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Perception of Food Hazards – Exploring the Interaction of Gender and Experience in an Experimental Study *

by

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Abstract

This paper aims to analyse whether interaction effects between gender and experience have an impact on food-related risk perception. While both components have received considerable attention in the risk research literature, possible interaction effects between them have rarely been considered yet. For data generation the psychometric approach was applied. Participants in an experiment rated selected food hazards with regard to 18 risk characteristics. Responses are grouped in four sub-samples, according to gender and food-poisoning experience. In a first step, principle-component analysis reduces these ratings to two dimensions. Plotting hazard perceptions for each sub-sample in a perceptual map then allows to identify differences between the sub-samples. Finally, significant differences between sub–samples are identified with analyses of variance for single risk characteristics. The results suggest that experience does not affect risk perception directly but through interacting with gender. This effect is not marginal and partially coexists with a pure gender effect and partially is the only significant effect.

1 Introduction

In the past decade consumers in high income countries have increasingly become concerned about the safety of the food they eat. Major food scares, e.g. BSE (mad-cow disease), illegal use of growth hormones and antibiotics in animal fattening or outbreaks of food-borne pathogens, have contributed to these growing concerns. As food-safety incidents may have far reaching consequences and may thus cause drastic consumer response, governments and private businesses, but also consumer associations are confronted with the task of developing adequate risk-communication strategies. For that purpose, understanding the structure of risk perception of consumers is important. A central element in that process is identifying differences between societal groups so that risk communication can effectively target specific groups.

In the risk-research literature these issues have long been recognized. In a number of studies the dimensions of risk perception and explanatory factors, that may be utilized for differentiating between groups in society, have been analysed over a whole range of hazard domains (Barnett and Breakwell 2001; Flynn et al. 1994; Gardner and Gould 1989; Trumbo 1996). Although evidence is mixed, gender appears to be a fairly robust determinant of risk perception. Theories of social role and everyday activity are well suited for explaining this, as women usually take the role of a nurturer and care provider and are thus more concerned about health issues (Gustafson 1998). In the domain of food-safety-related hazards evidence seems to be particularly strong (Dosman et al. 2001) and particularly plausible, as women are still mostly in charge of preparing the food for the whole family. Further support comes from economic analyses of willingness-to-pay measures for risk reductions in food and of consumer response to food scares (Henson 1996; Herrmann et al. 1997).

Experience with a food poisoning, however, has received less clear support as determinant of risk perception and preferences. While Lin and Milon (1995) found that such an experience increases the willingness to pay for a risk reduction, Henson (1996) reports the opposite finding. Recent research provides evidence for the effect that a negative experience increases perceived risk. Barnett and Breakwell (2001), who included two food-consumption activities in their multi-hazard study, restrict the validity of that intuitively held view to involuntary hazards, which usually applies to food-consumption activities.

The goal of this paper is to analyse both main and interaction effects of these two components on risk perception. The data were gathered in an experimental study conducted in December 2000. Subjects were asked to rate four food related hazards with regard to 18 risk characteristics that had been applied in a previous psychometric analysis by Fife-Schaw and Rowe (1996). Three of these hazards, salmonella bacteria, BSE and genetically modified foods, were rated once. The remaining one, listeria bacteria, was rated twice, before and after having received detailed information on that hazard.

In the analysis, a two step procedure is applied. First, hazard perceptions of four sub-samples that are derived from combining gender and experience with a food poisoning, are positioned in a perceptual map. The map's dimensions are the two components that were extracted in a preceding principle-component analysis and explain most of the variance in the mean ratings of the original risk characteristics. This step differs from the standard psychometric procedure insofar as mean ratings for sub samples and not for the entire sample enter the analysis. This allows to visualize specific patterns in which segments might differ from each other in the perception of hazards. In a second step, after such patterns have been identified, individual data are used for an in-depth analysis of differences between the four segments at the level of individual risk characteristics. For that purpose multivariate analyses of variance were conducted for single risk characteristics across hazards.

The remaining paper is organized as follows. The next section describes the methodology applied in the data-generation process, from the choice of hazards and risk characteristics to a brief account of the experiment, in which the psychometric study was embedded. Section three contains the presentation of the results, where first an overview of the segment-specific perception of the selected hazards is given and then a possible interaction effect between gender and experience is explored in more detail. In the concluding section, the findings are discussed in the wider context of gender differences in risk perception.

2 Methodology and Data

2.1 Hazards, Risk Characteristics and the Psychometric Paradigm

The psychometric paradigm, as developed by Slovic, Fischhoff and colleagues (Fischhoff et al. 1978; Slovic et al. 1980), can be characterized as a rather ambitious attempt to identify a small number of universally valid dimensions of risk perception. Ideally, albeit being subject to changes over time, these dimensions are used by all groups and sorts of people, i.e. the public, for assessing a whole range of very different hazards.

Indeed, the approach has been applied in a great variety of research domains to cover fields from high-technology risks, e.g. nuclear power, to everyday hazards, such as risk from food. Consequently, it has been described as having "…assumed great importance in explaining the factors that contribute to people's judgments about risk" (Barnett and Breakwell, 2001, p. 171), as "… a landmark in research about public attitudes toward risk" (Marris et al. 1997, p. 303), and as "(p)erhaps the most popular methodological approach to risk perception,… " (Fife-Schaw and Rowe 1996, p. 488). In the same breath, however, it has been increasingly criticised in the past decade on various grounds. Detailed accounts of these have been given in a number of recent articles (Fife-Schaw and Rowe 1996 2000; Marris et al. 1997; Marris et al. 1998; Langford et al. 1999; Sjöberg 2000; Barnett and Breakwell 2001). For the present research three of the various points raised are relevant. These concern the hazards or hazard domains chosen, the hazard characteristics chosen and the level of aggregation.

