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UNCERTAINTY BEYOND PROBABILITIES OF BSE: APPRAISALS PREDICTING WORRY AND COPING STRATEGIES IN THE CANADIAN PUBLIC

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The impact of bovine spongiform encephalopathy (BSE) is not limited to the infection with the BSE agent but also affects psychosocial responses, such as worry and loss of confidence in public authorities. It was shown in past crises that these reactions depended upon the way the event was perceived by the public. Understanding the nature of the perceptions of BSE is therefore of great importance for risk management in all phases of the risk, including the period before the onset of a crisis, when BSE is still only a pending threat to human health. This study analyzed data from a representative national survey of Canadians ($n = 1,517$) on the perceived risk of prion diseases. Factor analysis revealed emerging dimensions of BSE appraisals and regression analysis identified variables that predicted worry and coping strategies. Results yielded three significant factors, each relating differently to reactions to BSE: (1) *Perceived impact*, which combined perceived risk for health and likelihood of occurrence of BSE crises, was the main predictor of worry about eating tainted beef; (2) *perceived mastery*, consisting of personal knowledge and control, predicted taking action to avoid the disease; and (3) *perceived intricacy*, composed of perceived complexity and uncertainty, uniquely predicted trying to ignore BSE-related risks. Further regression analysis and analysis of variance exposed a moderating role of perceived intricacy on the relationship between perceived impact of BSE crises and worry. The implications of these findings for risk communication and management are described.

Past studies on bovine spongiform encephalopathy (BSE) demonstrated that effects on human populations extend well beyond the possibility of contacting variant Creutzfeldt–Jacob disease (vCJD) from the consumption of beef contaminated with the BSE agent (Frewer & Salter, 2002; Jasanoff, 1997). Indeed, psychosocial effects following the detection of cases of BSE in Europe evolved from public concern about human health, to loss in confidence in the ability of public authorities to protect public health (Lemyre et al., 2009a; Mitra et al., 2009).

Public reactions and behaviors were primarily determined by individuals' understanding and appraisal of the BSE situation. In the case of the BSE crisis in 2001 in Germany, individuals who perceived the threat from BSE as strong were three to four times more likely to reduce their beef consumption than people who did not perceive the threat as strong (Weitkunat et al., 2003). It is therefore appropriate that BSE risk management strategies consider not only the etiological aspects of the disease, but also public perception of the risk issue, and the way perceived risks affect public

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response. The aims of this study were to (1) examine the nature of BSE risk appraisals made by the Canadian public and (2) investigate how these appraisals relate to worry as well as to approach and avoidance coping strategies.

Risk Perception

Risk perception research demonstrated that risks do not exist “out there” in isolation of human minds; rather, risks are socially constructed and multidimensional (Slovic, 1999). Perceived risks should therefore be part of a comprehensive risk analysis cycle. There remains, however, a tendency in expert risk assessment to minimize or render abstract cultural and social norms, personal and societal values, and perceptions of risk. Studies showed that experts base their judgments on different criteria than members of the public do (Lazo et al., 2000). Lay individuals rely greatly on psychological and socioeconomic factors to evaluate risks and guide their personal risk decisions and risk behaviors (Barnett & Breakwell, 2001; Finucane et al., 2000; Siegrist & Cvetkovich, 2000). Ignoring the factors that shape public risk perception may have serious social and economic consequences in risk management, as exemplified by the negative cascade surrounding the BSE crises (commonly called mad cow disease) or the introduction of genetically modified food in Europe (Frewer et al., 2002; Lofstedt, 2006; O'Brien, 2000; Renn, 2007).

The Psychometric Paradigm of Risk Perception

The psychometric approach to studying risk perception (Fischhoff et al., 1978; Slovic, 1987) aims at identifying and classifying psychosocial factors that influence public perception of risks. This approach consists of extracting the latent structure of perceived risk characterization using factor analysis of the dimensions of a given hazard evaluated by the public (Slovic et al., 1982). Beyond documenting and

comparing the latent structure of different perceived risks, recent studies also linked different cognitive factors with worry and behavioral responses to pending threats such as terrorism in Canada (Lee & Lemyre, 2009). Such analyses are key to understanding and modelling the factors affecting risk perception of tacit or actual threats. Such analyses remain to be done in the context of BSE.

The Transactional Approach

According to the cognitive-appraisal theory of Lazarus and Folkman (1984), individual emotional and behavioral reactions to an event depend on its subjective evaluation. Lazarus and Folkman (1984) identified two main types of appraisal methods, namely, (1) the primary appraisal, which is the process of evaluating the significance of the event for oneself, and (2) the secondary appraisal, the process of assessing one's ability to cope with the consequences of the event. In the context of risk, this means (1) evaluating to what extent a certain risk represents a threat to one's health and (2) evaluating whether one has enough information on ways to mitigate the risk. This theory thus suggests that these appraisals predict the types of strategies adopted to cope with the event.

