group). People from academic institutions also fall into this category when the opinion provided is theirs and not that of the department or division they belong to.

This code will be also chosen for articles that are editorials or columns.

Domestic action groups (**3412**) includes activists from a wide spectrum of organizations such as NGOs, citizens' representative groups, anti-nuclear groups such as Greenpeace section form the country.

Secondary media source from the country (**3413**): Secondary sources of information are **reports of other media houses or press agencies**, eg. BELGA in Belgium or STA in Slovenia.

Another national agency (**3414**): only Italy: ENEA.

*Identification **SOURCEEXT** other than domestic information and other than Japan sources included in the article:*

Nuclear safety authority (**3501**) is the nuclear safety administration in other countries e.g. Nuclear Safety Authority of France (ASN).

Nuclear power plant, operator, owner or distributor (**3502**)., e.g. nuclear power plant in Germany.

The category Nuclear research institute (**3503**) includes the scientific institutions carrying out nuclear research and measurements. The code 3503 = 1 has to be given if the information comes from a research institute from another country, e.g. IRSN in France. If the article only reports about the activities of this research institute and the source of this information is not clearly the institute itself (e.g. spokesperson or press conference) it should NOT be coded under this code.

Ministry of the Environment and Spatial Planning (**3504**) – or the ministry that covers the issue of environment.

Ministry of Health (**3505**) – or the ministry that covers the issue of health.

Ministry of external affairs (**3506**) – or the ministry that covers the international relationships and the issues related to citizens abroad e.g. Ministry for external affairs of USA reports the number of USA citizens in Tokyo.

Ministry of energy (**3507**) – or the ministry that covers the issue of energy.

Government (**3508**): This term is used to denote a number of political actors; the president or prime minister, ministers in government (except for the minister for the environment and spatial planning, health and external affairs which have own codes), e.g. Austrian government expressed the anti-nuclear orientation of the country.

General public/inhabitants (**3509**): Refers to lay persons, usually mentioned in the context of the inhabitants and concerned citizens, e.g. local people living in the neighbourhood of NPP's in Switzerland.

Opinion makers/givers (**3510**): This category of actors includes scientists, well-known personalities and politicians, whose opinion is considered important enough to be represented separately, either in a full-fledged interview or via quotes. The actors grouped in this category represent themselves rather than an institution or a role attributed to them (the opinion given is that of an individual and not of a group). People from academic institutions also fall into this category. when the opinion provided is theirs and not that of the department or division they belong to. Also celebrities belong to this group, E.g. famous movie actor raised the money for casualties of disaster.

Action groups (**3511**) include activists from a wide spectrum of organizations such as NGOs, citizens' representative groups, anti-nuclear groups such as Greenpeace section, e.g. activist from Amsterdam.

Secondary media source (**3512**): Secondary sources of information are reports of other media houses or press agencies, eg. REUTERS, or Sunday Times…

IAEA International Atomic Energy Agency (**3513**) is an organisation of the United Nations. IAEA provided updated information on the Fukushima accident and posted it on the public website on a regular basis. The IAEA continued to monitor the situation in and around the Fukushima Daiichi nuclear power plant around the clock. IAEA was in close contact with Japanese authorities on stabilisation measures. They reported that, overall, the situation at the Fukushima Daiichi nuclear power plant remained very serious during the two month considered in our content analysis. (http://www.iaea.org/newscenter/news/2011/fukushimanote.html)

The IAEA experts were working daily with colleagues in Japan and around the world to acquire and analyze information to develop the clearest possible picture of the accident.

The European Commission or other EU institutions (**3514**) are responsible for the ECURIE (European Community Urgent Radiological Information Exchange) notification network which allows any EU Member State to notify the EC and the other Member States in case of a radiological accident and to exchange radiological information. In this group belong also commissionaires of EU or representatives of EU or European food agency. All information on the nuclear accident at Fukushima was published daily through the EU public information system RAPID.