Selecting Specific Food Hazards

From the very beginning of psychometric research awareness was present that the choice of hazards and risk characteristics may have a strong impact on the results, i.e. the factors identified as general forces behind risk perception (Slovic et al. 1980). This has been confirmed in various studies (Sparks and Shepherd 1994; Kraus and Slovic 1988). Frewer et al. (1998), e.g. stress that there exist large differences between technological and lifestyle hazards with respect to perception and knowledge. With respect to the specific area of risks from food, Fife-Schaw and Rowe (1996, p. 487 f.) present three logical reasons why findings from other domains cannot be readily generalized to this domain. These are the everyday dependence from food, the great number of non-risk-related factors affecting food choice and the obvious benefits associated with food consumption. Hence, they suggest "…that each hazard domain ought to be studied in its own right,…" (Fife-Schaw and Rowe 1996, p. 489).

Due to the fact that the elicitation of risk perception was embedded in an experiment (see next section), time constraints limited the number of hazards that could enter the analysis. The eventual choice of hazards reflects the attempt to meet two requirements within the experimental constraints. First, a hazard definition should be rather specific and still match the definition as perceived by the public (Sparks and Shepherd 1994; Fife-Schaw and Rowe 1996). Second, with respect to the goal of positioning the hazards in a perceptual map, the analysis should not be restricted to a limited portion of that component space a priori (Fife-Schaw and Rowe 2000, p. 170). The hazards chosen are thus:

- *listeria* bacteria
- *salmonella* bacteria
- the pathogen causing *BSE* (mad cow disease)
- *genetically modified foods* (*GMO*)

The first two hazards could have been represented in a more general category "bacteria in food", as used by Dosman et al. (2001). But this would contradict the first requirement of matching definitions, because media reports about food safety incidents usually differentiate between specific pathogens, provided the cause is known. Furthermore, consumers tend to associate different meanings of risk with specific food-borne pathogens, whose evaluations might then serve as surrogates for general food-safety preferences, as the results of a study on willingness to pay for risk reduction by Hayes et al. (1995) indicate.

Investigating pathogens alone would restrict the analysis to a very limited portion of the component space, as the results of Fife-Schaw and Rowe (1996, p. 495) indicate. Through including *genetically modified foods* it was expected to increase the component space considerably, thus meeting the second requirement and improving the basis for comparing results with previous studies.

Selecting Risk Characteristics

Obviously, the selection of risk characteristics on which the elicitation of risk perception is to be based is closely linked with the hazard domain(s) chosen for analysis. As argued by Fife-Schaw and Rowe (1996, p. 491), the crucial criterion for selecting a characteristic is that it be salient for the public's perception of risks in the specific hazard domain(s). They based their choice of characteristics on previous studies on food related risks and the results of a number of focus-group discussions. This procedure yielded 19 selected characteristics, most of which had also been used in previous studies.

Among the newly identified characteristics, one addressing the naturalness of a hazard and termed MANBLAME is particularly noteworthy. In addition to two main components resembling those termed 'serverity' and 'unknown' by Sparks and Shepherd (1994), Fife-Schaw and Rowe (1996) identified a third component that accounted for 8.4% of the variation at the aggregate level of mean ratings across individuals. This third dimension, primarily accounting for variance contributed by MANBLAME, was interpreted as reflecting "… an aspect of hazard perception that is relatively particular to food hazards" (Fife-Schaw and Rowe 1996, p. 496).

In a recent critique of the psychometric approach, however, Sjöberg (2000, pp. 4 ff.) shows that a component of "*Unnatural or Immoral Risk*" significantly improves the explanatory power of the psychometric model with the three components "newness", "dread", and "many people exposed" that were identified and confirmed in previous studies. Although discovered in the particular risk domain of nuclear power, Sjöberg (2000) generally views this component worthy of serious consideration for future research. It introduces "…notions about tampering with nature and moral questions" (Sjöberg, 2000, p. 5), which bring to mind "(o)ther current concerns such as genetic engineering and the BSE ("mad cow disease")…" Bringing the findings of both studies together, it would not seem justified to interpret a factor or characteristic such as "*Unnatural or Immoral Risk*" as particular to food hazards. The findings rather suggest that a new dimension in risk perception has generally evolved in the past decade.

The eventual choice of risk characteristics was based on the work by Fife-Schaw and Rowe (1996). 18 of their 19 characteristics were used in this study, mainly because their study is the most recent available using the psychometric approach specifically for food related risks. Furthermore, they had taken great care and effort in using focus-group discussions for actually identifying the salient characteristics for this particular hazard domain.

Considering the possible variation of risk perception in time and between cultures, the distance between their and this study appeared tolerable in both dimensions. It is quite unlikely that in the 5 years passed, major new risk dimensions or characteristics have evolved. Besides corresponding with Sjöberg's newer finding concerning the importance of an "*Unnatural or Immoral Risk*", they also discovered three more "new" risk characteristics.

The only characteristic dropped from their list was the one assessing the perceived benefits. With the somewhat unlikely exception of *genetically modified foods*, where benefits may occur to the consumer, this characteristic did not appear to make sense with the hazards analysed here, in case of *BSE* it would even sound cynical.

As in Fife-Schaw and Rowe (1996), the characteristics were rated on a five-point scale, additionally offering a "Don't know" option, which subjects were asked to use as little as possible. The list of characteristics, with their corresponding variable names and scale end points, is presented in the Appendix.