Coping efforts were described as either targeting the problem itself (problem-focused coping) or aimed at managing the emotional reaction (emotion-focused). Empirical evidence, however, demonstrated that emotions and behaviors are correlated, and that categorization into *approach* strategies versus *avoidance* strategies is more heuristic (Lemyre & Lee, 2006; Savoie, 1999). Knowing how these different strategies relate to cognitive appraisals of BSE would be useful from a risk communication and risk management perspective.

Strategic Risk Communication

Understanding the perspective of the public as a first step in risk communication forms the foundation of *strategic* risk communication.

This approach supports public policies fostering transparency in health risk communication, and addressing the issue of trust in government and in scientists (Palenchar & Heath, 2007). In particular, it speaks to some of the risk communication failures in the BSE and SARS crises. In strategic risk communication, there is a shift from “persuading” the public to consulting the public (Pfeiffer, 2006). The aim of risk communication is therefore broadened beyond the provision of information to the public, to include consideration of risk management issues such as the perceived meaning of risk messages and the adoption of healthy behaviors by the public (Palenchar & Heath, 2007). Understanding the dimensions underlying public appraisals of BSE and how they relate to affective and behavioral responses is therefore critical for informed and efficient communication with the public.

Perceptions of BSE in Canada

Most of the literature on public perceptions of the risk issues surrounding BSE documented the psychological and behavioral reactions directly following the outbreak of BSE (Lemyre et al., 2009a). There is less empirical evidence on public perceptions and anticipated responses to the *pending* threat of a new BSE crisis, which better reflects the current context in Canada. For this reason, focus groups (Lemyre et al., 2007) and a National Public Survey on Risk Perception and Risk Acceptability of Prion Disease and Food Safety in Canada (Lemyre et al., 2008) were conducted in fall of 2007.

Findings from the focus groups and the national survey both revealed that members of the general public perceived the health risk and the likelihood of occurrence of BSE crises in Canada as being relatively low (Lemyre et al., 2009b). Canadians considered it more of a threat to the economy and foreign trade than to their own health. The uncertainty about BSE expressed in the focus groups stemmed mostly from the perceived complexity of the issue and the confusion over the causes of the disease

and factors that served to protect against the risks of BSE (Markon et al., 2008). Finally, a lack of control over the risks of BSE was felt by Canadians, along with a perceived lack of information (Lemyre et al., 2009b). Testing whether these perceptions indeed constitute distinct factors affecting perceived risk is undertaken in this article.

The national survey also provided some information about Canadians’ level of worry about contracting “mad cow disease” and their coping behaviors. Although a majority of Canadians (58%) indicated no or only a little worry about contracting mad cow disease by eating tainted beef, a significant percentage (28%) still indicated being very much or extremely worried (Lemyre et al., 2009b). With respect to coping efforts, a majority of respondents reported attempting *not* to ignore the risk, but not as many reported being proactive in taking personal actions to avoid getting “mad cow disease,” such as avoiding eating processed meat from an unknown source (Lemyre et al., 2009b). There remain, however, questions about the type of perceptual factors related to those affective and behavioral reactions, which the current study seeks to answer.

STUDY 1: EMERGING RISK APPRAISALS FOR BSE AND THEIR RELATIONSHIP TO WORRY AND COPING STRATEGIES

This study aimed at identifying dimensions of cognitive appraisals of BSE among Canadians, and to test which dimensions predict worry as well as avoidant and approach coping strategies. Data from the National Public Survey on Risk Perceptions and Risk Acceptability of Prion Diseases and Food Safety (Lemyre et al., 2008) were used to accomplish this objective. The survey was funded by PrioNet Canada as a sub-component of Research Theme V: Prion Disease Risk Management. (For an overview of PrioNet’s Canada activities, see Wong et al., [2009].) Factor analyses were carried out on cognitive appraisals of BSE assessed in the survey in order to identify

the different dimensions of Canadians perceptions of BSE risks. Furthermore, regression analyses were performed to determine the extent to which the resulting perceptual factors predicted expressed emotional and behavioural reactions.

METHODS FOR STUDY 1

Participants

A nationally representative sample of 1517 adult Canadians participated in the telephone survey (Lemyre et al., 2009b). Respondents were stratified by gender (837 women and 680 men), region [Atlantic (8.2%): Newfoundland, Prince-Edward Island, Nova Scotia, and New-Brunswick; Quebec (25.6%); Ontario (35%); Prairies (6.5%): Manitoba and Saskatchewan; Alberta (10.6%); and British Columbia (13.8%)], and age group: [18 to 24 years of age (7.8%), 25–44 (38.6%), 45–64 (36.7%), and 65 years of age or older (16.5%); 0.4% refused to disclose this information]. The survey was then weighted to be fully representative of the Canadian population in accordance with the 2001 Census. The survey was available in Canada's two official languages: 1161 participants chose to answer in English and 356 responded in French.