The World Health Organisation WHO (**3515**) is the directing and coordinating authority for health within the United Nations system. It is responsible for providing leadership on global health matters, shaping the health research agenda, setting norms and standards, articulating evidence-based policy options, providing technical support to countries and monitoring and assessing health trends. WHO has been monitoring the international food implications related to the accident at Fukushima and continued to provide regular and detailed updates of the information on the event.

The Food and Agriculture Organization FAO is a specialised agency of the United Nations (**3516**) that acts as a neutral forum where all nations meet as equals to negotiate agreements and debate policy. FAO is also a source of knowledge and information, and helps developing countries and countries in transition modernise and improve agriculture, forestry and fisheries practices, ensuring good nutrition and food security for all.

The Department of Energy (**3517**) addresses energy, environmental, and nuclear challenges through transformative science and technology solutions. It has provided support to Japan for mapping the radioactive contamination after the Fukushima accident.

The Organisation for Economic Cooperation and Development (OECD), (**3518**) , (French: Organisation de coopération et de développement économiques, OCDE) is an international economic organisation of 34 countries founded in 1961 to stimulate economic progress and world trade. One of the special bodies of OECD is the Nuclear Energy Agency (NEA), which is an intergovernmental multinational agency. The mission of the NEA is to "assist its Member countries in maintaining and further developing, through international co-operation, the scientific, technological and legal bases required for the safe, environmentally friendly and economical use of nuclear energy for peaceful purposes."

3519 stands for European JRC: ISPRA in Italy, IRMM in Belgium.

NOTE: If the article mentions **only** United Nations as a source, without reference to any specific agency, the coder has to check:

- if the information is related to inspections, countermeasures, nuclear reactors, the INES scale, nuclear energy then choose the code 3513 (IAEA)
- if the information is related to health effects, psychological, social factors, then choose 3515 (WHO)
- if the information is related to food or agriculture, then choose 3516 (FAO)

In the group other (**3599**) are international or external sources that don't belong to any of other sub-groups.

*Identification of information sources from Japan "**SOURCEJAP**"*

The Tokyo Electric Power Company TEPCO (**3601**) is an operator of nuclear power plant in Fukushima

To the government (**3602**) belong Japanese prime minister, all other ministers and governmental agencies from Japan except Ministry of Education, Culture, Sports, Science & Technology in Japan (MEXT) (**3608**), Ministry of Health, labour and welfare (MHWL) (**3609**).

Population (**3603**) are inhabitants of the region, citizens of Japan or people being at the time of accident in Japan also embassy personnel being in Japan at the time of reporting belong to this group, e.g. families of Belgian citizens being at the time of the reporting in Japan or secretary of the Slovenian embassy in Tokyo.

The category opinion makers/givers (**3604**) includes scientists, well-known personalities and politicians, whose opinion is considered important enough to be represented separately, from the official governmental opinion. The actors grouped in this category represent themselves rather than an institution or a role attributed to them (the opinion given is that of an individual and not of a group). People from academic institutions also fall into this category. To this group belong also celebrities or experts from universities. E.g. Tokio university professor that wrote a petition.

Non-governmental organisations (**3605**) are different groups, consisting of different action groups, civil organisations… e.g. Greenpeace of Japan.

Emergency management actors (**3606**) is group consisting of many organisations and institutions. The fire-fighters, hospitals (doctors and other medical personnel), military, monitoring agencies, food agencies, marine institute … The group is diverse, but the goal of actors was to measure, prevent and minimise the radiation effects to the population and the environment.

Ministry of education, culture, sports, science & technology in Japan (MEXT) **(3608) .**

Ministry of health, labour and welfare (MHWL) (**3609**); This ministry provides regulations on maximum residue limits for agricultural chemicals in foods, basic food and drug regulations, standards for foods, food additives, etc.

Mass media from Japan (**3610**) e.g. Japan press agency or local TV station.

Commercial companies **(3611**) such as Sony, Toyota, Nissan are included in this category.