Level of Aggregation and Sample Segments

A major point of criticism is the way of data processing that has been typically applied in psychometric studies, i.e. more particular the use of mean ratings of the characteristics aggregated across individuals. As Sjöberg (2000, p. 4) points out, it was this procedure with the consequent neglect of variation between individuals that lead to the widespread evaluation that the components identified could actually explain a very large share of the variance of perceived risk. His single-risk analyses based on individual raw data revealed much lower degrees of explanatory power. Although this shortcoming has been discussed very early (e.g. Vlek and Stallen 1981; Kraus and Slovic 1988), only quite recently, with the application of multilevel statistical models to psychometric analysis, it can be addressed properly, so that "…psychometric analysis no longer needs to be confined to purely aggregate or individual level analyses" (Langford et al. 1999, p. 682). Langford et al. (1999) show how results from the purely aggregate level change, when aggregate and individual data are analysed simultaneously. Extending the application of their multilevel model to data with intermediate levels of aggregation and to multilevel factor analysis, as envisaged by them, is a promising route to future research in risk perception.

To the knowledge of the author, a practical and less demanding route to take at least part of the individual variance into account has not been presented in psychometric research yet. If risk perception differs between segments or groups of the general public, it seems justified to treat each segment's perception of a particular hazard as a different case. Applying such a practical compromise, which is certainly somewhere between purely individual and purely aggregate level analysis, has several merits. First, target-group-specific information is essential for effective risk communication. Identification of risk characteristics or dimensions of risk perceptions where differences between groups exist or not, may make an essential contribution to this goal.

Second, it may serve as an appropriate exploratory instrument, in that identification of differences between societal groups may trigger more in-depth research into newly discovered phenomena, e.g. interaction effects between the criteria on which the segmentation of the sample is based.

Third, by accounting for at least part of the variance at the individual level, it puts the findings of previous studies conducted at either the aggregate or the individual level to a test from an intermediate perspective. It helps particularly to answer the question whether previously identified components remain valid when the analysis is conducted at a less aggregate level with still a number of hazards.

Finally, from the data perspective it has the advantage that individual errors are reduced due to aggregating across individuals within groups (Kraus and Slovic 1988, p. 438). Furthermore, also due to aggregation, missing values do not lead to the exclusion of whole data sets, as is the case in analyses at the purely individual level.

On which concrete criteria the segmentation are to be based is determined by the study purpose, which also has to provide that specific groups are the proper units of analysis. Furthermore, the researcher has to take specific care in interpreting the results concerning both comparisons across groups and identification of general factors behind risk perception with the subsequent positioning of hazards in the emerging factor space. In both areas the significance of within-hazard differences between groups and the extent to which the individual variation is captured by the between-segment variation have to be considered.

In this study the segmentation of the sample is based on two dichotomous variables, gender and personal experience with a food poisoning. In various studies on risk perception and risk preferences gender has been identified as a rather robust determinant in so far that women tend to take a more pessimistic view on risk than men do. In particular they rate hazards as more risky (Dosman et al. 2001), are more likely to be amplifiers than attenuators of perceived risk (Trumbo 1996), are willing to pay more for reductions in risk of food poisoning (Henson 1996) and reduce consumption of products hit by a food scare more often (Herrmann et al. 1997).

Experience with a food poisoning, however, has been investigated less often as a determinant of risk perception and preferences in that hazard domain, and furthermore, empirical results are ambiguous. While Lin and Milon (1995) found that such an experience increases the willingness to pay for a risk reduction, Henson (1996) reports the opposite finding. Recent research across various hazard domains gives support to the expected effect that a negative experience increases perceived risk and thus concern. Results by Barnett and Breakwell (2001), however, restrict the validity of that view to involuntary hazards. Although food poisoning is not included in their analysis, two similar hazards, “Eating food containing food coloring” and “Eating food that has been genetically engineered,” were rated as involuntary by the survey respondents. As this finding, in addition to logical reasoning, supports the view that food poisoning is a hazard to which individuals subject themselves involuntarily, one may expect a significant impact on the perception of risks from food, too.

The combination of the two dichotomous variables divides the sample in four segments: men with/without a food poisoning experience, and women with/without a food poisoning experience. Within each sub-sample individual responses are aggregated to mean ratings for each risk characteristic and hazard. As each group’s perception of a hazard is treated as a different case, the number of cases entering the principle component analysis is thus quadrupled. As listeriosis was assessed both at the beginning and at the end of the experiment (see next section), a 20x18 data matrix evolved from five hazards which were each rated by four groups on 18 risk characteristics. The opportunity to directly compare the perceptions of different segments allows to identify a possibly existing interaction effect between gender and experience which would manifest itself in a systematic difference in the impact of experience between men and women. Exploring such effects has gained rather little attention yet, although knowledge of their existence might throw a very different light on effects that otherwise would be assigned to a single determinant only. Flynn et al. (1994) identified such an interaction effect for gender and race in the perception of environmental health risks, which was found to be interrelated with further factors, such as education and political orientation.

2.2 The Experimental Study

The experimental study was conducted at the University of Giessen in December 2000. Its primary purpose was to test an expected utility model with Bayesian information processing, in which consumer response to a food scare is determined by the degree of supplier differentiation with respect to reliability (Böcker and Hanf 2000, Böcker 2002). In an opening questionnaire, subjects' perceptions of the four hazards based on the ratings of the 18 risk characteristics, as described above, were elicited. In the next phases, subjects were provided with information about the specific risk factor listeria bacteria, followed by a product and market trial with two different types of cheese, and then were provided with information about a hypothetical food-safety incident, after which subjects were asked indirectly to judge the particular retailer previously described to be involved in that incident. In a final questionnaire subjects were then asked to rate the 18 characteristics for listeriosis again. With five hazards – BSE, GM food, salmonella, and two times listeria – being rated by four different groups, 20 cases for the subsequent principle component analysis emerged.