Measures

The survey was developed based on previous surveys conducted by members of our research team, including the National Survey on Health Risk Perception and Acceptability in Canadians (Krewski et al., 1995a, 1995b, 2005), the National General Health Hazard Survey (Lemyre et al., 2006; Krewski et al., 2006, 2008, 2009), and the Canadian National Public Survey on Perceived CBRN Terrorism Threat and Preparedness (Lemyre et al., 2005a). The survey was also based on key concepts that surfaced in pilot work on risk perception (Lee et al., 2004) and in discussion groups with members of the general population on public perceptions of BSE and food-related risks (Lemyre et al., 2007). The survey posed

153 questions to assess perceptions of prion disease risks within the larger context of food safety. The survey also aimed at documenting parameters of risk acceptability for the Canadian population. Respondents provided most of their answers on a 5-point Likert-type scale (1 = not at all; 2 = a little; 3 = moderately; 4 = very much; and 5 = extremely). Ratings of 0 (don't know/no opinion) were attributed to respondents not providing an answer to the question or having no opinion about the question.

Cognitive appraisals. The cognitive evaluations included in this study were elaborated based on previous work on cognitive risk appraisal (Lee & Lemyre, 2009) and on preliminary analyses of the focus groups on public perceptions of prion disease risks (Lemyre et al., 2007; Markon et al., 2008). Seven meaningful cognitive appraisals of BSE (referred to as "mad cow disease" in the survey) were selected for analysis. The specific questions were: (1) "Do you think mad cow disease represents a risk to your health?" (2) "Do you think mad cow disease represents a risk to the health of Canadians in general?" (3) "How likely do you think it is that crises arising from mad cow disease occur in Canada?" (4) "Do you feel you have personal control over the risks of mad cow disease?" (5) "What level of uncertainty do you think there is about mad cow disease?" (6) "How much knowledge do you feel you have about mad cow disease?" (7) "Do you think the nature of mad cow disease is complex?"

Worry and coping strategies. In order to investigate affective reactions to BSE, worry about personal health related to BSE was investigated by the following question: "Do you worry about getting mad cow from eating tainted beef?" Two possible types of behavioural responses, approach and avoidance, were also assessed. The question investigating the approach coping strategy asked: "Have you taken personal actions to avoid getting mad cow disease?"; the question probing the avoidant coping strategy asked: "Do you try to ignore risks related to mad cow disease?"

Procedure

Telephone interviews averaging 30 min in length were conducted by Goss Gilroy, Inc., between October 17 and December 14, 2007. A stratified random sampling procedure with random-digit dialling was used to select the study participants. In total, 31,287 numbers were dialled. The rate of contact was 46%, with invalid (25%) and unanswered (29%) accounting for the remainder of the calls. Completed interviews (1526, including 9 pilot interviews) corresponded to a response rate of 5% of all dialed numbers. The remaining numbers dialed represented a cooperation rate of 7% and a refusal rate of 38%, which is comparable to studies of this kind. The lists of items within sections of the survey were sequenced randomly to avoid possible order effects.

Data Analysis

Prior to data analysis, 8 multivariate outliers were removed from the data based on a Mahalanobis distance criterion of .001, leaving a total of 1509 cases. Values corresponding to don't know/no opinion were coded as missing data and were not included in the analysis, reducing the number of respondents accordingly. The decision to handle missing data by dropping cases followed Tabachnick and Fidell's recommendation (2007, p. 71) when the pattern appears random and when less than 5% from a large dataset are missing.

Exploratory factor analysis. The cognitive appraisals of BSE were first subjected to an exploratory factor analysis (EFA) prior to conducting a confirmatory factor analysis (CFA). The EFA was conducted using SPSS 17.0 for Windows, using a randomly derived subsample of approximately 50% ($n = 745$) of the respondents. The number of factors to extract was based on eigenvalues and break points of the scree plot. Since health risk perceptions are known to be correlated, principal axis factoring extraction was used with oblique rotation.

Confirmatory factor analysis. To test the results of the EFA, a CFA was performed on the remaining 764 subjects. The analysis was carried out with EQS 6.1 (Bentler, 2001). Model fit

was evaluated using indices from the Lagrange multiplier test, the χ^2 likelihood ratio statistic, the comparative fit index (CFI; Bentler, 1990), and the residual mean-square error of approximation (RMSEA). The χ^2 likelihood ratio statistic assesses the closeness between the observed covariance matrix and the fitted covariance matrix. Since this measure of fit is very sensitive to sample size, the CFI was also employed as a practical index of fit (Byrne, 1994). The CFI is based on the χ^2 statistic and is obtained from comparing the restricted model with the independence. The CFI can range from 0 to 1, with a value of at least 0.9 indicating an acceptable fit (Byrne, 1994). The RMSEA is obtained by comparing a model's lack of fit with a perfectly fitting model; adequate fit is indicated by values lower than 0.08 (Browne & Cudeck, 1993).