37) PRIMACTOR: If one or more actors have been identified in questions 34- through 36-, please select the primary actor from the list below (in Excel, this will be a sheet 2):

3701 Domestic Nuclear safety authority (FANC in Belgium, ASN in Italy and SNSA in Slovenia)
3702 - The Nuclear Power Plant in the country – operator, owner, distributor
3703 - Domestic nuclear research institute in country (SCK•CEN in Belgium, INFN in Italy and Institute Jozef Stefan in Slovenia)
3704 - Waste management agency (NIRAS in Belgium, ARAO in Slovenia)
3705 – Domestic Ministry of the Environment and Spatial Planning
3706 – Domestic Ministry of Health
3707 – Domestic Ministry of External Affairs
3708 – Domestic Ministry of Energy
3709 – National government
3710 – General public/inhabitants
3711 - Domestic opinion makers/givers
3712 - Domestic action groups
3713 – Secondary media sources from the country
3714 – Another national agency (only in Italy: ENEA)
3715 – Nuclear safety authority (another country, not Japan)
3716 – The Nuclear Power Plant– (another country, not Japan)
3717 – Nuclear research institute, (another country, not Japan)
3718 –Ministry of the Environment and Spatial Planning, (another country, not Japan)
3719 –Ministry of health, (another country, not Japan)
3720 –Ministry of external affairs (another country, not Japan)
3721 – Ministry of energy (another country, not Japan)
3722 – National government (another country, not Japan)
3723 – General public/inhabitants (another country, not Japan)
3724 - Opinion makers/givers (another country, not Japan)
3725 - Action groups (another country, not Japan)
3726 – Secondary media sources (another country, not Japan)
3727 – IAEA International Atomic Energy agency
3728 – European Union
3729 –World health organisation WHO
3730 – United Nations Food and Agricultural Organization FAO
3731 – USA department of energy (DoE)
3732 – OECD
3733 – ISPRA (Italy) or IRMM (Belgium)
3734 – operator TEPCO
3735 – government of Japan
3736 – inhabitants of Japan
3737 – opinion makers/givers in Japan
3738 – non-governmental organisations of Japan
3739 – health organisation of Japan
3740 – emergency management actors in Japan
3741 – Ministry of Education, culture, sports, science & technology in Japan (MEXT)
3742 - Ministry of Health, labour and welfare (MHWL)
3743– mass media from Japan
3744 – other (domestic, external or Japan)
3745 – Commercial companies from Japan
0 – not known

The primary actor in an article is the person, organization, or institution that the article is mostly about. In order to retain consistency, the primary actor for this study is the first actor to appear in the title or the first two paragraphs of the article. If no actor appears in the title or the first two paragraphs, there is no primary actor.

Even if some actors have been identified in questions 34 through 36, it is still possible in some rare occasions that none of these actors are the primary actor in an article. For example, a story that is primarily about a natural disaster can mention a statement by a minister. However, this statement does not have to be the essence of the article. If the story is not primarily about the statement, no primary actor should be coded.

Primary or secondary

4000 – primary article? 1=primary, 0=secondary

Primary=1: the Nuclear accident is of main importance (description of the accident, situation in Japan – direct effects of the accident)

Secondary= 0: the Nuclear accident is only of secondary importance (not the accident itself, but consequences induced by the accident)

With this category we will be coding whether the origin of the article is the nuclear accident in Fukushima "**PRIM**" or the accident is of secondary importance "**SEC**". We define an article of primary importance one that is written in response to the nuclear accident in Fukushima e.g. a report about the event. An article of secondary importance "**SEC**" is an article reporting a story induced by the accident, e.g. stress test of nuclear installations or future of nuclear energy. E.g. If people from China are buying salt because they think it protects them against radioiodine, this article has to be coded as 0. The protective measures in Japan have to be coded as 1. Determining whether an article is primary or secondary important will help scholars determine whether or not the media agenda has developed from the reporting about the accident in some other agenda.