The following details were presented to the subjects as part of more comprehensive information about listeria and the hypothetical food-safety incident. First, the key scientific information was presented to all subjects alike and is summarized in Figure 1.

Figure 1: Description of listeriosis

Occurrence
- ubiquitous bacteria, to be found in soil, many foods and living animals - one variety, *L. monocytogenes*, mainly responsible for human illness - contamination rates for raw milk cheese 5 to 15 times higher than those of cheese made from pasteurized milk - contamination often due to cross contamination after sterilization of foods
Infection, disease and vulnerable groups
- infection mainly through intake of contaminated food, but also skin contact - mainly affects the pregnant uterus, the central nervous system and the blood stream, with severity ranging from skin irritation, flu-like illness, vomiting and diarrhoea to meningitis, stillbirth and death - low incidence of human listeriosis (2-15 cases per million inhabitants), but high case-fatality rate of about 30% - vulnerable groups are pregnant women, unborn and little children, the elderly and immunocompromised people
Major outbreaks due to contaminated food in Europe and North America
- 21 outbreaks reported, varying in their impact between 4 and 750 cases, with a maximum of 85 deaths (France 1992) - no major outbreak reported for Germany, where 200 people are estimated to become seriously ill annually from sporadic listeriosis

Source: EC (2001)

Information about the hypothetical listeriosis incident in cheese varied between subjects in order to create four treatment levels, i.e. three different degrees of supplier differentiation and one control group without differentiation (Böcker 2002, 38). For describing distinct types of suppliers that differ in reliability, information about a hypothetical trade association of specialty-cheese importers was given to the subjects. The majority of this association's member firms were certified for "outstanding quality." The share of listeria contaminated samples in a quality control study served as indicator of reliability and was reported for certified member firms and non-member firms. The information provided to the subjects in the first three treatments only varied with respect to the exact figures of these shares. The control group differed from these three treatments in that the quality study did not differentiate between supplier types. Instead the results were reported to be representative of the entire market and showed a reduction in shares of listeria-contaminated samples in recent years.

Since that information had been provided before the final questionnaire, it might have had an impact on the second rating of listeriosis. Thus, it is necessary to check for a biased distribution of individuals from the four segments across treatments. A contingency analysis yielded a significance level of 0.275 for rejecting the null hypothesis that there is no interdependency between the two variables. So with some justification, information varying with the experimental treatments can be excluded as a determinant of differences between segments.

2.3 Describing the Sample

100 subjects participated in the experiment, 42 male and 58 female. The great majority (94) were students. Average age was 24, ranging from 19 to 44. Participation in household shopping is large, as 59 stated to mainly do the shopping themselves and a further 35 to do it together with another person. 29 subjects stated to consume cheese daily and 61 several times a week, so that for 90% of the sample cheese is a regular and essential part of the diet. 25 subjects stated that they had experienced a food poisoning before, while 22 reported such an incident for a close friend or a family member. As there was some overlap, in total there were 41 subjects who had been affected by a food poisoning – either directly or indirectly. Four sub-samples evolved from combining such an experience with gender: 23 men without, 18 with such an experience, 34 women without and 23 with such an experience. These segments did not differ significantly with respect to any of the socio-demographic variables or to variables relating to consumption behaviour.

3 Results

3.1 Segment specific positioning of hazards in component space

Investigating the patterns of missing data, 89% of which can be assigned to the use of the “Don’t know” option, provides information about how familiar subjects are with the different hazards (Fife-Schaw and Rowe 1996, p. 497). With a response rate of 59% and only 28 subjects answering all 18 items, listeria in the first round was by far the least known hazard. Furthermore, the response rate varied greatly between single risk characteristics, i.e. from 45% to 76%. As would be expected, this changed after information had been administered. With a response rate of 99% and 90 complete questionnaires, subjects were now least unsure about listeria. The corresponding response rate and completeness figures for the remaining hazards were 96% and 72 for GMO’s, 96% and 74 for BSE, and 97% and 87 for salmonella bacteria.

The data constituted by the mean ratings of a segment for each of the 18 characteristics and each of the five hazards were subjected to principle-component analysis. Four components were extracted. Conducting a varimax rotation yielded the component loadings presented in Table 1. The composition of the component found here deviates from those reported in previous studies on the hazard domain of risk in food (Fife-Schaw and Rowe 1996; Sparks and Shepherd 1994). The isolated role of CONTROL, which mainly constitutes the fourth component, is striking. The third component consists of characteristics relating to the familiarity with a hazard: The perception of a hazard to be commonplace and easy to identify in foods is associated with the individual being responsible for protection from harm. Previous studies did not yield comparable components. Some consistency with previous studies is, however, found in the second component, which embodies elements of severity and personal threat. It resembles the strongest component found by Fife-Schaw and Rowe (1996) which "…seems to tap something similar to Sparks and Shepherd's (1994) "severity" component." (p. 495) but also includes a number of characteristics which are represented by the first component identified here. These characteristics touch societal dimensions of the severity of a hazard, such as vulnerable groups, future generations, the costliness of avoiding harm and the degree to which man is to blame. The remaining characteristics of the first component – with the exception of DELAYEFF - also clearly relate to societal aspects of risk, such as the knowledge of science or the adequacy of consumer-protection regulation, thus differentiating it from the second 'personal threat' component. Rather strong overlap between the two components is found for the characteristics MANYHARM and WORRY. So, as a result of this study it can be noted that subjects appear to differentiate between a societal dimension and a personal risk dimension in the perception of food-borne hazards.