Regression analysis predicting worry and coping strategies. The degree to which emerging factors predicted: (1) worry, (2) taking actions to prevent getting mad cow disease, and (3) trying to ignore risk associated to mad cow disease was evaluated using sequential linear regression analyses. Demographic variables that were significant in previous analyses were included in the model as covariates.

RESULTS OF STUDY 1

Results of exploratory factor analysis. In total, 66 cases were discarded from the analysis because of missing data, leaving a final subsample of $n = 679$ for the exploratory factor analysis. The EFA was carried out using principal axis factoring extraction and oblimin rotation with listwise deletion of cases.

The freely estimated solution converged in four iterations and yielded three factors. The first factor included items reflecting perceived risk of mad cow disease for oneself and for Canadians in general, along with perceived likelihood of future crises arising from mad cow disease in Canada. This factor was interpreted as capturing the potential occurrence and consequences of mad cow disease; this is the reason why it was named *perceived impact*. The

TABLE 1. Factor Loadings and Percentage of Explained Variance Based on the Three-Factor Exploratory Analysis With Principal Axis Factoring Extraction and Oblimin Rotation of Items Assessing BSE Cognitive Appraisals

Item	F1 Perceived impact	F2 Perceived mastery	F3 Perceived intricacy
Perceived risk for Canadians	.97		
Perceived risk for oneself	.89		
Perceived likelihood	.33		
Perceived knowledge		.53	
Perceived personal control		.42	
Perceived complexity			.51
Perceived uncertainty			.39
Percent of variance explained	27.5	6.7	4.5

Note. Emerging solution using eigenvalue criterion of 1.

second factor consisted of items reflecting perceived information and personal control over the risks of mad cow disease, and was therefore called *perceived mastery*. Items capturing perceived level of uncertainty and complexity loaded to a third factor; since this factor revealed that the meaning of uncertainty in the context of BSE was understood in association with perceived complexity about the nature of mad cow disease, it was named *perceived intricacy*. Factor loadings are presented in Table 1.

Results of confirmatory factor analysis. The remaining cases were used to perform a CFA in order to test the validity of the three-factor model of cognitive appraisals of BSE. Data was examined for violation of assumptions and outliers. Small skewness and kurtosis values were observed along with a normalized Mardia's coefficient of multivariate kurtosis of 4.7, suggesting that the data were approximately normally distributed (Byrne, 1994). Eighty-one cases were excluded from the analysis because of missing data, for a final subsample of $n = 683$.

The model converged in five iterations, producing evenly distributed and small off-diagonal values in the standardized residual covariance matrix. A CFI value of 0.97 and RMSEA value of 0.077 suggested a good model fit (Byrne, 1994). Additional paths did not produce improvement to the fit indices, suggesting the three-factor model best captured Canadians perceptions of BSE. The three-factor

model with the estimate for each parameter is shown in Figure 1.

Results of regression analysis with factors. The sums of items loading on respective factors were computed to be used as variables in regression analyses predicting (1) worry, (2) taking personal actions to mitigate mad cow disease (approach coping), and (3) trying to ignore risks related to mad cow disease (avoidance coping). With the purpose of testing to what extent each of the three factors predicted the three types of reactions, a series of sequential linear regressions were performed on the full sample ($n = 1509$, with 8 multivariate outliers having been removed). Demographic variables were first entered to test if they could explain some of the variance. Gender was the only demographic variable significantly associated with worry and with approach coping. Age was also significant for avoidance coping, and was therefore entered along with gender in the first step for regressions predicting this coping strategy. Table 2 presents the standardized and unstandardized regression coefficients with the adjusted R^2 obtained for the following regressions.

Predictors of worry. Controlling for gender, the final model explained 22% of the variance of worry, with an adjusted R^2 of .22, $F(4, 1348) = 95.82, p < .001$. The relationship was mostly attributable to the unique contribution of *perceived impact* ($\beta = .47, t = 18.80, p < .001$).

Predictors of approach coping strategy. The final model predicting taking personal actions to mitigate mad cow disease explained 20% of the variance with $\Delta R^2 = .20, F(4, 1352) = 83.50, p < .001$. The most important unique factor contribution came from the cognitive appraisals of *perceived mastery* ($\beta = .38, t = 15.35, p < .001$) and, to a lesser extent, *perceived impact* ($\beta = .22, t = 8.70, p < .001$).