Correctly distinguishing which articles are primary or secondary is extremely complex because a number of different factors determine whether or not the story originates from nuclear accident (e.g. number of evacuated people) or is a result of nuclear accident (e.g. discussion about safety of nuclear reactors in EU).

Focus of the article

40) TECHASP = technical aspect	**4001** = 1 if yes, 0 if no
41) CRISMAN = crisis management	**4101** = 1 if yes, 0 if no
42) INHAB = affected inhabitants (casualties)	**4201** = 1 if yes, 0 if no
43) INREAC = international reaction	**4301** = 1 if yes, 0 if no
44) SAFRISK = safety/risk aspect	**4401** = 1 if yes, 0 if no
45) INFOEXCH = information exchange	**4501** = 1 if yes, 0 if no
46) FUTNUC = future of nuclear	**4601** = 1 if yes, 0 if no
47) ENERCONS = energy consump. and energy supply	**4701** = 1 if yes, 0 if no
48) SUSTENER = sustainable energy	**4801** = 1 if yes, 0 if no
49) BLAME = who has to be held responsible for the accident and consequences	**4901** = 1 if yes, 0 if no
50) Ecomic impact	**4909** = 1 if yes, 0 if no
51) FOCOTHER = other focus (open category!)	

Only one of 4001 till 4909 can be coded 1; the rest have to be coded 0

In this section, we will outline how we will identify the most important focus of the article. The purpose of this category is to determine as objectively as possible whether the article is mainly focused on "technical aspects", "emergency management" "inhabitants", "international reaction", "safety/risk aspect", "information exchange" "future of nuclear" "energy consumption/electricity supply", "sustainable energy", "economic impact" or "other".

The analysis of the main focus of the articles allows identifying the main challenge and the focal point of the communication during first two months after the Fukushima nuclear accident. The coder should always try to establish the major focus, i.e. try to identify the unique variable among 4101 till 4909 that could be coded 1. Only if none of the categories is applicable the coder can use code "**FOCOTHER**". For this category, the coder will be asked to write with few words what was the focus of the article. Each article can have only one focus - only one positive dummy variable although the articles may touch more than one aspect. Example: if the article is about the restrictions on specific food products in Japan, about the measurements of internal contamination of people, and also mentions the technical details of the contamination, the article has to be coded as **CRISMAN** and not **TECHASP** since the main focus is emergency management (protective actions). Usually it is possible to identify the focus of the article by the title of the article or by reading the first paragraph of the article. The aspects that appear later in the article are usually not the focus, but related themes.

With the code **"TECHASP"** will be coded articles that deal with the technical aspects of the accident, e.g. the technical data about the state of the reactors or the spent fuel ponds.

The articles for which **CRISMAN (4101)** will be coded 1 belong to emergency management and usually address protection measures for people or societal effects of the crisis, without too much focus on the technical aspects. The article has to describe the crisis management of the nuclear accident and it will be mainly limited to Japan, e.g. protective actions for local population or activation of the military. The articles that discuss the establishment of crisis management teams elsewhere than in Japan also belong to this category, e.g. the European commission established an emergency team. The public information articles discussing protective measures or level of accident (INES) belong to this group. (But NOT the problems or criticism to public information actors e.g. government or Tepco. This would be coded as INFOEXCH)

The code **INHAB** will be given to the articles that address the affected inhabitants in the frame of casualties. These are the people that were living in the contaminated area, which were evacuated or contaminated. In other words they were directly affected by the accident. This can be for instance a farmer from the contaminated area that committed suicide. Also affected workers (health affects) at the NPP belong to this group.

Under this code we don't code the people that evacuated by themselves (self-evacuation) because of their risk perception or uncertainty. For instance, if the article reports about the Belgians that took the possibility

to fly back to Belgium and were exposed to thyroid measurements, then this article has to be coded as **CRISMAN.**

With code **INREAC** will be coded the articles describing an international reaction on the Fukushima nuclear accident. E.g. protest of people in Germany, assistance or solidarity for Japan.