It is, however, not the primary goal of this article to compare results with previous studies. There are too many sources of deviations, such as the level of aggregation, composition of the sample, or the limited number of hazards investigated, whose impacts cannot be identified. Instead, the focus of this analysis is on identifying differences between segments, which are going to be visualized in the next step. For that purpose, a second principle-component analysis was conducted with a reduced set of characteristics, dropping those that loaded most highly on the third or fourth component. Since the analysis – as expected – only yielded two components, the two-dimensional plot of perceived hazards is then actually based on two-dimensional data. If the plot were based on the data of the two strongest components from the original analysis, both factor loadings and hazard positions would be biased in the sense that both are influenced by the presence of the third and fourth component, which are not represented in the plot at all. This bias would be rather severe, as the two strongest components account for "only" 60.7% of the variance, while the two remaining components account for 28.3%. Furthermore, by dropping the four characteristics, the KMO statistics was raised to an acceptable level of 0.653. Overall, the factor loadings have not been changed to a great extent, as can be seen from the last two columns in Table 1.

Table 1: Results of principle-component analyses of psychometric variables[a]

	Components[b]					
Variable	1	2	3	4	***1a***	***2a***
SCIKNOW	-.97				***-.96***	
VULNGPS	-.93				***-.87***	
FUTGEN	.89				***.90***	
DELAYEFF	.86				***.98***	
BADREGS	.82				***.77***	
MANBLAME	.82			.51	***.93***	
COSTLY	.64				***.79***	
MANYHARM	-.58	.66			***-.65***	***.68***
WORRY	.56	.75			***.62***	***.74***
LIKELY		.94				***.92***
BIGQUANT		-.91				***-.92***
AWARE		.83				***.82***
SERIOUS		.73				***.77***
MANYEAT		-.70	.54			***-.75***
EASYTELL			.88			
COMMON			.83			
OTHERESP			-.72			
CONTROL				.87		
Percentage total variance	34.2	26.5	15.9	12.4	***48.5***	***32.8***
Eigenvalues	6.16	4.76	2.86	2.24	***6.78***	***4.59***

[a] *Components were selected according to the Kaiser criterion, i.e. eigenvalue ≥ 1. Only loadings above |0.5| are listed. KMO statistics for the principle component analysis with 18 (14) variables = .324 (.653).*
[b] *Components labelled 1 through 4 were extracted from an analysis with all 18 characteristics, while components 1a and 2a were extracted from an analysis with 14 characteristics represented by the two components which had covered the largest shares of variance in the original analysis.*

When positioning hazard perceptions of the four segments in "risk" space, the picture in Figure 2 evolves, which also includes factor loadings of the characteristics as vectors. The four hazards are each positioned in a different quadrant, as indicated by the correspondingly labeled rectangles, which contain the positions of each segment for each hazard. The lack of overlap between rectangles nourishes the conjecture that correlations between variables and components are mainly determined by between-hazard variation rather than between-segment variation. Fife-Schaw and Rowe (2000) stress the possibility of introducing substantial method-induced error when applying the psychometric approach for identifying differences between groups or changes over time. As this error would primarily be caused by inconsistencies in question orderings and formulations, it is not an issue here, as all subjects answered the same questions in the same ordering. Biases due to changes in the risk perception over time are not relevant here either, as the experimental study was completed within three days. But still one has to be aware of "…the danger of over-interpreting minor differences in the plots…" (Fife-Schaw and Rowe 2000, p. 174) when describing the following regularities that emerge from the plot:

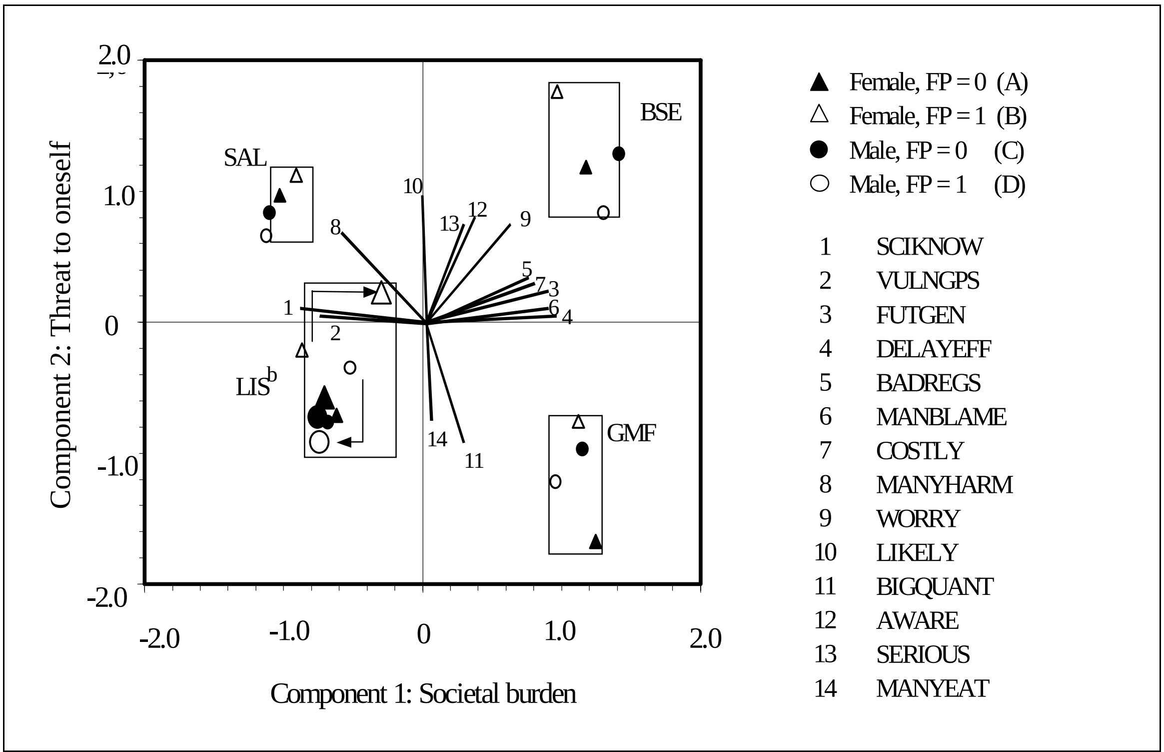
a) Differences in perception between segments are quite small for the well known hazard salmonella bacteria, while they are considerable for the remaining hazards.