Predictors of avoidance coping strategy. In the last regression, predicting trying to ignore risks related to mad cow disease, once gender and age were controlled for, the final model significantly predicted 2% of the variance, with $\Delta R^2 = .02, F(5, 1345) = 5.66, p < .001$. Only *perceived intricacy* emerged as the unique

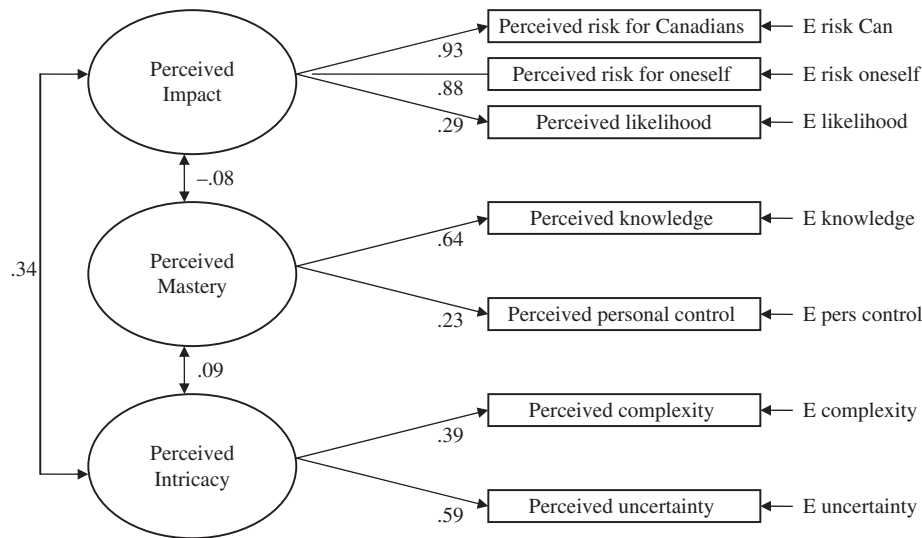


FIGURE 1. Graphical representation of the three-factor model of BSE cognitive appraisals with estimated factor loadings. E = error term for that item.

significant predictor of the avoidance coping strategy ($\beta = .09$, $t = 3.29$, $p = .001$).

Summary of the Results for Study 1

Study 1 revealed three emerging dimensions of BSE appraisals: *perceived impact*, *perceived mastery*, and *perceived intricacy*. The presence of these three factors showed that public perceptions of BSE cannot be reduced to probability of occurrence of BSE crises or perceived risk for health (i.e., *perceived impact*), because some perception of BSE are understood differently. A distinct factor captured individuals' perceived control along with perceived information, thereby shedding light on a dimension of *perceived mastery* in relation to the latent threat of BSE. Another noteworthy finding was that perceived uncertainty, often confused with probability assessments, general risk perception, or even perceived control, was related to perceived complexity. *Perceived intricacy*, including perceived uncertainty and perceived complexity, therefore appeared as a discrete factor in appraising BSE.

Furthermore, these dimensions of Canadians' cognitive appraisals all contributed to explain uniquely public reactions to BSE.

Perceived impact was an important predictor of worry, and also explained in part taking actions to mitigate mad cow disease, but did not explain trying to ignore risks. In contrast, *perceived mastery* did not predict variations in worry, but emerged as the strongest predictor of taking mitigation actions, while having no explanatory power on trying to ignore risks related to BSE. Lastly, *perceived intricacy* was unique in explaining a portion of the variance of avoidance coping, but did not emerge as significant predictor of the other reactions.

The links between perceived impact of a health hazard and worrying or taking personal actions were found in the literature on other topics (Fischhoff et al., 2004; Lee & Lemyre, 2009), as well as those between perceived mastery and adopting approach coping strategies (Bonetti et al., 2001; Rogers, 1983). However, it is somewhat surprising that uncertainty and complexity, reflected in *perceived intricacy*, did not have more unique power to predict worry and taking personal actions, given the links between uncertainty and such reactions in the literature (Lee & Lemyre, 2009).

A possible explanation was that *perceived intricacy* could possibly interact with *perceived impact* to explain worry or taking personal

TABLE 2. Dimensions of BSE Appraisals as Predictors of Worry, Approach Coping, and Avoidance Coping

Predictor	<i>B</i>	<i>SEB</i>	β	ΔR^2
Regression predicting worry				
<i>Step 1</i>				
Gender	0.19	0.08	0.06*	0.003*
<i>Step 2</i>				
Gender	0.06	0.07	0.02	
Perceived impact	0.69	0.04	0.47***	
Perceived intricacy	-0.23	0.04	-0.01	
Perceived mastery	-0.6	0.04	-0.04	0.22***
Regression predicting approach coping				
<i>Step 1</i>				
Gender	0.22	0.08	0.08	0.005**
<i>Step 2</i>				
Gender	0.19	0.07	0.06**	
Perceived impact	0.33	0.04	0.22***	
Perceived intricacy	0.04	0.04	0.02	
Perceived mastery	0.56	0.04	0.37***	0.20***
Regression predicting avoidance coping				
<i>Step 1</i>				
Gender	-0.18	0.07	-0.07*	
Age	0.02	0.01	0.07*	0.007**
<i>Step 2</i>				
Gender	-0.20	0.07	-0.08**	
Age	0.02	0.01	0.06*	
Perceived impact	0.04	0.04	0.03	
Perceived intricacy	0.14	0.04	0.09***	
Perceived mastery	0.05	0.04	0.03	0.02***