SAFRISK is the code corresponding to the articles discussing safety and/or risk aspects of nuclear installations, not only the NPP Fukushima (could be related to Chernobyl). In this category belong all articles discussing the possibility of an accident (e.g. in the first day after the earthquake, before any major radioactive release occurred), probabilistic estimations of accidents in NPP's or articles related to stress tests, probabilities to get sick, contamination of food…. The articles discussing the radioactivity or contamination in general, how danger/safe it is … belong to this category.

With **INFOEXCH** we want to know whether the focus of the story is related to the information exchange. The articles that will be coded with INFOEXCH will discuss the problem of information flow. E.g. IAEA sent a remark to the government of Japan concerning their lack of transparency in communication.

All articles that discuss the future of nuclear energy or reactors will be coded as dummy 1 on variable **FUTNUC.**

ENERCONS addresses the energy consumption and/or energy supply, including discussion about policy of electricity suppliers or operators. E.g. Electrabel's nuclear rent.

SUSTENER addresses the articles discussing sustainable energy e.g. solar panels

BLAME refers to article discussing who has to be held responsible for the accident and its consequences

ECONOMICIMPACT refers to article discussing the economic impact of an accident in different countries. E.g. changes in stock markets, decrease in value of goods.

The variable **FOCOTHER** other focus is an open category for which the coder has to write what was the focus of the article in words. This is only in the case when the coder is not able to assign any other category.

Numeracy

51) NUMERACY = what units are used in the article to describe the radioactivity

5100 – mSv (milli sievert)
5101 – mSv/h (millisievert per hour)
5102 – µSv/h (microsievert per hour)
5103 – nSV/h (nanosievert per hour)
5104 – Sv (Sievert)
5105 – Sv/h (Sievert per hour)
5106 – Bq/kg (Bequerel per kilogram)
5107 – Bq/g (Bequerel per gram)
5108 – Bq/l (Bequerel per litre)
5109 – kBq/kg (kilo Bequerel per kilogram)
5110 – MBq/kg (mega Bequerel per kilogram)

Each of these may be coded **1** or 0 (it is possible to have multiple 1's)

5111 – Bq/m^2 (Bequerel per square meter)
5112 – Bq/cm^2 (Bequerel per square centimetre)
5113 – kBq/cm^2 (kilo Bequerel per square centimetre)
5114 – MBq/m^2 (mega Bequerel per square metre)
5115 – MBq/km^2 (mega Bequerel per square kilometre)
5116 – TBq/km^2 (terra Bequerel per square kilometre)
5117 – no measurement units related to radioactivity in the article
5118 – another measurement unit related to radiation (e.g. air concentration in Bq/m3)

52) COMPRISK = does the article present any comparison related to radioactivity?

5200 – no comparisons
5201 – with risks from medical purposes (e.g. x-ray)
5202 – with risks from flying
5203 – with natural radiation background (usually the word "normal" will appear)
5204 – with professional (normal) exposure to radiation of workers at nuclear installations
5205 – with something else (open variable! Coder has to write with what the risk of radioactivity from Fukushima nuclear accident was compared)
5206 – with limits or norms (words such as "limits", "norms", "maximal allowed levels" have to appear).
5207 – with a historic nuclear accident e.g. Chernobyl (NOT the atomic bombs at Hiroshima or Nagasaki) – It has to be comparison of radioactivity and not an accident in general! E.g. Number of victims or size of evacuation would not belong to this category. The comparison of the rating given on the INES scale – Fukushima and other accidents – is included.

With these categories we will be coding the units that radiation was expressed "**NUMERACY"** and coding the possible radiation risk comparisons "**COMPRISK**". We will try to assess how the media described the risks by making use of numbers and/or examples. In the article different units and comparisons might be used to describe the risks of radioactivity due to the nuclear accident in Fukushima. The coder has to find the unit explicitly written in the article in order to give the value 1 to the corresponding dummy variable. If there is a value that is used to express the unit of radioactivity and is not listed, the coder has to write the unit in the variable **5205** as it is written in the article. The coder has to be careful also if the "squares" are written as " ^{2} ". e.g. kBq/cm^2. In this case the value 1 has to be given to **5205** and the unit from the article has to be written in Excel.