b) Variation between segments is larger in the second component representing elements of personal threat than in the first, which represents the societal dimension of risk perception.

c) For a given hazard, men and women without personal experience of a food poisoning tend to differ a lot less in their perception than men and women with such an experience, with genetically altered food being the only exception.

d) Concerning the second component, there is a difference between men and women in the impact of the personal experience with a food poisoning. For a given hazard, men – with the exception of listeria prior to information – perceive the risk as less a threat, while women always perceive it as a greater threat, as compared to the corresponding 'control' groups without a food poisoning experience.

Figure 2: Plot of segment specific food hazard perceptions in component space[a]



[a] Segmentation criteria are gender and personal experience with food poisoning: FP = 0 (1) indicates the absence (presence) of such an experience.
[b] For listeria the segment marks of the coordinates from the final questionnaire are increased in size.

For listeria the impact of the information provided in the experiment on the different segments is particularly noteworthy. While the information hardly changed the position of men without food-poisoning experience, it had a rather strong impact on men with such an experience: As indicated by the arrow pointing downward and to the left, they changed to a "position" of less personal threat and smaller societal burden. As indicated by the arrow pointing upward and to the right, the experience impact is exactly the opposite for women: While the information did not have a considerable effect on the perception of female subjects without food-poisoning experience, females with such an experience perceived the particular hazard listeriosis to be of larger personal threat and to be larger in its societal burden.

Drawing these findings together, it appears that personal experience with a food poisoning has opposite impacts on men and women. Male subjects tend to dread hazards less than the control group of males without such an experience, while the opposite is observed for female subjects: The food-poisoning experience appears to make women dread a hazard more. This hypothesized interaction effect is investigated in more detail in the next section. There, the research focus changes from identifying significant between-group differences in risk space to identifying the causes of these differences at the level of single risk characteristics. This perspective may, in turn, produce specific information for explaining group differences for concrete target-group-oriented risk communication.

3.2 Investigating an Interaction Effect between Gender and Experience

The analysis so far has remained at the aggregate level of segment means, thus not accounting for variation in responses at the individual level. In order to check whether and where the interaction effect suggested by the principle-component analysis in Figure 2 is supported at the individual level, a MANOVA was conducted for each risk characteristic across hazards. Identification of a significant effect for the multivariate test in conjunction with more than one significant result for the ANOVA simultaneously conducted for the four single hazards would hint at a systematic effect across hazards. The MANOVA results are given in Table 2. The listeria ratings from the opening questionnaire were omitted mainly for technical reasons. As pointed out above, the novelty of this hazard for many subjects reduced the number of valid responses considerably and simultaneously caused a large variation in the number of valid responses between risk characteristics. Including those data in the analysis would thus have lead to very small sub-samples and introduced additional bias due to the large variation of sample composition across risk characteristics. Finally, considering both ratings of listeria in one analysis would demand to treat them as repeated measurements rather than independent hazards.

Furthermore, variables found to load most highly on the third and fourth component (s. Table 1) were not included, as they had not been included in the preceding principle-component analysis either. For none of the thus omitted four variables, the multivariate tests yielded a significance level of less than 25% for the interaction effect, or of less than 15% for the main effects. So omitting them from analysis does not lead to a loss of information with respect to identifying group differences.

Of the 14 analyses in total, the multivariate tests yielded three significant interaction effects for $\alpha \leq 5\%$. A binomial test of this count against the given level of significance rejects the null hypothesis that interaction effects do not exist and thus three out of 14 identified cases is a product of mere chance at $\alpha = 3\%$.

Table 2: Identification of interaction and main effects: results of MANOVA[a]

Variables	N	ANOVA for single hazards: Significant interaction effects[b]				Significance levels for multivariate tests		
		Salmo-nella	GM food	BSE	Listeria	Inter-action	Gender	Food poisoning
VULNGPS	90	***	***	*		.004	.087	.186
FUTGEN	90			*		.252	.025	.828
BADREGS	94		*		**	.068	.054	.336
MANBLAME	95	**		*		.038	.361	.974
MANYHARM	84		*			.114	.042	.223
WORRY	96				**	.218	.003	.820
LIKELY	94		*	***	**	.018	.014	.207
BIGQUANT	85				*	.179	.056	.982
SERIOUS	89			**		.170	.969	.436

[a] *Results are shown for risk characteristics loading most highly on the first and second component with:*
- a significance level of 5% for at least one of the multivariate tests of main and interaction effects or
- at least one ANOVA result with a significance level of 10% indicating the presence of an interaction effect for a single hazard.
[b] **, **, *** indicate significance levels of 10%, 5%, and 1%, respectively.*

The distribution of the significant effects across variables and hazards in Table 2 does not render a simple interpretation of the results, but two general findings can be extracted. First, the lack of evidence for a food poisoning main effect and the simultaneous evidence in favour of an interaction effect suggest that experience in itself does not have a direct impact on risk perception but is moderated by other factors, such as gender in this case. Secondly, the gender main effect is most prevalent across risk characteristics. For $\alpha \leq$ 5% four tests, or 29% are significant, for $\alpha \leq$ 10% it is seven tests, or 50%.