Note. Significance indicated by * $p < .05$, ** $p < .01$, *** $p < .001$; *B* and β are unstandardized and standardized regression coefficients.

actions. This postulation was based on findings from the focus groups on perceptions of BSE (Lemyre et al., 2007; Markon et al., 2008), where it was observed that only those participants who were concerned about the health risks of BSE and the probability of BSE crises occurring in Canada (i.e., perceived impact) reported being aggravated by the presence of uncertainty and complexity surrounding the issue. Study 2 was therefore conducted to test whether *perceived intricacy* could moderate the relationship between *perceived impact* and worry, as well as on taking personal actions to avoid getting mad cow disease.

STUDY 2: TESTING THE INTERACTION OF PERCEIVED INTRICACY WITH PERCEIVED IMPACT

This second study was added to clarify whether *perceived intricacy*, a dimension of importance in qualitative studies on BSE (Markon et al., 2008), exerted more of an effect on worry and taking personal actions to mitigate mad cow disease in cases where *perceived impact* of BSE was high. The same participants, measures, and procedures as in study 1 were used.

Data Analysis

Two types of analyses were chosen to address this question. First, linear sequential regression analyses testing moderation aimed to verify if the addition of a multiplication term with *perceived intricacy* and *perceived impact* would predict worry and taking personal actions to avoid mad cow disease, beyond the predictive capacity of the two factors entered independently. Second, *perceived intricacy* and *perceived impact* were both categorized by tertiles, keeping only high and low contrasted thirds, to execute analyses of variance (ANOVA) comparing reaction scores on the four types of pairs. Two-way ANOVA was initially performed to verify the presence of main effects for *perceived intricacy* and *perceived impact* on worry and taking personal actions and to investigate the existence of an interaction between the two factors, followed by contrasts controlling for multiple comparisons with the Bonferroni correction.

RESULTS OF STUDY 2

Results of regression analysis testing moderation. Sequential linear regression analysis testing both worry and taking personal actions were performed with (1) gender as a potential covariate in the first step, (2) *perceived intricacy* in the second step, (3) *perceived impact* in the third step, and (4)

the multiplication of *perceived intricacy* and *perceived impact* in the fourth step. The 3-step model including *perceived intricacy* and *perceived impact* independently predicted 21% of the variance with an adjusted R^2 of .21, $F(3, 1363) = 124.91, p < .001$; the addition of the multiplicative term in the final 4-step model (testing moderation) increased significantly the explained variance, with an adjusted R^2 of .22, $F(4, 1362) = 95.12, p < .001$. The multiplicative term had a unique contribution in the final model ($\beta = .264, t = 2.172, p < .05$). In contrast, the addition of a fourth step for the regression predicting taking personal actions did not contribute significantly explaining the residual variance.

Results of analysis of variance. To triangulate the regression results, two-way ANOVA [*perceived intricacy* (higher third/lower third) by *perceived impact* (higher third/lower third)] were performed for both reactions. The ANOVA with worry as a dependent variable revealed a main effect of *perceived impact* [$F(1, 828) = 260.21, p < .001$], but not for *perceived intricacy* [$F(1, 828) = 1.05, p = .305$]. Most importantly, however, the interaction between *perceived impact* and *perceived intricacy* was significant [$F(1, 828) = 7.82, p < .05$].

The two-way ANOVA with "taking personal actions" as the dependent variable also showed a main effect of *perceived impact* [$F(1, 828) = 44.65, p < .001$], but not of *perceived intricacy* [$F(1, 828) = .142, p = .706$]. Nor was the interaction between *perceived impact* and *perceived intricacy* significant [$F(1, 828) = .036, p = .850$].

Subsequent contrasts controlling for multiple comparisons with the Bonferroni correction were performed to verify the nature of the interaction effect between *perceived impact* and *perceived intricacy* on worry. The nature of the differences observed between the 4 groups revealed that worry was much higher for high impact/high intricacy ($M = 3.45$), followed by high impact/low intricacy ($M = 3.08$) ($p < .05$), whereas low impact/high intricacy ($M = 1.65$) did not differ from low impact/low intricacy ($M = 1.82$) ($p > .20$).

Summary of the Results for Study 2

Taken together, the regression analyses and ANOVA corroborated the existence of an interaction between *perceived intricacy* and *perceived impact* on worry, but not on taking personal actions. Results further suggested that perceiving high uncertainty and perceiving high complexity about BSE were not linked to a difference in worry when the perceived risk for health and probability of occurrence of other BSE crises were perceived as low, but were indeed associated with an increase in worry when the risk and probability were perceived as high.