60) NUCLORIENT = Article orientation towards nuclear energy

6001 Positive connotation (in favour of nuclear energy)
6002 Negative connotation (against)
6003 Balanced (presents both arguments in favour, as well as against)
6004 Neutral (it does not discuss the nuclear energy)

This category records the article orientation towards **nuclear energy –** if energy is good or bad (not the orientation towards nuclear industry, management or authorities!) For instance, if there is more space given

to pro-nuclear opinions, than the article will be coded with 6001=1. If article concerns only the accident and not nuclear energy in general is coded as neutral (1).

Additional codes in interest of specific research group

Every research group can include the codes that are in their specific interest and will not be applied in all countries.

Additional codes in Belgium

53) SCK•CEN – Studiecentrum voor kernenergie SCK•CEN

5301 – Explicitly mentioned 1 (yes)
5302 – Positive connotation of the Centre
5303 – Negative connotation of the Centre
5304 – Neutral connotation of the Centre

54) MYRRHA - Multi-purpose hYbrid Research Reactor for High-tech Applications

5401 – If explicitly mentioned 1 (yes)
5402 – Positive connotation of MYRRHA
5403 – Negative connotation of MYRRHA
5404 – Neutral connotation of MYRRHA

Additional codes in Italy

55) Referendum about nuclear energy

5501 – Has the referendum been mentioned? Yes=1, No=0

Computation of inter-coder reliability

For the calculation of the inter-coder reliability it is important that the final file of each coder is saved separately, in order to allow the comparison of the codes. One Master file has to be made based on the comparison of the codes and the discussion on the possible differences. For the cases when the codes that are different, but consensus was not achieved, the original codes have to be preserved in the files of each coder. The master coder has to decide the value for master file.

Krippendorff's alpha (α) is a reliability coefficient developed to measure the agreement between observers, coders, judges, raters, or measuring instruments.

Let us consider two coders which have to code N units of information using the same answering categories for each unit (e.g. "a" to "e" or "0" to "1").

The reliability matrix can be constructed as follows, and it contains 2**N* values:

Units:	*1*	*2*	…	*u*	…	N
Observers:	1: c_{11}	c_{12}	…	c_{1u}	…	c_{1N}
	2: c_{21}	c_{22}	…	c_{2u}	…	c_{2N}

For each article, we can calculate α as follows:

$$\alpha = 1 - \frac{D_o}{D_e}, \text{ where}$$

D_o is the observed disagreement:

$$D_o = \frac{1}{n}\sum_{c \neq k} o_{ck} \; ;$$

D_e = the disagreement one would expect when the coding of units is attributable to chance rather than to the properties of these units:

$$D_e = \frac{1}{n(n-1)}\sum_{c \neq k} n_c \cdot n_k \; ;$$

c, k = codes given for the different observation units (one observation = one fully coded article);

o_{ck} = Σ_u (Number of (***c, k)*** pairs in unit *u*). **Remark**: if coder 1 gave the code c and coder 2 gave the code k for a unit u, the we shall have to consider both (c,k) as well as (k,c) (there is no order on the coders);

n_c = number of occurrences of answer "c" (e.g. "0") in the reliability matrix, taking **both** coders into consideration at the same time;

*n=2*N*.

Perfect reliability (D_o=0 and α=1) occurs when the coders agree perfectly. The absence of reliability is indicated by D_o=D_e and α=0; this case would mean that coders failed to observe and made arbitrary choices on their data.

For binary variables, since $o_{01} = o_{10}$, the expression of α is reduced to:

$$\alpha = 1 - \frac{D_o}{D_e} = 1 - (n-1)\frac{o_{01}}{n_0 \cdot n_1}$$