Two more specific findings apply to the ANOVA results across risk characteristics and hazards. Firstly, the interaction effect is most prevalent for VULNGPS and LIKELY. As Figure 2 and Figure 4 demonstrate, interaction effects are always characterized by significant differences between the two female groups. More specifically, a food-poisoning experience seems to increase women's concern for vulnerable groups and their perceived own susceptibility to the three hazards. For men, the contrary holds or, as is the case for the two ordinal interaction effects, no significant difference between the two groups is observed. Taking into account that women are mostly in charge of household shopping and food preparation, these interaction effects may contribute to explaining actual consumer response to a food scare: As vulnerable groups, especially children, are perceived to be more at risk and as the subjective likelihood of being harmed increases, the response should become more drastic. Furthermore, it is interesting to note that the interaction effect affects the perceived personal risk from hazards such as genetically altered foods and BSE, which cannot be associated with the negative outcomes of a food poisoning typically caused by food-borne pathogens.

Figure 3: Significant Interaction Effects for Risk Characteristic VULNGPS

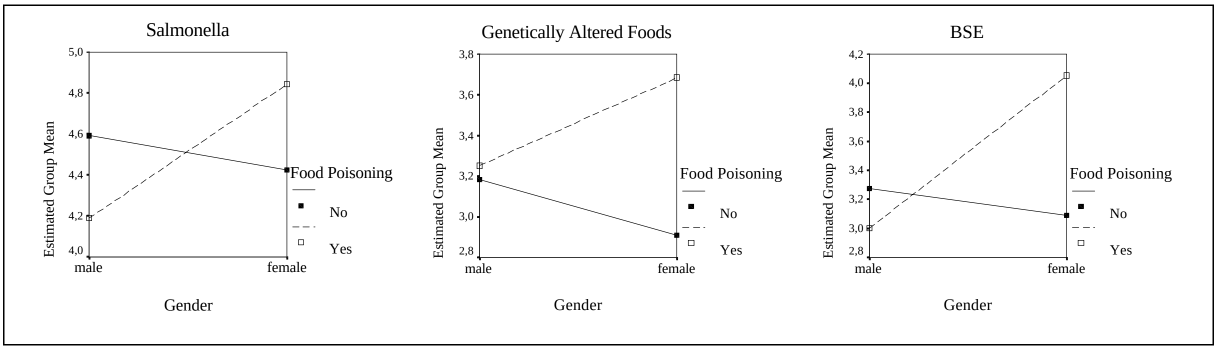
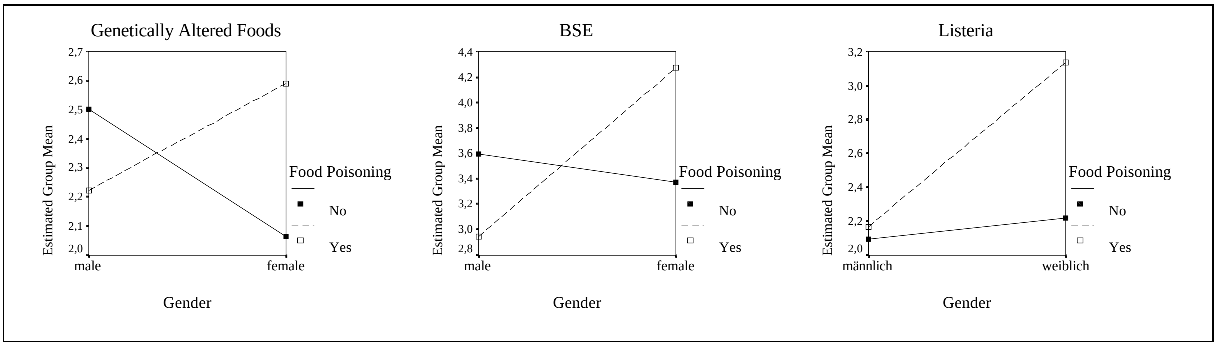


Figure 4: Significant Interaction Effects for Risk Characteristic LIKELY



Second, two more risk characteristics exhibit more than one significant ANOVA effect: BADREGS and MANBLAME. For each characteristic two effects with the same pattern are observed. The food poisoning-experience makes women (men) judge a hazard more pessimistic (optimistic). I.e., women with that experience perceive consumer-protection laws and regulation to be less adequate and the risks from the hazards to be more the fault of mankind than women without that experience do, while the opposite holds for men.

4 Discussion

Due to sample size and structure there are obvious limits when trying to generalize the findings of the preceding analysis. Therefore, the discussion in this section explores the implications of these findings further and raises some specific points for future research instead.

Summarizing the previous section, there seems no obvious and straightforward pattern to be identified in which an interaction effect between gender and a food-poisoning experience would occur across hazards and risk characteristics. There are, however, a number of noteworthy findings that shed light on a possible interaction between the two factors that will now be discussed, taking the issue of gender differences as a starting point.

Table 2 shows that gender is the most significant factor in explaining differences between groups, but it does not reveal the direction of these differences. For that purpose, group means have to be compared. In all cases where a significant gender effect has been identified, the direction is the same: women rate the corresponding risk characteristic more pessimistically than men do, i.e. they perceive a greater particular risk. This finding is consistent with the results of previous studies. An explanation that seems particularly plausible for this hazard domain has to be seen within the context of social roles and everyday activities. "It holds that the role as nurturer and care provider, a role largely performed by women, is associated with concern about health and safety issues… (and) …seems to reflect a greater overall concern about the well-being of others,.." (Gustafson 1998, p. 807).