GENERAL DISCUSSION

This study demonstrated that public perceptions of BSE as a new risk issue for Canada are multidimensional. *Perceived impact* includes perceived risk to health of oneself and of others as well as the overall probability of occurrence of BSE crises; however, this is only one dimension of Canadians' appraisals of BSE. *Perceived mastery* reflects knowledge regarding a risk issue and sense of personal control, while *perceived intricacy* conveys the uncertainty and complexity of the issue in the eyes of the public. These three dimensions were all differentially associated with emotional and behavioral reactions to the pending threat of BSE. *Perceived impact* was mostly related to worry and, to a lesser extent, to approach coping. *Perceived mastery* was a key predictor of approach coping. *Perceived intricacy* predicted avoidance coping, and was associated with an increase in worry when the impact of BSE was perceived as high.

The Multidimensionality of BSE Appraisals

The multiplicity of perceptual factors of health hazards has been documented on risk perception, but these are often only limited to dimensions of "dread" and "unknown" (Slovic, 1987, 2000). Current studies revealed more

nuanced distinctions, similar to the ones identified in studies on stress and coping, where perceived mastery is an important consideration (Lee & Lemyre, 2009; Sweet et al., 1999). The nature of the emerging perceptual facets of BSE was also in agreement with previous findings from the focus groups on BSE where those aspects had been acknowledged by participants (Lemyre et al., 2007). These results emphasize the relevance, articulation, and coherence of subjective evaluations as a distinct, yet complementary, portrait of risk analysis. The rigor and robustness of the factor pattern demonstrate a cogent structure, far from the labile stereotype too often depicted by scientific experts with respect to public perceptions of risk and uncertainty (Frewer et al. 2003). People do make sensible assessments of risks, within their own frames of reference. A better understanding of Canadians' perspectives on important risk issues should help to address their concerns in a more effective manner, and to develop appropriate responses to those concerns.

The Role of Perceived Risk for Health and Probability of Occurrence of BSE Crises in Explaining Worry

Perceived impact was a substantial predictor of worry about eating tainted beef, confirming the cognitive processes of evaluation described by Lee and Lemyre (2009). However, *perceived impact* explained only modestly taking actions to mitigate risks of BSE. This indicates a recurrent shortcoming of frequent risk communication strategies, especially those focusing on risks to population health. Many messages aim at creating a sense of dread, frequency, and danger; while these messages are effective in creating fear, they are not always very useful to induce protective preventive health behaviors (Ruiter et al., 2001). In contrast, our data show that proactive behavioral coping is more linked to *perceived mastery*, which reflects a sense that one feels knowledgeable about the risk and is capable of some form of personal control.

Perceived Knowledge and Control Predict the Most Being Proactive

Perceived control of BSE was linked to the perceived degree of individual knowledge about the issue. This is congruent with various investigations on coping with an uncertain pending threat (Lemyre & Lee, 2006). In such situations, personal knowledge, through provision of information about the issue, contributes to perceived mastery. In turn, results showed that *perceived mastery* was associated with a coping strategy for addressing the risks of BSE. Consequently, it follows that increasing knowledge about BSE and suggesting ways in which one can protect oneself (such as inquiring about meat origins and reading labels on food) can support proactive coping strategies, which are known to be related to well-being and reduced stress (Lemyre & Markon, 2009).

Uncertainty and Complexity: Predictors of Avoidance Coping and a Moderating Role on Worry

There exist various sources and forms of uncertainty about most risk issues. Most often, uncertainty analysis focuses on the confidence interval around the probability of occurrence of an adverse event. However, qualitative investigation of uncertainty reveals that people differentiate between sampling error associated with risk estimates, measurement error, contradiction between experts, lack of relevant data, and general scientific unknowns. From our survey on BSE, factor analyses triangulated previous qualitative work by showing that in the case of BSE, the level of uncertainty was appraised in relation to the perceived complexity of the issue, rather than to perceived probability of occurrence (Markon et al., 2008). This contrasts with results from psychometric studies performed on cognitive appraisals of terrorism, where factor loadings for items were related mostly to measures of probability (Lee & Lemyre, 2009). This supports the idea that uncertainty can have various meanings, depending on the context (Babrow, 2001; Brashers, 2001; McCormick, 2002).

In addition, findings suggest that uncertainty can have different roles. In the current context, uncertainty acted as a moderator rather than a main predictor of worry: If stakes are low, uncertainty does not matter much, but when the impact of an adverse event occurring is high, complexity and uncertainty become critical variables. Rarely has it been shown so clearly that perceived uncertainty has an indirect impact on worry, depending on the degree of perceived impact of the adverse health outcome. Moreover, our data demonstrated that perceived uncertainty, understood in relation to perceived complexity, helped to explain avoidance coping efforts. This suggests that if authorities want individuals to adopt specific behaviors or vest their trust in them, addressing perceived intricacy is key to the endeavor. This challenges the notion that risk issues are so complicated that they should be left to the experts; our data, in agreement with recent studies on risk perception (Fischhoff, 2009), suggest that this approach might be counterproductive, compared to one that acknowledges the subtleties of public perception of risk.