In addition to this well documented gender effect, this study simultaneously takes the interaction with an experience effect into account. A significant interaction effect was identified for several risk characteristics, and it is not marginal when compared to the significance levels and number of occurrences of the gender main effect. The practical relevance of the interaction effect receives further support, when the above MANOVA results are compared to those of a one-factorial MANOVA for an isolated analysis of gender and food-poisoning experience. As Table 3 reveals for those four risk characteristics for which the interaction effect was described as most significant, accounting for interaction carves out the gender main effect more sharply. In three cases the isolated analysis would considerably decrease the significance level of gender. In the remaining case the significance level is enhanced, but would remain far from an acceptable level for rejecting the null hypothesis. For the food-poisoning factor the consequence of accounting for an interaction effect is quite similar to the exceptional gender case just described: In all four cases the level of significance is enhanced but remains clear of a level conventionally accepted for rejecting the null hypothesis. For both gender and food poisoning, the remaining ten risk characteristics did not reveal any significant changes.

Table 3: Significance levels for gender and food poisoning experience factors in simultaneous[a] and isolated MANOVA

Variables	*Inter-action*	Gender		Food Poisoning	
		Simultan.	Isolated	*Simultan.*	Isolated
VULNGPS	*.004*	*.087*	.377	*.186*	.139
LIKELY	*.018*	*.014*	.039	*.207*	.162
MANBLAME	*.038*	*.361*	.280	*.974*	.918
BADREGS	*.068*	*.054*	.122	*.336*	.312

[a] *Results of the bi-factorial MANOVA, including the interaction effect, are marked in Italics.*

The analysis has identified differences between groups in the perception of given hazards. According to Gustafson (1998, p. 807) this is only one of three perspectives on gender differences, and thus on differences between societal groups more generally. Where appropriate, the other two perspectives, investigating a) whether the “same” risks mean something different to different groups and b) whether different groups perceive different risks to be relevant, will have to be considered more closely in future research,.

Beyond identifying such differences at less aggregate levels, accounting for a possible interaction effect may furthermore contribute to explaining gender differences, an issue that has so far mainly been neglected in psychometric studies of risk perception (Gustafson 1998, p. 807). As suggested by the principle-component analysis (Figure 2), there are far less differences between men and women without food poisoning experience then between men and women with that experience. This is confirmed by the number of significant group mean differences across the 14 characteristics and 4 hazards analysed in the previous section. Applying a t-test to the 56 comparisons in total, only two (seven) were found to be significant at the 5% (10%) significance level for men and women without food poisoning. The null hypothesis that actually no difference exists between the two groups can thus not be rejected ($\chi^2 < 0.4$ and $p > 0.5$ in both cases). Contrary, for men and women with a food poisoning experience, twelve (seventeen) significant differences in group means were identified for $\alpha < 5\%$ (10%), leading to the rejection of the null hypothesis for significance levels of less than 0.1% ($\chi^2 > 25$ in both cases).

These results lend support to the view that gender differences are socially and thus biographically produced rather than merely biologically based (Gustafson 1998, p. 809). Experience may thus help to explain the evolution or intensification of gender differences through the interaction of both factors, as was identified here. Furthermore and finally, if that interaction effect was to be confirmed on a larger and more representative scale as a significant determinant of risk perception, the experience of a food poisoning may serve as a good starting point for making risk communication more target group oriented.

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Appendix: List of risk characteristic variables used for ratings of hazards

Likely: How likely is it that your health will be damaged by eating or drinking the following things? (Not likely at all, to Extremely likely)

Manyharm: How many people in Germany are likely to have their health damaged by the following things? (No people, to Very many people)

Aware: How aware are people who eat or drink the following things of any potential risks to their health? (Not at all, to Fully aware)

Badregs: How adequate are laws and regulation in protecting people from any health risk associated with the following things? (Perfectly adequate, to Totally inadequate)

Bigquant: Is the potential harm to your health from the following things dependent upon how much of them you eat or drink? (Harmful in very small quantities, to Not harmful at all)

Control: How much control do people have over whether they eat or drink the following things? (No control, to Total control)

Delayeff: Would any damage to your health from the following things be immediately apparent or become apparent at a later date? (Immediately apparent, to After long time)

Manblame: To what extent are the risks to your health from the following things natural or the fault of mankind? (Natural risks, to Man is entirely to blame)

Serious: How seriously you think the following things may harm your health? (Not seriously at all, to Extremely seriously)

Costly: How costly, in terms of time, effort and money would it be for people to avoid potential health risks associated with the following things? (Not costly at all, to Extremely costly)

Worry: How worried are you about potential risks associated with the following things? (Not worried at all, to Extremely worried)

Manyeat: How many people in Germany eat or drink the following things? (Nobody, to Everybody)

Sciknow: How much do you think scientists know about any potential risks from eating or drinking the following things? (Nothing at all, to Everything)

Easytell: How easy is it for you to tell if foods like those listed below contain a risk to your health? (Impossible to tell, to You can always tell)

Otheresp: To what extent is it your responsibility, or the responsibility of others (e.g. government or producers), to protect you from harm from the following things? (Totally my responsibility, to Totally the responsibility of others)

Futgen: How serious are the following things likely to be for the health of future generations? (Not serious at all, to Extremely serious)

Common: How common are the following things in Germany? (Extremely rare, to Extremely common)

Vulngps: To what extent are certain vulnerable groups of people (children, the elderly, and those who are already ill) at greater or lesser risk, from the following things, than the average person? (At lot less risk, to At lot more risk)

Source: Fife-Shaw and Rowe (1996, p. 498 ff.)

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