Limitations

Overall, our results are aligned with conclusions from previous qualitative work on BSE. The fact that the present analyses were performed on a large sample representative of the Canadian population considerably strengthens the value of this quantitative research. However, some limitations must be acknowledged. For example, there is the potential for selection bias when using random-digit dialing to recruit subjects, especially given the large number of refusals and nonanswered calls. Since the survey design was cross-sectional rather than longitudinal, causality between perceptions and behaviours cannot be inferred based on the current findings. Perceptions of risk are self-reported, as are reactions to risk; these studies were not designed to observe behavioral markers in order to document the extent to which self-reports reflect actual behaviors.

The external validity of the items used in the analysis was still exploratory and the formulation of the appraisal questions leaves rooms for personal interpretation, especially in the case of "uncertainty," a concept about which there can be some confusion. However, factor analyses, by their very algorithm, shed considerable light on the perceived meaning of such a broad concept in the context of BSE. Worry and coping strategies were also not assessed using scales of measurement that have been validated against a gold standard, and relied on single items rather than the desirable three item clusters, mostly for reasons of practicality and ecological relevance (items had to be closely related to the context of BSE). There also remains some possible variation in the meaning attributed to the item investigating "taking personal actions to avoid getting mad cow disease." In the focus groups on BSE (Lemyre et al., 2007), "taking personal actions" generally referred to avoiding processed meat from unidentified source or avoiding cuts and parts prone to carry the infection; nonetheless, the item may also have been understood as referring to less protective behaviours unlikely to mitigate the risk.

Summary of Implications for Risk Communication and Management

The present investigation has important implications for risk communication and risk management policy development. Understanding the nature of the various dimensions of BSE on which members of the public base their appraisals of BSE risk can help adapt to the particular ways in which this risk issue is conceptualized by the public, and how this differs from expert appraisals of risk. The two approaches are more complementary rather than competitive, since they aim at two sets of different outcomes: mitigating the hazard on one hand, and minimizing the ripples on the Canadian population on the other (Lemyre et al., 2005b). In our opinion, both are useful and necessary in formulating a truly

population-focused approach to the development of BSE risk management strategies.

Our findings suggest that individual proactive coping strategies about BSE-related risks, such as verifying the origin of the meat and avoiding meat parts more susceptible to carry the infection, are best predicted—or promoted—via perceived mastery rather than through perceived impact and fear alone. In order to minimize worry while promoting a positive approach to coping with risk, strategic risk communication need to focus more on disseminating knowledge and explanations of ways to protect oneself, rather than merely documenting the likelihood of occurrence of crises or limiting the content of the information provided to quantitative statements about the risks of BSE.

Our results warn that increasing public knowledge about BSE (giving more information) without addressing the perceived intricacy of the nature of BSE may lead to avoidance coping strategies such as ignoring the associated risks. Therefore, not only is more information needed, but it has to be user-friendly and comprehensible. Risk communication is as much about explaining information as it is about disseminating information. This could be especially important in case of a future outbreak of BSE, where risks would likely be perceived as higher, and, as suggested by the current study, perceived intricacy would then be associated with amplified worry. The recent experience with pandemic flu (specifically, the H1N1 virus) serves to illustrate this phenomenon (Quinn et al. 2009). In that situation, uncertainty was not only about the probability of getting infected by the virus, but also about the lack of data, the divergence between experts regarding the gravity of the infection, and the effectiveness of the vaccine and its safety (Quinn et al. 2009). All these sources of uncertainty, beyond the probability of occurrence, appear to be distinct appraisals that likely interact with perceived impact, as in the context of our study, or have other effects on perceptions which need to be studied more extensively in the context of increasingly complex global risk issues.

These studies should inspire future investigations focusing on (1) need for longitudinal designs to test causal relations between perceptions and reactions; (2) inclusion of social factors to explain more of the residual variance in the data; and (3) testing of various sources of uncertainty, such as divergence of data as compared to a lack thereof, or alternative explanations of the findings, such as influence on perceived risk fostered by activities of advocacy groups.

Conclusion

The present study of the perceived risks of BSE reveals a coherent, forceful, and robust pattern of dimensions in public appraisal of risk that are powerful differential predictors of reactions and behaviors. These dimensions of perceived risk need to be considered in both risk communication and risk management: Understanding the factors that affect public appraisal of critical risk issues might lead to more effective risk messages and greater acceptance of risk management actions that take public perception of risk into account. In the case of BSE, public appraisals of risk extend beyond the traditional analysis of risk based on the probability of an adverse event occurring and the consequences of that event. The content of public appraisals of risk needs to be considered in risk management, as it has a different bearing on public reactions and behaviors and, ultimately, on our collective well-being.

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